Attachment E

PROJECT MANUAL

University of Kentucky

HEALTHY KENTUCKY RESEARCH BUILDING

FOR BID & PERMIT

Construct Research Building (Fit-Up Two Wet Labs)

August 25, 2020
UK Project Number 2538.0
CA Project Number 514-5350-00

HGA + CHAMPLIN ARCHITECTURE

TABLE OF CONTENTS

DIVISION 28 – ELECTRONIC SAFETY AND SECURITY

END OF TABLE OF CONTENTS

SECTION 017419 - CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes administrative and procedural requirements for the following:
   1. Recycling nonhazardous demolition and construction waste.
   2. Disposing of nonhazardous demolition and construction waste.

B. Related Requirements:
   1. Section 024119 "Selective Demolition" for disposition of waste resulting from partial demolition of buildings, structures, and site improvements.
   2. Section 042000 "Unit Masonry" for disposal requirements for masonry waste.
   3. Section 311000 "Site Clearing" for disposition of waste resulting from site clearing and removal of above- and below-grade improvements.

1.3 DEFINITIONS

A. Construction Waste: Building and site improvement materials and other solid waste resulting from construction, remodeling, renovation, or repair operations. Construction waste includes packaging.

B. Demolition Waste: Building and site improvement materials resulting from demolition or selective demolition operations.

C. Disposal: Removal off-site of demolition and construction waste and subsequent sale, recycling, reuse, or deposit in landfill or incinerator acceptable to authorities having jurisdiction.

D. Recycle: Recovery of demolition or construction waste for subsequent processing in preparation for reuse.

E. Salvage: Recovery of demolition or construction waste and subsequent sale or reuse in another facility.

F. Salvage and Reuse: Recovery of demolition or construction waste and subsequent incorporation into the Work.

1.4 PERFORMANCE REQUIREMENTS

A. General: Achieve end-of-Project rates for salvage/recycling of 75 percent by weight of total non-hazardous solid waste generated by the Work. Practice efficient waste management in the use

of materials in the course of the Work. Use all reasonable means to divert construction and demolition waste from landfills and incinerators. Facilitate recycling and salvage of materials**.**

1.5 ACTION SUBMITTALS

A. Waste Management Plan: Submit plan within 30 days of date established for the Notice to Proceed.

1.6 INFORMATIONAL SUBMITTALS

A. Waste Reduction Progress Reports: Concurrent with each Application for Payment, submit report. Use Construction Waste Management Tracking Worksheet at the end of this Section Include the following information:

1. Material category.
2. Generation point of waste.
3. Total quantity of waste in tons (tonnes).
4. Quantity of waste salvaged, both estimated and actual in tons (tonnes).
5. Quantity of waste recycled, both estimated and actual in tons (tonnes).
6. Total quantity of waste recovered (salvaged plus recycled) in tons (tonnes).
7. Total quantity of waste recovered (salvaged plus recycled) as a percentage of total waste.

B. Waste Reduction Calculations: Before request for Substantial Completion, submit calculated end-of-Project rates for salvage, recycling, and disposal as a percentage of total waste generated by the Work.

C. Records of Donations: Indicate receipt and acceptance of salvageable waste donated to individuals and organizations. Indicate whether organization is tax exempt.

D. Records of Sales: Indicate receipt and acceptance of salvageable waste sold to individuals and organizations. Indicate whether organization is tax exempt.

E. Recycling and Processing Facility Records: Indicate receipt and acceptance of recyclable waste by recycling and processing facilities licensed to accept them. Include manifests, weight tickets, receipts, and invoices.

F. Landfill and Incinerator Disposal Records: Indicate receipt and acceptance of waste by landfills and incinerator facilities licensed to accept them. Include manifests, weight tickets, receipts, and invoices.

G. LEED Submittal: Submit documentation to USGBC, signed by Contractor, tabulating total waste material, quantities diverted and means by which it is diverted, and statement that requirements for the credit have been met. Respond to questions and requests from USGBC regarding construction waste management and disposal until the USGBC has made its determination on the Project's LEED certification application. Document correspondence with USGBC as informational submittals.

H. Qualification Data: For waste management coordinator and refrigerant recovery technician.

I. Statement of Refrigerant Recovery: Signed by refrigerant recovery technician responsible for recovering refrigerant, stating that all refrigerant that was present was recovered and that

recovery was performed according to EPA regulations. Include name and address of technician and date refrigerant was recovered.

1.7 QUALITY ASSURANCE

A. Waste Management Coordinator Qualifications: Experienced firm, with a record of successful waste management coordination of projects with similar requirements.

1. Firm employs a LEED-Accredited Professional, certified by the USGBC, as waste management coordinator.
2. Waste management coordinator may also serve as LEED coordinator.

B. Refrigerant Recovery Technician Qualifications: Certified by EPA-approved certification program.

C. Regulatory Requirements: Comply with hauling and disposal regulations of authorities having jurisdiction.

D. Waste Management Conference: Conduct conference at Project site to comply with requirements in Section 013100 "Project Management and Coordination." Review methods and procedures related to waste management including, but not limited to, the following:

1. Review and discuss waste management plan including responsibilities of waste management coordinator.
2. Review requirements for documenting quantities of each type of waste and its disposition.
3. Review and finalize procedures for materials separation and verify availability of containers and bins needed to avoid delays.
4. Review procedures for periodic waste collection and transportation to recycling and disposal facilities.
5. Review waste management requirements for each trade.

1.8 WASTE MANAGEMENT PLAN

A. General: Develop a waste management plan according to ASTM E 1609 and requirements in this Section. Plan shall consist of waste identification, waste reduction work plan, and cost/revenue analysis. Indicate quantities by weight or volume, but use same units of measure throughout waste management plan.

B. Waste Identification: Indicate anticipated types and quantities of demolition site-clearing and construction waste generated by the Work. Include estimated quantities and assumptions for estimates.

C. Waste Reduction Work Plan: List each type of waste and whether it will be salvaged, recycled, or disposed of in landfill or incinerator. Include points of waste generation, total quantity of each type of waste, quantity for each means of recovery, and handling and transportation procedures.

1. Salvaged Materials for Reuse: For materials that will be salvaged and reused in this Project, describe methods for preparing salvaged materials before incorporation into the Work.

2. Salvaged Materials for Sale: For materials that will be sold to individuals and organizations, include list of their names, addresses, and telephone numbers.
3. Salvaged Materials for Donation: For materials that will be donated to individuals and organizations, include list of their names, addresses, and telephone numbers.
4. Recycled Materials: Include list of local receivers and processors and type of recycled materials each will accept. Include names, addresses, and telephone numbers.
5. Disposed Materials: Indicate how and where materials will be disposed of. Include name, address, and telephone number of each landfill and incinerator facility.
6. Handling and Transportation Procedures: Include method that will be used for separating recyclable waste including sizes of containers, container labeling, and designated location where materials separation will be performed.

D. Cost/Revenue Analysis: Indicate total cost of waste disposal as if there was no waste management plan and net additional cost or net savings resulting from implementing waste management plan. Include the following:

1. Total quantity of waste.
2. Estimated cost of disposal (cost per unit). Include hauling and tipping fees and cost of collection containers for each type of waste.
3. Total cost of disposal (with no waste management).
4. Revenue from salvaged materials.
5. Revenue from recycled materials.
6. Savings in hauling and tipping fees by donating materials.
7. Savings in hauling and tipping fees that are avoided.
8. Handling and transportation costs. Include cost of collection containers for each type of waste.
9. Net additional cost or net savings from waste management plan.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 PLAN IMPLEMENTATION

A. General: Implement approved waste management plan. Provide handling, containers, storage, signage, transportation, and other items as required to implement waste management plan during the entire duration of the Contract.

1. Comply with operation, termination, and removal requirements in Section 015000 "Temporary Facilities and Controls."

B. Waste Management Coordinator: Engage a waste management coordinator to be responsible for implementing, monitoring, and reporting status of waste management work plan. Coordinator shall be present at Project site full time for duration of Project.

C. Training: Train workers, subcontractors, and suppliers on proper waste management procedures, as appropriate for the Work.

1. Distribute waste management plan to everyone concerned within three days of submittal return.

2. Distribute waste management plan to entities when they first begin work on-site. Review plan procedures and locations established for salvage, recycling, and disposal.

D. Site Access and Temporary Controls: Conduct waste management operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.

1. Designate and label specific areas on Project site necessary for separating materials that are to be salvaged, recycled, reused, donated, and sold.
2. Comply with Section 015000 "Temporary Facilities and Controls" for controlling dust and dirt, environmental protection, and noise control.

3.2 RECYCLING DEMOLITION AND CONSTRUCTION WASTE, GENERAL

A. General: Recycle paper and beverage containers used by on-site workers.

B. Preparation of Waste: Prepare and maintain recyclable waste materials according to recycling or reuse facility requirements. Maintain materials free of dirt, adhesives, solvents, petroleum contamination, and other substances deleterious to the recycling process.

C. Procedures: Separate recyclable waste from other waste materials, trash, and debris. Separate recyclable waste by type at Project site to the maximum extent practical according to approved construction waste management plan.

1. Provide appropriately marked containers or bins for controlling recyclable waste until removed from Project site. Include list of acceptable and unacceptable materials at each container and bin.

    a. Inspect containers and bins for contamination and remove contaminated materials if found.

2. Stockpile processed materials on-site without intermixing with other materials. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.
3. Stockpile materials away from construction area. Do not store within drip line of remaining trees.
4. Store components off the ground and protect from the weather.
5. Remove recyclable waste from Owner's property and transport to recycling receiver or processor.

3.3 RECYCLING DEMOLITION WASTE

A. Asphalt Paving: Grind asphalt to maximum 1-1/2-inch (38-mm) size.

1. Crush asphaltic concrete paving and screen to comply with requirements in Section 312000 "Earth Moving" for use as general fill.

B. Asphalt Paving: Break up and transport paving to asphalt-recycling facility.

C. Concrete: Remove reinforcement and other metals from concrete and sort with other metals.

1. Pulverize concrete to maximum 1-1/2-inch (38-mm) size.

2. Crush concrete and screen to comply with requirements in Section 312000 "Earth Moving" for use as satisfactory soil for fill or subbase.

D. Masonry: Remove metal reinforcement, anchors, and ties from masonry and sort with other metals.

1. Pulverize masonry to maximum 3/4-inch (19-mm) size.

a. Crush masonry and screen to comply with requirements in Section 312000 "Earth Moving" for use as general fill or satisfactory soil for fill or subbase.
b. Crush masonry and screen to comply with requirements in Section 329300 "Plants" for use as mineral mulch.

2. Clean and stack undamaged, whole masonry units on wood pallets.

E. Wood Materials: Sort and stack members according to size, type, and length. Separate lumber, engineered wood products, panel products, and treated wood materials.

F. Metals: Separate metals by type.

1. Structural Steel: Stack members according to size, type of member, and length.
2. Remove and dispose of bolts, nuts, washers, and other rough hardware.

G. Asphalt Shingle Roofing: Separate organic and glass-fiber asphalt shingles and felts. Remove and dispose of nails, staples, and accessories.

H. Gypsum Board: Stack large clean pieces on wood pallets or in container and store in a dry location. Remove edge trim and sort with other metals. Remove and dispose of fasteners.

I. Acoustical Ceiling Panels and Tile: Stack large clean pieces on wood pallets and store in a dry location.

J. Metal Suspension System: Separate metal members including trim, and other metals from acoustical panels and tile and sort with other metals.

K. Carpet and Pad: Roll large pieces tightly after removing debris, trash, adhesive, and tack strips.

1. Store clean, dry carpet and pad in a closed container or trailer provided by Carpet Reclamation Agency or carpet recycler.

L. Carpet Tile: Remove debris, trash, and adhesive.

1. Stack tile on pallet and store clean, dry carpet in a closed container or trailer provided by Carpet Reclamation Agency or carpet recycler.

M. Piping: Reduce piping to straight lengths and store by type and size. Separate supports, hangers, valves, sprinklers, and other components by type and size.

N. Conduit: Reduce conduit to straight lengths and store by type and size.

3.4 RECYCLING CONSTRUCTION WASTE

A. Packaging:

1. Cardboard and Boxes: Break down packaging into flat sheets. Bundle and store in a dry location.
2. Polystyrene Packaging: Separate and bag materials.
3. Pallets: As much as possible, require deliveries using pallets to remove pallets from Project site. For pallets that remain on-site, break down pallets into component wood pieces and comply with requirements for recycling wood.
4. Crates: Break down crates into component wood pieces and comply with requirements for recycling wood.

B. Wood Materials:

1. Clean Cut-Offs of Lumber: Grind or chip into small pieces.
2. Clean Sawdust: Bag sawdust that does not contain painted or treated wood.

C. Gypsum Board: Stack large clean pieces on wood pallets or in container and store in a dry location.

1. Clean Gypsum Board: Grind scraps of clean gypsum board using small mobile chipper or hammer mill. Screen out paper after grinding.

3.5 DISPOSAL OF WASTE

A. General: Except for items or materials to be salvaged, recycled, or otherwise reused, remove waste materials from Project site and legally dispose of them in a landfill or incinerator acceptable to authorities having jurisdiction.

1. Except as otherwise specified, do not allow waste materials that are to be disposed of accumulate on-site.
2. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.

B. Burning: Do not burn waste materials.

C. Disposal: Remove waste materials from Owner's property and legally dispose of them.

3.6 ATTACHMENTS

A. Construction Waste Management Tracking Worksheet.

END OF SECTION 017419

LEED MRc2.1,2.2:

CONSTRUCTION WASTE MANAGEMENT

TRACKING WORKSHEET

Project Owner: ____________________
Project Title: ____________________
Project Address: ____________________
Project Size: ____________________
Project Number: __________

Leed Administrator: ____________________
Construction Manager: ____________________
General Contractor: ____________________
CWM Contractor: ____________________
Reporting Period: ____________________

Container or Pickup Ticket #	Haul Off Date	Container Total (Pickup from Site)		Concrete Material (diverted)		Metal/Steel Material (diverted)		Wood Material (diverted)		Paper / Cardboard Material (diverted)		Other Recycled Material (diverted)		C&D / Trash Material (Landfill)		% Diverted Material from Landfill		Diversion / Recycling Facility or Location: (Please provide location of where each material has been sent to)	Comments / Remarks: (If Landfilled, please explain why material was not diverted. If quanities are noted under Other Recyled Material, Please specify description of material (i.e. Plastic, Glass, Drywall, Acoustical Tile, Carpet, Insulation, etc)).
		Volume (Cuyd)	Weight (Tons)	Volume (Cuyd)	Weight (Tons)	Volume (Cuyd)	Weight (Tons)	Volume (Cuyd)	Weight (Tons)	Volume (Cuyd)	Weight (Tons)	Volume (Cuyd)	Weight (Tons)	Volume (Cuyd)	Weight (Tons)	Volume	Weight		
71109	4/21/2011	30.0	6.2	7.5	1.5	7.5	1.5	6.0	1.2	3.0	0.6			6.0	1.2	80.0%	79.9%	BSS Marion Road Sorting Yard	
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TOTAL WASTE DIVERTED (THIS PERIOD): 24.0 Tons
TOTAL WASTE SENT TO LANDFILL (THIS PERIOD): 6.0 Tons
TOTAL OF ALL WASTE (THIS PERIOD): 30.0 Tons
PERCENTAGE OF WASTE DIVERTED FROM LANDFILL (THIS PERIOD): 80.0%

GRAND TOTAL WASTE DIVERTED: 24.0 Tons
GRAND TOTAL WASTE SENT TO LANDFILL: 6.0 Tons
GRAND TOTAL OF ALL WASTE: 30.0 Tons
GRAND TOTAL PERCENTAGE OF WASTE DIVERTED FROM LANDFILL: 80.0%

PREPARED / SUBMITTED BY:

NAME: ____________________
TITLE: ____________________
COMPANY: ____________________
DATE: ____________________

REVIEWED / APPROVED BY:

NAME: ____________________
TITLE: ____________________
COMPANY: ____________________
DATE: ____________________

SECTION 018113.13 - SUSTAINABLE DESIGN REQUIREMENTS - LEED 2009 FOR NEW CONSTRUCTION AND MAJOR RENOVATIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes general requirements and procedures for compliance with certain USGBC LEED prerequisites and credits needed for Project to obtain LEED Silver certification based on USGBC's "LEED 2009 for New Construction & Major Renovations."

1. Other LEED prerequisites and credits needed to obtain LEED certification depend on product selections and may not be specifically identified as LEED requirements. Compliance with requirements needed to obtain LEED prerequisites and credits may be used as one criterion to evaluate substitution requests and comparable product requests.
2. A copy of LEED Project checklist is attached at the end of this Section for information only.

    a. Some LEED prerequisites and credits needed to obtain the indicated LEED certification depend on Architect's design and other aspects of Project that are not part of the Work of the Contract.

1.3 DEFINITIONS

A. LEED: USGBC's "LEED 2009 for New Construction & Major Renovations."

1. Definitions that are a part of "LEED 2009 for New Construction and Major Renovations" apply to this Section.

B. Chain-of-Custody Certificates: Certificates signed by manufacturers certifying that wood used to make products was obtained from forests certified by an FSC-accredited certification body to comply with FSC STD-01-001, "FSC Principles and Criteria for Forest Stewardship." Certificates shall include evidence that manufacturer is certified for chain of custody by an FSC-accredited certification body.

C. Regional Materials: Materials that have been extracted, harvested, or recovered, as well as manufactured, within 500 miles (800 km) of Project site. If only a fraction of a product or material is extracted/harvested/recovered and manufactured locally, then only that percentage (by weight) shall contribute to the regional value.

D. Recycled Content: The recycled content value of a material assembly shall be determined by weight. The recycled fraction of the assembly is then multiplied by the cost of assembly to determine the recycled content value.

1. "Postconsumer" material is waste material generated by households or by commercial, industrial, and institutional facilities in their role as end users of the product, which can no longer be used for its intended purpose.
2. "Preconsumer" material is material diverted from the waste stream during the manufacturing process. Reutilization of materials (such as rework, regrind, or scrap generated in a process and capable of being reclaimed within the same process that generated it) is excluded.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site. Review LEED requirements and action plans for complying with requirements.

1.5 ADMINISTRATIVE REQUIREMENTS

A. Respond to questions and requests from Architect and USGBC about LEED prerequisites and credits that are the responsibility of the Contractor, that depend on product selection or product qualities, or that depend on Contractor's procedures until USGBC has made its determination on Project's LEED certification application. Document responses as informational submittals.

B. Submit documentation to USGBC and respond to questions and requests from USGBC about LEED prerequisites and credits that are the responsibility of the Contractor, that depend on product selection or product qualities, or that depend on Contractor's procedures until USGBC has made its determination on Project's LEED certification application.

1. Document correspondence with USGBC as informational submittals.

1.6 ACTION SUBMITTALS

A. General: Submit additional sustainable design submittals required by other Specification Sections. Use LEED Product Data Sheet at the end of this section.

B. Sustainable design submittals are in addition to other submittals.

1. If submitted item is identical to that submitted to comply with other requirements, include an additional copy with other submittal as a record copy of compliance with indicated LEED requirements instead of separate sustainable design submittal. Mark additional copy "Sustainable design submittal."

C. Sustainable Design Documentation Submittals:

1. Credit EA 5: Product Data and wiring diagrams for sensors and data collection system used to provide continuous metering of building energy-consumption performance over time.
2. Credit MR 2: Comply with Section 017419 "Construction Waste Management and Disposal."
3. Credit MR 4: Product Data for recycled content indicating postconsumer and preconsumer recycled content and cost.
4. Credit MR 5: Product Data for regional materials indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project and cost for each regional material.

5. Credit MR 7: Product Data and chain-of-custody certificates for products containing certified wood. Include statement indicating cost for each certified wood product.
6. Credit IEQ 3.1:

    a. Construction indoor-air-quality management plan.
    b. Product Data for temporary filtration media.
    c. Product Data for filtration media used during occupancy.
    d. Construction Documentation: Six photographs at each of three different times during the construction period, along with a brief description of the SMACNA approach employed, documenting implementation of the indoor-air-quality management measures, such as protection of ducts and on-site stored or installed absorptive materials.

7. Credit IEQ 3.2:

    a. Signed statement describing the building air flush-out procedures including the dates when flush-out was begun and completed and statement that filtration media was replaced after flush-out.
    b. Product Data for filtration media used during flush-out and during occupancy.
    c. Report from testing and inspecting agency indicating results of indoor-air-quality testing and documentation showing compliance with indoor-air-quality testing procedures and requirements.

8. Credit IEQ 4.1: Product Data for adhesives and sealants used inside the weatherproofing system indicating VOC content of each product used.
9. Credit IEQ 4.2: Product Data for paints and coatings used inside the weatherproofing system indicating VOC content of each product used.
10. Credit IEQ 4.4: Product Data for products containing composite wood or agrifiber products or wood glues indicating that they do not contain urea-formaldehyde resin.

1.7 INFORMATIONAL SUBMITTALS

A. Qualification Data: For LEED coordinator.

B. Project Materials Cost Data: Provide statement indicating total cost for materials used for Project. Costs exclude labor, overhead, and profit. Include breakout of costs for the following categories of items:

1. Furniture.
2. Plumbing.
3. Mechanical.
4. Electrical.
5. Specialty items such as elevators and equipment.
6. Wood-based construction materials.

C. Sustainable Design Action Plans: Provide preliminary submittals within 30 days of date established for the Notice to Proceed indicating how the following requirements will be met:

1. Credit MR 2: Waste management plan complying with Section 017419 "Construction Waste Management and Disposal."
2. Credit MR 4: List of proposed materials with recycled content. Indicate cost, postconsumer recycled content, and preconsumer recycled content for each product having recycled content.

3. Credit MR 5: List of proposed regional materials. Identify each regional material, including its source, cost, and the fraction by weight that is considered regional.
4. Credit MR 7: List of proposed certified wood products. Indicate each product containing certified wood, including its source and cost of certified wood products.
5. Credit IEQ 3.1: Construction indoor-air-quality management plan.

D. Sustainable Design Progress Reports: Concurrent with each Application for Payment, submit reports comparing actual construction and purchasing activities with sustainable design action plans.

1.8 QUALITY ASSURANCE

A. LEED Coordinator: Engage an experienced LEED-Accredited Professional to coordinate LEED requirements. LEED coordinator may also serve as waste management coordinator.

PART 2 - PRODUCTS

2.1 MATERIALS, GENERAL

A. Provide products and procedures necessary to obtain LEED credits required in this Section. Although other Sections may specify some requirements that contribute to these LEED credits, Contractor shall provide additional materials and procedures necessary to obtain LEED credits indicated.

2.2 RECYCLED CONTENT OF MATERIALS

A. Credit MR 4: Building materials shall have recycled content such that postconsumer recycled content plus one-half of preconsumer recycled content for Project constitutes a minimum of 20 percent of cost of materials used for Project.

1. Cost of postconsumer recycled content plus one-half of preconsumer recycled content of an item shall be determined by dividing weight of postconsumer recycled content plus one-half of preconsumer recycled content in the item by total weight of the item and multiplying by cost of the item.
2. Do not include furniture, plumbing, mechanical and electrical components, and specialty items such as elevators and equipment in the calculation.

2.3 REGIONAL MATERIALS

A. Credit MR 5: Not less than 20 percent of building materials (by cost) shall be regional materials.

2.4 CERTIFIED WOOD

A. Credit MR 7: Not less than 50 percent (by cost) of wood-based materials shall be produced from wood obtained from forests certified by an FSC-accredited certification body to comply with FSC STD-01-001, "FSC Principles and Criteria for Forest Stewardship."

1. Wood-based materials include, but are not limited to, the following materials when made from wood, engineered wood products, or wood-based panel products:

    a. Rough carpentry.
    b. Miscellaneous carpentry.
    c. Heavy timber construction.
    d. Wood decking.
    e. Metal-plate-connected wood trusses.
    f. Structural glued-laminated timber.
    g. Finish carpentry.
    h. Architectural woodwork.
    i. Wood paneling.
    j. Wood veneer wall covering.
    k. Wood flooring.
    l. Wood lockers.
    m. Wood cabinets.
    n. Furniture.

2.5 LOW-EMITTING MATERIALS

A. Credit IEQ 4.1: For field applications that are inside the weatherproofing system, adhesives and sealants shall comply with VOC content limits of authorities having jurisdiction and the following VOC content limits:

1. Wood Glues: 30 g/L.
2. Metal-to-Metal Adhesives: 30 g/L.
3. Adhesives for Porous Materials (except Wood): 50 g/L.
4. Subfloor Adhesives: 50 g/L.
5. Plastic Foam Adhesives: 50 g/L.
6. Carpet Adhesives: 50 g/L.
7. Carpet Pad Adhesives: 50 g/L.
8. VCT and Asphalt Tile Adhesives: 50 g/L.
9. Cove Base Adhesives: 50 g/L.
10. Gypsum Board and Panel Adhesives: 50 g/L.
11. Rubber Floor Adhesives: 60 g/L.
12. Ceramic Tile Adhesives: 65 g/L.
13. Multipurpose Construction Adhesives: 70 g/L.
14. Fiberglass Adhesives: 80 g/L.
15. Contact Adhesive: 80 g/L.
16. Structural Glazing Adhesives: 100 g/L.
17. Wood Flooring Adhesive: 100 g/L.
18. Structural Wood Member Adhesive: 140 g/L.
19. Single-Ply Roof Membrane Adhesive: 250 g/L.
20. Special-Purpose Contact Adhesive (Contact Adhesive That Is Used to Bond Melamine-Covered Board, Metal, Unsupported Vinyl, Rubber, or Wood Veneer 1/16 Inch or Less in Thickness to Any Surface): 250 g/L.
21. Top and Trim Adhesive: 250 g/L.
22. Plastic Cement Welding Compounds: 250 g/L.
23. ABS Welding Compounds: 325 g/L.
24. CPVC Welding Compounds: 490 g/L.
25. PVC Welding Compounds: 510 g/L.
26. Adhesive Primer for Plastic: 550 g/L.
27. Sheet-Applied Rubber Lining Adhesive: 850 g/L.
28. Aerosol Adhesive, General-Purpose Mist Spray: 65 percent by weight.

29. Aerosol Adhesive, General-Purpose Web Spray: 55 percent by weight.
30. Special-Purpose Aerosol Adhesive (All Types): 70 percent by weight.
31. Other Adhesives: 250 g/L.
32. Architectural Sealants: 250 g/L.
33. Nonmembrane Roof Sealants: 300 g/L.
34. Single-Ply Roof Membrane Sealants: 450 g/L.
35. Other Sealants: 420 g/L.
36. Sealant Primers for Nonporous Substrates: 250 g/L.
37. Sealant Primers for Porous Substrates: 775 g/L.
38. Modified Bituminous Sealant Primers: 500 g/L.
39. Other Sealant Primers: 750 g/L.

B. Credit IEQ 4.2: For field applications that are inside the weatherproofing system, paints and coatings shall comply with VOC content limits of authorities having jurisdiction and the following VOC content limits:

1. Flat Paints and Coatings: VOC not more than 50 g/L.
2. Nonflat Paints and Coatings: VOC not more than 150 g/L.
3. Dry-Fog Coatings: VOC not more than 400 g/L.
4. Primers, Sealers, and Undercoaters: VOC not more than 200 g/L.
5. Anticorrosive and Antirust Paints Applied to Ferrous Metals: VOC not more than 250 g/L.
6. Zinc-Rich Industrial Maintenance Primers: VOC not more than 340 g/L.
7. Pretreatment Wash Primers: VOC not more than 420 g/L.
8. Clear Wood Finishes, Varnishes: VOC not more than 350 g/L.
9. Clear Wood Finishes, Lacquers: VOC not more than 550 g/L.
10. Floor Coatings: VOC not more than 100 g/L.
11. Shellacs, Clear: VOC not more than 730 g/L.
12. Shellacs, Pigmented: VOC not more than 550 g/L.
13. Stains: VOC not more than 250 g/L.

C. Credit IEQ 4.4: Composite wood, agrifiber products, and adhesives shall not contain urea-formaldehyde resin.

PART 3 - EXECUTION

3.1 NONSMOKING BUILDING

A. Smoking is not permitted within the building or within 25 feet (8 m) of entrances, operable windows, or outdoor-air intakes.

3.2 MEASUREMENT AND VERIFICATION

A. Credit EA 5: Implement measurement and verification plan consistent with Option B: Energy Conservation Measure Isolation or Option D: Calibrated Simulation, Savings Estimation Method 2 in the EVO's International Performance Measurement and Verification Protocol (IPMVP), "Volume III: Concepts and Options for Determining Energy Savings in New Construction," and as further defined by the following:

3.3 CONSTRUCTION WASTE MANAGEMENT

A. Credit MR 2: Comply with Section 017419 "Construction Waste Management and Disposal."

3.4 CONSTRUCTION INDOOR-AIR-QUALITY MANAGEMENT

A. Credit IEQ 3.1: Comply with SMACNA's "SMACNA IAQ Guideline for Occupied Buildings under Construction."

1. If Owner authorizes use of permanent heating, cooling, and ventilating systems during construction period as specified in Section 015000 "Temporary Facilities and Controls," install filter media having a MERV 8 according to ASHRAE 52.2 at each return-air inlet for the air-handling system used during construction.
2. Replace air filters immediately prior to occupancy.

END OF SECTION 018113.13

LEED 2009 for New Construction and Major Renovations

Project Checklist

Research Building 2

1/18/2016

Sustainable Sites — Possible Points: 26

Y	?	N			
Y			Prereq 1	Construction Activity Pollution Prevention	
1			Credit 1	Site Selection	1
5			Credit 2	Development Density and Community Connectivity	5
		1	Credit 3	Brownfield Redevelopment	1
6			Credit 4.1	Alternative Transportation—Public Transportation Access	6
1			Credit 4.2	Alternative Transportation—Bicycle Storage and Changing Rooms	1
	3		Credit 4.3	Alternative Transportation—Low-Emitting and Fuel-Efficient Vehicles	3
2			Credit 4.4	Alternative Transportation—Parking Capacity	2
		1	Credit 5.1	Site Development—Protect or Restore Habitat	1
	1		Credit 5.2	Site Development—Maximize Open Space	1
		1	Credit 6.1	Stormwater Design—Quantity Control	1
	1		Credit 6.2	Stormwater Design—Quality Control	1
	1		Credit 7.1	Heat Island Effect—Non-roof	1
1			Credit 7.2	Heat Island Effect—Roof	1
	1		Credit 8	Light Pollution Reduction	1

Water Efficiency — Possible Points: 10

Y	?	N			
Y			Prereq 1	Water Use Reduction—20% Reduction	
2	2		Credit 1	Water Efficient Landscaping	2 to 4
		2	Credit 2	Innovative Wastewater Technologies	2
3	1		Credit 3	Water Use Reduction	2 to 4

Energy and Atmosphere — Possible Points: 35

Y	?	N			
Y			Prereq 1	Fundamental Commissioning of Building Energy Systems	
Y			Prereq 2	Minimum Energy Performance	
Y			Prereq 3	Fundamental Refrigerant Management	
7	8		Credit 1	Optimize Energy Performance	1 to 19
		7	Credit 2	On-Site Renewable Energy	1 to 7
2			Credit 3	Enhanced Commissioning	2
		2	Credit 4	Enhanced Refrigerant Management	2
3			Credit 5	Measurement and Verification	3
	2		Credit 6	Green Power	2

Materials and Resources — Possible Points: 14

Y	?	N			
Y			Prereq 1	Storage and Collection of Recyclables	
		3	Credit 1.1	Building Reuse—Maintain Existing Walls, Floors, and Roof	1 to 3
		1	Credit 1.2	Building Reuse—Maintain 50% of Interior Non-Structural Elements	1
2			Credit 2	Construction Waste Management	1 to 2
		2	Credit 3	Materials Reuse	1 to 2

Materials and Resources, Continued

Y	?	N			
2			Credit 4	Recycled Content	1 to 2
2			Credit 5	Regional Materials	1 to 2
		1	Credit 6	Rapidly Renewable Materials	1
		1	Credit 7	Certified Wood	1

Indoor Environmental Quality — Possible Points: 15

Y	?	N			
Y			Prereq 1	Minimum Indoor Air Quality Performance	
Y			Prereq 2	Environmental Tobacco Smoke (ETS) Control	
1			Credit 1	Outdoor Air Delivery Monitoring	1
		1	Credit 2	Increased Ventilation	1
1			Credit 3.1	Construction IAQ Management Plan—During Construction	1
	1		Credit 3.2	Construction IAQ Management Plan—Before Occupancy	1
1			Credit 4.1	Low-Emitting Materials—Adhesives and Sealants	1
1			Credit 4.2	Low-Emitting Materials—Paints and Coatings	1
1			Credit 4.3	Low-Emitting Materials—Flooring Systems	1
1			Credit 4.4	Low-Emitting Materials—Composite Wood and Agrifiber Products	1
1			Credit 5	Indoor Chemical and Pollutant Source Control	1
		1	Credit 6.1	Controllability of Systems—Lighting	1
		1	Credit 6.2	Controllability of Systems—Thermal Comfort	1
1			Credit 7.1	Thermal Comfort—Design	1
1			Credit 7.2	Thermal Comfort—Verification	1
	1		Credit 8.1	Daylight and Views—Daylight	1
		1	Credit 8.2	Daylight and Views—Views	1

Innovation and Design Process — Possible Points: 6

Y	?	N			
		1	Credit 1.1	Innovation in Design: Site Assessment	1
	1		Credit 1.2	Innovation in Design: Appliance + process water use reduction	1
	1		Credit 1.3	Innovation in Design: Acoustic Performance	1
1			Credit 1.4	Innovation in Design: Green Education	1
			Credit 1.5	Innovation in Design: Specific Title	1
1			Credit 2	LEED Accredited Professional	1

Regional Priority Credits — Possible Points: 4

Y	?	N			
		1	Credit 1.1	Regional Priority: Stormwater Design - Quantity Control	1
1			Credit 1.2	Regional Priority: Thermal Comfort - Design	1
1			Credit 1.3	Regional Priority: Alt Transportation - Public Transp Access	1
	1		Credit 1.4	Regional Priority: Water Use Reduction 40%	1

Y	?	N			
52	25	28	Total		Possible Points: 110

Certified 40 to 49 points Silver 50 to 59 points Gold 60 to 79 points Platinum 80 to 110

LEED PRODUCT DATA SHEET

NOTE: This cover sheet is used to summarize the LEED submittal information. Manufacturer cut sheet, letter, MSDS, etc. must be provided to show fulfillment of the product requirements. The supporting documentation will be submitted to the Green Building Certification Institute.

Project: UK Research Building 2	Date:
Location: Lexington, KY	Spec. Section:
Product / Material:	
Manufacturer:	
Product / Material Cost:	

Information Provided By:	**Contractor Responsible:**
Name:	Trade:
Company:	Company:
Phone # and Email:	

Check [ ] if manufacturer's documentation (cut sheet, letter, MSDS, etc.) is included in LEED submittal.

[ ] MRc4 – Recycled Content:

Pre Consumer content (by weight):	%
Post Consumer content (by weight):	%

*For concrete, use Concrete Tracking Form

*For assemblies, use Assembly Calculator for Recycled Content

[ ] MRc5 – Regional Materials:

Manufacture Location:	
• Distance from Project Site:	miles
Extraction Location:	
• Distance from Project Site:	miles
% Regional (by weight):	%

*For assemblies, use Assembly Calculator for Recycled Content

[ ] MRc6 – Rapidly Renewable Materials:

Contains Rapidly Renewable Material? (Y / N):	
% Rapidly Renewable (by weight):	%

*For assemblies, use Assembly Calculator for Rapidly Renewable Materials

[ ][2] MRc7 – Certified Wood:

Contains Wood? (Y / N):	
% of Product Containing New Wood:	%
% of New Wood that is Certified:	%
FSC Chain of Custody Number:	

*For assemblies, use Assembly Calculator for Certified Wood

[ ] IEQc4.1 – Low-Emitting Materials – Adhesives and Sealants[1]:

Category and Use:	
SCAQMD Rule #1168 Compliant?	
VOC Level (less water & exempted solids):	Grams/L

[ ] IEQc4.2 – Low-Emitting Materials – Paints and Coatings[1]:

Category and Use:	
VOC Level (less water & exempted solids):	Grams/L

[ ] IEQc4.3 – Low-Emitting Materials – Flooring Systems[1]:

Carpet? (Y / N):	
• CRI Green Label Plus Compliant? (Y / N):	
Hard Flooring (Y / N):	
• FloorScore Compliant? (Y / N):	

[ ] IEQc4.4 – Low-Emitting Materials – Composite Wood and Agrifiber Products[1]:

Contains Added Urea-Formaldehyde? (Y / N)	

1. Products which are applied on-site and interior to the weatherproofing layer.
2. Vendor invoice required.

SECTION 019113 - BUILDING SYSTEMS COMMISSIONING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. The work under this Section is subject to requirements of the Contract Documents including the Owner's General Conditions and articles of the Construction Manager's General Conditions.

B. This section includes the Commissioning (Cx) requirements for the Building Fire Protection, Plumbing, HVAC, Electrical, Communications, and Electronic Safety and Security systems.

1.2 DESCRIPTION

A. Commissioning is a systematic process of ensuring all building systems perform interactively according to design intent and Owner's operational needs. Commissioning will encompass and coordinate traditionally separate functions of system documentation, installation checkout, equipment Start-Up, control system calibration and point-to-point checkout, testing and balancing, and Functional Performance Testing. Commissioning is intended to achieve the following specific objectives according to the Contract Documents:

1. Verify and document proper installation and performance of equipment and systems.
2. Provide Owner with functional buildings and/or systems with minimal operational problems at time of move-in.

B. Commissioning does not take away from or reduce responsibility of system designers or installing contractors to provide a finished and fully functioning product.

C. This section shall in no way diminish the responsibility of the Division 21, 22, 23, 26, 27 and 28 Contractors, Subcontractors and Suppliers in performing all aspects of work and testing as outlined in the contract documents. The commissioning requirements of this specification section are separate from and in addition to any other commissioning, testing or demonstration requirements in other specification sections of the Project Manual.

1.3 ABBREVIATIONS

A. The following are common abbreviations used in the Specifications (definitions are found further in this Section):

1. A/E - Architect and Design Engineers
2. BAS - Building Automation System
3. CM - Construction Manager
4. CxA - Commissioning Agent
5. CT - Commissioning Team
6. Cx - Commissioning
7. Cx Plan - Commissioning Plan
8. CC - Controls Contractor
9. EC - Electrical Contractor
10. FPT - Functional Performance Test

11. MC - Mechanical Contractor
12. OR - Owner's Representative
13. PC – Plumbing Contractor
14. PFC - Pre-Functional Checklist
15. TAB - Test, Adjust and Balance
16. O&M - Operations & Maintenance
17. RFI - Request for Information

1.4 DEFINITIONS

A. Acceptance Phase: Phase of construction after Start-Up and initial checkout when Functional Performance Tests, O&M documentation review and training occur.

B. Approval: Acceptance that a piece of equipment or system has been properly installed and is functioning in tested modes according to the Contract Documents.

C. Architect/Engineer (A/E): Prime consultant (architect) and sub-consultants who comprise the design team, generally HVAC Mechanical Designer/Engineer and Electrical Designer/Engineer.

D. Basis of Design (BOD): Documentation of primary thought processes and assumptions behind design decisions made to meet design intent. Describes systems, components, conditions and methods chosen to meet intent.

E. Commissioning Agent (CxA): Contracted to Owner. CxA directs and coordinates day-to-day Commissioning activities. CxA reports directly to Owner.

F. Commissioning Plan: Overall plan developed after bidding that provides structure, schedule and coordination planning for Commissioning process.

G. Contract Documents: Documents binding on parties involved in construction of this project (drawings, specifications, change orders, amendments, contracts, etc.).

H. Contractor: Contracted directly to Owner.

I. Control System: System and components associated with building automation system.

J. "Building Start" - A "cloud-based" process management platform provided by Building Test utilized to execute the Commissioning process.

K. Deferred Functional Tests: Functional tests performed after substantial completion due to partial occupancy, equipment, seasonal requirements, design or other site conditions that disallow test from being performed.

L. Deficiency: Condition of a component, piece of equipment or system that is not in compliance with Contract Documents (that is, does not perform properly or is not complying with design intent).

M. Functional Performance Test Procedures: Commissioning protocols and detailed test procedures and instructions that fully describe system configuration and steps required to determine if the system is performing and functioning properly. These procedures shall be used to document Functional Performance Tests.

N. Functional Performance Test (FPT): Test of dynamic function and operation of equipment and systems. Systems are tested under various modes, such as during low cooling or heating

loads, high loads, component failures, unoccupied, varying outside air temperatures, life safety conditions, power failure, etc. Systems are run through all specified sequences of operation. Components are verified to be responding in accordance with contract documents. Functional Performance Tests are executed after Pre-Functional Checklists and Start-Ups are complete.

O. Monitoring: Recording of parameters (flow, current, status, pressure, etc.) of equipment operation using data loggers or trending capabilities of control systems.

P. Overridden Value: Writing over a sensor value in control system to see response of a system (e.g., changing outside air temperature value from 52oF to 72oF to verify economizer operation). See also “Simulated Signal”.

Q. Pre-Functional Checklist (PFC): A list of static inspections and elementary component tests that verify proper installation of equipment (e.g., belt tension, oil levels, labels affixed, gages in place, sensors calibrated, etc.).

R. Seasonal Performance Tests: Functional Performance Tests deferred until system(s) ambient conditions are closer to design conditions.

S. Simulated Condition: Condition created for testing component or system (e.g., applying heat to space temperature sensor to monitor response of VAV box).

T. Simulated Signal: Disconnecting sensor and using signal generator to send amperage, resistance or pressure to transducer and/or DDC system to simulate value to BAS.

U. Specifications: Construction specifications of Contract Documents.

V. Start-up: The activities where systems or equipment are initially tested and operated. Start-up is completed prior to Functional Performance Testing.

W. Subcontractor: Contractors of CM, and their Subcontractors, who provide and install building components and systems.

X. Test Procedures: Step-by-step process, which must be executed to fulfill test requirements.

Y. Test Requirements: Requirements specifying what modes and functions, etc. will be tested. Test requirements are not detailed test procedures. Test requirements are specified in the Cx Plan.

Z. Trending: Monitoring using building control system.

AA. Vendor: Supplier of equipment.

BB. Warranty Period: Warranty period for entire project, including equipment components.

1.5 RELATED WORK

A. Specific Commissioning requirements are given in this specification. The following specifications apply to Work specified in this section:

1. Basic Fire Protection System Requirements: Refer to Division 21.
2. Basic Plumbing System Requirements: Refer to Division 22.
3. Basic HVAC System Requirements: Refer to Division 23.
4. Basic Electrical System Requirements: Refer to Division 26.

5. Basic Communication System Requirements: Refer to Division 27.
6. Basic Electronic Safety and Security System Requirements: Refer to Division 28.

1.6 COORDINATION

A. Commissioning Team: Members of the Commissioning Team (CT) will consist of:

1. Commissioning Agent (CxA).
2. Owner's Representative(s) (OR).
3. Representatives of the Facility User and Operation and Maintenance Personnel.
4. Architect and Design Engineers (A/E).
5. Construction Manager (CM)
6. Mechanical Contractor (MC).
7. Plumbing Contractor (PC).
8. Electrical Contractor (EC).
9. Test and Balance Contractor (TAB Contractor).
10. Controls Contractor (CC).
11. Any other Division 21, 22, 23, 26, 27, or 28 Contractors or Subcontractors who provide and install the equipment to be commissioned.
12. Equipment Suppliers and Vendors.

B. Management: Owner will contract services of the CxA. The CxA directs and coordinates Commissioning activities and reports to OR. All members of the Commissioning Team shall cooperate to fulfill contracted responsibilities and objectives of the Contract Documents.

C. Kick-Off Meeting: CxA will plan, schedule and conduct a Commissioning Kick-Off Meeting. Membership and responsibilities of the Commissioning team will be clarified at this meeting. Cx Kick-Off Meeting shall be conducted no later than 30 days prior to initial installation of any commissioned equipment on-site (i.e. equipment set on site). CxA will distribute meeting minutes to all parties.

D. Scheduling:

1. CxA will work with Commissioning team to establish required Commissioning activities to incorporate in preliminary Commissioning schedule. The CM will integrate Commissioning activities into master construction schedule. Representatives of the Commissioning team will address scheduling problems. Necessary notifications are to be made in a timely manner in order to expedite Commissioning.
2. The CxA will provide initial schedule of primary Commissioning events at Commissioning Kick-Off Meeting. As construction progresses, more detailed schedules are developed by the Commissioning team.

E. Project Phasing:

1. Phased completion of project construction is not anticipated. All CxA work with the exception of the following must be completed prior to Owner move-in/occupancy. The following Cx work will be completed after Owner move-in/occupancy: Compilation and delivery of Final Commissioning Report.

PART 2 - PRODUCTS / COMMISSIONING DOCUMENTATION

2.1 "BUILDING START" DATABASE

A. The Commissioning process will be executed utilizing a "cloud-based" process management platform called "Building Start" provided by the CxA. "Building Start" is accessed by authorized users using any device running an HTML-5 internet browser (e.g. PC, laptop, tablet, phone) or by an operating system specific (e.g. iOS) application downloaded from corresponding app store.

B. CxA will provide the CM/Subcontractors with web access to the "Building Start" database during the Commissioning process to allow the CM/Subcontractors to complete the scoped Commissioning tasks indicated in other sections of this specification (e.g. completion of Commissioning activities such as notification of deficiency item corrections, readiness for Functional Performance Testing, etc.).

2.2 COMMISSIONING PLAN

A. CxA will develop overall plan for execution of the Commissioning Process. CxA will provide a single overall Commissioning Plan for all phases of work.

B. The Cx Plan will contain:

1. Executive Summary of overall commissioning process.
2. List of CT members and roles and responsibilities.
3. Master Equipment List (list of commissioned equipment and systems).
4. Pre-Functional Checklists (PFCs) for commissioned equipment. The PFCs will be developed in the "Building Start" database.
5. Functional Performance Test Procedures for each commissioned equipment/system. The FPTs will be developed in the "Building Start" database. The initial Cx Plan will not include the FPTs; these will be developed once the Control Submittal is approved by the A/E.
6. Sample Master Issues Log (used to track issues/deficiencies throughout the commissioning process). The MIL will be developed in the "Building Start" database.

C. The Cx Plan will be delivered to the CT in electronic format (Adobe PDF file searchable from the Table of Contents).

2.3 CxA SUBMITTAL REVIEWS

A. Contractor shall provide CxA with documentation required for Commissioning work. At minimum, documentation shall include: Requirements as described in Section 013300, detailed Start-Up procedures, full sequences of operation, O&M data, performance data, any performance test procedures, duct pressure testing procedures and results, piping pressure testing and flushing procedures and results, control drawings and details of Owner contracted tests. In addition, installation and checkout materials actually shipped inside equipment and actual field checkout sheet forms used by factory or field technicians shall be submitted to CxA.

B. CM shall submit one copy of the final A/E approved submittal data to the CxA for record purposes.

2.4 PRE-FUNCTIONAL CHECKLISTS (PFC)

A. The objective of the Pre-Functional Checklist is to verify and document that the equipment/systems are provided and installed according to documented design intent and Contract Documents.

B. CxA will develop the Pre-Functional Checklists from the Contract Documents and A/E approved Equipment Submittals. The Pre-Functional Checklists will be developed in the “Building Start” database. The Pre-Functional Checklists will be completed during construction in the “Building Start” database by the CM and Subcontractors.

C. Sample copies of Pre-Functional Checklists are included at the end of this specification. The sample copies are provided to give the Subcontractors a general idea of the work required to complete the Pre-Functional Checklists. The Pre-Functional Checklists included are prototypical, and do not reflect specific requirements of this project’s plans or specification. Specific Pre-Functional Checklist items may be added, modified or deleted in the Construction Phase Cx Plan delivered to the Subcontractor in order to reflect the final construction document requirements. CM and Subcontractors shall review final construction documentation for applicable details and specifications related to equipment to be commissioned in order to fully ascertain all of the Pre-Functional Checklist requirements.

2.5 CM / SUBCONTRACTOR START-UP PLAN

A. CM/Subcontractors responsible for purchase, installation and Start-Up of commissioned equipment shall compile all testing and equipment Start-Up documentation into an overall Start-Up Plan document.

B. Start-Up Plan shall include the following documentation:

1. Testing Documentation:

a. CM/Subcontractor shall compile documentation and recording forms for all testing required by Division 21, 22, 23, 26, 27, and 28 specifications (e.g. duct pressure testing, duct cleaning, pipe pressure testing, piping flushing and cleaning plans, electrical testing, communications cabling testing, fire alarm component testing, security systems testing, etc.). Testing documentation shall include:

1) A written description of the required testing and the procedures required to complete the testing.
2) All instrumentation utilized for the testing.
3) Checklist with boxes or lines for recording and documenting the completion of the testing activity and results.

2. Equipment Start-Up Documentation:

a. CM/Subcontractor shall compile detailed Start-Up procedures from equipment manufacturer and checkout procedures with normally used field checkout sheets. Start-up documentation shall include checklists and procedures with specific boxes or lines for recording and documenting inspections of each piece of equipment.

3. Control System Start-Up Documentation:

a. CM/Controls Contractor shall compile all control systems Start-Up and initial check-out documentation and recording forms including but not limited to point-to-

point verifications, control sensor calibrations, and control valve/damper actuator calibrations for inclusion in the Start-Up Plan. Control System Start-up documentation shall include checklists and procedures with specific boxes or lines for recording and documenting inspections of each control system point, sensor or device.

4. Test and Balance Documentation:

a. Start-Up Plan documentation shall include the TAB Execution Plan outlining the TAB procedures and proposed sequencing and scheduling of required TAB work.

5. Equipment Maintenance Log:

a. Start-Up Plan documentation shall include a list of all maintenance tasks (including frequency of execution) required to be performed on equipment started to insure equipment warranties are not voided. Start-Up Plan documentation shall include a log for each required maintenance task for Subcontractor/Vendor to document execution of the required maintenance tasks from Start-Up through Final Application for Payment.

C. Start-Up Plan documentation shall be provided in “searchable” electronic PDF format as follows:

1. Provide a separate Start-Up Plan PDF file for each Division of work (e.g. Division 21 Start-Up Plan, Division 22 Start-Up Plan, Division 23 Start-Up Plan, etc.)
2. Each Start-Up Plan PDF file will have a Cover Sheet with Project Information and Document Title.
3. Each Start-Up Plan PDF file will have a Table of Contents. The Table of Contents shall be “bookmarked” for hyperlink navigation directly to each section and item/document noted below.

a. Proposed Schedule/Sequencing Plan of Testing and Start-Up activities.
b. Testing documentation (e.g. duct pressure testing, duct cleaning, piping pressure testing, piping flushing and cleaning, electrical testing, etc.) organized by specification section.
c. Start-Up Checklists for each item of equipment organized by specification section.
d. Control System Start-Up activities completed by the Controls Contractor including but not limited to all point-to-point verifications, control sensor calibrations and control actuator calibrations.
e. Warranty Maintenance Log for each item of equipment organized by specification section.
f. TAB Execution Plan.

2.6 CM / SUBCONTRACTOR OWNER TRAINING PLAN

A. CM/Subcontractors/Vendors will provide complete Owner training in Start-Up, operation and maintenance of all commissioned systems/equipment under contract per Division 1, 21, 22, 23, 26, 27, and 28 specifications.

B. CM with assistance from responsible Subcontractors/Vendors and CxA shall develop a detailed program for Owner Training per 017900 Demonstration and Training.

2.7 FUNCTIONAL PERFORMANCE TESTS (FPT)

A. CxA will develop the Functional Performance Testing procedures from the Contract Documents and A/E approved BAS Control Submittal. The Functional Performance Test Procedures will be developed in the "Building Start" database. The Functional Performance Tests will be executed by the CM/Subcontractors. The CxA will witness the Functional Performance Testing and document the results in the "Building Start" database.

B. Development of Test Procedures:

1. The purpose of any given specific test is to verify and document compliance with stated criteria of acceptance given on test form. CxA shall develop specific test procedures and forms to verify and document proper operation of each piece of equipment and system. Subcontractor responsible to execute test will provide limited assistance to CxA in developing procedure (i.e. answering questions about equipment, operation, sequences, etc.). Prior to execution, CxA shall provide a copy of test procedures to Subcontractor. Subcontractor will review tests for feasibility, safety and equipment warranty protection. CxA shall submit tests to Owner, CM and A/E and other Commissioning team members for review.
2. Test procedure forms developed by the CxA will include (but not be limited to) the following information:

a. System and equipment or component name(s)
b. Equipment location and ID number
c. Date
d. Project name
e. Participating parties
f. Specific sequence of operation or other specified parameters being verified
g. Instructions for setting up test
h. Specific step-by-step procedures to execute test, in a clear, sequential and repeatable format
i. A Yes/No checkbox to allow for clearly marking whether or not proper performance of each part of test was achieved
j. Section for comments

3. Sample copies of Functional Performance Test (FPT) forms are included at the end of this specification. The sample copies are provided to give the Subcontractors a general idea of the work required to complete the FPT. The FPT checklists included are prototypical, and do not reflect specific requirements of this project's plans or specification. Specific FPT items may be added, modified or deleted in the Cx plan delivered to the Subcontractor in order to reflect the final construction document requirements. CM and Subcontractors shall review final construction documentation for applicable details and specifications related to equipment to be commissioned in order to fully ascertain all of the FPT requirements.

2.8 CxA MASTER ISSUES LOG (MIL)

A. Any issues noted by CxA are tracked in a Master Issues Log (MIL) located on the "Building Start" platform.

2.9 TEST EQUIPMENT

A. Division contractors shall provide all specialized tools, test equipment and instruments required to execute Start-Up, checkout and Functional Performance Testing of equipment under their contract.

B. Test equipment shall be of sufficient quality and accuracy to test and/or measure system performance with tolerances specified. A testing laboratory shall have calibrated test equipment within the previous 12 months. Calibration shall be NIST traceable. Equipment shall be calibrated according to manufacturer's recommended intervals and when dropped or damaged. Calibration tags shall be affixed or certificates readily available.

2.10 CxA FINAL COMMISSIONING REPORT

A. The CxA Final Commissioning Report will include:

1. Executive Summary including:

a. List of Commissioned Equipment/Systems.
b. List of participants and roles.
c. Overview of Commissioning and testing scope and general description of testing and verification methods.
d. Evaluation regarding disposition of equipment, systems and documentation in the following areas:

1) Conformance to specifications and design intent.
2) Equipment installation.
3) Functional performance.
4) Recommendations for improvement to equipment or operations, future actions, etc. will also be listed

2. Master Issues Log.
3. Executed Pre-Functional Checklists.
4. Executed Functional Performance Tests.
5. Site Visit Reports.

PART 3 - EXECUTION

3.1 COMMISSIONING OVERVIEW

A. The following provides a brief overview of typical Commissioning tasks during construction and general order in which they occur:

1. CxA develops project specific Construction Phase Commissioning Plan including specific Pre-Functional Checklists and equipment and system Functional Performance Test procedures. Construction Phase Commissioning Plan is forwarded to Commissioning team members for review prior to Cx Kick-Off meeting.
2. Commissioning during construction begins with a Kick-Off Meeting conducted by CxA where membership of Commissioning team is established and responsibilities reviewed. The construction phase Commissioning plan is reviewed during this meeting.

3. CxA schedules subsequent meetings as necessary to plan, coordinate and schedule Commissioning activities. Deficiencies and problem resolution will also be discussed at these meetings.
4. CM submits copies of final A/E approved submittals for all equipment to be commissioned to CxA for review. CxA revises Cx Plan if required.
5. CxA makes periodic site visits to review commissioned equipment installations and sample verify Pre-Functional Checklists completed by Subcontractors. Subcontractors provide the necessary personnel to assist CxA (e.g. remove A/C unit covers, open electrical panel covers, etc.) with sample PFC verifications.
6. Any issues noted by CxA are tracked in a Master Issues Log (MIL) on the “Building Start” platform. CM/Subcontractors correct issues noted by CxA and update MIL in “Building Start” for CxA verification of issue corrections.
7. CM/Subcontractors develop Start-Up Plans. CM and Subcontractors coordinate overall schedule of equipment/systems Testing and Start-Up and submit schedule to CxA so that CxA may witness Testing and Start-Up activities as required.
8. Subcontractors complete testing (e.g. duct and piping pressure testing, piping flushing, etc.) as required by Division 21, 22, 23, 26, 27 and 28 specifications. CxA witnesses a sampling of the testing activities during periodic site visits to verify that the proper procedures are followed. Subcontractors compile copies of completed testing documentation in the Start-Up Plan and submit to CxA for verification of completion of testing activities prior to Functional Performance Tests.
9. Subcontractors perform Start-Up and Initial Checkout per the Start-Up Plan documentation and checklists. Subcontractors assemble completed Start-Up Plan documentation and submit to CxA for verification of completion of Start-Up activities prior to Functional Performance Tests.
10. Functional Performance Tests are executed by Subcontractors, under supervision of and documented by CxA.
11. Items of non-compliance in material, installation or set-up will be corrected at Subcontractor expense and system shall be retested.
12. CM/Subcontractors execute Owner Training exercises per Owner Training Plan.
13. CxA issues Final Commissioning Report.

3.2 SYSTEMS TO BE COMMISSIONED

A. PLUMBING AND FIRE PROTECTION:

1. Verification of Hot Water delivery to plumbing fixtures
2. Automatic Sprinkler System (installation review only)

B. MECHANICAL:

1. All Air Valves, Chilled Beams, and Radiant Panels serving the Laboratory Modules
2. All Fan Coil Units
3. All Pressurization-Based Room Alarm Systems (if any)
4. General installation review of HVAC Piping and Ductwork.
5. Building Automation Systems (‘BAS/EMS’) for all commissioned equipment including graphics, system integration components, and network tie-ins to the existing campus BAS.
6. Note: We will not functionally re-test those central mechanical systems (AHUs, EFs, HHW and CHW Distribution) that serve the space that were previously commissioned in previous phases but will ensure that there are no capacity issues with the new fit-out spaces added.

C. ELECTRICAL:

1. Lighting and Daylighting Control Systems.
2. Normal and Emergency Electrical Power Distribution Systems including Switchboards, Distribution Panelboards and Panelboards with buss ratings greater than 400A, Bus Duct, Emergency Generators, Automatic Transfer Switches, and UPS.

D. COMMUNICATIONS SYSTEMS:

1. Telephone and Intercommunications Systems.
2. Cable TV and CCTV System

E. ELECTRONIC SAFETY AND SECURITY:

1. The Fire Alarm System – All typical interface functions with HVAC systems, smoke evacuation, security, doors, and emergency power will be witnessed for each distinct sequence. A sampling of 20% of all fire alarm devices will be witnessed to ensure correct alarm notification, labeling of device, activation of general alarm, etc.
2. Security and Intrusion Detection System.

3.3 RESPONSIBILITIES OF COMMISSIONING TEAM MEMBERS

A. Architect/Engineer (A/E):

1. Document design intent of systems. Respond to any issues developed during the commissioning process that may require clarification of design intent.

B. Commissioning Agent (CxA):

1. Facilitate cooperation of CT in Commissioning work.
2. Provide periodic progress reports of Commissioning status.
3. Review, track and coordinate resolution of non-compliance and deficiencies identified by Commissioning team. Maintain Master Issues Log (MIL), Resolution Log, & Testing Record. Maintain records of all issues submitted by Commissioning team.
4. Identify Commissioning activities for inclusion into the project schedule by the CM.
5. Attend and chair Commissioning team meetings as required.
6. Develop Construction Phase Commissioning Plan including project specific Pre-Functional Checklists and Functional Performance Test procedures. A single overall Commissioning Plan will be prepared for all phases of work.
7. Conduct initial Commissioning Kick-Off Meeting to review Cx Plan and responsibilities of each member of the CT.
8. Review TAB Execution Plan.
9. Review final A/E approved shop drawings for equipment to be commissioned and modify Cx Plan if required.
10. Review A/E approved control submittal sequences of operation and update Commissioning Plan Functional Performance Tests (FPTs) if required. Work with Contractors and AE until sufficient clarity has been obtained, in writing, to update Commissioning Plan FPTs.
11. Make periodic site visits to complete Commissioning work. Provide a summary “Site Visit Report” following each site visit
12. Attend construction meetings as necessary. Typically periodic site visits will be scheduled to allow attendance at regularly scheduled contractor progress meetings.

13. Monitor completion of Pre-Functional Checklists by Subcontractors by sample verifying completed checklists during periodic site visits.
14. Review final executed Start-Up Plan systems testing and equipment Start-Up documentation completed by Subcontractors.

15. Review the final Test and Balance report prior to Functional Performance Testing to verify systems readiness for testing.
16. Witness FPTs. Document test results and recommend system for acceptance.
17. During Functional Performance Testing (ideally) or immediately following, CxA shall verify the completeness and correctness of the BAS Graphical User Interface (GUI) in conjunction with the Owner's Facility personnel.
18. Provide final Commissioning report, summarizing final disposition of building systems after Functional Performance Testing. A single overall Final Commissioning Report will be provided for all phases of work.

C. Construction Manager (CM):

1. The CM leads the commissioning process for the construction team and facilitates cooperation of Subcontractors in executing and completing the commissioning work. In addition to the specific CM commissioning roles and responsibilities specified herein, the CM is ultimately responsible for ensuring that the Subcontractor commissioning roles and responsibilities given in other sections of this specification are executed and completed as specified.
2. Ensures resolution of non-compliance and deficiencies of construction related items identified by CxA. Insures "Building Start" database Master Issues Log (MIL) is updated by Subcontractors to reflect deficiency item corrections for CxA verification. Updates to "Building Start" database regarding corrections of deficiencies shall be made within two working days of completion of deficiency correction work.
3. Notifies CxA of completion of CM/Subcontractor Commissioning Activities (e.g. deficiency corrections, Start-Up completion, readiness for Functional Performance Testing, etc.) via "Building Start" database. Updates to "Building Start" database regarding status of Commissioning activities shall be made within two working days of activity completion.
4. Review Commissioning Plan, Pre-Functional Checklists, and FPT procedures.
5. Attend Commissioning Kick-Off Meeting and other Commissioning Team Meetings.
6. Assist CT with developing a comprehensive Commissioning schedule.
7. Incorporate Commissioning activities into the construction schedule.
8. Periodically update Commissioning activities in the construction schedule.
9. Submit copies of final A/E approved submittal data for all commissioned equipment to CxA for record purposes.
10. Develop, with cooperation of Sub-Contractors/Vendors, detailed Owner Training Program. Oversee development of equipment Start-Up Plan by Subcontractor and execution of equipment Start-Up checks by Subcontractor/Vendors.

a. Ensure equipment Start-Up Plan is developed and contains forms for all required Testing and Start-Up activities (see paragraph 2.5).
b. With Subcontractors, develop overall schedule of Testing and Start-Up activities. Submit final Testing and Start-Up schedule to CxA 30 days prior to start of any such activities to allow CxA to schedule site visit trips to witness activities as required.
c. Insure final executed Start-Up Plan is submitted to CxA prior to start of Functional Performance Testing. Insure final executed Start-Up plan is organized and contains all documentation required by this specification before submitting to CxA.

11. Update the Master Construction Schedule to include all Functional Performance Testing activities.
12. Assures CxA that equipment and systems are ready for Functional Performance Testing. Verifies that the following activities are completed, and documentation submitted to CxA as a prerequisite for Functional Performance Testing:

    a. PFCs are 100% complete in “Building Start” database.
    b. All deficiency items noted by CxA prior to Functional Performance Testing are corrected by Subcontractors and MIL is updated accordingly.
    c. Executed Start-Up Plan electronic PDF files submitted to CxA including:

        1) All equipment/systems testing documents completed by Subcontractors.
        2) All equipment/systems Start-Up documents completed by Subcontractors/Vendors.
        3) All Control System Start-Up documentation completed by Controls Contractor.
        4) Maintenance logs of all interim maintenance tasks performed by Subcontractors/Vendors on all equipment from initial Start-Up through final Owner acceptance, so warranties are not void.

    d. Submit hard-copy Commissioning Plan Functional Performance Test checklists signed and dated by Controls Subcontractor to CxA for review prior to start of Functional Testing (to verify controls contractor has thoroughly checked all FPTs prior to CxA witnessing FPTs).
    e. Final Test and Balance Report is submitted to CxA for review.

13. Submit maintenance logs of all interim maintenance tasks performed by Subcontractors/Vendors on all equipment from initial Start-Up through final Owner acceptance so warranties are not void.

D. Subcontractors/Vendors:

1. Review Commissioning Plan, Pre-Functional Checklists, and FPT procedures.
2. Correct deficiencies of construction related items identified by CxA. Update “Building Start” database to reflect deficiency item corrections for CxA verification. Updates to “Building Start” database regarding corrections of deficiencies shall be made within two working days of completion of deficiency correction work.
3. Notify CxA of completion of Commissioning Activities (e.g. deficiency corrections, Start-Up completion, readiness for Functional Performance Testing, etc.) via “Building Start” database. Updates to “Building Start” database regarding status of Commissioning activities shall be made within two working days of activity completion.
4. Attend Commissioning Kick-Off Meeting and other Commissioning Team Meetings.
5. Assist CT with developing a comprehensive Commissioning schedule.
6. Complete PFCs in “Building Start” database during each phase of construction (installation, piping, ducting, insulation, electrical, controls, etc.) as the work is completed.
7. Provide necessary personnel to assist CxA (e.g. remove FCU covers, open electrical panel covers, manipulate BAS, etc.) with sample verifications of the Pre-Functional Checklists as required during periodic CxA site visits.
8. Develop Start-Up Plan with CM (see paragraph 2.5).
9. Prepare Owner Training Program with CM.
10. Execute all required equipment and systems testing as required by project specifications (e.g. duct pressure testing, piping pressure testing, piping flushing, electrical acceptance testing, etc.). Provide schedule of testing activities to CxA 30 days prior to start of any testing so that CxA may witness a sampling of the testing

as required. Submit completed testing documentation in final executed Start-Up Plan electronic PDF files to CxA for review prior to start of Functional Performance Testing.

11. Execute equipment Start-Up per Start-Up Plan. Provide schedule of equipment Start-Up activities to CxA 30 days prior to beginning any equipment Start-Up so that CxA may witness a sampling of the equipment Start-Up activities as required. Submit completed Start-Up documentation in final executed Start-Up Plan electronic PDF files to CxA prior to start of Functional Performance Testing.
12. Execute all periodic maintenance required on started equipment from initial Start-Up of equipment to final acceptance by Owner to prevent equipment warranties from being voided. Document execution of periodic maintenance by signing and dating maintenance logs for each item of equipment. Submit maintenance log documentation in final executed Start-Up Plan electronic PDF files to CxA prior to start of Functional Performance Testing.
13. Ensure installation work is complete, is in compliance with Contract Documents and is ready for Functional Performance Testing.

    a. Verify PFCs are 100% complete in “Building Start” database.
    b. Verify all deficiency items noted by CxA prior to Functional Performance Testing are corrected and deficiency item status is updated in “Building Start” database. Deficiency item status updates should be made within two days of completion of corrective work.
    c. Verify Start-Up Plan electronic PDF files are forwarded to CM/CxA.
    d. Notify CT that equipment and systems are ready for Functional Performance Testing.

14. Execute FPTs developed by CxA as described in contract documents and Commissioning Plan. FPT test results will be documented by CxA.
15. Provide certified and calibrated instrumentation required to take measurements of system and equipment performance during Functional Performance Testing.
16. Execute training per Owner Training Program.
17. In addition to the above, the Mechanical Contractor shall assist and cooperate with the TAB Contractor, Controls Contractor and CxA by:

    a. Putting all HVAC Equipment and Systems into operation and continuing the operation during each working day of TAB and Commissioning, as required.
    b. Including cost of sheaves and belts that may be required by TAB.
    c. Providing test holes in ducts and plenums where directed by TAB to allow air measurements and air balancing.
    d. Provide factory fabricated, airtight, and non-corrosive test ports with screw cap and gasket equal to Ventlok type 699 at all locations where TAB Contractor shall make temperature, pressure, or velocity measurements. Mechanical Contractor shall coordinate location and quantity of TAB test ports with TAB Contractor.
    e. Providing Pressure and / or Temperature Testing Taps / Ports (a.k.a. P/T ports) according to the Construction Documents to facilitate TAB and Commissioning Testing or as required based on specified testing procedures. Install a P/T port at each Water Sensor (Temperature or Pressure) which is an Analog Input point to the Control System. P/T port shall be located within six inches of the Control System Sensor.

E. Controls Contractor (CC):

1. Review Commissioning Plan, Pre-Functional Checklists, and FPT procedures.
2. Correct deficiencies of construction related items identified by CxA. Update “Building Start” database to reflect deficiency item corrections for CxA verification.

Updates to “Building Start” database regarding corrections of deficiencies shall be made within two working days of completion of deficiency correction work.

3. Notify CxA of completion of Commissioning Activities (e.g. deficiency corrections, Start-Up completion, readiness for Functional Performance Testing, etc.) via “Building Start” database. Updates to “Building Start” database regarding status of Commissioning activities shall be made within two working days of activity completion.
4. Attend Commissioning Kick-Off Meeting and other Commissioning Team Meetings.
5. Prepare Owner Training Program with CM.
6. Completely install and thoroughly inspect Start-Up, test, adjust, calibrate and document systems and equipment under Building Automation/Controls Contract.
7. Complete PFCs in “Building Start” database as control work is completed.
8. Provide laptop computer, software and training to accommodate TAB Contractor in system balancing.
9. Maintain database of control parameters submitted by TAB Contractor subsequent to field adjustments and measurements.
10. Submit schedule of Control System Start-Up activities to CxA 30 days prior to beginning any Control System Start-Up work to allow CxA to witness Control Systems Start-Up work as required. Provide on-site technician skilled in software programming and hardware operation to assist CxA during DDC Sensor calibrations and device checks required during Start-Up.
11. Maintain comprehensive records of all Control System Start-Up records including but not limited to system calibration checkout records and point-to-point checklists. Submit completed Start-Up documentation in final executed Start-Up Plan electronic PDF files to CxA prior to start of Functional Performance Testing.
12. Ensure installation work is complete, is in compliance with Contract Documents and is ready for Functional Performance Testing.

    a. Verify PFCs are 100% complete in “Building Start” database.
    b. Verify all deficiency items noted by CxA prior to Functional Performance Testing are corrected and deficiency item status is updated in “Building Start” database. Deficiency item status updates should be made within two days of completion of corrective work.
    c. Verify Start-Up Plan electronic PDF files are forwarded to CM/CxA.
    d. Notify CT that equipment and systems are ready for Functional Performance Testing.
    e. Submit executed copies of the Commissioning Functional Performance Tests to CxA for review prior to start of Functional Performance Testing. The executed copies shall be signed and dated by the Control Contractor technician directly responsible for verification of the control sequence or system operation. The purpose of this process is to document that the Control Contractor has actually tested and verified each sequence prior to the CxA witnessing the Functional Performance Testing.
13. Provide instrumentation, computer, software, and communication resources necessary to demonstrate total operation of building systems and control system equipment during Functional Performance Testing.

14. Provide on-site technician skilled in software programming and hardware operation to exercise sequences of operation and to correct control deficiencies identified during Functional Performance Testing.
15. Execute training per Owner Training Program.

F. Test, Adjust and Balance (TAB) Contractor:

1. Review Commissioning Plan, Pre-Functional Checklists, and FPT procedures.

2. Correct deficiencies of construction related items identified by CxA. Update "Building Start" database to reflect deficiency item corrections for CxA verification. Updates to "Building Start" database regarding corrections of deficiencies shall be made within two working days of completion of deficiency correction work.
3. Notify CxA of completion of Commissioning Activities (e.g. deficiency corrections, Start-Up completion, readiness for Functional Performance Testing, etc.) via "Building Start" database. Updates to "Building Start" database regarding status of Commissioning activities shall be made within two working days of activity completion.
4. Attend Commissioning Kick-Off Meeting and other Commissioning Team Meetings.
5. Prepare Owner Training Program with CM.
6. Submit TAB Plan and forms describing methodology for execution of test and balance procedures specific to this project to CT for review.
7. Cooperate with CC with execution of required work.
8. The TAB Contractor shall assist and cooperate with the Mechanical Contractor, Controls Contractor and CxA by:

a. Coordinating with the Mechanical Contractor regarding the cost of sheaves and belts that may be required by TAB.
b. Coordinating location and quantity of TAB test ports with Mechanical Contractor.
c. The TAB Contractor shall permanently mark and identify the location points of the duct test ports with computer generated (DYMO type) labels. If the ducts have exterior insulation, these markings shall be made on the exterior side of the duct insulation. All test port locations shall be labeled corresponding to final TAB report.
d. Coordinating location and quantity of TAB P/T ports with Mechanical Contractor.

9. Coordinate schedule for all TAB activities with CxA. Provide CxA with final schedule for all TAB activities 30 days prior to starting TAB work to allow CxA to schedule site visits to witness TAB work and readings as required.
10. Submit copy of final TAB report to CxA for review prior to start of Functional Performance Testing.
11. Rebalance deficient areas identified during Commissioning.
12. Provide on-site technician and equipment, as necessary, skilled in TAB procedures to provide verification of equipment and system performance and to correct any TAB deficiencies identified during:

a. Functional Performance Testing.

13. Provide on-site technician and equipment, as necessary, skilled in TAB procedures to provide verification of Final TAB report air and water readings during Functional Performance Testing.

3.4 COMMISSIONING TEAM (CT) MEETINGS

A. CT meetings will be held periodically as determined by CxA with frequency increasing as construction advances and systems become operational. Attendance is mandatory. CxA will record minutes and attendance. CxA will chair CT Meetings.

B. Discussions held in CT meetings shall include, but not be limited to system/equipment Start-Up, progress, scheduling, testing, documentation, deficiencies and problem resolution.

3.5 REPORTING

A. CxA will provide regular status reports to CM and Owner, with increasing frequency as construction and Commissioning progresses.

B. CxA will regularly communicate with members of Commissioning team, keeping them apprised of Commissioning progress.

C. CxA shall submit non-compliance and deficiency reports to Owner and CM.

D. CxA shall provide a Final Commissioning Report to Owner.

3.6 PRE-FUNCTIONAL CHECKLISTS (PFC)

A. CM/Subcontractors will complete the Pre-Functional Checklists in the “Building Start” database.

B. CM/Subcontractors will complete the PFCs in phases (e.g. setting equipment, piping equipment, insulating it, making up electrical connections, etc.) as the work is completed in the field. *The intent is for the CM/Subcontractors to complete the PFCs in the “Building Start” database as the work is being completed - not to wait until the end of the installation to complete the PFCs*.

C. CxA will monitor the CM/Subcontractor PFC completion via the “Building Start” database and provide updates on completion status in CxA Site Visit Reports. CM/Subcontractor shall provide necessary field personnel to compete the PFCs in a timely manner concurrent with work progress. PFC completion status not matching work completion observed in the field will be noted as a deficiency issue by the CxA.

D. CxA will sample verify completed PFCs during periodic site visits.

E. The CxA will randomly select PFCs from each commissioned system for verification during periodic site visits. The Pre-Functional Checklists will be sample verified by the CxA at approximately 50% equipment rough-in stage (equipment set, piped and/or ducted) and at 100% complete installation just prior to Functional Performance Testing.

F. Any deficiency issues noted will be included and tracked in the Master Issues Log.

3.7 MASTER ISSUES LOG (MIL)

A. Commissioning Issues will be tracked from initial notice by CxA through correction via the “Building Start” database as follows:

1. Open Issue:

a. Issues noted by the CxA during periodic site visits will be included to the “Building Start” Master Issues Log (MIL) for each building.

2. Pending Issue:

a. The Subcontractors shall correct the deficiency items and notify the CxA when the items are corrected and ready for CxA verification by updating the deficiency item status from “Open” to “Pending” in the “Building Start:” database. CxA does not recheck issues until they have been noted ready to be reviewed on the “Building Start” MIL by the Subcontractor that corrected the issue.

3. Closed Issue:

a. The CxA will verify the correction and update the item status from “Pending” to “Closed” in the “Building Start” database.

B. Costs for CxA to reverify any Issue marked by the Subcontractor for CxA recheck and found to be incomplete will be back-charged to the CM (see paragraphs below for CxA costs).

3.8 START-UP AND INITIAL CHECKOUT

A. CM/Subcontractors shall schedule all required Systems Testing and Equipment Start-Up with Commissioning Team. CM/Subcontractors shall execute Systems Testing and Equipment/Systems Start-Up per the Start-Up Plan.

B. CM/Subcontractor shall submit initial Start-Up Plan to CxA for review 60 days prior to start of any Testing or Start-Up activities. CxA shall review the initial Start-Up Plan to ensure that the required documentation is provided and organized as required. CxA shall provide a Start-Up Plan review report. CM/Subcontractors shall revise the initial Start-Up Plan documentation as required by CxA review comments.

C. CM/Subcontractor shall submit final schedule of Testing and Start-Up activities to CxA 30 days prior to any testing or Start-Up activity to allow CxA to witness as required.

D. CM/Subcontractor shall execute equipment/systems Testing and Start-Up per Start-Up Plan, document results and compile/organize all Start-Up Plan documentation into electronic PDF files (searchable from Table of Contents to each documentation item).

E. CM/Subcontractor forward copy of completed Start-Up Plan PDF files to CxA for review to verify completion of Start-Up activities. Executed Start-Up Plan PDF files must be submitted to CxA prior to start of Functional Testing.

F. CM/Subcontractors shall clearly list outstanding items or Testing/Start-Up activities that are not completed successfully. Updates to “Building Start” database regarding corrections of any Testing and Start-Up deficiency issues shall be made within two working days of completion of retesting work.

G. Subcontractors shall submit an updated Start-Up report and Statement of Correction on any incomplete or non-compliance report.

H. Any Testing or Start-Up activity marked as completed which is later found to be incomplete and causes re-verification work by CxA, delays during Functional Performance Testing, or retesting will be back-charged to the CM (see paragraphs below for CxA costs).

3.9 FUNCTIONAL PERFORMANCE TESTING

A. Objectives and Scope:

1. The objective of Functional Performance Testing is to demonstrate each system is operating according to documented design intent and Contract Documents. Functional Performance Testing facilitates bringing systems from a state of substantial completion to full dynamic operation. Additionally, during Functional Performance Testing, areas of deficient performance are identified and corrected, improving operation and functioning of systems.

2. Each system shall be operated through all modes of operation (occupied, unoccupied, warm-up, cool-down, etc.) where there is a specified system response. Verifying each sequence in the sequences of operation is required.
3. Functional Performance Testing is separate from and in addition to any other Start-Up, testing, demonstration or contractor commissioning required by the project specifications.
4. The CxA will document the Functional Performance Testing utilizing the "Building Start" database.

B. Initial Control Systems Checkout:

1. The control systems must be verified for correct operation by the Control System Subcontractor *prior to the CxA witnessing and documenting the Functional Performance Tests*. The CxA Functional Performance Tests are intended to document completion of the Control System and proper operation of the Commissioned Systems. The CxA Functional Performance Tests are not intended to serve as a "Quality Control" measure or "Punch List" for the Construction Manager, Controls Contractor or other Subcontractor. The CxA Functional Performance Tests are not intended to serve as "Beta" testing for the Control Systems.
2. The Control Systems Subcontractor shall sign/initial and date a copy of the Cx Plan FPT forms prior to verification by CxA. Only individuals having direct knowledge that a line item task or sequence of operation was actually performed or checked will initial or check that item off. The Control Systems Subcontractor shall list any FPT sequences or items not completed successfully utilizing the notes section of the FPT form. These notes shall clearly indicate why the item or sequence was not completed or operated as indicated on the FPT form.
3. The intent of this process is for the Control Systems Subcontractor to physically check and verify proper equipment and integrated systems operation for all operational sequences prior to the CxA witnessing and documenting the actual Functional Performance Testing.

C. Coordination and Scheduling:

1. Prior to equipment Start-Up, CxA will conduct a Commissioning Functional Testing Schedule Workshop with the Commissioning Team in order to establish a coordinated approach to the integration of the Functional Performance Testing activities within the Master Construction Schedule. The CM will update the Master Construction Schedule to include all Functional Performance Testing activities.
2. CM will provide sufficient notice to CxA regarding completion schedule for equipment and systems. CM will schedule Functional Performance Tests with CT. CxA shall witness and document functional testing of equipment and systems. Subcontractor shall execute tests under direction of CxA.
3. CM must allow sufficient time in the Construction Schedule to complete the Functional Performance Testing prior to Owner move-in/occupancy. This includes completing the commissioned systems installations, Testing, Start-Up, and all prerequisites required for Functional Performance Testing. Time and expenses for CxA to complete Functional Performance Testing during Owner move-in or after Owner occupancy will be considered Additional Services to be paid by the CM.
4. Functional Performance Tests are integrated systems tests. For example, the Fire Alarm System must be complete and ready for operation in order to test the AHU Fire Alarm shutdown sequence. All equipment and systems associated with a Functional Performance Test must be complete and ready for testing.
5. In general the Functional Performance Testing will be organized/scheduled based on the following hierarchy:

a. Project completion. Some areas of the building may be complete before other areas. Priority will be given to these area systems assuming they can be grouped together for integrated systems testing.
b. Integrated systems. In general, the testing will be organized into groups of integrated systems from larger systems down to smaller systems (e.g. chilled water system, air handling system, terminal units, etc.).
c. Systems with limited integration and "stand alone" systems (e.g. unit heater or fan only being monitored by the building control system).

6. Functional Performance Tests will be grouped together to allow testing to be conducted over weekly testing periods to maximize testing efficiencies. Single systems testing spread out over multiple testing weeks will not be allowed. In general, the testing will begin on Monday and end on Friday afternoon. The actual testing hours will be coordinated with the CM/Subcontractors based on the amount of testing work to be completed during that week. CM/Subcontractors should be prepared to work from 8:00AM to 5:00PM each day to complete the testing for that weekly period.
7. Some systems may require testing after normal working hours (e.g. Lighting Controls, etc.) to avoid conflicts with ongoing work or adjacent building operations. This testing will be scheduled for evenings (Monday – Thursday) or early mornings (Tuesday – Friday). Weekend testing will only be allowed if agreed upon by CT in advance.

D. Prerequisites for Functional Performance Testing:

1. Pre-Functional Checklists must be 100% complete in "Building Start" - *including any deficiency corrections noted from CxA sample verifications* - as a prerequisite to scheduling Functional Performance Tests.
2. The CM/Subcontractors must submit the fully executed Start-Up Plan electronic PDF files including all equipment and systems testing documentation (e.g. duct and piping pressure testing, cleaning/flushing documentation, etc.), and all executed start up and initial check-out documentation as a prerequisite to scheduling Functional Performance Tests.
3. The TAB Subcontractor shall complete all test and balance work and submit Final Test and Balance Report for review by A/E and CxA prior to start of Commissioning Functional Testing. A/E shall review Final Test and Balance Report for acceptance. CxA review of Final TAB Report is cursory (not for acceptance) and is primarily intended to ensure that the equipment and systems are ready to be functionally tested.
4. The CM/Control Contractor must submit all control systems Start-Up and initial checkout documentation (including point-to-point verifications, etc.) in the Start-Up Plan as a prerequisite to scheduling Functional Performance Tests.
5. The CM/Control Contractor must submit executed copies of the Commissioning Functional Performance Tests (signed and dated by the Control Contractor technician directly responsible for verification of the control sequence or system operation) to the CxA as a prerequisite to scheduling Functional Performance Tests (to show that the Control Contractor has actually tested and verified each sequence prior to CxA witnessing the Functional Performance Tests).

E. Test and Balance (TAB) Verification:

1. Initial TAB Verification test will include a random sampling of all TAB final report air and water readings. TAB Subcontractor will re-read devices with the same equipment used in the TAB process in the presence of the CxA. The devices will be selected at random by the CxA and the CxA will record the TAB Verification

readings. All Verification readings must be within ±10% of final TAB report readings.

2. Readings outside of the ±10% tolerance in more than 10% of the TAB Verification readings will indicate failure of the initial TAB Verification testing and require re-testing. TAB Subcontractor will correct all deficient readings and schedule TAB Verification re-testing with CxA. The CxA will randomly select a different sample of the TAB final report readings for the Verification re-testing.
3. Readings outside of the ±10% tolerance in more than 10% of the TAB Verification re-testing readings will indicate failure of the Verification re-test and will require a second re-testing. TAB Subcontractor will correct all deficient readings and schedule second TAB Verification re-testing with CxA. The TAB Verification re-testing procedures will be repeated a second time again utilizing a different sample of the final TAB report readings selected at random by the CxA.
4. Readings outside of the ±10% tolerance in more than 10% of the second TAB Verification re-testing readings will require TAB Verification retesting for all of the TAB final report readings.
5. All TAB verification retesting will be completed at no additional cost to the Owner. See paragraphs below for CxA costs for retesting.

3.10 DOCUMENTATION, NON-CONFORMANCE AND APPROVAL OF TESTS

A. Documentation:

1. CxA will witness and document results of FPT utilizing “Building Start”. FPTs are made available to the Commissioning Team in “Building Start” for review and approval prior to testing. CxA will include the executed FPTs in the Final Commissioning Report.

B. Non-Conformance:

1. CxA will record results of Functional Performance Testing. Deficiency or Non-Conformance Issues will be noted and reported to CM and Owner in the “Building Start” Master Issues Log (MIL).
2. Corrections of minor deficiencies identified may be made during tests at discretion of CxA. In such cases, deficiency and resolution will be documented in “Building Start” FPT.
3. Every effort will be made to expedite testing and minimize unnecessary delays, while not compromising integrity of tests. CxA shall not overlook deficient work or loosen acceptance criteria to satisfy scheduling or cost issues unless directed to do so by the Owner.
4. Deficiency and Non-Conformance Issues are handled in the following manner:

a. When there is no dispute on Deficiency Issue and Subcontractor accepts responsibility for remedial action:

1) CxA documents Deficiency Issue and Subcontractors response and intentions in “Building Start” MIL and they go on to another test or sequence.
2) All issues are made available to CT via “Building Start” MIL and written Cx Site Visit Reports.
3) Subcontractor corrects deficiency and updates Issue status to “Pending” in “Building Start” MIL.
4) CM reschedules test with Subcontractor.
5) CxA witnesses retesting and documents results. Corrected issues will be updated in “Building Start” MIL to “Closed”.
6) See paragraphs below for CxA costs for retesting and reverification work

b. When there is a dispute about a Deficiency Issue, regarding whether it is a deficiency or who is responsible:

1) CxA documents Deficiency Issue and Subcontractors response and intentions in "Building Start" MIL and they go on to another test or sequence.
2) All issues are made available to CT via "Building Start" MIL and written Cx Site Visit Reports.
3) CM facilitates resolution of deficiency. Other parties are brought into discussions as needed. Final interpretive authority is with A/E. Final acceptance authority is with the Owner.
4) CM documents resolution process.
5) Once interpretation and resolution has been decided, appropriate party corrects deficiency and updates Issue status to "Pending in "Building Start" MIL.
6) CM reschedules test and test is repeated until satisfactory performance is achieved.
7) CxA witnesses retesting and documents results. Corrected issues will be updated in "Building Start" MIL to "Closed".
8) See paragraphs below for CxA costs for retesting and reverification work

C. Costs for CxA MIL Verifications and Retesting:

1. Cost for Subcontractor to correct and retest any PFC or FPT deficiency item, if they are responsible for deficiency, will be theirs. If Subcontractor is not responsible, cost recovery for retesting will be negotiated with CM.
2. CxA has included a 8 hour allowance for delays, reverifications, and retesting work to be used over the duration of the Cx process. CxA will provide status of retesting allowance to CT in periodic site visit reports. CxA labor and expenses for any of the following work beyond the 8 hour allowance will be back-charged to the CM at a cost of $2500 per man-day. The CM must pay retesting costs to CxA in advance for CxA to schedule retesting or reverification site visits.

a. Excessive Deficiency Issue Verifications (for excessive/repeated issues).
b. Any reverification of a Deficiency Issue when the Issue is marked as corrected by the Subcontractor and found to remain deficient by CxA on verification.
c. Retesting required because any Functional Performance Test prerequisite reported to have been successfully completed by the CM/Subcontractor is found to be faulty or incomplete during Functional Performance Testing.
d. Delays during Functional Performance Testing caused by excessive or repeated testing failures.
e. FPT Retesting for any reason.
f. Any FPT MIL Issue Verifications or Retesting.

D. Cost for TAB Verification Retesting:

1. Cost for TAB Subcontractor to correct and retest any TAB deficiency item, if they are responsible for deficiency, will be theirs. If TAB Subcontractor is not responsible, cost recovery for retesting will be negotiated with CM.
2. CxA labor and expenses for any TAB Verification retesting will be back charged to the TAB Subcontractor (or responsible Subcontractor) at a cost of $2500 per man-day. TAB Subcontractor (or responsible Subcontractor) must pay retesting costs to CxA in advance for CxA to schedule retesting site visits.

E. Costs for Functional Performance Test Additional Services:

1. Cost for CM/Subcontractor to complete Functional Performance Testing Additional Services will be theirs.
2. Additional Services for CxA to complete any Functional Performance Testing during Owner move-in or after Owner occupancy (regardless of whether the testing was attempted prior to that point or not) will be paid for by the CM at a cost of $2500 per man-day. CM must pay testing costs to CxA in advance for CxA to schedule testing site visits during Owner move-in or after Owner occupancy.

F. Approval:

1. CxA notes each satisfactorily demonstrated function on test form. CxA, A/E and Owner provide formal approval of FPT. CxA recommends acceptance of each test to Owner. The Owner gives final approval, providing a signature to CM and Subcontractor.

3.11 TRAINING OF OWNER PERSONNEL

A. CM/Subcontractors/Vendors will provide complete training in start-up, operation and maintenance of all equipment under contract.

B. CM and Subcontractors will be responsible for

1. Developing Owner Training Program.
2. Scheduling of Owner Training with Owner and Subcontractors.
3. Execution of Owner Training.
4. Documentation of completed Owner Training.

C. General sequencing of the development of the Owner Training Program and completion of the Owner training is as follows:

1. CM will prepare an outline of the Owner Training Program within 30 days of completion of submittal process (i.e. all equipment/systems approved by A/E). Submit Owner Training Program outline to CT for review.
2. Schedule for Owner Training sessions will be reviewed and updated as required throughout the project construction by CT at contractor progress meetings. CM will submit final Owner Training Schedule to CT 30 days prior to start of training exercises to allow CxA sufficient time to schedule site visit trips to witness the Owner training exercises as required.
3. Subcontractors/vendors will execute training exercises per Training Program.
4. CM will submit a copy of the final executed Owner Training Program and Owner Training Manuals including all training documentation (sign-in sheets, handouts, training DVDs, comprehension tests, etc.) on completion of Owner Training exercises.

END OF SECTION 019113

Note: Sample Pre-Functional Checklists, Sample Functional Performance Tests, and Table of Sample BAS Monitoring Points by System Type follow.

Sample HVAC Pre-Functional Checklist

PROJECT: University of Kentucky - RB2 - Phase 2
LOCATION: Lexington, KY

SYSTEM/UNIT: HVAC Equipment/ AHU

Tested By:
Date:

Model Verification - HVAC Equipment/ AHU

	Verification	Response	Notes	By	Date/Time
1	Specified Manufacturer				
2	Installed Manufacturer				
3	Specified Model #				
4	Installed Model #				
5	Serial #				
6	Specified Airflow				
7	Specified Static Pressure				

General - HVAC Equipment/ AHU

	Verification	Response	Notes	By	Date/Time
1	Inspection and Access doors are operable				
2	Casing Undamaged				
3	Equipment has been cleaned and finish touched up if necessary.				
4	Manufacturer's required maintenance clearance provided for service.		23 05 [illegible] 1.8 E		
5	Specified unit mounting requirements		Sch[illegible]ule Note 10		
6	Verify unit is mounted per plans and specs		Schedule Note 10		
7	Specified access doors		Schedule Note 4		
8	Verify access doors are provided per plans and specs		Schedule Note 4		
9	Access doors are installed so [illegible] air leaks through door				
10	Access doors open against air pressure				
11	Specified lights are provided per plans and specs		Schedule Note 5		
12	Verify lights are installed in locations per plans and specs		Schedule Note 5		
13	4" housekeeping pad is provided under all floor mounted equipment		23 05 48 3.4 G		
14	Flexible pipe connectors are installed on all equipment supported by vibration isolation		23 05 48 3.4 L		

Accessories - HVAC Equipment/ AHU

	Verification	Response	Notes	By	Date/Time
1	Specified accessories are provided (1)		Schedule Note 12		
2	Verify accessories are provided (1)		Schedule Note 12		
3	Specified accessories are provided (2)		Schedule Note 11		
4	Verify accessories are provided (2)		Schedule Note 11		
5	UV lights are factory installed downstream of cooling coils		Schedule Note 16		

Sample HVAC Pre-Functional Checklist

PROJECT: University of Kentucky - RB2 - Phase 2
LOCATION: Lexington, KY

SYSTEM/UNIT: HVAC Equipment- AHU

Tested By:
Date:

Ductwork - HVAC Equipment - AHU

	Verification	Response	Notes	By	Date/Time
1	Ductwork is connected to unit with flexible connections		Schedule Note 19		
2	Duct installation is complete				
3	Access doors installed and labeled at fire / smoke dampers, fire dampers, and smoke detectors		23 31 13 3.1 E		

Controls - HVAC Equipment/ AHU

	Verification	Response	Notes	By	Date/Time
1	Return duct smoke detector is installed in return duct		Schedule Note 1		
2	Supply duct smoke detector is installed after supply fan		Schedule Note 13		
3	Specified return air sensors are installed per the controls schematic		M06-02 Detail C3		
4	Verify return air sensors are installed per the controls schematic		M06-02 Detail C3		
5	Specified mixed air sensors are installed per the controls schematic		M06-02 Detail C3		
6	Verify mixed air sensors are installed per the controls schematic		M06-02 Detail C3		
7	Specified discharge air sensors are installed per the controls schematic		M06-02 Detail C3		
8	Verify discharge air sensors are installed per the controls schematic		M06-02 Detail C3		
9	Specified automatic dampers are installed per the controls schematic		M06-02 Detail C3		
10	Verify automatic dampers are installed per the controls schematic				

Labeling - HVAC Equipment/ AHU

	Verification	Response	Notes	By	Date/Time
1	Permanently fasten labels are on each major item of mechanical equipment. Labels are located in accessible and visible areas.		23 05 53 2.3 A		
2	Duct is labeled with contents and flow direction		23 05 53 2.3 C		

Insulation - HVAC Equipment/ AHU

	Verification	Response	Notes	By	Date/Time
1	Specified Air Duct Insulation requirements:		23 07 13 4.1 - EXPOSED: 2" Rigid Fiberglass Board; CONCEALED: 2" Flexible Fiberglass with Vapor Barrier		
2	Verify Air Duct Insulation requirements:		23 07 13 4.1		

Startup Mechanical - HVAC Equipment/ AHU

	Verification	Response	Notes	By	Date/Time
1	Contractor's executed startup procedures haves been submitted for review				

Sample HVAC Functional Performance Test

PROJECT: University of Kentucky - RB2 - Phase 2
LOCATION: Lexington, KY

SYSTEM/UNIT: AHU

Tested By:
Date:

1.01 Pre-test Set points & Conditions - HVAC Equipment/ AHU

	Verification	Response	Notes	By	Date/Time
1	RECOR D: OA Flow				
2	RECOR D: OA Damper Command				
3	RECOR D: RA Temperature °F				
4	RECORD: RA Humidity %RH				
5	RECOR D: CHW Valve Status/Command				
6	RECORD: CHW Coil LAT				
7	RECORD: VFD - 1 Status/Command				
8	RECORD: VFD - 1 Speed %				
9	RECORD: VFD - 2 Status/Command				
10	RECORD: VFD - 2 Speed %				
11	RECORD: SA Temperature Setpoint/Actual	°F			
12	RECORD: SA Flow Setpoint/Actual				
13	RECORD: Interlocked Exhaust Fan(s) Status/Command				
14	RECORD: Coil DP Setpoint/Actual				
15	RECORD: 2/3 Duct Static Pressure				

1.02 Post-test Set points - HVAC Equipment/ AHU

	Verification	Response	Notes	By	Date/Time
1	RESET: Upon completion of test reset set points to pre-test set point values				

Sample HVAC Functional Performance Test

PROJECT: University of Kentucky - RB2 - Phase 2
LOCATION: Lexington, KY

SYSTEM/UNIT: HVAC Equipment/AHU

Tested By:
Date:

2.01 Unit - On - HVAC Equipment/AHU

	Verification	Response	Notes	By	Date/Time
1 **-1x**	TEST PROCEDURE: Unit is commanded on via building BMS				
2	EXPECTED RESPONSE: Fire/Smoke Dampers are fully opened				
3	EXPECTED RESPONSE: Supply fan is energized and runs continuously during unit operation				
4	EXPECTED RESPONSE: Interlocked Exhaust Fan(s) is energized and runs continuously during unit operation				
5	EXPECTED RESPONSE: VFD(s) modulates to maintain constant flow as filters get loaded				
6	EXPECTED RESPONSE: OA damper opens to minimum airflow position				
7	EXPECTED RESPONSE: RA damper opens fully				
8	EXPECTED RESPONSE: OA damper modulates to maintain OA flow setpoint				
9	EXPECTED RESPONSE: Cooling coil valve modulates to maintain LAT setpoint (50°F, adj.)				
10	VERIFY: Supply fan minimum runtime is programmed				

2.02 Cooling Coil Control - HVAC Equipment/AHU

	Verification	Response	Notes	By	Date/Time
1	TEST PROCEDURE: Simulate OA temp > 45°F				
2	EXPECTED RESPONSE: Cooling Coil is enabled				
3	EXPECTED RESPONSE: Cooling coil control valve modulates to maintain LAT setpoint of 50°F (adj.)				

Sample HVAC Functional Performance Test

PROJECT: University of Kentucky - RB2 - Phase 2
LOCATION: Lexington, KY

SYSTEM/UNIT: HVAC Equipment/AHU

Tested By:
Date:

2.03 Supply Air Reset - HVAC Equipment/AHU

	Verification	Response	Notes	By	Date/Time
1	TEST PROCEDURE: Simulate return air temperature > return air high limit				
2	EXPECTED RESPONSE: Supply air temperature setpoint is reset downward				
3	RECORD: RA Temperature High Limit Setpoint	°F			
4	RECORD: Supply Air Temperature Setpoint/Actual	°F			
5	TEST PROCEDURE: Simulate return air temperature < return air low limit				
6	EXPECTED RESPONSE: Supply air temperature setpoint is reset upward				
7	RECORD: RA Temperature Low Limit Setpoint	°F			
8	RECORD: Supply Air Temperature Setpoint/Actual	°F			

2.04 Unit - Off - HVAC Equipment/AHU

	Verification	Response	Notes	By	Date/Time
1	TEST PROCEDURE: Unit is commanded to shut down via building BMS				
2	EXPECTED RESPONSE: OA damper closes				
3	EXPECTED RESPONSE: CHW Coil opens				
4	EXPECTED RESPONSE: Supply fan deenergizes				
5	EXPECTED RESPONSE: Interlocked exhaust fan(s) deenergizes				

3.01 High Space Temperature Alarm - HVAC Equipment/AHU

	Verification	Response	Notes	By	Date/Time
1	TEST PROCEDURE: Simulate space temperature greater than the cooling setpoint by a "user defined amount"				
2	EXPECTED RESPONSE: Alarm is sent to BMS				

3.02 Low Space Temperature Alarm - HVAC Equipment/AHU

	Verification	Response	Notes	By	Date/Time
1	TEST PROCEDURE: Simulate space temperature lower than the cooling setpoint by a "user defined amount"				
2	EXPECTED RESPONSE: Alarm is sent to BMS				

Sample HVAC Functional Performance Test

PROJECT: University of Kentucky - RB2 - Phase 2
LOCATION: Lexington, KY

SYSTEM/UNIT: HVAC Equipment/AHU

Tested By:
Date:

3.03 High Return Air Humidity - AHU

	Verification	Response	Notes	By	Date/Time
1	TEST PROCEDURE: Simulate RA humidity > 70% (adj.)				
2	EXPECTED RESPONSE: Alarm is sent to BMS				

3.04 Low Return Air Humidity - AHU

	Verification	Response	Notes	By	Date/Time
1	TEST PROCEDURE: Simulate RA humidity < 35% (adj.)				
2	EXPECTED RESPONSE: Alarm is sent to BMS				

3.05 Supply Fan Failure - HVAC Equipment/AHU

	Verification	Response	Notes	By	Date/Time
1	TEST PROCEDURE: Simulate supply fan status does not match command				
2	VERIFY: Remaining supply fan(s) ramp up to maintain supply airflow setpoint				
3	EXPECTED RESPONSE: Alarm is sent to BMS				
4	TEST PROCEDURE: Simulate supply fan runtime exceeded				
5	EXPECTED RESPONSE: Alarm is sent to BMS				
6	RECORD: Runtime Alarm Setpoint				

3.06 Pre Filter DP Alarm - HVAC Equipment/AHU

	Verification	Response	Notes	By	Date/Time
1	TEST PROCEDURE: Simulate DP across pre filter > pre filter DP setpoint				
2	EXPECTED RESPONSE: Alarm is sent to BMS				

3.07 Final Filter DP Alarm - HVAC Equipment/AHU

	Verification	Response	Notes	By	Date/Time
1	TEST PROCEDURE: Simulate DP across final filter > final filter DP setpoint				
2	EXPECTED RESPONSE: Alarm is sent to BMS				

3.08 Smoke/Fire Detection Alarm - HVAC Equipment/AHU

	Verification	Response	Notes	By	Date/Time
1	TEST PROCEDURE: Simulate smoke detected/emergency shutdown signal				
2	EXPECTED RESPONSE: Unit shuts down according to shutdown sequence				
3	EXPECTED RESPONSE: Alarm is sent to BMS				

Sample Plumbing Systems Functional Performance Test

PROJECT: University of Kentucky RB2 - Phase 2
LOCATION: Lexington, KY

SYSTEM/UNIT: Domestic Hot Water System

1.00 Sample FPT - Domestic Hot Water System

	Verification	Response	Notes	By	Date/Time
1	Sample FPT				

1.02 Pre-test Setpoints & Conditions - Domestic Hot Water System

	Verification	Response	Notes	By	Date/Time
1	RECORD: WH-A Status				
2	RECORD: WH-B Status				
3	RECORD: Recirculation Pump A Status				
4	RECORD: Recirculation Pump B Status				
5	RECORD: DHWR Temperature				
6	RECORD: DHWS Leaving WH-A Temperature Setpoint/Actual				
7	RECORD: DHWS Leaving WH-B Temperature Setpoint/Actual				
8	RECORD: WH-A Circulation Pump Status				
9	RECORD: WH-B Circulation Pump Status				
10	RECORD: WH-A Temperature Control Valve Position (If available)				
11	RECORD: WH-B Temperature Control Valve Position (If available)				
12	RECORD: HW Temperature to HX				
13	RECORD: HW Temperature Leaving HX				
14	RECORD: Mixing Valve Setpoint/Actual Leaving Water Temperature				

Sample Plumbing Systems Functional Performance Test

PROJECT: University of Kentucky RB2 - Phase 2
LOCATION: **Lexington, KY**

SYSTEM/UNIT: Domestic Hot Water System

2.01 System Enabled - Domestic Hot Water System

	Verification	Response	Notes	By	Date/Time
1	TEST PROCEDURE: Domestic Water System is enabled				
2	EXPECTED RESPONSE: Domestic Water Recirculation Pumps are energized manually				
3	EXPECTED RESPONSE: Active Water Heater's circulation pump is energized				
4	EXPECTED RESPONSE: Water Heaters Temperature Control Valve modulates to maintain the LWT Setpoint				
5	EXPECTED RESPONSE: Mixing Valve maintains setpoint				
6	TEST PROCEDURE: Water Heater LWT is above or below setpoint				
7	EXPECTED RESPONSE: Water Heaters Temperature Control Valve modulates to maintain the LWT Setpoint				
8	RECORD: DHWS Leaving WH-A Temperature Setpoint/Actual				
9	RECORD: DHWS Leaving WH-B Temperature Setpoint/Actual				
10	EXPECTED RESPONSE: Mixing Valve maintains setpoint				

2.02 System Disabled - Domestic Hot Water System

	Verification	Response	Notes	By	Date/Time
1	TEST PROCEDURE: Domestic Water System is disabled				
2	EXPECTED RESPONSE: Domestic Water Recirculation Pumps are de-energized manually				
3	EXPECTED RESPONSE: Water Heater's circulation pumps are de-energized				
4	EXPECTED RESPONSE: Water Heaters Temperature Control Valves open to bypass				

3.01 System Alarm - Domestic Hot Water System

	Verification	Response	Notes	By	Date/Time
1	TEST PROCEDURE: Simulate an alarm from the system				
2	EXPECTED RESPONSE: Alarm is sent to BAS				

Sample Electrical Systems Functional Performance Test

PROJECT: University of Kentucky RB2 - Phase 2
LOCATION: Lexington, IN

SYSTEM/UNIT: Lighting Controls

1.0 Test Procedure: Occupancy Sensor

	Verification	Response	Notes	By	Date/Time
1	VERIFY A minimum of 20% of occupancy sensors are to be functionally tested. Document room tested and results of device tested.				
2	VERIFY by visual response that:				
3	PROCEDURE Device senses space is occupied and turns lights ON.				
4	PROCEDURE Device senses space is un-occupied.				
5	PROCEDURE Device turns lights off after preset time delay. (10-30 minutes)				
6	PROCEDURE Local switch operates properly, if applicable.				
7	PROCEDURE Device location during time of functional testing is indicated below:				

1.1 Device Location: Occupancy Sensor

	Verification	Response	Notes	By	Date/Time
1	RECORD Devices installed in the following areas were demonstrated to operate, with any issues noted on the MIL. See 'Comments' section for device location.				
2	Level 1				

1.2 Device Location: Occupancy Sensor

	Verification	Response	Notes	By	Date/Time
1	Level 2				

1.3 Device Location: Occupancy Sensor

	Verification	Response	Notes	By	Date/Time
1	Level 3				

1.4 Device Location: Occupancy Sensor

	Verification	Response	Notes	By	Date/Time
1	Level 4				

1.5 Device Location: Occupancy Sensor

	Verification	Response	Notes	By	Date/Time
1	Level 5				

1.6 Device Location: Occupancy Sensor

	Verification	Response	Notes	By	Date/Time
1	Level 6				

Sample Electrical Systems Functional Performance Test

PROJECT: **University of Kentucky RB2 - Phase 2**
LOCATION: Lexington, KY

SYSTEM/UNIT: Lighting Controls

	Verification	Response	Notes	By	Date/Time
1	VERIFY the following features are provided:				
2	3.5 inch touch screen				
3	On/Off buttons for each group of fixtures				
4	Dimmer for each group of fixtures				
5					

2.1 Device Location: Graphic Wall Pod

	Verification	Response	Notes	By	Date/Time
1	RECORD Device(s) installed in the following areas were demonstrated to operate, with any issues noted on the MIL. See 'Comments' section for additional device location.				
2	Level 1				

2.2 Device Location: Graphic Wall Pod

	Verification	Response	Notes	By	Date/Time
1	Level 2				

2.3 Device Location: Graphic Wall Pod

	Verification	Response	Notes	By	Date/Time
1	Level 3				

2.4 Device Location: Graphic Wall Pod

	Verification	Response	Notes	By	Date/Time
1	Level 4				

2.5 Device Location: Graphic Wall Pod

	Verification	Response	Notes	By	Date/Time
1	Level 5				

2.6 Device Location: Graphic Wall Pod

	Verification	Response	Notes	By	Date/Time
1	Level 6				

SAMPLE BAS DATA POINT TRENDING / ARCHIVING PLAN

		Equipment ID / Trending Interval (minutes)													
Point Description	Units	Weather Station	Air Handling Units	Chilled Water System	Condenser Water System	Hot Water System	Air Terminal Unit / Space	Fan Coil Units	Computer Room Air Conditioner	Exhaust Fan	Unit Heater	Electrical Panels	Domestic Water Heating System	Irrigation System	Lighting Control System
Outdoor Air Dry Bulb Temp	F	15													
Outdoor Air Relative Humidity	%RH	15													
SF VFD Power	kWh		15												
SF Airflow	CFM		15												
SF Airflow Setpoint	CFM		15												
Unit Discharge Air Temp	F		15												
Unit DAT Setpoint	F		15												
Space Humidity	%RH		15				15		15						
Space Humidity Setpoint	%RH		15				15		15						
Humidifier Valve Position	% Open		15												
CHW Return Temp	F		15												
CHW Valve Position	% Open		15					15	15						
HW Return Temp	F		15												
AHU HW Valve Position	% Open		15												
Zone Airflow	CFM						15								
Zone Damper Position	% Open		15				15								
Zone HW Discharage Air Temp	F		15				15								
Zone HW Valve Position	% Open		15				15	15	15						
Space Temperature	F		15				15	15	15		15				
Space Temperature Active Setpoint	F		15				15	15	15		15				
Occupied Status (Sensor or Schedule)	On/Off						15	15	15						
RF VFD Power	kWh		15												
RF Airflow	CFM		15												
Space Differential Static Pressure	in. w.c.		15				15								
Space Differential Static Pressure Setpoint	in. w.c.		15				15								
Outdoor Air Damper Position	% Open		15												
Outdoor Airflow	CFM		15												
Outdoor Airflow Setpoint	CFM														
Duct Static Pressure	in. w.c.														
Duct Static Pressure Setpoint	in. w.c.														
Supply Air CO2	ppm														
Space CO2	ppm						15								
Space Differential CO2 Setpoint	ppm						15								
Bldg Supply Temp	F			15											
Bldg Supply Temp Setpoint	F			15											
System Supply Setpoint	F			15	15	15									
System Supply Temp	F			15	15	15							15		
System Return Temp	F			15	15	15									
System Flow	gpm			15	15	15									
System Capacity	MBh			15	15	15									
System Diff Pressure	psi			15	15	15									
System Diff Pressure Setpoint	psi			15	15	15									
Pump VFD Power	kWh			15	15	15									
Chiller CHW Supply Temp	F			15											
Chiller CHW Return Temp	F			15											
Chiller Evaporator Flow	gpm			15											
Chiller Entering CW Temp	F			15											
Chiller Leaving CW Temp	F			15											
Chiller Power (Typical each compressor)	kWh			15											
Cooling Tower VFD Power (Typical each fan)	kWh				15										
Heat Recovery Chiller HW Return Temp	F					15									
Heat Recovery Chiller HW Supply Temp	F					15									
Heat Recovery Chiller HW Supply Temp Setpoint	F					15									
Boiler Status	On/Off					15							15		
Fan Status	On/Off							15	15	15	15				
Pump Status	On/Off												15		
Exhaust Fan VFD Power	kWh									15					
Illuminance	fc														15
Make-up Water Consumption	gpm													15	
Electric Consumption	kWh											15			
Natural Gas Consumption	cu. ft.					15							15		

SECTION 024119 - SELECTIVE DEMOLITION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Demolition and removal of selected portions of building or structure.
2. Demolition and removal of selected site elements.
3. Salvage of existing items to be reused or recycled.

1.3 DEFINITIONS

A. Remove: Detach items from existing construction and dispose of them off-site unless indicated to be salvaged or reinstalled.

B. Remove and Salvage: Detach items from existing construction, in a manner to prevent damage, and deliver to Owner.

C. Remove and Reinstall: Detach items from existing construction, in a manner to prevent damage, prepare for reuse, and reinstall where indicated.

D. Existing to Remain: Leave existing items that are not to be removed and that are not otherwise indicated to be salvaged or reinstalled.

E. Dismantle: To remove by disassembling or detaching an item from a surface, using gentle methods and equipment to prevent damage to the item and surfaces; disposing of items unless indicated to be salvaged or reinstalled.

1.4 MATERIALS OWNERSHIP

A. Unless otherwise indicated, demolition waste becomes property of Contractor.

B. Historic items, relics, antiques, and similar objects including, but not limited to, cornerstones and their contents, commemorative plaques and tablets, and other items of interest or value to Owner that may be uncovered during demolition remain the property of Owner.

1. Carefully salvage in a manner to prevent damage and promptly return to Owner.

1.5 PREINSTALLATION MEETINGS

A. Predemolition Conference: Conduct conference at Project site.

1. Inspect and discuss condition of construction to be selectively demolished.
2. Review structural load limitations of existing structure.
3. Review and finalize selective demolition schedule and verify availability of materials, demolition personnel, equipment, and facilities needed to make progress and avoid delays.
4. Review requirements of work performed by other trades that rely on substrates exposed by selective demolition operations.
5. Review areas where existing construction is to remain and requires protection.

1.6 INFORMATIONAL SUBMITTALS

A. Engineering Survey: Submit engineering survey of condition of building.

B. Proposed Protection Measures: Submit report, including Drawings, that indicates the measures proposed for protecting individuals and property, for environmental protection, for dust control and for noise control. Indicate proposed locations and construction of barriers.

C. Schedule of Selective Demolition Activities: Indicate the following:

1. Detailed sequence of selective demolition and removal work, with starting and ending dates for each activity. Ensure Owner's on-site operations are uninterrupted.
2. Interruption of utility services. Indicate how long utility services will be interrupted.
3. Coordination for shutoff, capping, and continuation of utility services.
4. Use of elevator and stairs.
5. Coordination of Owner's continuing occupancy of portions of existing building and of Owner's partial occupancy of completed Work.

D. Predemolition Photographs or Video: Show existing conditions of adjoining construction, including finish surfaces, that might be misconstrued as damage caused by demolition operations.

E. Warranties: Documentation indicating that existing warranties are still in effect after completion of selective demolition.

1.7 CLOSEOUT SUBMITTALS

A. Inventory: Submit a list of items that have been removed and salvaged.

1.8 FIELD CONDITIONS

A. Owner will occupy portions of building immediately adjacent to selective demolition area. Conduct selective demolition so Owner's operations will not be disrupted.

B. Conditions existing at time of inspection for bidding purpose will be maintained by Owner as far as practical.

C. Notify Architect of discrepancies between existing conditions and Drawings before proceeding with selective demolition.

D. Hazardous Materials: It is not expected that hazardous materials will be encountered in the Work.
   1. If suspected hazardous materials are encountered, do not disturb; immediately notify Architect and Owner. Hazardous materials will be removed by Owner under a separate contract.

E. Storage or sale of removed items or materials on-site is not permitted.

F. Utility Service: Maintain existing utilities indicated to remain in service and protect them against damage during selective demolition operations.

   1. Maintain fire-protection facilities in service during selective demolition operations.

1.9 WARRANTY

A. Existing Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during selective demolition, by methods and with materials and using approved contractors so as not to void existing warranties. Notify warrantor before proceeding.

B. Notify warrantor on completion of selective demolition, and obtain documentation verifying that existing system has been inspected and warranty remains in effect. Submit documentation at Project closeout.

1.10 COORDINATION

A. Arrange selective demolition schedule so as not to interfere with Owner's operations.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Regulatory Requirements: Comply with governing EPA notification regulations before beginning selective demolition. Comply with hauling and disposal regulations of authorities having jurisdiction.

B. Standards: Comply with ASSE A10.6 and NFPA 241.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that utilities have been disconnected and capped before starting selective demolition operations.

B. Review Project Record Documents of existing construction or other existing condition and hazardous material information provided by Owner. Owner does not guarantee that existing conditions are same as those indicated in Project Record Documents.

C. Perform an engineering survey of condition of building to determine whether removing any element might result in structural deficiency or unplanned collapse of any portion of structure or adjacent structures during selective building demolition operations.

1. Perform surveys as the Work progresses to detect hazards resulting from selective demolition activities.

D. Survey of Existing Conditions: Record existing conditions by use of measured drawings, preconstruction photographs or video and templates.
1. Inventory and record the condition of items to be removed and salvaged. Provide photographs or video of conditions that might be misconstrued as damage caused by salvage operations.
2. Before selective demolition or removal of existing building elements that will be reproduced or duplicated in final Work, make permanent record of measurements, materials, and construction details required to make exact reproduction.

3.2 UTILITY SERVICES AND MECHANICAL/ELECTRICAL SYSTEMS

A. Existing Services/Systems to Remain: Maintain services/systems indicated to remain and protect them against damage.

B. Existing Services/Systems to Be Removed, Relocated, or Abandoned: Locate, identify, disconnect, and seal or cap off utility services and mechanical/electrical systems serving areas to be selectively demolished.

1. Owner will arrange to shut off indicated services/systems when requested by Contractor.
2. If services/systems are required to be removed, relocated, or abandoned, provide temporary services/systems that bypass area of selective demolition and that maintain continuity of services/systems to other parts of building.
3. Disconnect, demolish, and remove fire-suppression systems, plumbing, and HVAC systems, equipment, and components indicated on Drawings to be removed.

    a. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
    b. Piping to Be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material and leave in place.
    c. Equipment to Be Removed: Disconnect and cap services and remove equipment.
    d. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
    e. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.
    f. Ducts to Be Removed: Remove portion of ducts indicated to be removed and plug remaining ducts with same or compatible ductwork material.
    g. Ducts to Be Abandoned in Place: Cap or plug ducts with same or compatible ductwork material and leave in place.

3.3 PROTECTION

A. Temporary Protection: Provide temporary barricades and other protection required to prevent injury to people and damage to adjacent buildings and facilities to remain.

1. Provide protection to ensure safe passage of people around selective demolition area and to and from occupied portions of building.
2. Provide temporary weather protection, during interval between selective demolition of existing construction on exterior surfaces and new construction, to prevent water leakage and damage to structure and interior areas.
3. Protect walls, ceilings, floors, and other existing finish work that are to remain or that are exposed during selective demolition operations.
4. Cover and protect furniture, furnishings, and equipment that have not been removed.
5. Comply with requirements for temporary enclosures, dust control, heating, and cooling specified in Section 015000 "Temporary Facilities and Controls."

B. Temporary Shoring: Design, provide, and maintain shoring, bracing, and structural supports as required to preserve stability and prevent movement, settlement, or collapse of construction and finishes to remain, and to prevent unexpected or uncontrolled movement or collapse of construction being demolished.

1. Strengthen or add new supports when required during progress of selective demolition.

C. Remove temporary barricades and protections where hazards no longer exist.

3.4 SELECTIVE DEMOLITION, GENERAL

A. General: Demolish and remove existing construction only to the extent required by new construction and as indicated. Use methods required to complete the Work within limitations of governing regulations and as follows:

1. Proceed with selective demolition systematically, from higher to lower level. Complete selective demolition operations above each floor or tier before disturbing supporting members on the next lower level.
2. Neatly cut openings and holes plumb, square, and true to dimensions required. Use cutting methods least likely to damage construction to remain or adjoining construction. Use hand tools or small power tools designed for sawing or grinding, not hammering and chopping. Temporarily cover openings to remain.
3. Cut or drill from the exposed or finished side into concealed surfaces to avoid marring existing finished surfaces.
4. Do not use cutting torches until work area is cleared of flammable materials. At concealed spaces, such as duct and pipe interiors, verify condition and contents of hidden space before starting flame-cutting operations. Maintain portable fire-suppression devices during flame-cutting operations.
5. Maintain fire watch during and for at least two hours after flame-cutting operations.
6. Maintain adequate ventilation when using cutting torches.
7. Remove decayed, vermin-infested, or otherwise dangerous or unsuitable materials and promptly dispose of off-site.
8. Remove structural framing members and lower to ground by method suitable to avoid free fall and to prevent ground impact or dust generation.
9. Locate selective demolition equipment and remove debris and materials so as not to impose excessive loads on supporting walls, floors, or framing.

10. Dispose of demolished items and materials promptly. Comply with requirements in Section 017419 "Construction Waste Management and Disposal."

B. Site Access and Temporary Controls: Conduct selective demolition and debris-removal operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.

C. Removed and Salvaged Items:

1. Clean salvaged items.
2. Pack or crate items after cleaning. Identify contents of containers.
3. Store items in a secure area until delivery to Owner.
4. Transport items to Owner's storage area designated by Owner.
5. Protect items from damage during transport and storage.

D. Removed and Reinstalled Items:

1. Clean and repair items to functional condition adequate for intended reuse.
2. Pack or crate items after cleaning and repairing. Identify contents of containers.
3. Protect items from damage during transport and storage.
4. Reinstall items in locations indicated. Comply with installation requirements for new materials and equipment. Provide connections, supports, and miscellaneous materials necessary to make item functional for use indicated.

E. Existing Items to Remain: Protect construction indicated to remain against damage and soiling during selective demolition. When permitted by Architect, items may be removed to a suitable, protected storage location during selective demolition and cleaned and reinstalled in their original locations after selective demolition operations are complete.

3.5 SELECTIVE DEMOLITION PROCEDURES FOR SPECIFIC MATERIALS

A. Concrete: Demolish in small sections. Using power-driven saw, cut concrete to a depth of at least 3/4 inch (19 mm) at junctures with construction to remain. Dislodge concrete from reinforcement at perimeter of areas being demolished, cut reinforcement, and then remove remainder of concrete. Neatly trim openings to dimensions indicated.

B. Concrete: Demolish in sections. Cut concrete full depth at junctures with construction to remain and at regular intervals using power-driven saw, and then remove concrete between saw cuts.

C. Masonry: Demolish in small sections. Cut masonry at junctures with construction to remain, using power-driven saw, and then remove masonry between saw cuts.

D. Concrete Slabs-on-Grade: Saw-cut perimeter of area to be demolished, and then break up and remove.

3.6 DISPOSAL OF DEMOLISHED MATERIALS

A. Remove demolition waste materials from Project site and dispose of them in an EPA-approved construction and demolition waste landfill acceptable to authorities having jurisdiction and recycle or dispose of them according to Section 017419 "Construction Waste Management and Disposal."

1. Do not allow demolished materials to accumulate on-site.
2. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.
3. Remove debris from elevated portions of building by chute, hoist, or other device that will convey debris to grade level in a controlled descent.
4. Comply with requirements specified in Section 017419 "Construction Waste Management and Disposal."

B. Burning: Do not burn demolished materials.

3.7 CLEANING

A. Clean adjacent structures and improvements of dust, dirt, and debris caused by selective demolition operations. Return adjacent areas to condition existing before selective demolition operations began.

END OF SECTION 024119

SECTION 055000 - METAL FABRICATIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Steel framing and supports for mechanical and electrical equipment.
2. Steel framing and supports for applications where framing and supports are not specified in other Sections.

1.3 COORDINATION

A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written recommendations to ensure that shop primers and topcoats are compatible with one another.

B. Coordinate installation of metal fabrications that are anchored to or that receive other work. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

1.4 ACTION SUBMITTALS

A. Product Data: For the following:

1. Paint products.
2. Grout.

B. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.

C. Shop Drawings: Show fabrication and installation details. Include plans, elevations, sections, and details of metal fabrications and their connections. Show anchorage and accessory items. Provide Shop Drawings for the following:

1. Steel framing and supports for mechanical and electrical equipment.
2. Steel framing and supports for applications where framing and supports are not specified in other Sections.

D. Delegated-Design Submittal: For miscellaneous supports and framing including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For professional engineer.

B. Welding certificates.

C. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers, certifying that shop primers are compatible with topcoats.

D. Research/Evaluation Reports: For post-installed anchors, from ICC-ES.

1.6 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

B. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."

1.7 FIELD CONDITIONS

A. Field Measurements: Verify actual locations of walls and other construction contiguous with metal fabrications by field measurements before fabrication.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer to design miscellaneous supports and framing.

B. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes acting on exterior metal fabrications by preventing buckling, opening of joints, overstressing of components, failure of connections, and other detrimental effects.

1. Temperature Change: 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

2.2 METALS

A. Metal Surfaces, General: Provide materials with smooth, flat surfaces unless otherwise indicated. For metal fabrications exposed to view in the completed Work, provide materials without seam marks, roller marks, rolled trade names, or blemishes.

B. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.

C. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.

D. Steel Tubing: ASTM A 500/A 500M, cold-formed steel tubing.

E. Steel Pipe: ASTM A 53/A 53M, Standard Weight (Schedule 40) unless otherwise indicated.

F. Slotted Channel Framing: Cold-formed metal box channels (struts) complying with MFMA-4.

1. Size of Channels: As indicated.
2. Material: Galvanized steel, ASTM A 653/A 653M, structural steel, Grade 33 (Grade 230), with G90 (Z275) coating.

G. Cast Iron: Either gray iron, ASTM A 48/A 48M, or malleable iron, ASTM A 47/A 47M, unless otherwise indicated.

2.3 FASTENERS

A. General: Unless otherwise indicated, provide Type 316 stainless-steel fasteners for exterior use and zinc-plated fasteners with coating complying with ASTM B 633 or ASTM F 1941 (ASTM F 1941M), Class Fe/Zn 5, at exterior walls. Select fasteners for type, grade, and class required.

B. Steel Bolts and Nuts: Regular hexagon-head bolts, ASTM A 307, Grade A (ASTM F 568M, Property Class 4.6); with hex nuts, ASTM A 563 (ASTM A 563M); and, where indicated, flat washers.

C. Anchors, General: Anchors capable of sustaining, without failure, a load equal to six times the load imposed when installed in unit masonry and four times the load imposed when installed in concrete, as determined by testing according to ASTM E 488/E 488M, conducted by a qualified independent testing agency.

D. Post-Installed Anchors: Torque-controlled expansion anchors or chemical anchors.

1. Material for Interior Locations: Carbon-steel components zinc plated to comply with ASTM B 633 or ASTM F 1941 (ASTM F 1941M), Class Fe/Zn 5, unless otherwise indicated.
2. Material for Exterior Locations and Where Stainless Steel Is Indicated: Alloy Group 2 (A4) stainless-steel bolts, ASTM F 593 (ASTM F 738M), and nuts, ASTM F 594 (ASTM F 836M).

E. Slotted-Channel Inserts: Cold-formed, hot-dip galvanized-steel box channels (struts) complying with MFMA-4, 1-5/8 by 7/8 inches (41 by 22 mm) by length indicated with anchor straps or studs not less than 3 inches (75 mm) long at not more than 8 inches (200 mm) o.c. Provide with temporary filler and tee-head bolts, complete with washers and nuts, all zinc-plated to comply with ASTM B 633, Class Fe/Zn 5, as needed for fastening to inserts.

2.4 MISCELLANEOUS MATERIALS

A. Shop Primers: Provide primers that comply with Section 099113 "Exterior Painting," Section 099123 Interior Painting," and Section 099600 "High-Performance Coatings."

B. Universal Shop Primer: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with MPI#79 and compatible with topcoat.

1. Use primer containing pigments that make it easily distinguishable from zinc-rich primer.

C. Water-Based Primer: Emulsion type, anticorrosive primer for mildly corrosive environments that is resistant to flash rusting when applied to cleaned steel, complying with MPI#107 and compatible with topcoat.

D. Epoxy Zinc-Rich Primer: Complying with MPI#20 and compatible with topcoat.

E. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187/D 1187M.

F. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107/C 1107M. Provide grout specifically recommended by manufacturer for interior and exterior applications.

2.5 FABRICATION, GENERAL

A. Shop Assembly: Preassemble items in the shop to greatest extent possible. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.

B. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch (1 mm) unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.

C. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.

D. Form exposed work with accurate angles and surfaces and straight edges.

E. Weld corners and seams continuously to comply 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. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.

F. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners or welds where possible. Where exposed fasteners are required, use Phillips flat-head (countersunk) fasteners unless otherwise indicated. Locate joints where least conspicuous.

G. Fabricate seams and other connections that are exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.

H. Cut, reinforce, drill, and tap metal fabrications as indicated to receive finish hardware, screws, and similar items.

I. Provide for anchorage of type indicated; coordinate with supporting structure. Space anchoring devices to secure metal fabrications rigidly in place and to support indicated loads.

J. Where units are indicated to be cast into concrete or built into masonry, equip with integrally welded steel strap anchors, 1/8 by 1-1/2 inches (3.2 by 38 mm), with a minimum 6-inch (150-mm) embedment and 2-inch (50-mm) hook, not less than 8 inches (200 mm) from ends and corners of units and 24 inches (600 mm) o.c., unless otherwise indicated.

2.6 MISCELLANEOUS FRAMING AND SUPPORTS

A. General: Provide steel framing and supports not specified in other Sections as needed to complete the Work.

B. Fabricate units from steel shapes, plates, and bars of welded construction unless otherwise indicated. Fabricate to sizes, shapes, and profiles indicated and as necessary to receive adjacent construction.

1. Fabricate units from slotted channel framing where indicated.
2. Furnish inserts for units installed after concrete is placed.

C. Prime miscellaneous framing and supports with zinc-rich primer primer specified in Section 099600 "High-Performance Coatings" where indicated.

2.7 FINISHES, GENERAL

A. Finish metal fabrications after assembly.

B. Finish exposed surfaces to remove tool and die marks and stretch lines, and to blend into surrounding surface.

2.8 STEEL AND IRON FINISHES

A. Shop prime iron and steel items not indicated to be galvanized unless they are to be embedded in concrete, sprayed-on fireproofing, or masonry, or unless otherwise indicated.

1. Shop prime with universal shop primer unless zinc-rich primer is indicated.

B. Preparation for Shop Priming: Prepare surfaces to comply with requirements indicated below:

1. Items Indicated to Receive Zinc-Rich Primer: SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
2. Items Indicated to Receive Primers Specified in Section 099600 "High-Performance Coatings": SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
3. Other Items: SSPC-SP 3, "Power Tool Cleaning."

C. Shop Priming: Apply shop primer to comply with SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting.

1. Stripe paint corners, crevices, bolts, welds, and sharp edges.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing metal fabrications. Set metal fabrications accurately in location, alignment, and elevation; with edges and surfaces level, plumb, true, and free of rack; and measured from established lines and levels.

B. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Do not weld, cut, or abrade surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.

C. Field Welding: Comply with the following requirements:

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. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.

D. Fastening to In-Place Construction: Provide anchorage devices and fasteners where metal fabrications are required to be fastened to in-place construction. Provide threaded fasteners for use with concrete and masonry inserts, toggle bolts, through bolts, lag screws, wood screws, and other connectors.

E. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.

F. Corrosion Protection: Coat concealed surfaces of aluminum that come into contact with grout, concrete, masonry, wood, or dissimilar metals with the following:

1. Cast Aluminum: Heavy coat of bituminous paint.
2. Extruded Aluminum: Two coats of clear lacquer.

3.2 INSTALLING MISCELLANEOUS FRAMING AND SUPPORTS

A. General: Install framing and supports to comply with requirements of items being supported, including manufacturers' written instructions and requirements indicated on Shop Drawings.

3.3 ADJUSTING AND CLEANING

A. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas. Paint uncoated and abraded areas with the same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.

1. Apply by brush or spray to provide a minimum 2.0-mil (0.05-mm) dry film thickness.

B. Touchup Painting: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint are specified in Section 099113 "Exterior Painting." Section 099123 "Interior Painting."

END OF SECTION 055000

SECTION 061053 - MISCELLANEOUS ROUGH CARPENTRY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Wood blocking.
2. Plywood backing panels.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of process and factory-fabricated product. Indicate component materials and dimensions and include construction and application details.
   1. Include data for fire-retardant treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements. Include physical properties of treated materials based on testing by a qualified independent testing agency.
   2. For fire-retardant treatments, include physical properties of treated lumber both before and after exposure to elevated temperatures, based on testing by a qualified independent testing agency according to ASTM D 5664.

B. Sustainable Design Submittals:

1. Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project and cost for each regional material.

2. Chain-of-Custody Certificates: For certified wood products. Include statement of costs.

3. Chain-of-Custody Qualification Data: For manufacturer and vendor.

4. Product Data: For installation adhesives, indicating VOC content.

5. Laboratory Test Reports: For installation adhesives, indicating compliance with requirements for low-emitting materials.

1.4 INFORMATIONAL SUBMITTALS

A. Evaluation Reports: For the following, from ICC-ES:

1. Fire-retardant-treated wood.

1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: For testing agency providing classification marking for fire-retardant-treated material, an inspection agency acceptable to authorities having jurisdiction that periodically performs inspections to verify that the material bearing the classification marking is representative of the material tested.

B. Manufacturer Qualifications: A qualified manufacturer that is certified for chain of custody by an FSC-accredited certification body.

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

1.6 DELIVERY, STORAGE, AND HANDLING

A. Stack lumber flat with spacers beneath and between each bundle to provide air circulation. Protect lumber from weather by covering with waterproof sheeting, securely anchored. Provide for air circulation around stacks and under coverings.

PART 2 - PRODUCTS

2.1 WOOD PRODUCTS, GENERAL

A. Certified Wood: Lumber and plywood shall be certified as "FSC Pure" according to FSC STD-01-00 and FSC STD-40-004.

B. Lumber: DOC PS 20 and applicable rules of grading agencies indicated. If no grading agency is indicated, provide lumber that complies with the applicable rules of any rules-writing agency certified by the ALSC Board of Review. Provide lumber graded by an agency certified by the ALSC Board of Review to inspect and grade lumber under the rules indicated.

1. Factory mark each piece of lumber with grade stamp of grading agency.
2. Dress lumber, S4S, unless otherwise indicated.

C. Maximum Moisture Content of Lumber: 15 percent for 2-inch nominal (38-mm actual) thickness or less, 19 percent for more than 2-inch nominal (38-mm actual) thickness unless otherwise indicated.

2.2 FIRE-RETARDANT-TREATED MATERIALS

A. General: Where fire-retardant-treated materials are indicated, materials shall comply with requirements in this article, that are acceptable to authorities having jurisdiction, and with fire-test-response characteristics specified as determined by testing identical products per test method indicated by a qualified testing agency.

B. Fire-Retardant-Treated Lumber and Plywood by Pressure Process: Products with a flame-spread index of 25 or less when tested according to ASTM E 84, and with no evidence of significant progressive combustion when the test is extended an additional 20 minutes, and with the flame front not extending more than 10.5 feet (3.2 m) beyond the centerline of the burners at any time during the test.

1. Treatment shall not promote corrosion of metal fasteners.
2. Interior Type A: Treated materials shall have a moisture content of 28 percent or less when tested according to ASTM D 3201 at 92 percent relative humidity. Use where exterior type is not indicated.
3. Design Value Adjustment Factors: Treated lumber shall be tested according to ASTM D 5664, and design value adjustment factors shall be calculated according to ASTM D 6841.

C. Kiln-dry lumber after treatment to a maximum moisture content of 19 percent. Kiln-dry plywood after treatment to a maximum moisture content of 15 percent.

D. Identify fire-retardant-treated wood with appropriate classification marking of qualified testing agency.

E. Application: Treat items indicated on Drawings, and the following:

1. Concealed blocking.
2. Plywood backing panels.

2.3 MISCELLANEOUS LUMBER

A. General: Provide miscellaneous lumber indicated and lumber for support or attachment of other construction, including the following:

1. Blocking.

B. Concealed Boards: 19 percent maximum moisture content of the following species and grades:

1. Mixed southern pine or southern pine, No. 2 grade; SPIB.

C. For blocking not used for attachment of other construction, Utility, Stud, or No. 3 grade lumber of any species may be used provided that it is cut and selected to eliminate defects that will interfere with its attachment and purpose.

D. For blocking and nailers used for attachment of other construction, select and cut lumber to eliminate knots and other defects that will interfere with attachment of other work.

2.4 PLYWOOD BACKING PANELS

A. Equipment Backing Panels: Plywood, DOC PS 1, Exposure 1, C-D Plugged, fire-retardant treated, in thickness indicated or, if not indicated, not less than 3/4-inch (19-mm) nominal thickness.

2.5 FASTENERS

A. General: Provide fasteners of size and type indicated that comply with requirements specified in this article for material and manufacture.

B. Nails, Brads, and Staples: ASTM F 1667.

C. Screws for Fastening to Metal Framing: ASTM C 1002, length as recommended by screw manufacturer for material being fastened.

D. Power-Driven Fasteners: Fastener systems with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC70.

E. Post-Installed Anchors: Fastener systems with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC01 ICC-ES AC58 ICC-ES AC193 or ICC-ES AC308 as appropriate for the substrate.

1. Material: Carbon-steel components, zinc plated to comply with ASTM B 633, Class Fe/Zn 5.
2. Material: Stainless steel with bolts and nuts complying with ASTM F 593 and ASTM F 594, Alloy Group 1 or 2 (ASTM F 738M and ASTM F 836M, Grade A1 or A4).

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Set carpentry to required levels and lines, with members plumb, true to line, cut, and fitted. Fit carpentry accurately to other construction. Locate blocking, and similar supports to comply with requirements for attaching other construction.

B. Install plywood backing panels by fastening to studs; coordinate locations with utilities requiring backing panels. Install fire-retardant-treated plywood backing panels with classification marking of testing agency exposed to view.

C. Provide blocking and framing as indicated and as required to support facing materials, fixtures, specialty items, and trim.

1. Provide metal clips for fastening gypsum board or lath at corners and intersections where framing or blocking does not provide a surface for fastening edges of panels. Space clips not more than 16 inches (406 mm) o.c.

D. Provide fire blocking in furred spaces, stud spaces, and other concealed cavities as indicated and as follows:

1. Fire block furred spaces of walls, at each floor level, at ceiling, and at not more than 96 inches (2438 mm) o.c. with solid wood blocking or noncombustible materials accurately fitted to close furred spaces.

E. Sort and select lumber so that natural characteristics do not interfere with installation or with fastening other materials to lumber. Do not use materials with defects that interfere with function of member or pieces that are too small to use with minimum number of joints or optimum joint arrangement.

F. Comply with AWPA M4 for applying field treatment to cut surfaces of preservative-treated lumber.

1. Use inorganic boron for items that are continuously protected from liquid water.
2. Use copper naphthenate for items not continuously protected from liquid water.

G. Securely attach carpentry work to substrate by anchoring and fastening as indicated, complying with the following:

1. Table 2304.9.1, "Fastening Schedule," in ICC's International Building Code.
2. ICC-ES evaluation report for fastener.

3.2 WOOD BLOCKING INSTALLATION

A. Install where indicated and where required for attaching other work. Form to shapes indicated and cut as required for true line and level of attached work. Coordinate locations with other work involved.

B. Attach items to substrates to support applied loading. Recess bolts and nuts flush with surfaces unless otherwise indicated.

END OF SECTION 061053

SECTION 062023 - INTERIOR FINISH CARPENTRY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Interior trim.
2. Interior paneling.

B. Related Requirements:

1. Section 061053 "Miscellaneous Rough Carpentry" for furring, blocking, and other carpentry work not exposed to view.

1.3 DEFINITIONS

A. MDF: Medium-density fiberboard.

B. MDO: Plywood with a medium-density overlay on the face.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of process and factory-fabricated product. Indicate component materials, dimensions, profiles, textures, and colors and include construction and application details.

B. Sustainable Design Submittals:

1. Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project and cost for each regional material.
2. Chain-of-Custody Certificates: For certified wood products. Include statement of costs.
3. Product Data: For composite wood products, indicating that product contains no urea formaldehyde.
4. Product Data: For installation adhesives, indicating VOC content.

C. Samples for Initial Selection: For each type of product involving selection of colors, profiles, or textures.

D. Samples for Verification:

1. For each species and cut of lumber and panel products with nonfactory-applied finish, with half of exposed surface finished, 50 sq. in. (300 sq. cm) for lumber and 8 by 10 inches (200 by 250 mm) for panels.
2. For each finish system and color of lumber and panel products with factory-applied finish, 50 sq. in. (300 sq. cm) for lumber and 8 by 10 inches (200 by 250 mm) for panels.

1.5 INFORMATIONAL SUBMITTALS

A. Sample Warranty: For manufacturer's warranty.

1.6 QUALITY ASSURANCE

A. Manufacturer Qualifications: A qualified manufacturer that is certified for chain of custody by an FSC-accredited certification body.

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

C. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.

1. Build mockups of typical interior architectural woodwork as shown on Drawings including, but not limited to, wood screen wall.
2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Stack lumber, plywood, and other panels flat with spacers between each bundle to provide air circulation. Protect materials from weather by covering with waterproof sheeting, securely anchored. Provide for air circulation around stacks and under coverings.

B. Deliver interior finish carpentry materials only when environmental conditions comply with requirements specified for installation areas. If interior finish carpentry materials must be stored in other than installation areas, store only where environmental conditions comply with requirements specified for installation areas.

1.8 FIELD CONDITIONS

A. Environmental Limitations: Do not deliver or install interior finish carpentry materials until building is enclosed and weatherproof, wet work in space is completed and nominally dry, and HVAC system is operating and maintaining temperature and relative humidity at occupancy levels during the remainder of the construction period.

B. Do not install finish carpentry materials that are wet, moisture damaged, or mold damaged.

1. Indications that materials are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
2. Indications that materials are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

PART 2 - PRODUCTS

2.1 MATERIALS, GENERAL

A. Regional Materials: The following wood products shall be manufactured within 500 miles (800 km) of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within 500 miles (800 km) of Project site.

1. Interior trim.
2. Interior paneling.

B. Certified Wood: The following wood products shall be certified as "FSC Pure" or "FSC Mixed Credit" according to FSC STD-01-00 and FSC STD-40-004.

1. Interior trim.
2. Interior paneling.

C. Composite Wood Products: Products shall be made without urea formaldehyde.

D. Lumber: DOC PS 20 and applicable rules of grading agencies indicated. If no grading agency is indicated, comply with the applicable rules of any rules-writing agency certified by the American Lumber Standard Committee's Board of Review. Grade lumber by an agency certified by the American Lumber Standard Committee's Board of Review to inspect and grade lumber under the rules indicated.

1. Factory mark each piece of lumber with grade stamp of grading agency.
2. For exposed lumber, mark grade stamp on end or back of each piece.

E. Softwood Plywood: DOC PS 1.

F. Hardboard: ANSI A135.4.

G. MDF: ANSI A208.2, Grade 130.

H. Particleboard: ANSI A208.1, Grade M-2-Exterior Glue.

2.2 INTERIOR TRIM

A. Hardwood Lumber Trim for Transparent Finish (Stain or Clear Finish):

1. Species and Grade: Hickory, quarter sawn; NHLA. Dodge Veneers Inc., Log #131227/3.
2. Maximum Moisture Content: 10 percent.
3. Finger Jointing: Not allowed.
4. Gluing for Width: Not allowed.
5. Veneered Material: Not allowed.
6. Face Surface: Surfaced (smooth).
7. Matching: Selected for compatible grain and color.

2.3 PANELING

A. Hardwood Veneer Plywood Paneling: Manufacturer's stock hardwood plywood panels complying with HPVA HP-1.
   1. Face Veneer Species and Cut: Hickory, quarter sawn. Dodge Veneers Inc., Log #131227/3.
   2. Veneer Matching: Selected for similar color and grain.
   3. Backing Veneer Species: Any hardwood compatible with face species.
   4. Construction: Veneer core.
   5. Thickness: As indicated on Drawings.
   6. Panel Size: As indicated on Drawings.
   7. Glue Bond: Type II (interior).
   8. Face Pattern: Smooth.
   9. Finish: Match Architect's samples.

2.4 MISCELLANEOUS MATERIALS

A. Fasteners for Interior Finish Carpentry: Nails, screws, clips, Z furring, and other anchoring devices of type, size, material, and finish required for application indicated to provide secure attachment, concealed where possible.

2.5 FABRICATION

A. Back out or kerf backs of the following members, except those with ends exposed in finished work:

   1. Interior standing and running trim, except shoe and crown molds.
   2. Wood-board paneling.

B. Ease edges of lumber less than 1 inch (25 mm) in nominal thickness to 1/16-inch (1.5-mm) radius and edges of lumber 1 inch (25 mm) or more in nominal thickness to 1/8-inch (3-mm) radius.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine finish carpentry materials before installation. Reject materials that are wet, moisture damaged, and mold damaged.

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

3.2 PREPARATION

A. Clean substrates of projections and substances detrimental to application.

B. Before installing interior finish carpentry, condition materials to average prevailing humidity in installation areas for a minimum of 24 hours unless longer conditioning is recommended by manufacturer.

3.3 INSTALLATION, GENERAL

A. Do not use materials that are unsound; warped; improperly treated or finished; inadequately seasoned; too small to fabricate with proper jointing arrangements; or with defective surfaces, sizes, or patterns.

B. Install interior finish carpentry level, plumb, true, and aligned with adjacent materials. Use concealed shims where necessary for alignment.

1. Scribe and cut interior finish carpentry to fit adjoining work. Refinish and seal cuts as recommended by manufacturer.
2. Where face fastening is unavoidable, countersink fasteners, fill surface flush, and sand unless otherwise indicated.
3. Install to tolerance of 1/8 inch in 96 inches (3 mm in 2438 mm) for level and plumb. Install adjoining interior finish carpentry with 1/32-inch (0.8-mm) maximum offset for flush installation and 1/16-inch (1.5-mm) maximum offset for reveal installation.
4. Coordinate interior finish carpentry with materials and systems in or adjacent to it. Provide cutouts for mechanical and electrical items that penetrate interior finish carpentry.

3.4 STANDING AND RUNNING TRIM INSTALLATION

A. Install with minimum number of joints practical, using full-length pieces from maximum lengths of lumber available. Do not use pieces less than 24 inches (610 mm) long, except where necessary. Stagger joints in adjacent and related standing and running trim. Miter at returns, miter at outside corners, and cope at inside corners to produce tight-fitting joints with full-surface contact throughout length of joint. Use scarf joints for end-to-end joints. Plane backs of casings to provide uniform thickness across joints where necessary for alignment.

1. Match color and grain pattern of trim for transparent finish (stain or clear finish) across joints.
2. Install trim after gypsum-board joint finishing operations are completed.
3. Install without splitting; drill pilot holes before fastening where necessary to prevent splitting. Fasten to prevent movement or warping. Countersink fastener heads on exposed carpentry work and fill holes.

3.5 PANELING INSTALLATION

A. Paneling: Select and arrange panels on each wall to minimize noticeable variations in grain character and color between adjacent panels. Leave 1/4-inch (6-mm) gap to be covered with trim at top, bottom, and openings. Install with uniform tight joints between panels.

1. Attach panels to supports with manufacturer's recommended concealed clips and fasteners. Space fasteners and clips as recommended by panel manufacturer.
2. Conceal fasteners to greatest practical extent.

3.6 ADJUSTING

A. Replace interior finish carpentry that is damaged or does not comply with requirements. Interior finish carpentry may be repaired or refinished if work complies with requirements and shows no evidence of repair or refinishing. Adjust joinery for uniform appearance.

3.7 CLEANING

A. Clean interior finish carpentry on exposed and semiexposed surfaces. Restore damaged or soiled areas and touch up factory-applied finishes if any.

3.8 PROTECTION

A. Protect installed products from damage from weather and other causes during construction.

B. Remove and replace finish carpentry materials that are wet, moisture damaged, and mold damaged.

1. Indications that materials are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
2. Indications that materials are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

END OF SECTION 062023

SECTION 064116 - PLASTIC-LAMINATE-FACED ARCHITECTURAL CABINETS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Plastic-laminate-faced architectural cabinets.
2. Wood furring, blocking, shims, and hanging strips for installing plastic-laminate-faced architectural cabinets that are not concealed within other construction.

B. Related Requirements:

1. Section 061053 "Miscellaneous Rough Carpentry" for wood furring, blocking, shims, and hanging strips required for installing cabinets that are concealed within other construction before cabinet installation.
2. Section 123623.13 "Plastic-Laminate-Clad Countertops."
3. Section 123661.19 "Quartz Agglomerate Countertops."

1.3 COORDINATION

A. Coordinate sizes and locations of framing, blocking, furring, reinforcements, and other related units of Work specified in other Sections to support loads imposed by installed and fully loaded cabinets.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include data for fire-retardant treatment from chemical-treatment manufacturer and certification by treating plant that treated materials comply with requirements.

B. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.

2. Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project and cost for each regional material.
3. Chain-of-Custody Certificates: For certified wood products. Include statement of costs.
4. Product Data: For adhesives, indicating that product contains no urea formaldehyde.
5. Laboratory Test Reports: For adhesives, indicating compliance with requirements for low-emitting materials.
6. Product Data: For composite wood products, indicating that product contains no urea formaldehyde.
7. Laboratory Test Reports: For composite wood products, indicating compliance with requirements for low-emitting materials.

C. Shop Drawings: For plastic-laminate-faced architectural cabinets.

1. Include plans, elevations, sections, and attachment details.
2. Show large-scale details.
3. Show locations and sizes of furring, blocking, and hanging strips, including concealed blocking and reinforcement specified in other Sections.
4. Show locations and sizes of cutouts and holes for items installed in plastic-laminate architectural cabinets.

D. Samples: For each exposed product and for each color and texture specified, in manufacturer's or fabricator's standard size.

1. Exposed Cabinet Hardware and Accessories: One full-size unit for each type and finish.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer and fabricator.

B. Product Certificates: For each type of product.

1.7 QUALITY ASSURANCE

A. Fabricator Qualifications: Shop that employs skilled workers who custom fabricate products similar to those required for this Project and whose products have a record of successful in-service performance.

B. Installer Qualifications: Fabricator of products.

C. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.

1. Build mockups of typical architectural cabinets as shown on Drawings.
2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Do not deliver cabinets until painting and similar finish operations that might damage architectural cabinets have been completed in installation areas. Store cabinets in installation

areas or in areas where environmental conditions comply with requirements specified in "Field Conditions" Article.

1.9 FIELD CONDITIONS

A. Environmental Limitations: Do not deliver or install cabinets until building is enclosed, wet-work is complete, and HVAC system is operating and maintaining temperature and relative humidity at levels planned for building occupants during the remainder of the construction period.

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

1. Locate concealed framing, blocking, and reinforcements that support cabinets by field measurements before being enclosed/concealed by construction, and indicate measurements on Shop Drawings.

C. Established Dimensions: Where cabinets are indicated to fit to other construction, establish dimensions for areas where cabinets are to fit. Provide allowance for trimming at site, and coordinate construction to ensure that actual dimensions correspond to established dimensions.

PART 2 - PRODUCTS

2.1 PLASTIC-LAMINATE-FACED ARCHITECTURAL CABINETS

A. Quality Standard: Unless otherwise indicated, comply with the "Architectural Woodwork Standards" for grades of cabinets indicated for construction, finishes, installation, and other requirements.

B. Grade: Premium.

C. Regional Materials: Wood products shall be manufactured within 500 miles (800 km) of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within 500 miles (800 km) of Project site.

D. Certified Wood: Wood products shall be certified as "FSC Pure" or "FSC Mixed Credit" according to FSC STD-01-001 and FSC STD-40-004.

E. Door and Drawer-Front Style: Flush overlay.

F. High-Pressure Decorative Laminate: NEMA LD 3, grades as indicated or if not indicated, as required by quality standard.

1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

a. Formica Corporation.
b. Pionite; a Panolam Industries International, Inc. brand.
c. Wilsonart.

G. Laminate Cladding for Exposed Surfaces:

1. Horizontal Surfaces: Grade HGS.
2. Vertical Surfaces: Grade VGS.
3. Edges: PVC edge banding, 0.12 inch (3 mm) thick, matching laminate in color, pattern, and finish.
4. Pattern Direction: As indicated.

H. Materials for Semiexposed Surfaces:

1. Surfaces Other Than Drawer Bodies: Thermoset decorative panels.

   a. Edges of Plastic-Laminate Shelves: PVC edge banding, 0.12 inch (3 mm) thick, matching laminate in color, pattern, and finish.
   b. Edges of Thermoset Decorative Panel Shelves: PVC or polyester edge banding.
   c. For semiexposed backs of panels with exposed plastic-laminate surfaces, provide surface of high-pressure decorative laminate, NEMA LD 3, Grade VGS.

2. Drawer Sides and Backs: Thermoset decorative panels with PVC or polyester edge banding.
3. Drawer Bottoms: Thermoset decorative panels.

I. Concealed Backs of Panels with Exposed Plastic-Laminate Surfaces: High-pressure decorative laminate, NEMA LD 3, Grade BKL.

J. Drawer Construction: Fabricate with exposed fronts fastened to subfront with mounting screws from interior of body.

1. Join subfronts, backs, and sides with glued rabbeted joints supplemented by mechanical fasteners or glued dovetail joints.

K. Colors, Patterns, and Finishes: Provide materials and products that result in colors and textures of exposed laminate surfaces complying with the following requirements:

1. As indicated on Drawings.

2.2 WOOD MATERIALS

A. Wood Products: Provide materials that comply with requirements of referenced quality standard for each type of architectural cabinet and quality grade specified unless otherwise indicated.

1. Wood Moisture Content: 5 to 10 percent.

B. Composite Wood and Agrifiber Products: Provide materials that comply with requirements of referenced quality standard for each type of architectural cabinet and quality grade specified unless otherwise indicated.

1. Recycled Content of MDF and Particleboard: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 40 percent.

C. Composite Wood Products: Products shall be made without urea formaldehyde.

1. Medium-Density Fiberboard (MDF): ANSI A208.2, Grade 130.

2. Particleboard: ANSI A208.1, Grade M-2-Exterior Glue.
3. Straw-Based Particleboard: ANSI A208.1, Grade M-2, except for density.
4. Softwood Plywood: DOC PS 1, medium-density overlay.
5. Thermoset Decorative Panels: Particleboard or MDF finished with thermally fused, melamine-impregnated decorative paper and complying with requirements of NEMA LD 3, Grade VGL, for Test Methods 3.3, 3.4, 3.6, 3.8, and 3.10.

2.3 CABINET HARDWARE AND ACCESSORIES

A. General: Provide cabinet hardware and accessory materials associated with architectural cabinets except for items specified in Section 087100 "Door Hardware."

B. Butt Hinges: 2-3/4-inch (70-mm), five-knuckle steel hinges made from 0.095-inch- (2.4-mm-) thick metal, and as follows:

1. Semiconcealed Hinges for Overlay Doors: BHMA A156.9, B01521.

C. Back-Mounted Pulls: BHMA A156.9, B02011.

D. Wire Pulls: Back mounted, solid metal, matt, stainless steel, 4 inches (100 mm) long, 5/16 inch (8 mm) in diameter.

E. Catches: Roller catches, BHMA A156.9, B03071.

F. Adjustable Shelf Standards and Supports: BHMA A156.9, B04071; with shelf rests, B04081.

G. Shelf Rests: BHMA A156.9, B04013; metal, two-pin type with shelf hold-down clip.

H. Drawer Slides: BHMA A156.9.

1. Grade 1HD-100 and Grade 1HD-200: Side mounted; full-extension type; zinc-plated-steel ball-bearing slides.
2. For drawers not more than 3 inches (75 mm) high and not more than 24 inches (600 mm) wide, provide Grade 2.
3. For drawers more than 3 inches (75 mm) high, but not more than 6 inches (150 mm) high and not more than 24 inches (600 mm) wide, provide Grade 1.
4. For drawers more than 6 inches (150 mm) high or more than 24 inches (600 mm) wide, provide Grade 1HD-100.

I. Door Locks: BHMA A156.11, E07121.

J. Drawer Locks: BHMA A156.11, E07041.

K. Door and Drawer Silencers: BHMA A156.16, L03011.

L. Grommets for Cable Passage: 2-inch (51-mm) OD, molded-plastic grommets and matching plastic caps with slot for wire passage.

1. Color: Black.

M. Exposed Hardware Finishes: For exposed hardware, provide finish that complies with BHMA A156.18 for BHMA finish number indicated.
1. Satin Stainless Steel: BHMA 630.

N. For concealed hardware, provide manufacturer's standard finish that complies with product class requirements in BHMA A156.9.

O. Work Surface Supports: Basis-of-Design: Doug Mockett & Company, Inc.

1. SWS2 – 18-1/8" Inter-Arc Work support
   a. Finish: Select by Architect from Manufacturer's standard.
2. SWS4 – 24-1/4" Large Basic Work Surface Support
   a. Finish: White powder coat.

2.4 MISCELLANEOUS MATERIALS

A. Anchors: Select material, type, size, and finish required for each substrate for secure anchorage. Provide metal expansion sleeves or expansion bolts for post-installed anchors. Use nonferrous-metal or hot-dip galvanized anchors and inserts at inside face of exterior walls and at floors.

B. Adhesives: Do not use adhesives that contain urea formaldehyde.

2.5 FABRICATION

A. Fabricate architectural cabinets to dimensions, profiles, and details indicated.

B. Complete fabrication, including assembly and hardware application, to maximum extent possible before shipment to Project site. Disassemble components only as necessary for shipment and installation. Where necessary for fitting at site, provide ample allowance for scribing, trimming, and fitting.
1. Trial fit assemblies at fabrication shop that cannot be shipped completely assembled. Install dowels, screws, bolted connectors, and other fastening devices that can be removed after trial fitting. Verify that various parts fit as intended and check measurements of assemblies against field measurements before disassembling for shipment.

C. Shop-cut openings to maximum extent possible to receive hardware, appliances, electrical work, and similar items. Locate openings accurately and use templates or roughing-in diagrams to produce accurately sized and shaped openings. Sand edges of cutouts to remove splinters and burrs.

PART 3 - EXECUTION

3.1 PREPARATION

A. Before installation, condition cabinets to humidity conditions in installation areas for not less than 72 hours.

3.2 INSTALLATION

A. Grade: Install cabinets to comply with quality standard grade of item to be installed.

B. Assemble cabinets and complete fabrication at Project site to extent that it was not completed in the shop.

C. Anchor cabinets to anchors or blocking built in or directly attached to substrates. Secure with wafer-head cabinet installation screws.

D. Install cabinets level, plumb, and true in line to a tolerance of 1/8 inch in 96 inches (3 mm in 2400 mm) using concealed shims.

1. Scribe and cut cabinets to fit adjoining work, refinish cut surfaces, and repair damaged finish at cuts.
2. Install cabinets without distortion so doors and drawers fit openings and are accurately aligned. Adjust hardware to center doors and drawers in openings and to provide unencumbered operation. Complete installation of hardware and accessory items as indicated.
3. Fasten wall cabinets through back, near top and bottom, and at ends not more than 16 inches (400 mm) o.c. with No. 10 wafer-head screws sized for not less than 1-1/2-inch (38-mm) penetration into wood blocking or No. 10 wafer-head sheet metal screws through metal backing or metal framing behind wall finish.

3.3 ADJUSTING AND CLEANING

A. Repair damaged and defective cabinets, where possible, to eliminate functional and visual defects. Where not possible to repair, replace architectural cabinets. Adjust joinery for uniform appearance.

B. Clean, lubricate, and adjust hardware.

C. Clean cabinets on exposed and semiexposed surfaces.

END OF SECTION 064116

SECTION 078413 - PENETRATION FIRESTOPPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Penetrations in fire-resistance-rated walls.
2. Penetrations in horizontal assemblies.
3. Penetrations in smoke barriers.

B. Related Requirements:

1. Section 078443 "Joint Firestopping" for joints in or between fire-resistance-rated construction, at exterior curtain-wall/floor intersections, and in smoke barriers.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Product Schedule: For each penetration firestopping system. Include location, illustration of firestopping system, and design designation of qualified testing and inspecting agency.

1. Engineering Judgments: Where Project conditions require modification to a qualified testing and inspecting agency's illustration for a particular penetration firestopping system, submit illustration, with modifications marked, approved by penetration firestopping system manufacturer's fire-protection engineer as an engineering judgment or equivalent fire-resistance-rated assembly. Obtain approval of authorities having jurisdiction prior to submittal.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Product Test Reports: For each penetration firestopping system, for tests performed by a qualified testing agency.

1.6 CLOSEOUT SUBMITTALS

A. Installer Certificates: From Installer indicating that penetration firestopping systems have been installed in compliance with requirements and manufacturer's written instructions.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: A firm that has been approved by FM Global according to FM Global 4991, "Approval of Firestop Contractors," or been evaluated by UL and found to comply with its "Qualified Firestop Contractor Program Requirements."

1.8 PROJECT CONDITIONS

A. Environmental Limitations: Do not install penetration firestopping system when ambient or substrate temperatures are outside limits permitted by penetration firestopping system manufacturers or when substrates are wet because of rain, frost, condensation, or other causes.

B. Install and cure penetration firestopping materials per manufacturer's written instructions using natural means of ventilations or, where this is inadequate, forced-air circulation.

1.9 COORDINATION

A. Coordinate construction of openings and penetrating items to ensure that penetration firestopping systems can be installed according to specified firestopping system design.

B. Coordinate sizing of sleeves, openings, core-drilled holes, or cut openings to accommodate penetration firestopping systems.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Fire-Test-Response Characteristics:

1. Perform penetration firestopping system tests by a qualified testing agency acceptable to authorities having jurisdiction.
2. Test per testing standards referenced in "Penetration Firestopping Systems" Article. Provide rated systems complying with the following requirements:

a. Penetration firestopping systems shall bear classification marking of a qualified testing agency.

1) UL in its "Fire Resistance Directory."
2) Intertek Group in its "Directory of Listed Building Products."
3) FM Global in its "Building Materials Approval Guide."

2.2 PENETRATION FIRESTOPPING SYSTEMS

A. Penetration Firestopping Systems: Systems that resist spread of fire, passage of smoke and other gases, and maintain original fire-resistance rating of construction penetrated. Penetration firestopping systems shall be compatible with one another, with the substrates forming openings, and with penetrating items if any.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. 3M Fire Protection Products.
    b. Hilti, Inc.
    c. Specified Technologies, Inc.
    d. Tremco, Inc.

B. Penetrations in Fire-Resistance-Rated Walls: Penetration firestopping systems with ratings determined per ASTM E 814 or UL 1479, based on testing at a positive pressure differential of 0.01-inch wg (2.49 Pa).

1. F-Rating: Not less than the fire-resistance rating of constructions penetrated.

C. Penetrations in Horizontal Assemblies: Penetration firestopping systems with ratings determined per ASTM E 814 or UL 1479, based on testing at a positive pressure differential of 0.01-inch wg (2.49 Pa).

1. F-Rating: At least one hour, but not less than the fire-resistance rating of constructions penetrated.
2. T-Rating: At least one hour, but not less than the fire-resistance rating of constructions penetrated except for floor penetrations within the cavity of a wall.
3. W-Rating: Provide penetration firestopping systems showing no evidence of water leakage when tested according to UL 1479.

D. Penetrations in Smoke Barriers: Penetration firestopping systems with ratings determined per UL 1479, based on testing at a positive pressure differential of 0.30-inch wg (74.7 Pa).

1. L-Rating: Not exceeding 5.0 cfm/sq. ft. (0.025 cu. m/s per sq. m) of penetration opening at and no more than 50-cfm (0.024-cu. m/s) cumulative total for any 100 sq. ft. (9.3 sq. m) at both ambient and elevated temperatures.

E. Exposed Penetration Firestopping Systems: Flame-spread and smoke-developed indexes of less than 25 and 450, respectively, per ASTM E 84.

F. Accessories: Provide components for each penetration firestopping system that are needed to install fill materials and to maintain ratings required. Use only those components specified by penetration firestopping system manufacturer and approved by qualified testing and inspecting agency for conditions indicated.

1. Permanent forming/damming/backing materials.
2. Substrate primers.
3. Collars.
4. Steel sleeves.

2.3 FILL MATERIALS

A. Cast-in-Place Firestop Devices: Factory-assembled devices for use in cast-in-place concrete floors and consisting of an outer sleeve lined with an intumescent strip, a flange attached to one end of the sleeve for fastening to concrete formwork, and a neoprene gasket.

B. Latex Sealants: Single-component latex formulations that do not re-emulsify after cure during exposure to moisture.

C. Firestop Devices: Factory-assembled collars formed from galvanized steel and lined with intumescent material sized to fit specific diameter of penetrant.

D. Intumescent Composite Sheets: Rigid panels consisting of aluminum-foil-faced intumescent elastomeric sheet bonded to galvanized-steel sheet.

E. Intumescent Putties: Nonhardening, water-resistant, intumescent putties containing no solvents or inorganic fibers.

F. Intumescent Wrap Strips: Single-component intumescent elastomeric sheets with aluminum foil on one side.

G. Mortars: Prepackaged dry mixes consisting of a blend of inorganic binders, hydraulic cement, fillers and lightweight aggregate formulated for mixing with water at Project site to form a nonshrinking, homogeneous mortar.

H. Pillows/Bags: Reusable heat-expanding pillows/bags consisting of glass-fiber cloth cases filled with a combination of mineral-fiber, water-insoluble expansion agents, and fire-retardant additives. Where exposed, cover openings with steel-reinforcing wire mesh to protect pillows/bags from being easily removed.

I. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.

J. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants.

2.4 MIXING

A. Penetration Firestopping Materials: For those products requiring mixing before application, comply with penetration firestopping system manufacturer's written instructions for accurate proportioning of materials, water (if required), type of mixing equipment, selection of mixer speeds, mixing containers, mixing time, and other items or procedures needed to produce products of uniform quality with optimum performance characteristics for application indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements for opening configurations, penetrating items, substrates, and other conditions affecting performance of the Work.

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

3.2 PREPARATION

A. Surface Cleaning: Before installing penetration firestopping systems, clean out openings immediately to comply with manufacturer's written instructions and with the following requirements:

1. Remove from surfaces of opening substrates and from penetrating items foreign materials that could interfere with adhesion of penetration firestopping materials.
2. Clean opening substrates and penetrating items to produce clean, sound surfaces capable of developing optimum bond with penetration firestopping materials. Remove loose particles remaining from cleaning operation.
3. Remove laitance and form-release agents from concrete.

B. Prime substrates where recommended in writing by manufacturer using that manufacturer's recommended products and methods. Confine primers to areas of bond; do not allow spillage and migration onto exposed surfaces.

3.3 INSTALLATION

A. General: Install penetration firestopping systems to comply with manufacturer's written installation instructions and published drawings for products and applications.

B. Install forming materials and other accessories of types required to support fill materials during their application and in the position needed to produce cross-sectional shapes and depths required to achieve fire ratings.

1. After installing fill materials and allowing them to fully cure, remove combustible forming materials and other accessories not forming permanent components of firestopping.

C. Install fill materials by proven techniques to produce the following results:

1. Fill voids and cavities formed by openings, forming materials, accessories and penetrating items to achieve required fire-resistance ratings.
2. Apply materials so they contact and adhere to substrates formed by openings and penetrating items.
3. For fill materials that will remain exposed after completing the Work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.

3.4 IDENTIFICATION

A. Wall Identification: Permanently label walls containing penetration firestopping systems with the words "FIRE AND/OR SMOKE BARRIER - PROTECT ALL OPENINGS," using lettering not less than 3 inches (76 mm) high and with minimum 0.375-inch (9.5-mm) strokes.

1. Locate in accessible concealed floor, floor-ceiling, or attic space at 15 feet (4.57 m) from end of wall and at intervals not exceeding 30 feet (9.14 m).

B. Penetration Identification: Identify each penetration firestopping system with legible metal or plastic labels. Attach labels permanently to surfaces adjacent to and within 6 inches (150 mm)

of penetration firestopping system edge so labels are visible to anyone seeking to remove penetrating items or firestopping systems. Use mechanical fasteners or self-adhering-type labels with adhesives capable of permanently bonding labels to surfaces on which labels are placed. Include the following information on labels:

1. The words "Warning - Penetration Firestopping - Do Not Disturb. Notify Building Management of Any Damage."
2. Contractor's name, address, and phone number.
3. Designation of applicable testing and inspecting agency.
4. Date of installation.
5. Manufacturer's name.
6. Installer's name.

3.5 FIELD QUALITY CONTROL

A. Owner will engage a qualified testing agency to perform tests and inspections according to ASTM E 2174.

B. Where deficiencies are found or penetration firestopping system is damaged or removed because of testing, repair or replace penetration firestopping system to comply with requirements.

C. Proceed with enclosing penetration firestopping systems with other construction only after inspection reports are issued and installations comply with requirements.

3.6 CLEANING AND PROTECTION

A. Clean off excess fill materials adjacent to openings as the Work progresses by methods and with cleaning materials that are approved in writing by penetration firestopping system manufacturers and that do not damage materials in which openings occur.

B. Provide final protection and maintain conditions during and after installation that ensure that penetration firestopping systems are without damage or deterioration at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, immediately cut out and remove damaged or deteriorated penetration firestopping material and install new materials to produce systems complying with specified requirements.

END OF SECTION 078413

SECTION 078443 - JOINT FIRESTOPPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Joints in or between fire-resistance-rated constructions.
2. Joints at exterior curtain-wall/floor intersections.
3. Joints in smoke barriers.

B. Related Requirements:

1. Section 078413 "Penetration Firestopping" for penetrations in fire-resistance-rated walls, horizontal assemblies, and smoke barriers and for wall identification.
2. Section 092216 "Non-Structural Metal Framing" for firestop tracks for metal-framed partition heads.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Sustainable Design Submittals:

1. Product Data: For sealants, indicating VOC content.
2. Laboratory Test Reports: For sealants, indicating compliance with requirements for low-emitting materials.

C. Product Schedule: For each joint firestopping system. Include location, illustration of firestopping system, and design designation of qualified testing agency.

1. Engineering Judgments: Where Project conditions require modification to a qualified testing agency's illustration for a particular joint firestopping system condition, submit illustration, with modifications marked, approved by joint firestopping system manufacturer's fire-protection engineer as an engineering judgment or equivalent fire-resistance-rated assembly.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Product Test Reports: For each joint firestopping system, for tests performed by a qualified testing agency.

1.6 CLOSEOUT SUBMITTALS

A. Installer Certificates: From Installer indicating that joint firestopping systems have been installed in compliance with requirements and manufacturer's written instructions.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: A firm that has been approved by FM Global according to FM Global 4991, "Approval of Firestop Contractors," or been evaluated by UL and found to comply with UL's "Qualified Firestop Contractor Program Requirements."

1.8 PROJECT CONDITIONS

A. Environmental Limitations: Do not install joint firestopping systems when ambient or substrate temperatures are outside limits permitted by joint firestopping system manufacturers or when substrates are wet due to rain, frost, condensation, or other causes.

B. Install and cure joint firestopping systems per manufacturer's written instructions using natural means of ventilation or, where this is inadequate, forced-air circulation.

1.9 COORDINATION

A. Coordinate construction of joints to ensure that joint firestopping systems can be installed according to specified firestopping system design.

B. Coordinate sizing of joints to accommodate joint firestopping systems.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Fire-Test-Response Characteristics:

1. Perform joint firestopping system tests by a qualified testing agency acceptable to authorities having jurisdiction.
2. Test per testing standards referenced in "Joint Firestopping Systems" Article. Provide rated systems complying with the following requirements:

a. Joint firestopping systems shall bear classification marking of a qualified testing agency.

1) UL in its "Fire Resistance Directory."

2.2 JOINT FIRESTOPPING SYSTEMS

A. Joint Firestopping Systems: Systems that resist spread of fire, passage of smoke and other gases, and maintain original fire-resistance rating of assemblies in or between which joint firestopping systems are installed. Joint firestopping systems shall accommodate building movements without impairing their ability to resist the passage of fire and hot gases.

B. Joints in or between Fire-Resistance-Rated Construction: Provide joint firestopping systems with ratings determined per ASTM E 1966 or UL 2079.

1. Products: Subject to compliance with requirements, provide one of the following:

   a. 3M Fire Protection Products.
   b. Hilti, Inc.
   c. Roxul Inc; SAFE.
   d. Specified Technologies, Inc.
   e. Thermafiber, Inc.; an Owens Corning company; TopStop.
   f. Tremco, Inc.

2. Fire-Resistance Rating: Equal to or exceeding the fire-resistance rating of the wall, floor, or roof in or between which it is installed.

C. Joints at Exterior Curtain-Wall/Floor Intersections: Provide joint firestopping systems with rating determined per ASTM E 2307.

1. Products: Subject to compliance with requirements, provide one of the following:

   a. 3M Fire Protection Products.
   b. Hilti, Inc.
   c. Roxul Inc; SAFE.
   d. Specified Technologies, Inc.
   e. Thermafiber, Inc.; an Owens Corning company; Safing.
   f. Tremco, Inc.

2. F-Rating: Equal to or exceeding the fire-resistance rating of the floor assembly.

D. Joints in Smoke Barriers: Provide fire-resistive joint systems with ratings determined per UL 2079 based on testing at a positive pressure differential of 0.30-inch wg (74.7 Pa).

1. Products: Subject to compliance with requirements, provide one of the following:

   a. 3M Fire Protection Products.
   b. Hilti, Inc.
   c. Roxul Inc.
   d. Specified Technologies, Inc.
   e. Thermafiber, Inc.; an Owens Corning company.
   f. Tremco, Inc.

2. L-Rating: Not exceeding 5.0 cfm/ft. (0.00775 cu. m/s x m) of joint at both ambient and elevated temperatures.

E. Exposed Joint Firestopping Systems: Flame-spread and smoke-developed indexes of less than 25 and 450, respectively, as determined per ASTM E 84.

1. Sealant shall have a VOC content of 250 g/L or less.

F. Accessories: Provide components of fire-resistive joint systems, including primers and forming materials, that are needed to install elastomeric fill materials and to maintain ratings required. Use only components specified by joint firestopping system manufacturer and approved by the qualified testing agency for conditions indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements for joint configurations, substrates, and other conditions affecting performance of the Work.

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

3.2 PREPARATION

A. Surface Cleaning: Before installing fire-resistive joint systems, clean joints immediately to comply with fire-resistive joint system manufacturer's written instructions and the following requirements:

1. Remove from surfaces of joint substrates foreign materials that could interfere with adhesion of elastomeric fill materials or compromise fire-resistive rating.
2. Clean joint substrates to produce clean, sound surfaces capable of developing optimum bond with elastomeric fill materials. Remove loose particles remaining from cleaning operation.
3. Remove laitance and form-release agents from concrete.

B. Prime substrates where recommended in writing by joint firestopping system manufacturer using that manufacturer's recommended products and methods. Confine primers to areas of bond; do not allow spillage and migration onto exposed surfaces.

3.3 INSTALLATION

A. General: Install fire-resistive joint systems to comply with manufacturer's written installation instructions and published drawings for products and applications indicated.

B. Install forming materials and other accessories of types required to support elastomeric fill materials during their application and in position needed to produce cross-sectional shapes and depths required to achieve fire ratings indicated.

1. After installing elastomeric fill materials and allowing them to fully cure, remove combustible forming materials and other accessories not indicated as permanent components of fire-resistive joint system.

C. Install elastomeric fill materials for fire-resistive joint systems by proven techniques to produce the following results:

1. Elastomeric fill voids and cavities formed by joints and forming materials as required to achieve fire-resistance ratings indicated.
2. Apply elastomeric fill materials so they contact and adhere to substrates formed by joints.
3. For elastomeric fill materials that will remain exposed after completing the Work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.

3.4 IDENTIFICATION

A. Joint Identification: Identify joint firestopping systems with legible metal or plastic labels. Attach labels permanently to surfaces adjacent to and within 6 inches (150 mm) of joint edge so labels are visible to anyone seeking to remove or joint firestopping system. Use mechanical fasteners or self-adhering-type labels with adhesives capable of permanently bonding labels to surfaces on which labels are placed. Include the following information on labels:

1. The words "Warning - Joint Firestopping - Do Not Disturb. Notify Building Management of Any Damage."
2. Contractor's name, address, and phone number.
3. Designation of applicable testing agency.
4. Date of installation.
5. Manufacturer's name.
6. Installer's name.

3.5 FIELD QUALITY CONTROL

A. Inspecting Agency: Owner will engage a qualified testing agency to perform tests and inspections according to ASTM E 2393.

B. Where deficiencies are found or joint firestopping systems are damaged or removed due to testing, repair or replace joint firestopping systems so they comply with requirements.

C. Proceed with enclosing joint firestopping systems with other construction only after inspection reports are issued and installations comply with requirements.

3.6 CLEANING AND PROTECTION

A. Clean off excess elastomeric fill materials adjacent to joints as the Work progresses by methods and with cleaning materials that are approved in writing by joint firestopping system manufacturers and that do not damage materials in which joints occur.

B. Provide final protection and maintain conditions during and after installation that ensure joint firestopping systems are without damage or deterioration at time of Substantial Completion. If damage or deterioration occurs despite such protection, cut out and remove damaged or deteriorated fire-resistive joint systems immediately and install new materials to produce fire-resistive joint systems complying with specified requirements.

3.7 JOINT FIRESTOPPING SYSTEM SCHEDULE

A. Where UL-classified systems are indicated, they refer to system numbers in UL's "Fire Resistance Directory" under product Category XHBN or Category XHDG.

B. Floor-to-Floor, Joint Firestopping Systems:

1. UL-Classified Systems: FF-D- 0000-0999.
2. Assembly Rating: As indicated on Drawings.
3. Nominal Joint Width: As indicated on Drawings.
4. W-Rating: No leakage of water at completion of water leakage testing.

C. Wall-to-Wall, Joint Firestopping Systems:

1. UL-Classified Systems: WW-D-0000-0999.
2. Assembly Rating: As indicated on Drawings.
3. Nominal Joint Width: As indicated on Drawings.

D. Floor-to-Wall, Joint Firestopping Systems:

1. UL-Classified Systems: FW-D-0000-0999.
2. Assembly Rating: As indicated on Drawings.
3. Nominal Joint Width: As indicated on Drawings.

E. Head-of-Wall, Fire-Resistive Joint Firestopping Systems:

1. UL-Classified Systems: HW-D-0000-0999.
2. Assembly Rating: As indicated on Drawings.
3. Nominal Joint Width: As indicated on Drawings.

F. Bottom-of-Wall, Joint Firestopping Systems:

1. UL-Classified Systems: BW-D-0000-0999.
2. Assembly Rating: As indicated on Drawings.
3. Nominal Joint Width: As indicated on Drawings.

G. Perimeter Joint Firestopping Systems:

1. UL-Classified Perimeter Fire-Containment Systems: CW-D-0000-0999.
2. Linear Opening Width: As indicated on Drawings.

END OF SECTION 078443

SECTION 079200 - JOINT SEALANTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Urethane joint sealants.
2. Mildew-resistant joint sealants.
3. Latex joint sealants.
4. Non-halogenated latex-based elastomeric sealant.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.4 ACTION SUBMITTALS

A. Product Data: For each joint-sealant product.

B. LEED Submittals:

1. Product Data for Credit IEQ 4.1: For sealants and sealant primers used inside the weatherproofing system, documentation including printed statement of VOC content.

C. Samples for Initial Selection: Manufacturer's color charts consisting of strips of cured sealants showing the full range of colors available for each product exposed to view.

D. Samples for Verification: For each kind and color of joint sealant required, provide Samples with joint sealants in 1/2-inch- (13-mm-) wide joints formed between two 6-inch- (150-mm-) long strips of material matching the appearance of exposed surfaces adjacent to joint sealants.

E. Joint-Sealant Schedule: Include the following information:

1. Joint-sealant application, joint location, and designation.
2. Joint-sealant manufacturer and product name.
3. Joint-sealant formulation.
4. Joint-sealant color.

1.5 INFORMATIONAL SUBMITTALS

A. Product Test Reports: For each kind of joint sealant, for tests performed by a qualified testing agency.

B. Sample Warranties: For special warranties.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.

B. Product Testing: Test joint sealants using a qualified testing agency.

1. Testing Agency Qualifications: Qualified according to ASTM C 1021 to conduct the testing indicated.

C. Mockups: Install sealant in mockups of assemblies specified in other Sections that are indicated to receive joint sealants specified in this Section. Use materials and installation methods specified in this Section. Perform adhesion testing in mockups.

1.7 FIELD CONDITIONS

A. Do not proceed with installation of joint sealants under the following conditions:

1. When ambient and substrate temperature conditions are outside limits permitted by joint-sealant manufacturer or are below 40 deg F (5 deg C).
2. When joint substrates are wet.
3. Where joint widths are less than those allowed by joint-sealant manufacturer for applications indicated.
4. Where contaminants capable of interfering with adhesion have not yet been removed from joint substrates.

1.8 WARRANTY

A. Special Installer's Warranty: Installer agrees to repair or replace joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.

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

B. Special Manufacturer's Warranty: Manufacturer agrees to furnish joint sealants to repair or replace those joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.

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

C. Special warranties specified in this article exclude deterioration or failure of joint sealants from the following:

1. Movement of the structure caused by stresses on the sealant exceeding sealant manufacturer's written specifications for sealant elongation and compression.
2. Disintegration of joint substrates from causes exceeding design specifications.
3. Mechanical damage caused by individuals, tools, or other outside agents.
4. Changes in sealant appearance caused by accumulation of dirt or other atmospheric contaminants.

PART 2 - PRODUCTS

2.1 JOINT SEALANTS, GENERAL

A. Compatibility: Provide joint sealants, backings, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by joint-sealant manufacturer, based on testing and field experience.

B. VOC Content of Interior Sealants: Sealants and sealant primers used inside the weatherproofing system shall comply with the following:

1. Architectural sealants shall have a VOC content of 250 g/L or less.
2. Sealants and sealant primers for nonporous substrates shall have a VOC content of 250 g/L or less.
3. Sealants and sealant primers for nonporous substrates shall have a VOC content of 775 g/L or less.

2.2 URETHANE JOINT SEALANTS (JS-1)

A. Urethane, M, NS, 50, NT: Multicomponent, nonsag, plus 50 percent and minus 50 percent movement capability nontraffic-use, urethane joint sealant; ASTM C 920, Type M, Grade NS, Class 50, Use NT.

1. Products: Subject to compliance with requirements, provide the following:

a. Pecora Corporation; Dynatrol II.

2.3 MILDEW-RESISTANT JOINT SEALANTS (JS-2)

A. Mildew-Resistant Joint Sealants: Formulated for prolonged exposure to humidity with fungicide to prevent mold and mildew growth.

B. Silicone, Mildew Resistant, Acid Curing, S, NS, 25, NT: Mildew-resistant, single-component, nonsag, plus 25 percent and minus 25 percent movement capability, nontraffic-use, acid-curing silicone joint sealant; ASTM C 920, Type S, Grade NS, Class 25, Use NT.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Dow Corning Corporation; 786-M White.
b. GE Construction Sealants; Momentive Performance Materials Inc.; SCS1700 Sanitary.
c. Tremco Incorporated; Tremsil 200.

2.4 LATEX JOINT SEALANTS (JS-3)

A. Siliconized Acrylic Latex: Acrylic latex or siliconized acrylic latex, ASTM C 834, Type OP, Grade NF. Note: Latex plus silicone is not an acceptable product.

2.5 NON-HALOGENATED LATEX-BASED ELASTOMERIC SEALANT (JS-4)

A. Non-halogenated latex-based elastomeric sealant, ASTM C920.

2.6 JOINT-SEALANT BACKING

A. Sealant Backing Material, General: Nonstaining; compatible with joint substrates, sealants, primers, and other joint fillers; and approved for applications indicated by sealant manufacturer based on field experience and laboratory testing.

B. Cylindrical Sealant Backings: ASTM C 1330, Type C (closed-cell material with a surface skin), and of size and density to control sealant depth and otherwise contribute to producing optimum sealant performance.

C. Bond-Breaker Tape: Polyethylene tape or other plastic tape recommended by sealant manufacturer for preventing sealant from adhering to rigid, inflexible joint-filler materials or joint surfaces at back of joint. Provide self-adhesive tape where applicable.

2.7 MISCELLANEOUS MATERIALS

A. Primer: Material recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from preconstruction joint-sealant-substrate tests and field tests.

B. Cleaners for Nonporous Surfaces: Chemical cleaners acceptable to manufacturers of sealants and sealant backing materials, free of oily residues or other substances capable of staining or harming joint substrates and adjacent nonporous surfaces in any way, and formulated to promote optimum adhesion of sealants to joint substrates.

C. Masking Tape: Nonstaining, nonabsorbent material compatible with joint sealants and surfaces adjacent to joints.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine joints indicated to receive joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting performance of the Work.

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

3.2 PREPARATION

A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with joint-sealant manufacturer's written instructions and the following requirements:

1. Remove all foreign material from joint substrates that could interfere with adhesion of joint sealant, including dust, paints (except for permanent, protective coatings tested and approved for sealant adhesion and compatibility by sealant manufacturer), old joint sealants, oil, grease, waterproofing, water repellents, water, surface dirt, and frost.
2. Clean porous joint substrate surfaces by brushing, grinding, mechanical abrading, or a combination of these methods to produce a clean, sound substrate capable of developing optimum bond with joint sealants. Remove loose particles remaining after cleaning operations above by vacuuming or blowing out joints with oil-free compressed air. Porous joint substrates include the following:

    a. Concrete.
    b. Masonry.

3. Remove laitance and form-release agents from concrete.
4. Clean nonporous joint substrate surfaces with chemical cleaners or other means that do not stain, harm substrates, or leave residues capable of interfering with adhesion of joint sealants. Nonporous joint substrates include the following:

    a. Metal.
    b. Glass.
    c. Porcelain enamel.
    d. Glazed surfaces of ceramic tile.

B. Joint Priming: Prime joint substrates where recommended by joint-sealant manufacturer or as indicated by preconstruction joint-sealant-substrate tests or prior experience. Apply primer to comply with joint-sealant manufacturer's written instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or migration onto adjoining surfaces.

C. Masking Tape: Use masking tape where required to prevent contact of sealant or primer with adjoining surfaces that otherwise would be permanently stained or damaged by such contact or by cleaning methods required to remove sealant smears. Remove tape immediately after tooling without disturbing joint seal.

3.3 INSTALLATION OF JOINT SEALANTS

A. General: Comply with joint-sealant manufacturer's written installation instructions for products and applications indicated, unless more stringent requirements apply.

B. Sealant Installation Standard: Comply with recommendations in ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.

C. Install sealant backings of kind indicated to support sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.

1. Do not leave gaps between ends of sealant backings.
2. Do not stretch, twist, puncture, or tear sealant backings.

3. Remove absorbent sealant backings that have become wet before sealant application, and replace them with dry materials.

D. Install bond-breaker tape behind sealants where sealant backings are not used between sealants and backs of joints.

E. Install sealants using proven techniques that comply with the following and at the same time backings are installed:

1. Place sealants so they directly contact and fully wet joint substrates.
2. Completely fill recesses in each joint configuration.
3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.

F. Tooling of Nonsag Sealants: Immediately after sealant application and before skinning or curing begins, tool sealants according to requirements specified in subparagraphs below to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint.

1. Remove excess sealant from surfaces adjacent to joints.
2. Use tooling agents that are approved in writing by sealant manufacturer and that do not discolor sealants or adjacent surfaces.
3. Provide concave joint profile per Figure 8A in ASTM C 1193 unless otherwise indicated.
4. Provide flush joint profile at locations indicated on Drawings according to Figure 8B in ASTM C 1193.
5. Provide recessed joint configuration of recess depth and at locations indicated on Drawings according to Figure 8C in ASTM C 1193.

    a. Use masking tape to protect surfaces adjacent to recessed tooled joints.

3.4 CLEANING

A. Clean off excess sealant or sealant smears adjacent to joints as the Work progresses by methods and with cleaning materials approved in writing by manufacturers of joint sealants and of products in which joints occur.

3.5 PROTECTION

A. Protect joint sealants during and after curing period from contact with contaminating substances and from damage resulting from construction operations or other causes so sealants are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out, remove, and repair damaged or deteriorated joint sealants immediately so installations with repaired areas are indistinguishable from original work.

3.6 JOINT-SEALANT SCHEDULE

A. Joint-Sealant Application: Interior joints in horizontal traffic surfaces.

1. Joint Locations:

    a. Isolation joints in cast-in-place concrete slabs.

b. Control and expansion joints in tile flooring.
c. Seal door thresholds to the floor and around the threshold.
d. Seal top and bottom of cove base.
e. Seal all around floor surface-mounted mounting plates and cover plates, if exposed and permanently affixed to floor.
f. Other joints as indicated on Drawings.

2. Joint Sealant: Urethane, S, P, 25, T, NT.
3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.

B. Joint-Sealant Application: Interior joints in vertical surfaces and horizontal nontraffic surfaces.

1. Joint Locations:

a. Control and expansion joints on exposed interior surfaces of exterior walls.
b. Tile control and expansion joints.
c. Vertical joints on exposed surfaces of unit masonry, concrete walls and partitions.
d. Control joints in walls and ceilings.
e. Seal all fixed equipment that is within 38 mm or less from a ceiling.
f. Seal floor mounted equipment supports, legs and standoff supports.
g. Other joints as indicated on Drawings.

2. Joint Sealant: Urethane, S, NS, 25, NT.
3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.

C. Joint-Sealant Application: Interior joints in vertical surfaces and horizontal nontraffic surfaces not subject to significant movement.

1. Joint Locations:

a. Control joints on exposed interior surfaces of exterior walls.
b. Perimeter joints between interior wall surfaces and frames of interior doors, windows and elevator entrances.
c. Seal openings in the base of tables where the support feet mount to the table.
d. Seal openings in table legs where the support feet mount to the floor.
e. Seal all cabinets where they contact dissimilar materials and where they contact one another.
f. Seal all countertops where they contact with dissimilar material.
g. Seal tops and bottoms of all wall mounted shelving brackets.
h. Seal covers between shelf standards.
i. Seal around all wall guards, bumpers, and rails.
j. Seal all around corner guards.
k. Seal the perimeter of all suspended acoustical of FRP ceiling frames at the wall juncture.
l. Seal around wall and ceiling, surface-mounted cover plates and surface-mounted mounting plates, if exposed and permanently affixed to wall.
m. Seal joints between walls of dissimilar materials.
n. Large gaps, behind the back splash shall be filled in with foam cord and sealed in place.
o. Other joints as indicated on Drawings.

2. Joint Sealant: Siliconized acrylic latex.
3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.

D. Joint-Sealant Application: Mildew-resistant interior joints in vertical surfaces and horizontal nontraffic surfaces.

1. Joint Locations:

a. Joints between plumbing fixtures and adjoining walls, floors, and counters.
b. Tile control and expansion joints where indicated.
c. Seal peninsula shelving support at countertop and at ceiling.
d. Seal all interior window frames (including gasketed areas). Sealant shall be sloped to promote cleaning. Seal all joints, including stops, juncture to glass and screw heads.
e. Seal around frames and holes inside of fire extinguisher boxes.
f. Other joints as indicated on Drawings.

2. Joint Sealant: Silicone, mildew resistant, acid curing, S, NS, 25, NT.
3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.

E. Joint-Sealant Application:

1. Joint Locations:

a. Seal all penetrations on the top and bottom of slab, to include but not limited to HVAC, plumbing, and electrical penetrations, and like penetrations through interstitial space.
b. Seal space in wall penetrations, including inside sleeves, collars, and surrounding construction. Where stuff mineral wool is applied, use fore stop and spray over with this sealant.
c.

2. Joint Sealant: Non-Halogenated Latex-Based Elastomeric Sealant.
3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.

END OF SECTION 079200

SECTION 081113 - HOLLOW METAL DOORS AND FRAMES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes hollow-metal work.

B. Related Requirements:

1. Section 087100 "Door Hardware" for door hardware for hollow-metal doors.

1.3 DEFINITIONS

A. Minimum Thickness: Minimum thickness of base metal without coatings according to NAAMM-HMMA 803 or SDI A250.8.

1.4 COORDINATION

A. Coordinate anchorage installation for hollow-metal frames. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors. Deliver such items to Project site in time for installation.

1.5 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.6 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, core descriptions, fire-resistance ratings, and finishes.

B. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.

C. Shop Drawings: Include the following:

1. Elevations of each door type.
2. Details of doors, including vertical- and horizontal-edge details and metal thicknesses.
3. Frame details for each frame type, including dimensioned profiles and metal thicknesses.
4. Locations of reinforcement and preparations for hardware.
5. Details of each different wall opening condition.
6. Details of anchorages, joints, field splices, and connections.
7. Details of accessories.
8. Details of moldings, removable stops, and glazing.
9. Details of conduit and preparations for power, signal, and control systems.

D. Samples for Verification:

1. For each type of exposed finish required, prepared on Samples of not less than 3 by 5 inches (75 by 127 mm).
2. For "Doors" and "Frames" subparagraphs below, prepare Samples approximately 12 by 12 inches (305 by 305 mm) to demonstrate compliance with requirements for quality of materials and construction:

    a. Doors: Show vertical-edge, top, and bottom construction; core construction; and hinge and other applied hardware reinforcement. Include separate section showing glazing if applicable.
    b. Frames: Show profile, corner joint, floor and wall anchors, and silencers. Include separate section showing fixed hollow-metal panels and glazing if applicable.

E. Schedule: Provide a schedule of hollow-metal work prepared by or under the supervision of supplier, using same reference numbers for details and openings as those on Drawings. Coordinate with final Door Hardware Schedule.

1.7 INFORMATIONAL SUBMITTALS

A. Product Test Reports: For each type of hollow-metal door and frame assembly, for tests performed by a qualified testing agency.

B. Oversize Construction Certification: For assemblies required to be fire rated and exceeding limitations of labeled assemblies.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver hollow-metal work palletized, packaged, or crated to provide protection during transit and Project-site storage. Do not use nonvented plastic.

1. Provide additional protection to prevent damage to factory-finished units.

B. Deliver welded frames with two removable spreader bars across bottom of frames, tack welded to jambs and mullions.

C. Store hollow-metal work vertically under cover at Project site with head up. Place on minimum 4-inch- (102-mm-) high wood blocking. Provide minimum 1/4-inch (6-mm) space between each stacked door to permit air circulation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Amweld Building Products, Inc.
2. Benchmark Commercial Doors
3. Ceco Door; ASSA ABLOY.
4. Fenestra Corp.
5. Kentucky Products, Inc., Corbin, Kenticky.
6. Steelcraft; an Allegion brand.

B. Source Limitations: Obtain hollow-metal work from single source from single manufacturer.

2.2 REGULATORY REQUIREMENTS

A. Fire-Rated Assemblies: Complying with NFPA 80 and listed and labeled by a qualified testing agency acceptable to authorities having jurisdiction for fire-protection ratings indicated, based on testing at positive pressure according to NFPA 252 or UL 10C.

1. Smoke- and Draft-Control Assemblies: Provide an assembly with gaskets listed and labeled for smoke and draft control by a qualified testing agency acceptable to authorities having jurisdiction, based on testing according to UL 1784 and installed in compliance with NFPA 105.

2.3 INTERIOR DOORS AND FRAMES

A. Construct interior doors and frames to comply with the standards indicated for materials, fabrication, hardware locations, hardware reinforcement, tolerances, and clearances, and as specified.

B. Heavy-Duty Doors and Frames: SDI A250.8, Level 2.

1. Physical Performance: Level B according to SDI A250.4.
2. Doors:

a. Type: As indicated in the Door and Frame Schedule.
b. Thickness: 1-3/4 inches (44.5 mm).
c. Face: Uncoated, cold-rolled steel sheet, minimum thickness of 0.0478 inch.
d. Edge Construction: Model 2, Seamless.
e. Core: Manufacturer's standard kraft-paper honeycomb, polystyrene, polyurethane, polyisocyanurate, mineral-board, or vertical steel-stiffener core at manufacturer's discretion.

3. Frames:

a. Materials: Uncoated steel sheet, 16 gauge. Frames for interior openings over 48 inches wide shall be 14 gauge steel.
b. Sidelite Frames: Fabricated from same thickness material as adjacent door frame.

c. Construction: Full profile welded.

4. Exposed Finish: Prime.

2.4 BORROWED LITES

A. Hollow-metal frames of steel sheet, minimum thickness of 16 ga.

B. Construction: Full profile welded.

2.5 FRAME ANCHORS

A. Jamb Anchors:

1. Masonry Type: Adjustable strap-and-stirrup or T-shaped anchors to suit frame size, not less than 0.042 inch (1.0 mm) thick, with corrugated or perforated straps not less than 2 inches (51 mm) wide by 10 inches (254 mm) long; or wire anchors not less than 0.177 inch (4.5 mm) thick.
2. Stud-Wall Type: Designed to engage stud, welded to back of frames; not less than 0.042 inch (1.0 mm) thick.

B. Floor Anchors: Formed from same material as frames, minimum thickness of 0.042 inch (1.0 mm), and as follows:

1. Monolithic Concrete Slabs: Clip-type anchors, with two holes to receive fasteners.
2. Separate Topping Concrete Slabs: Adjustable-type anchors with extension clips, allowing not less than 2-inch (51-mm) height adjustment. Terminate bottom of frames at finish floor surface.

2.6 MATERIALS

A. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.

B. Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, Commercial Steel (CS), Type B; suitable for exposed applications.

C. Hot-Rolled Steel Sheet: ASTM A 1011/A 1011M, Commercial Steel (CS), Type B; free of scale, pitting, or surface defects; pickled and oiled.

D. Frame Anchors: ASTM A 879/A 879M, Commercial Steel (CS), 04Z (12G) coating designation; mill phosphatized.

1. For anchors built into exterior walls, steel sheet complying with ASTM A 1008/A 1008M or ASTM A 1011/A 1011M, hot-dip galvanized according to ASTM A 153/A 153M, Class B.

E. Inserts, Bolts, and Fasteners: Hot-dip galvanized according to ASTM A 153/A 153M.

F. Mineral-Fiber Insulation: ASTM C 665, Type I (blankets without membrane facing); consisting of fibers manufactured from slag or rock wool; with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively; passing ASTM E 136 for combustion characteristics.

G. Glazing: Comply with requirements in Section 088000 "Glazing."

2.7 FABRICATION

A. Fabricate hollow-metal work to be rigid and free of defects, warp, or buckle. Accurately form metal to required sizes and profiles, with minimum radius for metal thickness. Where practical, fit and assemble units in manufacturer's plant. To ensure proper assembly at Project site, clearly identify work that cannot be permanently factory assembled before shipment.

B. Hollow-Metal Doors:

1. Steel-Stiffened Door Cores: Provide minimum thickness 0.026 inch (0.66 mm), steel vertical stiffeners of same material as face sheets extending full-door height, with vertical webs spaced not more than 6 inches (152 mm) apart. Spot weld to face sheets no more than 5 inches (127 mm) o.c. Fill spaces between stiffeners with glass- or mineral-fiber insulation.
2. Fire Door Cores: As required to provide fire-protection ratings indicated.
3. Vertical Edges for Single-Acting Doors: Bevel edges 1/8 inch in 2 inches (3.2 mm in 51 mm).
4. Top Edge Closures: Close top edges of doors with inverted closures, except provide flush closures at exterior doors of same material as face sheets.
5. Bottom Edge Closures: Close bottom edges of doors with end closures or channels of same material as face sheets.
6. Astragals: Provide overlapping astragal on one leaf of pairs of doors where required by NFPA 80 for fire-performance rating or where indicated. Extend minimum 3/4 inch (19 mm) beyond edge of door on which astragal is mounted or as required to comply with published listing of qualified testing agency.

C. Hollow-Metal Frames: Where frames are fabricated in sections due to shipping or handling limitations, provide alignment plates or angles at each joint, fabricated of same thickness metal as frames.

1. Sidelite Frames: Provide closed tubular members with no visible face seams or joints, fabricated from same material as door frame. Fasten members at crossings and to jambs by butt welding.
2. Provide countersunk, flat- or oval-head exposed screws and bolts for exposed fasteners unless otherwise indicated.
3. Grout Guards: Weld guards to frame at back of hardware mortises in frames to be grouted.
4. Floor Anchors: Weld anchors to bottoms of jambs with at least four spot welds per anchor; however, for slip-on drywall frames, provide anchor clips or countersunk holes at bottoms of jambs.
5. Jamb Anchors: Provide number and spacing of anchors as follows:

    a. Stud-Wall Type: Locate anchors not more than 18 inches (457 mm) from top and bottom of frame. Space anchors not more than 32 inches (813 mm) o.c. and as follows:

        1) Three anchors per jamb up to 60 inches (1524 mm) high.

2) Four anchors per jamb from 60 to 90 inches (1524 to 2286 mm) high.
3) Five anchors per jamb from 90 to 96 inches (2286 to 2438 mm) high.
4) Five anchors per jamb plus one additional anchor per jamb for each 24 inches (610 mm) or fraction thereof above 96 inches (2438 mm) high.

6. Door Silencers: Except on weather-stripped frames, drill stops to receive door silencers as follows. Keep holes clear during construction.

   a. Single-Door Frames: Drill stop in strike jamb to receive three door silencers.
   b. Double-Door Frames: Drill stop in head jamb to receive two door silencers.

D. Fabricate concealed stiffeners and edge channels from either cold- or hot-rolled steel sheet.

E. Hardware Preparation: Factory prepare hollow-metal work to receive templated mortised hardware; include cutouts, reinforcement, mortising, drilling, and tapping according to SDI A250.6, the Door Hardware Schedule, and templates.

1. Reinforce doors and frames to receive nontemplated, mortised, and surface-mounted door hardware.
2. Comply with applicable requirements in SDI A250.6 and BHMA A156.115 for preparation of hollow-metal work for hardware.
3. Provisions for Electrical Devices: Provide steel conduit, boxes and other necessary devices required for the installation of electrical hardware in doors and frames.

F. Stops and Moldings: Provide stops and moldings around glazed lites where indicated. Form corners of stops and moldings with butted or mitered hairline joints.

1. Single Glazed Lites: Provide fixed stops and moldings welded on secure side of hollow-metal work.
2. Multiple Glazed Lites: Provide fixed and removable stops and moldings so that each glazed lite is capable of being removed independently.
3. Provide fixed frame moldings on outside of exterior and on secure side of interior doors and frames.
4. Provide loose stops and moldings on inside of hollow-metal work.
5. Coordinate rabbet width between fixed and removable stops with glazing and installation types indicated.
6. Moldings for glazed lites in doors and loose stops for glazed lites in frames: Minimum 20 gauge thick, fabricated from same material as door face sheet in which they are installed.
7. Preformed metal frames for lite openings: Manufacturer’s standard frame formed of 0.048-inch-thick, cold rolled steel sheet; with baked enamel or powder coated finish; and approved for use in doors of fire protection rating indicated. Match pre-finished door paint color where applicable.

2.8 STEEL FINISHES

A. Prime Finish: Clean, pretreat, and apply manufacturer's standard primer.

1. Shop Primer: Manufacturer's standard, fast-curing, lead- and chromate-free primer complying with SDI A250.10; recommended by primer manufacturer for substrate; compatible with substrate and field-applied coatings despite prolonged exposure.

2.9 ACCESSORIES

A. Grout Guards: Formed from same material as frames, not less than 0.016 inch (0.4 mm) thick.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for embedded and built-in anchors to verify actual locations before frame installation.

C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.

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

3.2 PREPARATION

A. Remove welded-in shipping spreaders installed at factory. Restore exposed finish by grinding, filling, and dressing, as required to make repaired area smooth, flush, and invisible on exposed faces.

B. Drill and tap doors and frames to receive nontemplated, mortised, and surface-mounted door hardware.

3.3 INSTALLATION

A. General: Install hollow-metal work plumb, rigid, properly aligned, and securely fastened in place. Comply with Drawings and manufacturer's written instructions.

B. Hollow-Metal Frames: Install hollow-metal frames for doors, transoms, sidelites, borrowed lites, and other openings, of size and profile indicated. Comply with SDI A250.11 or NAAMM-HMMA 840 as required by standards specified.

1. Set frames accurately in position; plumbed, aligned, and braced securely until permanent anchors are set. After wall construction is complete, remove temporary braces, leaving surfaces smooth and undamaged. All hollow metal frames shall be slushed full of grout.

    a. At fire-rated openings, install frames according to NFPA 80.
    b. Where frames are fabricated in sections because of shipping or handling limitations, field splice at approved locations by welding face joint continuously; grind, fill, dress, and make splice smooth, flush, and invisible on exposed faces.
    c. Install frames with removable stops located on secure side of opening.
    d. Install door silencers in frames before grouting.
    e. Remove temporary braces necessary for installation only after frames have been properly set and secured.

f. Check plumb, square, and twist of frames as walls are constructed. Shim as necessary to comply with installation tolerances.

2. Floor Anchors: Provide floor anchors for each jamb and mullion that extends to floor, and secure with postinstalled expansion anchors.

a. Floor anchors may be set with power-actuated fasteners instead of postinstalled expansion anchors if so indicated and approved on Shop Drawings.

3. Metal-Stud Partitions: Solidly pack mineral-fiber insulation inside frames.
4. Installation Tolerances: Adjust hollow-metal door frames for squareness, alignment, twist, and plumb to the following tolerances:

a. Squareness: Plus or minus 1/16 inch (1.6 mm), measured at door rabbet on a line 90 degrees from jamb perpendicular to frame head.
b. Alignment: Plus or minus 1/16 inch (1.6 mm), measured at jambs on a horizontal line parallel to plane of wall.
c. Twist: Plus or minus 1/16 inch (1.6 mm), measured at opposite face corners of jambs on parallel lines, and perpendicular to plane of wall.
d. Plumbness: Plus or minus 1/16 inch (1.6 mm), measured at jambs at floor.

C. Hollow-Metal Doors: Fit hollow-metal doors accurately in frames, within clearances specified below. Shim as necessary.

1. Non-Fire-Rated Steel Doors:

a. Between Door and Frame Jambs and Head: 1/8 inch (3.2 mm) plus or minus 1/32 inch (0.8 mm).
b. Between Edges of Pairs of Doors: 1/8 inch (3.2 mm) to 1/4 inch (6.3 mm) plus or minus 1/32 inch (0.8 mm).
c. At Bottom of Door: 5/8 inch (15.8 mm**)** plus or minus 1/32 inch (0.8 mm).
d. Between Door Face and Stop: 1/16 inch (1.6 mm) to 1/8 inch (3.2 mm) plus or minus 1/32 inch (0.8 mm).

2. Fire-Rated Doors: Install doors with clearances according to NFPA 80.
3. Smoke-Control Doors: Install doors and gaskets according to NFPA 105.

D. Glazing: Comply with installation requirements in Section 088000 "Glazing" and with hollow-metal manufacturer's written instructions.

1. Secure stops with countersunk flat- or oval-head machine screws spaced uniformly not more than 9 inches (230 mm) o.c. and not more than 2 inches (51 mm) o.c. from each corner.

3.4 ADJUSTING AND CLEANING

A. Final Adjustments: Check and readjust operating hardware items immediately before final inspection. Leave work in complete and proper operating condition. Remove and replace defective work, including hollow-metal work that is warped, bowed, or otherwise unacceptable.

B. Prime-Coat Touchup: Immediately after erection, sand smooth rusted or damaged areas of prime coat and apply touchup of compatible air-drying, rust-inhibitive primer.

END OF SECTION 081113

SECTION 081416 - FLUSH WOOD DOORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Solid-core doors with wood-veneer faces.
2. Factory finishing flush wood doors.
3. Factory fitting flush wood doors to frames and factory machining for hardware.

B. Related Requirements:

1. Section 088000 "Glazing" for glass view panels in flush wood doors.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of door. Include details of core and edge construction and trim for openings. Include factory-finishing specifications.

B. LEED Submittals:

1. Product Certificates for Credit MR 5: For products and materials required to comply with requirements for regional materials, certificates indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include statement indicating distance to Project, cost for each regional material, and fraction by weight that is considered regional.

2. Certificates for Credit MR 7: Chain-of-custody certificates indicating that flush wood doors comply with forest certification requirements. Include documentation that manufacturer is certified for chain of custody by an FSC-accredited certification body. Include statement indicating cost for each certified wood product.
3. Product Data for Credit IEQ 4.4: For adhesives and composite wood products, documentation indicating that product contains no urea formaldehyde.

C. Shop Drawings: Indicate location, size, and hand of each door; elevation of each kind of door; construction details not covered in Product Data; and the following:

1. Dimensions and locations of blocking.
2. Dimensions and locations of mortises and holes for hardware.
3. Dimensions and locations of cutouts.
4. Undercuts.
5. Requirements for veneer matching.
6. Doors to be factory finished and finish requirements.
7. Fire-protection ratings for fire-rated doors.

D. Samples for Verification:

1. Factory finishes applied to actual door face materials, approximately 8 by 10 inches (200 by 250 mm), for each material and finish. For each wood species and transparent finish, provide set of three Samples showing typical range of color and grain to be expected in finished Work.
2. Corner sections of doors, approximately 8 by 10 inches (200 by 250 mm), with door faces and edges representing actual materials to be used.
    a. Provide Samples for each species of veneer and solid lumber required.
    b. Finish veneer-faced door Samples with same materials proposed for factory-finished doors.
3. Frames for light openings, 6 inches (150 mm) long, for each material, type, and finish required.

1.5 INFORMATIONAL SUBMITTALS

A. Sample Warranty: For special warranty.

B. Quality Standard Compliance Certificates: AWI Quality Certification Program certificates.

1.6 QUALITY ASSURANCE

A. Manufacturer Qualifications: A qualified manufacturer that is a certified participant in AWI's Quality Certification Program.

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

1.7 DELIVERY, STORAGE, AND HANDLING

A. Comply with requirements of referenced standard and manufacturer's written instructions.

B. Package doors individually in plastic bags or cardboard cartons.

C. Mark each door on top and bottom rail with opening number used on Shop Drawings.

1.8 FIELD CONDITIONS

A. Environmental Limitations: Do not deliver or install doors until spaces are enclosed and weathertight, wet work in spaces is complete and dry, and HVAC system is operating and

maintaining ambient temperature and humidity conditions at occupancy levels during remainder of construction period.

1.9 WARRANTY

A. A. Special Warranty: Manufacturer agrees to repair or replace doors that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Warping (bow, cup, or twist) more than 1/4 inch (6.4 mm) in a 42-by-84-inch (1067-by-2134-mm) section.
b. Telegraphing of core construction in face veneers exceeding 0.01 inch in a 3-inch (0.25 mm in a 76.2-mm) span.

2. Warranty shall also include installation and finishing that may be required due to repair or replacement of defective doors.
3. Warranty Period for Solid-Core Interior Doors: Life of installation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Algoma Hardwoods, Inc.
2. Eggers Industries.
3. Marshfield DoorSystems, Inc.

B. Source Limitations: Obtain flush wood doors from single manufacturer.

2.2 FLUSH WOOD DOORS, GENERAL

A. Quality Standard: In addition to requirements specified, comply with AWI's, AWMAC's, and WI's "Architectural Woodwork Standards."

B. Regional Materials: Flush wood doors shall be manufactured within 500 miles (800 km) of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within 500 miles (800 km) of Project site.

C. Certified Wood: Flush wood doors shall be certified as "FSC Pure" according to FSC STD-01-001, "FSC Principles and Criteria for Forest Stewardship," and to FSC STD-40-004, "FSC Standard for Chain of Custody Certification."

D. Low-Emitting Materials: Fabricate doors with adhesives and composite wood products that do not contain urea formaldehyde.

E. Fire-Rated Wood Doors: Doors complying with NFPA 80 that are listed and labeled by a qualified testing agency, for fire-protection ratings indicated, based on testing at positive pressure according to NFPA 252 or UL 10C.

1. Oversize Fire-Rated Door Assemblies: For units exceeding sizes of tested assemblies, provide certification by a qualified testing agency that doors comply with standard construction requirements for tested and labeled fire-rated door assemblies except for size.
2. Cores: Provide core specified or mineral core as needed to provide fire-protection rating indicated.
3. Edge Construction: Provide edge construction with intumescent seals concealed by outer stile. Comply with specified requirements for exposed edges.
4. Pairs: Provide fire-retardant stiles that are listed and labeled for applications indicated without formed-steel edges and astragals. Provide stiles with concealed intumescent seals. Comply with specified requirements for exposed edges.
5. Pairs: Provide formed-steel edges and astragals with intumescent seals.

    a. Finish steel edges and astragals with baked enamel same color as doors.
    b. Finish steel edges and astragals to match door hardware (locksets or exit devices).

F. Smoke- and Draft-Control Door Assemblies: Listed and labeled for smoke and draft control, based on testing according to UL 1784.

G. Particleboard-Core Doors:

1. Particleboard: ANSI A208.1, Grade LD-1, made with binder containing no urea-formaldehyde.
2. Particleboard: Straw-based particleboard complying with ANSI A208.1, Grade LD-2 or M-2, except for density.
3. Blocking: Provide wood blocking in particleboard-core doors asneeded to eliminate through-bolting hardware.
4. Provide doors with glued-wood-stave or structural-composite-lumber cores instead of particleboard cores for doors indicated to receive exit devices.

H. Structural-Composite-Lumber-Core Doors:

1. Structural Composite Lumber: WDMA I.S.10.

    a. Screw Withdrawal, Face: 700 lbf (3100 N).
    b. Screw Withdrawal, Edge: 400 lbf (1780 N).

I. Mineral-Core Doors:

1. Core: Noncombustible mineral product complying with requirements of referenced quality standard and testing and inspecting agency for fire-protection rating indicated.
2. Blocking: Provide composite blocking with improved screw-holding capability approved for use in doors of fire-protection ratings indicated as needed to eliminate through-bolting hardware.

3. Edge Construction: At hinge stiles, provide laminated-edge construction with improved screw-holding capability and split resistance. Comply with specified requirements for exposed edges.

    a. Screw-Holding Capability: 475 lbf (2110 N) per WDMA T.M.-10.

2.3 VENEER-FACED DOORS FOR TRANSPARENT FINISH

A. Interior Solid-Core Doors:

1. Grade: Premium, with Grade AA faces.
2. Species: Hickory.
3. Cut: Quarter sliced.
4. Match between Veneer Leaves: Book match.
5. Assembly of Veneer Leaves on Door Faces: Center-balance match.
6. Pair and Set Match: Provide for doors hung in same opening or separated only by mullions.
7. Room Match: Match door faces within each separate room or area of building. Corridor-door faces do not need to match where they are separated by 20 feet (6 m) or more.
8. Exposed Vertical and Top Edges: Same species as faces or a compatible species.
9. Core: Particleboard.
10. Construction: Five plies. Stiles and rails are bonded to core, then entire unit is abrasive planed before veneering. Faces are bonded to core using a hot press.
11. WDMA I.S.1-A Performance Grade: Heavy Duty.
12. Doors to match existing.

2.4 LIGHT FRAMES

A. Wood Beads for Light Openings in Wood Doors: Provide manufacturer's standard wood beads unless otherwise indicated.

1. Wood Species: Same species as door faces.
2. Profile: Manufacturer's standard shape.
3. At wood-core doors with 20-minute fire-protection ratings, provide wood beads and metal glazing clips approved for such use.

B. Wood-Veneered Beads for Light Openings in Fire-Rated Doors: Manufacturer's standard wood-veneered noncombustible beads matching veneer species of door faces and approved for use in doors of fire-protection rating indicated. Include concealed metal glazing clips where required for opening size and fire-protection rating indicated.

2.5 FABRICATION

A. Factory fit doors to suit frame-opening sizes indicated. Comply with clearance requirements of referenced quality standard for fitting unless otherwise indicated.

1. Comply with NFPA 80 requirements for fire-rated doors.

B. Factory machine doors for hardware that is not surface applied. Locate hardware to comply with DHI-WDHS-3. Comply with final hardware schedules, door frame Shop Drawings, BHMA-156.115-W, and hardware templates.

1. Coordinate with hardware mortises in metal frames to verify dimensions and alignment before factory machining.
2. Metal Astragals: Factory machine astragals and formed-steel edges for hardware for pairs of fire-rated doors.

C. Openings: Factory cut and trim openings through doors.

1. Light Openings: Trim openings with moldings of material and profile indicated.
2. Glazing: Factory install glazing in doors indicated to be factory finished. Comply with applicable requirements in Section 088000 "Glazing."

2.6 FACTORY FINISHING

A. General: Comply with referenced quality standard for factory finishing. Complete fabrication, including fitting doors for openings and machining for hardware that is not surface applied, before finishing.

1. Finish faces, all four edges, edges of cutouts, and mortises. Stains and fillers may be omitted on bottom edges, edges of cutouts, and mortises.

B. Factory finish doors.

C. Transparent Finish:

1. Grade: Premium.
2. Finish: AWI's, AWMAC's, and WI's "Architectural Woodwork Standards" System 9, UV curable, acrylated epoxy, polyester, or urethane.
3. Staining: Match Architect's sample.
4. Sheen: Match Architect’s sample.
5. Doors to match existing.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine doors and installed door frames, with Installer present, before hanging doors.

1. Verify that installed frames comply with indicated requirements for type, size, location, and swing characteristics and have been installed with level heads and plumb jambs.
2. Reject doors with defects.

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

3.2 INSTALLATION

A. Hardware: For installation, see Section 087100 "Door Hardware."

B. Installation Instructions: Install doors to comply with manufacturer's written instructions and referenced quality standard, and as indicated.

1. Install fire-rated doors according to NFPA 80.
2. Install smoke- and draft-control doors according to NFPA 105.

C. Factory-Fitted Doors: Align in frames for uniform clearance at each edge.

D. Factory-Finished Doors: Restore finish before installation if fitting or machining is required at Project site.

3.3 ADJUSTING

A. Operation: Rehang or replace doors that do not swing or operate freely.

B. Finished Doors: Replace doors that are damaged or that do not comply with requirements. Doors may be repaired or refinished if Work complies with requirements and shows no evidence of repair or refinishing.

END OF SECTION 081416

SECTION 081713 - INTEGRATED METAL DOOR OPENING ASSEMBLIES

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. Integrated metal door opening assemblies with doors, operating hardware, accessories, and installation for a complete assembly.

1.03 REFERENCES

A. ANSI/BHMA A156.3 – Exit Devices, American National Standards Institute/ Building Hardware Manufacturers Association, 2001.
B. ANSI/BHMA A156.4 – Closers, American National Standards Institute/ Building Hardware Manufacturers Association, 2000.
C. ANSI/BHMA A156.13 – Mortise Locks/Latches, American National Standards Institute/ Building Hardware Manufacturers Association, 2002.
D. ANSI/BHMA A156.26 – Continuous Hinges, American National Standards Institute/ Building Hardware Manufacturers Association, 2000.
E. ANSI/SDI - A250.8 Recommended Specifications for Standard Steel Doors and Frames, American National Standards Institute/Steel Door Institute, 2003.
F. ANSI/UL 10C -- Positive Pressure Fire Tests of Door Assemblies, American National Standards Institute/Underwriters Laboratories, 2001.
G. ASTM A1008 - Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability, American Society of Testing and Materials; 2004a.
H. AWI AWQS - Architectural Woodwork Quality Standards P-208; The Architectural Woodwork Institute; 8th Edition.
I. NFPA 101 – Life Safety Code, National Fire Protection Association, 2003.
J. NFPA 252 - Standard Methods of Fire Tests of Door Assemblies, National Fire Protection Association, 2003.
K. SDI 111 A - Recommended Steel Door Frame Details, Steel Door Institute; 2002.
L. SDI 112 - Zinc-Coated (Galvanized/Galvannealed) Standard Steel Doors and Frames, Steel Door Institute, 1997.
M. UL 305 - Standard for Panic Hardware, Underwriters Laboratories Inc., 1997.
N. UL 1784 – Air Leakage Tests for Door Assemblies, Underwriters Laboratories Inc., 2001 (for elevator shaft & lobby applications).

1.04 SYSTEM DESCRIPTION

A. Performance Requirements
   1. Integrated metal door opening assemblies: Exceed minimum performance standards.
      a. Steel Doors: In accordance with ANSI/SDI A250.8, Grade 1, but not less than 5,000,000 cycles.
      b. Exit Devices: In accordance with ANSI/BHMA A156.3, Grade 1, but not less than 5,000,000 cycles.
      c. Closers: In accordance with ANSI/BHMA A156.4, Grade 1.

d. Mortise Locks/Latches: In accordance with ANSI/ BHMA A156.13, Grade 1, but not less than 5,000,000 cycles.
e. Full-height Hinges: In accordance with ANSI/ BHMA A156.26, Grade 1, but not less than 5,000,000 cycles.

1.05 SUBMITTALS

A. Shop Drawings
1. Indicate each door and frame condition; frame type, profile and installation detail; items of finish hardware, finishes and electrical rough-in requirements.

B. Samples
1. For "Doors" and "Frames" subparagraphs below, prepare Samples approximately 12 by 12 inches (305 by 305 mm) to demonstrate compliance with requirements for quality of materials and construction:

a. Doors: Show vertical-edge, top, and bottom construction; core construction; and hinge and other applied hardware reinforcement. Include separate section showing glazing if applicable.
b. Frames: Show profile, corner joint, floor and wall anchors, and silencers. Include separate section showing fixed hollow-metal panels and glazing if applicable.

1.06 QUALITY ASSURANCE

A. Qualifications
1. Manufacturer: Firm with not less than 5 years successful experience in fabrication of integrated metal door opening assemblies with full-height latch/lock and full-height hinge.
2. Supplier: Authorized distributor of manufacturer.
3. Installer: Manufacturer certified.

B. Regulatory Requirements
1. Rated door assemblies shall have been tested to meet conditions of NFPA 252 as required by NFPA 101 section 6-2.3.3.

1.07 DELIVERY, STORAGE AND HANDLING

A. Packaging: Polyvinyl wrapped, palette by floor, and clearly marked for each opening.
B. Delivery: Deliver to site in original unopened containers and pallets bearing system manufacturers name, and brand.
C. Store: Horizontally on level surface, not less than 2 inches off floor in a clean, dry well-ventilated area protected from sunlight, extreme heat, dryness and moisture.
D. Receiving, off-loading, and site distribution should be handled by an authorized Total Door Distributor unless otherwise stipulated by contract. If the G.C. or other entity handles all or any portion of the receiving, off-loading, and site distribution, they are held responsible for any and all damages that may result from potential miss handling of the product.

1.08 PROJECT CONDITIONS

A. Do not bring door systems to site until building temperature and humidity ranges are compatible with recommended values for preservation of wood moisture content as listed by AWI AWQS. Building shall be stabilized at 30 to 60 percent humidity.

1.09 WARRANTY

A. Integrated metal door opening assembly: Manufacturer’s standard 2 year warranty against defects in material and workmanship.
B. Locksets, hanger rods, and panic exit devices: Manufacturer’s lifetime limited warranty against defects in material and workmanship.
C. Store doors in a clear, dry ventilated space having controlled temperature and a relative humidity range between 30 and 60 percent. Stack doors flat and off the floor to prevent warpage.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Integrated metal door systems
   1. Basis-of-Design: Total Door or approved equal.
B. Hardware
   1. Basis-of-Design: Total Door or approved equal.

2.02 MATERIALS

A. Frames
   1. In accordance with ANSI/SDI A250.8, SDI 111A, and SDI 112.
   2. Construction: All-welded unit, type.
   3. Material: Steel, cold rolled, ASTM A1008, 16 gauge.
   4. Fire Resistance Rating: Where indicated on Drawings for doors.
   5. Spreader Bar: Removable, at sill.
B. Frame Anchorage Devices
   1. To securely fasten to wall construction without distortion or stress.
   2. In accordance with fire resistance rating indicated on Drawings.
C. Door Systems
   1. In accordance with ANSI/SDI A250.8.
   2. General Use – Interior & Fire Rated
      a. Stiles: Steel, galvannealed, 16 gauge, spot welded.
      b. Top and Bottom Rails: 5-1/2 inch 18 gauge steel rails.
      c. Cores:
         1) Solid polystyrene continuously bonded to faces.
         2) Temperature Rise.
      d. Thickness: 1-3/4 inches.
      e. Faces: Steel, stretcher leveled, without seams or spot welds, galvannealed 20 gauge.
      f. Weld pattern: Enhanced in accordance with manufactures standard details.
   3. Gasketing
      a. U.L. approved for fire doors.
      b. Jambs: Factory applied to latch/locking channels.
      c. Floor: Factory Mortised Sweep.

2.03 FINISHES

A. Hinge and Locking Channel
   1. Finish: Factory Pre-Finished.
      a. Color to be selected by Architect.
B. Door Faces, Interior
   1. Finish: To be selected by Architect. To match adjacent wall finish.

2.04 FABRICATION

A. Unless modified by Contract Documents, construct integrated metal door opening assemblies in accordance with manufacturer's published specifications and applicable Code requirements.
B. Factory assemble with full-height hinges and latching/locking channels, locksets, exit devices, closers, lite kits, glazing, kickplates, stretcher plates, and armor plates.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Field Conditions
   1. Prior to commencing installation, examine parts of building structure, which are to receive door systems and component parts.
   2. Report, in writing, conditions which would prevent proper execution or endanger permanency of the work to the Architect.

B. Field Dimensions
   1. Where possible, verify frame tolerances before fabrication of door systems.
   2. Notify Architect of variances with reviewed shop drawings.

C. Corrective measures, when necessary, shall be determined and approved prior to commencing fabrication.

D. Coordinate door opening assembly details with adjacent work to assure proper attachments, clean junctions, etc.

3.02 INSTALLATION

A. Install work in accordance with Contract Documents and reviewed shop drawings.
   1. Install door systems and hardware in accordance with manufacturer's recommendations.
   2. Installer: Manufacturer certified.
   3. Deliver frames to be installed by others.

B. Frames
   1. Set plumb and square in accordance with DHI standards.
      a. Out-of-square at frame head: Not to exceed 1/16 inch.
      b. Out-of-plumb for each frame jamb: Not to exceed 1/16 inch.
      c. Out-of-alignment for each side in plan: Not to exceed 1/16 inch.
      d. Twist dimension: Not to exceed 1/16 inch.
   2. Brace until adjacent wall is constructed.
   3. Securely anchor to adjacent wall.
   4. Furnish and install clips, fastenings, and anchorages and conceal unless otherwise noted.

C. Door Systems
   1. Hang to maintain manufacturer's installation tolerances.
   2. Adjust to freely swing without binding, sticking, or sagging, and to eliminate excessive clearances.

D. Hardware: When installation is otherwise complete, adjust hardware for proper operation and function.

PART 4 - SYSTEM SCHEDULE

Refer to Section 087100 "Door Hardware" for Hardware Sets.

END OF SECTION 081713

SECTION 083113 - ACCESS DOORS AND FRAMES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes access doors and frames for walls and ceilings.

B. Related Requirements:

1. Section 077200 "Roof Accessories" for roof hatches.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, fire ratings, material descriptions, dimensions of individual components and profiles, and finishes.

B. Samples: For each type of access door and frame and for each finish specified, complete assembly minimum 6 by 6 inches (150 by 150 mm) in size.

C. Product Schedule: For access doors and frames. Use same designations indicated on Drawings.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Fire-Rated Access Doors and Frames: Assemblies complying with NFPA 80 that are listed and labeled by a qualified testing agency, for fire-protection ratings indicated, according to NFPA 252 or UL 10B.

2.2 ACCESS DOORS AND FRAMES

A. Flush Access Doors with Concealed Flanges:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Babcock-Davis.

b. JL Industries, Inc.; a division of the Activar Construction Products Group.
c. Larsens Manufacturing Company.
d. Nystrom, Inc.

2. Description: Face of door flush with frame; with concealed flange for gypsum board installation and concealed hinge.
3. Locations: Wall and ceiling.
4. Door Size: As indicated on Drawings.
5. Uncoated Steel Sheet for Door: Nominal 0.060 inch (1.52 mm), 16 gage, factory finished.
6. Metallic-Coated Steel Sheet for Door: Nominal 0.064 inch (1.63 mm), 16 gage factory finished.
7. Frame Material: Same material and thickness as door.
8. Latch and Lock: Latch bolt, key operated. Prepared for mortise cylinder.

2.3 FIRE-RATED ACCESS DOORS AND FRAMES

A. Fire-Rated, Flush Access Doors with Concealed Flanges:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Babcock-Davis.
b. JL Industries, Inc.; a division of the Activar Construction Products Group.
c. Nystrom, Inc.

2. Description: Door face flush with frame, with a core of mineral-fiber insulation enclosed in sheet metal; with concealed flange for gypsum board installation, self-closing door, and concealed hinge.
3. Locations: Wall and ceiling.
4. Door Size: As indicated on Drawings.
5. Fire-Resistance Rating: Not less than that of adjacent construction.
6. Uncoated Steel Sheet for Door: Nominal 0.036 inch (0.91 mm), 20 gage, factory finished.
7. Metallic-Coated Steel Sheet for Door: Nominal 0.040 inch (1.02 mm), 20 gage, factory finished.
8. Frame Material: Same material, thickness, and finish as door.
9. Latch and Lock: Self-closing, self-latching door hardware, operated by key.

2.4 MATERIALS

A. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.

B. Steel Sheet: Uncoated or electrolytic zinc coated, ASTM A 879/A 879M, with cold-rolled steel sheet substrate complying with ASTM A 1008/A 1008M, Commercial Steel (CS), exposed.

C. Metallic-Coated Steel Sheet: ASTM A 653/A 653M, Commercial Steel (CS), Type B; with minimum G60 (Z180) or A60 (ZF180) metallic coating.

D. Frame Anchors: Same material as door face.

E. Inserts, Bolts, and Anchor Fasteners: Hot-dip galvanized steel according to ASTM A 153/A 153M or ASTM F 2329.

2.5 FABRICATION

A. General: Provide access door and frame assemblies manufactured as integral units ready for installation.

B. Metal Surfaces: For metal surfaces exposed to view in the completed Work, provide materials with smooth, flat surfaces without blemishes. Do not use materials with exposed pitting, seam marks, roller marks, rolled trade names, or roughness.

C. Doors and Frames: Grind exposed welds smooth and flush with adjacent surfaces. Furnish mounting holes, attachment devices and fasteners of type required to secure access doors to types of supports indicated.

1. For concealed flanges with drywall bead, provide edge trim for gypsum panels securely attached to perimeter of frames.

D. Latch and Lock Hardware:

1. Quantity: Furnish number of latches and locks required to hold doors tightly closed.
2. Keys: Furnish two keys per lock and key all locks alike.
3. Mortise Cylinder Preparation: Where indicated, prepare door panel to accept cylinder. Locking device shall accept a 7 pin Yale removable core lock cylinder.

2.6 FINISHES

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

C. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

D. Painted Finishes: Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.

1. Factory Finished: Apply manufacturer's standard baked-enamel or powder-coat finish immediately after cleaning and pretreating, with minimum dry-film thickness of 1 mil (0.025 mm) for topcoat.

a. Color: Bright white.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

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

3.2 INSTALLATION

A. Comply with manufacturer's written instructions for installing access doors and frames.

3.3 ADJUSTING

A. Adjust doors and hardware, after installation, for proper operation.

END OF SECTION 083113

SECTION 083323 - OVERHEAD COILING DOORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Fire-rated service doors.

1.3 ACTION SUBMITTALS

A. Product Data: For each type and size of overhead coiling door and accessory.

1. Include construction details, material descriptions, dimensions of individual components, profiles for slats, and finishes.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished accessories.
3. Include description of automatic-closing device and testing and resetting instructions.

B. Shop Drawings: For each installation and for special components not dimensioned or detailed in manufacturer's product data.

1. Include plans, elevations, sections, and mounting details.
2. Include details of equipment assemblies, and indicate dimensions, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include points of attachment and their corresponding static and dynamic loads imposed on structure.
4. Show locations of controls, locking devices, detectors or replaceable fusible links, and other accessories.

C. Samples for Initial Selection: Manufacturer's finish charts showing full range of colors and textures available for units with factory-applied finishes.

1. Include similar Samples of accessories involving color selection.

D. Samples for Verification: For each type of exposed finish on the following components, in manufacturer's standard sizes:

1. Curtain slats.
2. Bottom bar.
3. Guides.
4. Brackets.
5. Hood.

6. Locking device(s).
7. Include similar Samples of accessories involving color selection.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For overhead coiling doors to include in maintenance manuals.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer for both installation and maintenance of units required for this Project.

1. Maintenance Proximity: Not more than two hours' normal travel time from Installer's place of business to Project site.

1.7 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of doors that fail in materials or workmanship within specified warranty period.

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

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Source Limitations: Obtain overhead coiling doors from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Fire-Rated Door Assemblies: Complying with NFPA 80; listed and labeled by qualified testing agency, for fire-protection ratings indicated, based on testing at as close to neutral pressure as possible according to NFPA 252 or UL 10B.

1. Oversize Fire-Rated Door Assemblies: For units exceeding sizes of tested assemblies, provide certification by a qualified testing agency that doors comply with standard construction requirements for tested and labeled fire-rated door assemblies except for size.

B. Accessibility Standard: Comply with applicable provisions in the USDOJ's "2010 ADA Standards for Accessible Design" and ICC A117.1.

C. Seismic Performance: Overhead coiling doors shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

2.3 FIRE-RATED DOOR ASSEMBLY

A. Fire-Rated Service Door: Overhead fire-rated coiling door formed with curtain of interlocking metal slats.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Overhead Door Corporation; FireKing Model 630 or a comparable product by one of the following:

a. Cookson Company.
b. Cornell.
c. McKeon Rolling Steel Door Company, Inc.
d. Raynor.
e. Wayne-Dalton Corp.

B. Operation Cycles: Door components and operators capable of operating for not less than 20,000. One operation cycle is complete when a door is opened from the closed position to the fully open position and returned to the closed position.

1. Include tamperproof cycle counter.

C. Fire Rating: 3 hours.

D. Door Curtain Material: Galvanized steel.

E. Door Curtain Slats: Curved profile slats of 1-7/8-inch (48-mm) center-to-center height.

F. Curtain Jamb Guides: Galvanized steel with exposed finish matching curtain slats.

G. Hood: Match curtain material and finish.

1. Shape: Round.
2. Mounting: As indicated on Drawings.

H. Locking Devices: Equip door with slide bolt for padlock and chain lock keeper.

I. Manual Door Operator: Push-up operation.

1. Provide operator with through-wall shaft operation.
2. Provide operator with manufacturer's standard removable operating arm.

J. Curtain Accessories: Equip door with smoke seals, automatic-closing device, push/pull handles and pull-down strap.

K. Door Finish:

1. Baked-Enamel or Powder-Coated Finish: Color as selected by Architect from manufacturer's full range.
2. Interior Curtain-Slat Facing: Match finish of exterior curtain-slat face.

2.4 DOOR CURTAIN MATERIALS AND CONSTRUCTION

A. Door Curtains: Fabricate overhead coiling-door curtain of interlocking metal slats, designed to withstand wind loading indicated, in a continuous length for width of door without splices. Unless otherwise indicated, provide slats of thickness and mechanical properties recommended by door manufacturer for performance, size, and type of door indicated, and as follows:

1. Steel Door Curtain Slats: Zinc-coated (galvanized), cold-rolled structural-steel sheet; complying with ASTM A 653/A 653M, with G90 (Z275) zinc coating; nominal sheet thickness (coated) of 0.028 inch (0.71 mm); and as required.

B. Curtain Jamb Guides: Manufacturer's standard angles or channels and angles of same material and finish as curtain slats unless otherwise indicated, with sufficient depth and strength to retain curtain, to allow curtain to operate smoothly, and to withstand loading. Slot bolt holes for guide adjustment. Provide removable stops on guides to prevent overtravel of curtain.

2.5 HOODS

A. General: Form sheet metal hood to entirely enclose coiled curtain and operating mechanism at opening head. Contour to fit end brackets to which hood is attached. Roll and reinforce top and bottom edges for stiffness. Form closed ends for surface-mounted hoods and fascia for any portion of between-jamb mounting that projects beyond wall face. Equip hood with intermediate support brackets as required to prevent sagging.

1. Galvanized Steel: Nominal 0.028-inch- (0.71-mm-) thick, hot-dip galvanized-steel sheet with G90 (Z275) zinc coating, complying with ASTM A 653/A 653M.
2. Include automatic drop baffle on fire-rated doors to guard against passage of smoke or flame.
3. No wording or illustrations allowed on hood where exposed to view unless required by the building code.

2.6 LOCKING DEVICES

A. Slide Bolt: Fabricate with side-locking bolts to engage through slots in tracks for locking by padlock, located on both left and right jamb sides, operable from coil side.

2.7 CURTAIN ACCESSORIES

A. Smoke Seals: Equip each fire-rated door with replaceable smoke-seal perimeter gaskets or brushes for smoke and draft control as required for door listing and labeling by a qualified testing agency.

B. Push/Pull Handles: Equip each push-up-operated or emergency-operated door with lifting handles on each side of door, finished to match door.

C. Pull-Down Strap: Provide pull-down straps for doors more than 84 inches (2130 mm) high.

D. Automatic-Closing Device for Fire-Rated Doors: Equip each fire-rated door with an automatic-closing device or holder-release mechanism and governor unit complying with NFPA 80 and an easily tested and reset release mechanism. Testing for manually operated doors shall allow

resetting by opening the door without retensioning the counterbalance mechanism. Automatic-closing device shall be designed for activation by the following:

1. Replaceable fusible links with temperature rise and melting point of 165 deg F (74 deg C) interconnected and mounted on both sides of door opening.

2.8 COUNTERBALANCE MECHANISM

A. General: Counterbalance doors by means of manufacturer's standard mechanism with an adjustable-tension, steel helical torsion spring mounted around a steel shaft and contained in a spring barrel connected to top of curtain with barrel rings. Use grease-sealed bearings or self-lubricating graphite bearings for rotating members.

B. Counterbalance Barrel: Fabricate spring barrel of manufacturer's standard hot-formed, structural-quality, seamless or welded carbon-steel pipe, of sufficient diameter and wall thickness to support rolled-up curtain without distortion of slats and to limit barrel deflection to not more than 0.03 in./ft. (2.5 mm/m) of span under full load.

C. Counterbalance Spring: One or more oil-tempered, heat-treated steel helical torsion springs. Size springs to counterbalance weight of curtain, with uniform adjustment accessible from outside barrel. Secure ends of springs to barrel and shaft with cast-steel barrel plugs.

1. Fire-Rated Doors: Equip with auxiliary counterbalance spring and prevent tension release from main counterbalance spring when automatic-closing device operates.

D. Torsion Rod for Counterbalance Shaft: Fabricate of manufacturer's standard cold-rolled steel, sized to hold fixed spring ends and carry torsional load.

E. Brackets: Manufacturer's standard mounting brackets of either cast iron or cold-rolled steel plate.

2.9 MANUAL DOOR OPERATORS

A. General: Equip door with manual door operator by door manufacturer.

B. Push-up Door Operation: Lift handles and pull rope for raising and lowering doors, with counterbalance mechanism designed so that required lift or pull for door operation does not exceed 25 lbf (111 N).

2.10 GENERAL FINISH REQUIREMENTS

A. Comply with NAAMM/NOMMA 500 for recommendations for applying and designating finishes.

B. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.11 STEEL AND GALVANIZED-STEEL FINISHES

A. Baked-Enamel or Powder-Coat Finish: Manufacturer's standard baked-on finish consisting of prime coat and thermosetting topcoat. Comply with coating manufacturer's written instructions for cleaning, pretreatment, application, and minimum dry film thickness.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates areas and conditions, with Installer present, for compliance with requirements for substrate construction and other conditions affecting performance of the Work.

B. Examine locations of electrical connections.

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

3.2 INSTALLATION

A. Install overhead coiling doors and operating equipment complete with necessary hardware, anchors, inserts, hangers, and equipment supports; according to manufacturer's written instructions and as specified.

B. Install overhead coiling doors, hoods, controls, and operators at the mounting locations indicated for each door.

C. Fire-Rated Doors: Install according to NFPA 80.

3.3 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.

3.4 ADJUSTING

A. Adjust hardware and moving parts to function smoothly so that doors operate easily, free of warp, twist, or distortion.

B. Lubricate bearings and sliding parts as recommended by manufacturer.

C. Adjust seals to provide tight fit around entire perimeter.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain overhead coiling doors.

END OF SECTION 083323

SECTION 087100 – DOOR HARDWARE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes commercial door hardware for the following:

1. Swinging doors.
2. Sliding doors.
3. Other doors to the extent indicated.

B. Door hardware includes, but is not necessarily limited to, the following:

1. Mechanical door hardware.
2. Electromechanical door hardware.

C. Related Sections:

1. Division 08 Section “Hollow Metal Doors and Frames”.
2. Division 08 Section “Flush Wood Doors”.
3. Division 28 Section “Access Control”.

D. Codes and References: Comply with the version year adopted by the Authority Having Jurisdiction.

1. ANSI A117.1 - Accessible and Usable Buildings and Facilities.
2. ICC/IBC - International Building Code.
3. NFPA 70 - National Electrical Code.
4. NFPA 80 - Fire Doors and Windows.
5. NFPA 101 - Life Safety Code.
6. NFPA 105 - Installation of Smoke Door Assemblies.
7. UL/ULC and CSA C22.2 – Standards for Automatic Door Operators Used on Fire and Smoke Barrier Doors and Systems of Doors.
8. State Building Codes, Local Amendments.

E. Standards: All hardware specified herein shall comply with the following industry standards:

1. ANSI/BHMA Certified Product Standards - A156 Series
2. UL10C – Positive Pressure Fire Tests of Door Assemblies

1.3 SUBMITTALS

A. Product Data: Manufacturer's product data sheets including installation details, material descriptions, dimensions of individual components and profiles, operational descriptions and finishes.

B. Door Hardware Schedule: Prepared by or under the supervision of supplier, detailing fabrication and assembly of door hardware, as well as procedures and diagrams. Coordinate the final Door Hardware Schedule with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of door hardware.

1. Format: Comply with scheduling sequence and vertical format in DHI's "Sequence and Format for the Hardware Schedule."

2. Organization: Organize the Door Hardware Schedule into door hardware sets indicating complete designations of every item required for each door or opening. Organize door hardware sets in same order as in the Door Hardware Sets at the end of Part 3. Submittals that do not follow the same format and order as the Door Hardware Sets will be rejected and subject to resubmission.

3. Content: Include the following information:

    a. Type, style, function, size, label, hand, and finish of each door hardware item.
    b. Manufacturer of each item.
    c. Fastenings and other pertinent information.
    d. Location of door hardware set, cross-referenced to Drawings, both on floor plans and in door and frame schedule.
    e. Explanation of abbreviations, symbols, and codes contained in schedule.
    f. Mounting locations for door hardware.
    g. Door and frame sizes and materials.
    h. Warranty information for each product.

4. Submittal Sequence: Submit the final Door Hardware Schedule at earliest possible date, particularly where approval of the Door Hardware Schedule must precede fabrication of other work that is critical in the Project construction schedule. Include Product Data, Samples, Shop Drawings of other work affected by door hardware, and other information essential to the coordinated review of the Door Hardware Schedule.

C. Shop Drawings: Details of electrified access control hardware indicating the following:

1. Wiring Diagrams: Upon receipt of approved schedules, submit detailed system wiring diagrams for power, signaling, monitoring, communication, and control of the access control system electrified hardware. Differentiate between manufacturer-installed and field-installed wiring. Include the following:

    a. Elevation diagram of each unique access controlled opening showing location and interconnection of major system components with respect to their placement in the respective door openings.
    b. Complete (risers, point-to-point) access control system block wiring diagrams.
    c. Wiring instructions for each electronic component scheduled herein.

2. Electrical Coordination: Coordinate with related sections the voltages and wiring details required at electrically controlled and operated hardware openings.

D. Keying Schedule: After a keying meeting with the owner has taken place prepare a separate keying schedule detailing final instructions. Submit the keying schedule in electronic format. Include keying system explanation, door numbers, key set symbols, hardware set numbers and special instructions. Owner must approve submitted keying schedule prior to the ordering of permanent cylinders/cores.

E. Proof of Compliance: (California located Projects): Provide a list of product(s) containing chemicals known to cause cancer or reproductive toxicity as defined by the Office of Environmental Health Hazard Assessment (OEHHA) under Proposition 65 (CA Code of Regulations, Title 27, Section 27001). The list includes the specific chemical(s), if the chemical will be exposed to consumers, the means of warning, and an illustration of the label.

F. Informational Submittals:

1. Product Test Reports: Indicating compliance with cycle testing requirements, based on evaluation of comprehensive tests performed by manufacturer and witnessed by a qualified independent testing agency.

G. Operating and Maintenance Manuals: Provide manufacturers operating and maintenance manuals for each item comprising the complete door hardware installation in quantity as required in Division 01, Closeout Submittals.

1.4 QUALITY ASSURANCE

A. Manufacturers Qualifications: Engage qualified manufacturers with a minimum 5 years of documented experience in producing hardware and equipment similar to that indicated for this Project and that have a proven record of successful in-service performance.

B. Installer Qualifications: A minimum 3 years documented experience installing both standard and electrified door hardware similar in material, design, and extent to that indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.

C. Door Hardware Supplier Qualifications: Experienced commercial door hardware distributors with a minimum 5 years documented experience supplying both mechanical and electromechanical hardware installations comparable in material, design, and extent to that indicated for this Project. Supplier recognized as a factory direct distributor by the manufacturers of the primary materials with a warehousing facility in Project's vicinity. Supplier to have on staff a certified Architectural Hardware Consultant (AHC) available during the course of the Work to consult with Contractor, Architect, and Owner concerning both standard and electromechanical door hardware and keying.

D. Source Limitations: Obtain each type and variety of door hardware specified in this section from a single source unless otherwise indicated.

1. Electrified modifications or enhancements made to a source manufacturer's product line by a secondary or third party source will not be accepted.

2. Provide electromechanical door hardware from the same manufacturer as mechanical door hardware, unless otherwise indicated.

E. Each unit to bear third party permanent label demonstrating compliance with the referenced standards.

F. Keying Conference: Conduct conference to comply with requirements in Division 01 Section "Project Meetings." Keying conference to incorporate the following criteria into the final keying schedule document:

1. Function of building, purpose of each area and degree of security required.
2. Plans for existing and future key system expansion.
3. Requirements for key control storage and software.
4. Installation of permanent keys, cylinder cores and software.
5. Address and requirements for delivery of keys.

G. Pre-Submittal Conference: Conduct coordination conference in compliance with requirements in Division 01 Section "Project Meetings" with attendance by representatives of Supplier(s), Installer(s), and Contractor(s) to review proper methods and the procedures for receiving, handling, and installing door hardware.

1. Prior to installation of door hardware, conduct a project specific training meeting to instruct the installing contractors' personnel on the proper installation and adjustment of their respective products. Product training to be attended by installers of door hardware (including electromechanical hardware) for aluminum, hollow metal and wood doors. Training will include the use of installation manuals, hardware schedules, templates and physical product samples as required.
2. Inspect and discuss electrical roughing-in, power supply connections, and other preparatory work performed by other trades.
3. Review sequence of operation narratives for each unique access controlled opening.
4. Review and finalize construction schedule and verify availability of materials.
5. Review the required inspecting, testing, commissioning, and demonstration procedures

H. At completion of installation, provide written documentation that components were applied to manufacturer's instructions and recommendations and according to approved schedule.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Inventory door hardware on receipt and provide secure lock-up and shelving for door hardware delivered to Project site. Do not store electronic access control hardware, software or accessories at Project site without prior authorization.

B. Tag each item or package separately with identification related to the final Door Hardware Schedule, and include basic installation instructions with each item or package.

C. Deliver, as applicable, permanent keys, cylinders, cores, access control credentials, software and related accessories directly to Owner via registered mail or overnight package service. Instructions for delivery to the Owner shall be established at the "Keying Conference".

1.6 COORDINATION

A. Templates: Obtain and distribute to the parties involved templates for doors, frames, and other work specified to be factory prepared for installing standard and electrified hardware. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing hardware to comply with indicated requirements.

B. Door Hardware and Electrical Connections: Coordinate the layout and installation of scheduled electrified door hardware and related access control equipment with required connections to source power junction boxes, low voltage power supplies, detection and monitoring hardware, and fire and detection alarm systems.

C. Door and Frame Preparation: Doors and corresponding frames are to be prepared, reinforced and pre-wired (if applicable) to receive the installation of the specified electrified, monitoring, signaling and access control system hardware without additional in-field modifications.

1.7 WARRANTY

A. General Warranty: Reference Division 01, General Requirements. Special warranties specified in this Article shall not deprive Owner of other rights Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under requirements of the Contract Documents.

B. Warranty Period: Written warranty, executed by manufacturer(s), agreeing to repair or replace components of standard and electrified door hardware that fails in materials or workmanship within specified warranty period after final acceptance by the Owner. Failures include, but are not limited to, the following:

1. Structural failures including excessive deflection, cracking, or breakage.
2. Faulty operation of the hardware.
3. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
4. Electrical component defects and failures within the systems operation.

C. Standard Warranty Period: One year from date of Substantial Completion, unless otherwise indicated.

D. Special Warranty Periods:

1. Ten years for mortise locks and latches.
2. Five years for exit hardware.
3. Twenty five years for manual surface door closer bodies.
4. Five years for motorized electric latch retraction exit devices.
5. Two years for electromechanical door hardware.

1.8 MAINTENANCE SERVICE

A. Maintenance Tools and Instructions: Furnish a complete set of specialized tools and maintenance instructions as needed for Owner's continued adjustment, maintenance, and removal and replacement of door hardware.

PART 2 - PRODUCTS

2.1 SCHEDULED DOOR HARDWARE

A. General: Provide door hardware for each door to comply with requirements in Door Hardware Sets and each referenced section that products are to be supplied under.

B. Designations: Requirements for quantity, item, size, finish or color, grade, function, and other distinctive qualities of each type of door hardware are indicated in the Door Hardware Sets at the end of Part 3. Products are identified by using door hardware designations, as follows:

1. Named Manufacturer's Products: Product designation and manufacturer are listed for each door hardware type required for the purpose of establishing requirements. Manufacturers' names are abbreviated in the Door Hardware Schedule.

C. Substitutions: Requests for substitution and product approval for inclusive mechanical and electromechanical door hardware in compliance with the specifications must be submitted in writing and in accordance with the procedures and time frames outlined in Division 01, Substitution Procedures. Approval of requests is at the discretion of the architect, owner, and their designated consultants.

2.2 HANGING DEVICES

A. Hinges: ANSI/BHMA A156.1 certified butt hinges with number of hinge knuckles and other options as specified in the Door Hardware Sets.

1. Quantity: Provide the following hinge quantity:

    a. Two Hinges: For doors with heights up to 60 inches.
    b. Three Hinges: For doors with heights 61 to 90 inches.
    c. Four Hinges: For doors with heights 91 to 120 inches.
    d. For doors with heights more than 120 inches, provide 4 hinges, plus 1 hinge for every 30 inches of door height greater than 120 inches.

2. Hinge Size: Provide the following, unless otherwise indicated, with hinge widths sized for door thickness and clearances required:

    a. Widths up to 3’0”: 4-1/2” standard or heavy weight as specified.
    b. Sizes from 3’1” to 4’0”: 5” standard or heavy weight as specified.

3. Hinge Weight and Base Material: Unless otherwise indicated, provide the following:

    a. Exterior Doors: Heavy weight, non-ferrous, ball bearing or oil impregnated bearing hinges unless Hardware Sets indicate standard weight.
    b. Interior Doors: Standard weight, steel, ball bearing or oil impregnated bearing hinges unless Hardware Sets indicate heavy weight.

4. Hinge Options: Comply with the following:

    a. Non-removable Pins: Provide set screw in hinge barrel that, when tightened into a groove in hinge pin, prevents removal of pin while door is closed; for the all out-swinging lockable doors.

5. Manufacturers:

    a. Hager Companies (HA) - CB Series.
    b. McKinney Products; ASSA ABLOY Architectural Door Accessories (MK) - MacPro Series.

c. McKinney Products; ASSA ABLOY Architectural Door Accessories (MK) - TA Series.
d. Stanley Hardware (ST) - CB Series.

B. Continuous Geared Hinges: ANSI/BHMA A156.26 Grade 1-600 certified continuous geared hinge. with minimum 0.120-inch thick extruded 6060 T6 aluminum alloy hinge leaves and a minimum overall width of 4 inches. Hinges are non-handed, reversible and fabricated to template screw locations. Factory trim hinges to suit door height and prepare for electrical cut-outs.

1. Manufacturers:

a. McKinney Products; ASSA ABLOY Architectural Door Accessories (MK).
b. Pemko Products; ASSA ABLOY Architectural Door Accessories (PE).

C. Pin and Barrel Continuous Hinges: ANSI/BHMA A156.26 Grade 1-600 certified pin and barrel continuous hinges with minimum 14 gauge Type 304 stainless steel hinge leaves, concealed teflon coated stainless pin, and twin self lubricated nylon bearings at each knuckle separation. Factory trim hinges to suit door height and prepare for electrical cut-outs.

1. Manufacturers:

a. Markar Products; ASSA ABLOY Architectural Door Accessories (MR).
b. Pemko Products; ASSA ABLOY Architectural Door Accessories (PE).

2.3 POWER TRANSFER DEVICES

A. Electrified Quick Connect Transfer Hinges: Provide electrified transfer hinges with Molex™ standardized plug connectors and sufficient number of concealed wires (up to 12) to accommodate the electrified functions specified in the Door Hardware Sets. Connectors plug directly to through-door wiring harnesses for connection to electric locking devices and power supplies. Wire nut connections are not acceptable.

1. Manufacturers:

a. Hager Companies (HA) - ETW-QC (# wires) Option.
b. McKinney Products; ASSA ABLOY Architectural Door Accessories (MK) - QC (# wires) Option.
c. Stanley Hardware (ST) – C Option.

B. Electrified Quick Connect Continuous Geared Transfer Hinges: Provide electrified transfer continuous geared hinges with a 12" removable service panel cutout accessible without de-mounting door from the frame. Furnish with Molex™ standardized plug connectors with sufficient number of concealed wires (up to 12) to accommodate the electrified functions specified in the Door Hardware Sets. Connectors plug directly to through-door wiring harnesses for connection to electric locking devices and power supplies. Wire nut connections are not acceptable.

1. Manufacturers:

a. McKinney Products; ASSA ABLOY Architectural Door Accessories (MK) - SER-QC (# wires) Option.

b. Pemko Products; ASSA ABLOY Architectural Door Accessories (PE) - SER-QC (# wires) Option.

C. Concealed Quick Connect Electric Power Transfers: Provide concealed wiring pathway housing mortised into the door and frame for low voltage electrified door hardware. Furnish with Molex™ standardized plug connectors and sufficient number of concealed wires (up to 12) to accommodate the electrified functions specified in the Door Hardware Sets. Connectors plug directly to through-door wiring harnesses for connection to electric locking devices and power supplies. Wire nut connections are not acceptable.

1. Manufacturers:

a. Pemko Products; ASSA ABLOY Architectural Door Accessories (PE) – EL-CEPT Series.
b. Securitron (SU) - EL-CEPT Series.
c. Von Duprin (VD) - EPT-10 Series.

D. Electric Door Wire Harnesses: Provide electric/data transfer wiring harnesses with standardized plug connectors to accommodate up to twelve (12) wires. Connectors plug directly to through-door wiring harnesses for connection to electric locking devices and power supplies. Provide sufficient number and type of concealed wires to accommodate electric function of specified hardware. Provide a connector for through-door electronic locking devices and from hinge to junction box above the opening. Wire nut connections are not acceptable. Determine the length required for each electrified hardware component for the door type, size and construction, minimum of two per electrified opening.

1. Provide one each of the following tools as part of the base bid contract:
a. McKinney Products; ASSA ABLOY Architectural Door Accessories (MK) - Electrical Connecting Kit: QC-R001.
b. McKinney Products; ASSA ABLOY Architectural Door Accessories (MK) - Connector Hand Tool: QC-R003.

2. Manufacturers:

a. Hager Companies (HA) - Quick Connect.
b. McKinney Products; ASSA ABLOY Architectural Door Accessories (MK) – QC-C Series.
c. Stanley Hardware (ST) – WH Series.

2.4 DOOR OPERATING TRIM

A. Flush Bolts and Surface Bolts: ANSI/BHMA A156.3 and A156.16, Grade 1, certified.

1. Flush bolts to be furnished with top rod of sufficient length to allow bolt retraction device location approximately six feet from the floor.
2. Furnish dust proof strikes for bottom bolts.
3. Surface bolts to be minimum 8” in length and U.L. listed for labeled fire doors and U.L. listed for windstorm components where applicable.
4. Provide related accessories (mounting brackets, strikes, coordinators, etc.) as required for appropriate installation and operation.

5. Manufacturers:

a. Door Controls International (DC).
b. Rockwood Products; ASSA ABLOY Architectural Door Accessories (RO).
c. Trimco (TC).

B. Door Push Plates and Pulls: ANSI/BHMA A156.6 certified door pushes and pulls of type and design specified in the Hardware Sets. Coordinate and provide proper width and height as required where conflicting hardware dictates.

1. Push/Pull Plates: Minimum .050 inch thick, size as indicated in hardware sets, with beveled edges, secured with exposed screws unless otherwise indicated.
2. Door Pull and Push Bar Design: Size, shape, and material as indicated in the hardware sets. Minimum clearance of 2 1/2-inches from face of door unless otherwise indicated.
3. Offset Pull Design: Size, shape, and material as indicated in the hardware sets. Minimum clearance of 2 1/2-inches from face of door and offset of 90 degrees unless otherwise indicated.
4. Fasteners: Provide manufacturer's designated fastener type as indicated in Hardware Sets.

5. Manufacturers:

a. Hiawatha, Inc. (HI).
b. Rockwood Products; ASSA ABLOY Architectural Door Accessories (RO).
c. Trimco (TC).

2.5 CYLINDERS AND KEYING

A. General: Cylinder manufacturer to have minimum (10) years experience designing secured master key systems and have on record a published security keying system policy.

B. Source Limitations: Obtain each type of keyed cylinder and keys from the same source manufacturer as locksets and exit devices, unless otherwise indicated.

C. Cylinders: Original manufacturer cylinders complying with the following:

1. Mortise Type: Threaded cylinders with rings and cams to suit hardware application.
2. Rim Type: Cylinders with back plate, flat-type vertical or horizontal tailpiece, and raised trim ring.
3. Bored-Lock Type: Cylinders with tailpieces to suit locks.
4. Mortise and rim cylinder collars to be solid and recessed to allow the cylinder face to be flush and be free spinning with matching finishes.
5. Keyway: Manufacturer’s Standard.

D. Patented Cylinders: ANSI/BHMA A156.5, Grade 1, certified cylinders employing a utility patented and restricted keyway requiring the use of patented controlled keys. Provide bump resistant, fixed core cylinders as standard with solid recessed cylinder collars. Cylinders are to be factory keyed where permanent keying records will be established and maintained.

1. Provide a 6 pin multi-level master key system comprised of patented controlled keys and security and high security cylinders operated by one (1) key of the highest level. Geographical exclusivity to be provided for all security and high security cylinders and UL437 certification where specified.

a. Level 1 Cylinders: Provide utility patented controlled keyway cylinders that are furnished with patented keys available only from authorized distribution.
b. Refer to hardware sets for specified levels.

2. Manufacturers:
   a. Sargent Manufacturing (SA) - Degree Series.
   b. Corbin Russwin (RU) – Access 3 Series.

E. Keying System: Each type of lock and cylinders to be factory keyed.

1. Conduct specified "Keying Conference" to define and document keying system instructions and requirements.
2. Furnish factory cut, nickel-silver large bow permanently inscribed with a visual key control number as directed by Owner.
3. New System: Key locks to a new key system as directed by the Owner.

F. Key Quantity: Provide the following minimum number of keys:

1. Change Keys per Cylinder: Two (2)
2. Master Keys (per Master Key Level/Group): Five (5).
3. Construction Keys (where required): Ten (10).

G. Construction Keying: Provide construction master keyed cylinders.

2.6 MECHANICAL LOCKS AND LATCHING DEVICES

A. Mortise Locksets, Grade 1 (Heavy Duty): ANSI/BHMA A156.13, Series 1000, Operational Grade 1 certified. Locksets are to be manufactured with a corrosion resistant steel case and be field-reversible for handing without disassembly of the lock body.

1. Provide status indicators with highly reflective color and wording for “locked/unlocked” or “vacant/occupied” with custom wording options if required. Indicator to be located above the cylinder with the inside thumbturn not blocking the visibility of the indicator status. Indicator window size to be a minimum of 2.1” x 0.6” with a curved design allowing a 180 degree viewing angle.

2. Manufacturers:

   a. Corbin Russwin Hardware (RU) – ML2000 Series.
   b. Sargent Manufacturing (SA) – 8200 Series.
   c. Yale Locks and Hardware (YA) – 8800FL Series.

2.7 ELECTROMECHANICAL LOCKING DEVICES

A. Electromechanical Mortise Locksets, Grade 1 (Heavy Duty): Subject to same compliance standards and requirements as mechanical mortise locksets, electrified locksets to be of type and design as specified below.

1. Electrified Lock Options: Where indicated in the Hardware Sets, provide electrified options including: outside door lock/unlock trim control, latchbolt and lock/unlock status monitoring, deadbolt monitoring, and request-to-exit signaling. Support end-of-line

resistors contained within the lock case. Unless otherwise indicated, provide electrified locksets standard as fail secure.

2. Energy Efficient Design: Provide lock bodies which have a holding current draw of 15mA maximum, and can operate on either 12 or 24 volts. Locks are to be field configurable for fail safe or fail secure operation.

3. High Security Monitoring: Provide lock bodies which have built-in request to exit monitoring and are provided with accompanying door position switches. Provide a resistor configuration which is compatible with the access control system.

4. Manufacturers:

    a. Corbin Russwin Hardware (RU) - ML20900 Series.
    b. Sargent Manufacturing (SA) - 8200 Series.
    c. Yale Locks and Hardware (YA) – 8800FL Series.

2.8 INTEGRATED WIEGAND OUTPUT LOCKING DEVICES – MULTI-CLASS READER

A. Integrated Wiegand Output Multi-Class Mortise Locks: Wiegand output ANSI A156.13, Grade 1, mortise lockset with integrated card reader, request-to-exit signaling, door position status switch, and latchbolt monitoring in one complete unit. Hard wired, solenoid driven locking/unlocking control of the lever handle trim, 3/4" deadlocking anti-friction latch, and 1" case-hardened steel deadbolt. Lock is U.L listed and labeled for use on up to 3 hour fire rated openings. Available with or without keyed high security cylinder override.

1. Open architecture, hard wired platform supports centralized control of locking units with new or existing Wiegand compatible access control systems. Latchbolt monitoring and door position switch act in conjunction to report door-in-frame (DPS) and door latched (door closed and latched) conditions.
2. Integrated reader supports the following credentials:
    a. 125kHz proximity credentials: HID, AWID, Indala, and EM4102.
    b. 13.56 MHz proximity credentials: HID iClass, HID iClass SE, SE for MIFARE Classic, DESFire EV1.
3. 12VDC external power supply required for reader and lock, with optional 24VDC lock solenoid. Fail safe or fail secure options.
4. Energy Efficient Design: Provide lock bodies which have a holding current draw of 15mA maximum, and can operate on either 12 or 24 volts. Locks are to be field configurable for fail safe or fail secure operation.
5. Support end-of-line resistors contained within the lock case.
6. Installation requires only one cable run from the lock to the access control panel without requirements for additional proprietary lock panel interface boards or modules.
7. Installation to include manufacturer's access control panel interface board or module where required for Wiegand output protocol.

8. Manufacturers:

    a. Corbin Russwin (RU) – ML2000 SE-LP10 Series.
    b. Sargent Manufacturing (SA) – M1 8200 Series.

2.9 AUXILIARY LOCKS

A. Mortise Deadlocks, Small Case: ANSI/BHMA A156.36, Grade 1, small case mortise type deadlocks constructed of heavy gauge wrought corrosion resistant steel. Steel or stainless steel bolts with a 1" throw and hardened steel roller pins. Deadlocks to be products of the same source manufacturer and keyway as other specified locksets.

1. Manufacturers:

    a. Corbin Russwin Hardware (RU) - DL4100 Series.
    b. Sargent Manufacturing (SA) - 4870 Series.
    c. Yale Locks and Hardware (YA) - 350 Series.

2.10 LOCK AND LATCH STRIKES

A. Strikes: Provide manufacturer's standard strike with strike box for each latch or lock bolt, with curved lip extended to protect frame, finished to match door hardware set, unless otherwise indicated, and as follows:

1. Flat-Lip Strikes: For locks with three-piece antifriction latchbolts, as recommended by manufacturer.
2. Extra-Long-Lip Strikes: For locks used on frames with applied wood casing trim.
3. Aluminum-Frame Strike Box: Provide manufacturer's special strike box fabricated for aluminum framing.
4. Double-lipped strikes: For locks at double acting doors. Furnish with retractable stop for rescue hardware applications.

B. Standards: Comply with the following:

1. Strikes for Mortise Locks and Latches: BHMA A156.13.
2. Strikes for Bored Locks and Latches: BHMA A156.2.
3. Strikes for Auxiliary Deadlocks: BHMA A156.36.
4. Dustproof Strikes: BHMA A156.16.

2.11 CONVENTIONAL EXIT DEVICES

A. General Requirements: All exit devices specified herein shall meet or exceed the following criteria:

1. At doors not requiring a fire rating, provide devices complying with NFPA 101 and listed and labeled for "Panic Hardware" according to UL305. Provide proper fasteners as required by manufacturer including sex nuts and bolts at openings specified in the Hardware Sets.

2. Where exit devices are required on fire rated doors, provide devices complying with NFPA 80 and with UL labeling indicating "Fire Exit Hardware". Provide devices with the proper fasteners for installation as tested and listed by UL. Consult manufacturer’s catalog and template book for specific requirements.

3. Except on fire rated doors, provide exit devices with hex key dogging device to hold the pushbar and latch in a retracted position. Provide optional keyed cylinder dogging on devices where specified in Hardware Sets.

4. Devices must fit flat against the door face with no gap that permits unauthorized dogging of the push bar. The addition of filler strips is required in any case where the door light extends behind the device as in a full glass configuration.

5. Energy Efficient Design: Provide lock bodies which have a holding current draw of 15mA maximum, and can operate on either 12 or 24 volts. Locks are to be field configurable for fail safe or fail secure operation.

6. Electromechanical Options: Subject to same compliance standards and requirements as mechanical exit devices, electrified devices to be of type and design as specified in hardware sets. Include any specific controllers when conventional power supplies are not sufficient to provide the proper inrush current.

7. Lever Operating Trim: Where exit devices require lever trim, furnish manufacturer's heavy duty escutcheon trim with threaded studs for thru-bolts.

    a. Lock Trim Design: As indicated in Hardware Sets, provide finishes and designs to match that of the specified locksets.
    b. Where function of exit device requires a cylinder, provide a cylinder (Rim or Mortise) as specified in Hardware Sets.

8. Vertical Rod Exit Devices: Where surface or concealed vertical rod exit devices are used at interior openings, provide as less bottom rod (LBR) unless otherwise indicated. Provide dust proof strikes where thermal pins are required to project into the floor.

9. Narrow Stile Applications: At doors constructed with narrow stiles, or as specified in Hardware Sets, provide devices designed for maximum 2” wide stiles.

10. Dummy Push Bar: Nonfunctioning push bar matching functional push bar.

11. Rail Sizing: Provide exit device rails factory sized for proper door width application.

12. Through Bolt Installation: For exit devices and trim as indicated in Door Hardware Sets.

B. Conventional Push Rail Exit Devices (Heavy Duty): ANSI/BHMA A156.3, Grade 1 certified panic and fire exit hardware devices furnished in the functions specified in the Hardware Sets. Exit device latch to be stainless steel, pullman type, with deadlock feature.

1. Manufacturers:

    a. Corbin Russwin Hardware (RU) - ED4000 / ED5000 Series.
    b. Sargent Manufacturing (SA) - 80 Series.

2.12 DOOR CLOSERS

A. All door closers specified herein shall meet or exceed the following criteria:

1. General: Door closers to be from one manufacturer, matching in design and style, with the same type door preparations and templates regardless of application or spring size. Closers to be non-handed with full sized covers including installation and adjusting information on inside of cover.

2. Standards: Closers to comply with UL-10C for Positive Pressure Fire Test and be U.L. listed for use of fire rated doors.

3. Cycle Testing: Provide closers which have surpassed 15 million cycles in a test witnessed and verified by UL.

4. Size of Units: Comply with manufacturer's written recommendations for sizing of door closers depending on size of door, exposure to weather, and anticipated frequency of use. Where closers are indicated for doors required to be accessible to the physically handicapped, provide units complying with ANSI ICC/A117.1.

5. Closer Arms: Provide heavy duty, forged steel closer arms unless otherwise indicated in Hardware Sets.

6. Closers shall not be installed on exterior or corridor side of doors; where possible install closers on door for optimum aesthetics.

7. Closer Accessories: Provide door closer accessories including custom templates, special mounting brackets, spacers and drop plates as required for proper installation. Provide through-bolt and security type fasteners as specified in the hardware sets.

B. Door Closers, Surface Mounted (Large Body Cast Iron): ANSI/BHMA A156.4, Grade 1 surface mounted, heavy duty door closers with complete spring power adjustment, sizes 1 thru 6; and fully operational adjustable according to door size, frequency of use, and opening force. Closers to be rack and pinion type, one piece cast iron body construction, with adjustable backcheck and separate non-critical valves for closing sweep and latch speed control.

1. Manufacturers:

    a. Corbin Russwin Hardware (RU) - DC8000 Series.
    b. Norton Door Controls (NO) – 9500 Series.
    c. Sargent Manufacturing (SA) - 281 Series.

C. Door Closers, Surface Mounted (Heavy Duty): ANSI/BHMA A156.4, Grade 1 surface mounted, heavy duty door closers with complete spring power adjustment, sizes 1 thru 6; and fully operational adjustable according to door size, frequency of use, and opening force. Closers to be rack and pinion type, one piece cast iron or aluminum alloy body construction, with adjustable backcheck and separate non-critical valves for closing sweep and latch speed control. Provide non-handed units standard.

1. Manufacturers:

    a. Corbin Russwin Hardware (RU) - DC6000 Series.
    b. Sargent Manufacturing (SA) - 351 Series.
    c. Norton Door Controls (NO) - 7500 Series.
    d. Yale Locks and Hardware (YA) - 4400 Series.

2.13 ARCHITECTURAL TRIM

A. Door Protective Trim

1. General: Door protective trim units to be of type and design as specified below or in the Hardware Sets.

2. Size: Fabricate protection plates (kick, armor, or mop) not more than 2" less than door width (LDW) on stop side of single doors and 1” LDW on stop side of pairs of doors, and not more than 1" less than door width on pull side. Coordinate and provide proper width and height as required where conflicting hardware dictates. Height to be as specified in the Hardware Sets.

3. Where plates are applied to fire rated doors with the top of the plate more than 16” above the bottom of the door, provide plates complying with NFPA 80. Consult manufacturer’s catalog and template book for specific requirements for size and applications.

4. Protection Plates: ANSI/BHMA A156.6 certified protection plates (kick, armor, or mop), fabricated from the following:

    a. Stainless Steel: 300 grade, 050-inch thick.

5. Options and fasteners: Provide manufacturer's designated fastener type as specified in the Hardware Sets. Provide countersunk screw holes.

6. Manufacturers:

    a. Hiawatha, Inc. (HI).
    b. Rockwood Products; ASSA ABLOY Architectural Door Accessories (RO).
    c. Trimco (TC).

2.14 DOOR STOPS AND HOLDERS

A. General: Door stops and holders to be of type and design as specified below or in the Hardware Sets.

B. Door Stops and Bumpers: ANSI/BHMA A156.16, Grade 1 certified door stops and wall bumpers. Provide wall bumpers, either convex or concave types with anchorage as indicated, unless floor or other types of door stops are specified in Hardware Sets. Do not mount floor stops where they will impede traffic. Where floor or wall bumpers are not appropriate, provide overhead type stops and holders.

1. Manufacturers:

    a. Hiawatha, Inc. (HI).
    b. Rockwood Products; ASSA ABLOY Architectural Door Accessories (RO).
    c. Trimco (TC).

C. Overhead Door Stops and Holders: ANSI/BHMA A156.6, Grade 1 certified overhead stops and holders to be surface or concealed types as indicated in Hardware Sets. Track, slide, arm and jamb bracket to be constructed of extruded bronze and shock absorber spring of heavy

tempered steel. Provide non-handed design with mounting brackets as required for proper operation and function.

1. Manufacturers:

    a. Rixson Door Controls (RF).
    b. Rockwood Products; ASSA ABLOY Architectural Door Accessories (RO).
    c. Sargent Manufacturing (SA).

2.15 ARCHITECTURAL SEALS

A. General: Thresholds, weatherstripping, and gasket seals to be of type and design as specified below or in the Hardware Sets. Provide continuous weatherstrip gasketing on exterior doors and provide smoke, light, or sound gasketing on interior doors where indicated. At exterior applications provide non-corrosive fasteners and elsewhere where indicated.

B. Smoke Labeled Gasketing: Assemblies complying with NFPA 105 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for smoke control ratings indicated, based on testing according to UL 1784.

1. Provide smoke labeled perimeter gasketing at all smoke labeled openings.

C. Fire Labeled Gasketing: Assemblies complying with NFPA 80 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire ratings indicated, based on testing according to UL-10C.

1. Provide intumescent seals as indicated to meet UL10C Standard for Positive Pressure Fire Tests of Door Assemblies, and NPFA 252, Standard Methods of Fire Tests of Door Assemblies.

D. Sound-Rated Gasketing: Assemblies that are listed and labeled by a testing and inspecting agency, for sound ratings indicated.

E. Replaceable Seal Strips: Provide only those units where resilient or flexible seal strips are easily replaceable and readily available from stocks maintained by manufacturer.

F. Manufacturers:

1. National Guard Products (NG).
2. Pemko Products; ASSA ABLOY Architectural Door Accessories (PE).
3. Reese Enterprises, Inc. (RE).

2.16 ELECTRONIC ACCESSORIES

A. Key Switches: Key switches furnished standard with stainless steel single gang face plate with a 12/24VDC bi-color LED indicator. Integral backing bracket permits integration with any 1 1/4" or 1 1/2" mortise type cylinder. Key switches available as momentary or maintained action and in narrow face plate options.

1. Manufacturers:

a. Security Door Controls (SD) - 800 Series.
b. Securitron (SU) - MK Series.

B. Push-Button Switches: Industrial grade momentary or alternate contact, back-lighted push buttons with stainless-steel switch enclosures. 12/24 VDC bi-color illumination suitable for either flush or surface mounting.

1. Manufacturers:

a. Security Door Controls (SD) - 400 Series.
b. Securitron (SU) - PB Series.

C. Door Position Switches: Door position magnetic reed contact switches specifically designed for use in commercial door applications. On recessed models the contact and magnetic housing snap-lock into a 1" diameter hole. Surface mounted models include wide gap distance design complete with armored flex cabling. Provide SPDT, N/O switches with optional Rare Earth Magnet installation on steel doors with flush top channels.

1. Manufacturers:

a. Security Door Controls (SD) - DPS Series.
b. Securitron (SU) - DPS Series.

D. Power Supplies: Provide Nationally Recognized Testing Laboratory Listed 12VDC or 24VDC (field selectable) filtered and regulated power supplies. Include battery backup option with integral battery charging capability in addition to operating the DC load in event of line voltage failure. Provide the least number of units, at the appropriate amperage level, sufficient to exceed the required total draw for the specified electrified hardware and access control equipment.

1. Manufacturers:

a. Security Door Controls (SD) - 630 Series.
b. Securitron (SU) - BPS Series.

E. Energy Efficient Switching Power Supplies: Provide UL listed or recognized filtered and regulated power supplies. Provide single voltage units as shown in the hardware sets. Units must have one access control input and one fire alarm input. Standby power consumption of unit must be less than 10mW at 120VAC. Provide integral battery backup as standard for all units. Provide the least number of units, at the appropriate amperage level, sufficient to exceed the required total draw for the specified electrified hardware and access control equipment.

1. Manufacturers:

a. Securitron (SU) – EPS Series.

2.17 FABRICATION

A. Fasteners: Provide door hardware manufactured to comply with published templates generally prepared for machine, wood, and sheet metal screws. Provide screws according to manufacturers recognized installation standards for application intended.

2.18 FINISHES

A. Standard: Designations used in the Hardware Sets and elsewhere indicate hardware finishes complying with ANSI/BHMA A156.18, including coordination with traditional U.S. finishes indicated by certain manufacturers for their products.

B. Provide quality of finish, including thickness of plating or coating (if any), composition, hardness, and other qualities complying with manufacturer's standards, but in no case less than specified by referenced standards for the applicable units of hardware

C. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine scheduled openings, with Installer present, for compliance with requirements for installation tolerances, labeled fire door assembly construction, wall and floor construction, and other conditions affecting performance.

B. Notify architect of any discrepancies or conflicts between the door schedule, door types, drawings and scheduled hardware. Proceed only after such discrepancies or conflicts have been resolved in writing.

3.2 PREPARATION

A. Hollow Metal Doors and Frames: Comply with ANSI/DHI A115 series.

B. Wood Doors: Comply with ANSI/DHI A115-W series.

3.3 INSTALLATION

A. Install each item of mechanical and electromechanical hardware and access control equipment to comply with manufacturer's written instructions and according to specifications.

1. Installers are to be trained and certified by the manufacturer on the proper installation and adjustment of fire, life safety, and security products including: hanging devices; locking devices; closing devices; and seals.

B. Mounting Heights: Mount door hardware units at heights indicated in following applicable publications, unless specifically indicated or required to comply with governing regulations:

1. Standard Steel Doors and Frames: DHI's "Recommended Locations for Architectural Hardware for Standard Steel Doors and Frames."
2. Wood Doors: DHI WDHS.3, "Recommended Locations for Architectural Hardware for Wood Flush Doors."
3. Where indicated to comply with accessibility requirements, comply with ANSI A117.1 "Accessibility Guidelines for Buildings and Facilities."

4. Provide blocking in drywall partitions where wall stops or other wall mounted hardware is located.

C. Retrofitting: Install door hardware to comply with manufacturer's published templates and written instructions. Where cutting and fitting are required to install door hardware onto or into surfaces that are later to be painted or finished in another way, coordinate removal, storage, and reinstallation of surface protective trim units with finishing work specified in Division 9 Sections. Do not install surface-mounted items until finishes have been completed on substrates involved.

D. Thresholds: Set thresholds for exterior and acoustical doors in full bed of sealant complying with requirements specified in Division 7 Section "Joint Sealants."

E. Storage: Provide a secure lock up for hardware delivered to the project but not yet installed. Control the handling and installation of hardware items so that the completion of the work will not be delayed by hardware losses before and after installation.

3.4 FIELD QUALITY CONTROL

A. Field Inspection: Supplier will perform a final inspection of installed door hardware and state in report whether work complies with or deviates from requirements, including whether door hardware is properly installed, operating and adjusted.

3.5 ADJUSTING

A. Initial Adjustment: Adjust and check each operating item of door hardware and each door to ensure proper operation or function of every unit. Replace units that cannot be adjusted to operate as intended. Adjust door control devices to compensate for final operation of heating and ventilating equipment and to comply with referenced accessibility requirements.

3.6 CLEANING AND PROTECTION

A. Protect all hardware stored on construction site in a covered and dry place. Protect exposed hardware installed on doors during the construction phase. Install any and all hardware at the latest possible time frame.

B. Clean adjacent surfaces soiled by door hardware installation.

C. Clean operating items as necessary to restore proper finish. Provide final protection and maintain conditions that ensure door hardware is without damage or deterioration at time of owner occupancy.

3.7 DEMONSTRATION

A. Instruct Owner's maintenance personnel to adjust, operate, and maintain mechanical and electromechanical door hardware.

3.8 DOOR HARDWARE SETS

A. The hardware sets represent the design intent and direction of the owner and architect. They are a guideline only and should not be considered a detailed hardware schedule. Discrepancies, conflicting hardware and missing items should be brought to the attention of the architect with corrections made prior to the bidding process. Omitted items not included in a hardware set should be scheduled with the appropriate additional hardware required for proper application and functionality.

B. The supplier is responsible for handing and sizing all products and providing the correct option for the appropriate door type and material where more than one is presented in the hardware sets. Quantities listed are for each pair of doors, or for each single door.

C. Manufacturer's Abbreviations:

1. MK - McKinney
2. OT - OTHER
3. RO - Rockwood
4. SA - SARGENT
5. BE - dormakaba Best
6. RF - Rixson
7. NO - Norton
8. SU - Securitron

Hardware Sets

Set: 1.0

Doors: 151CB
Description: Interior - All by Others

1	All Hardware Provided By Door Supplier	

Notes:

Set: 8.0

Doors: 129
Description: Interior - Card Reader Lock / Closer / Door Stop

3	Hinge	TA2714 (size per spec) (NRP as applicable)	US26D	MK
1	Access Control Lock	70 M1-82271-12V-IPS 03 LNMU	US26D	SA
1	Core	1CF71 x match owner's existing key system	626	BE

1	Door Closer	(PR)7500 (Reg or P/A as applicable)	689	NO
1	Kick Plate	K1050 10" high 4BE CSK	US32D	RO
1	Door Stop	403 (or) 441CU (As Required)	US26D	RO
3	Silencer	608		RO
1	ElectroLynx Harness	QC-C3000P		MK
1	Wiring Diagram	WD-SYSPK (Elevations and Point to Point)		
1	Electric Power Transfer	EL-CEPT		SU
1	Door Wire Harness	QC-C*** x Length / Type as Required)		MK
1	Power Supply	EPS-05		SU

Notes:
* All access control & electrified hardware to be coordinated with Section 28 16 43.
* Lay-out and hardware to match access control lay-out in Phase 1.
* Coordinate all wiring & conduit with the electrical contractor.
* Electronic opening to operate as follows: Outside, Card reader (Integrated in trim) signals power supply to release fail secure electric lock allowing entry by lever. Key override. Inside, Free egress at all times by lever.

Set: 10.0

Doors: 151BA, 151DA, 151EA, 151FA, 151GA, 151JA, 151KA, 152AA, 152BA, 152DA, 152EA, 152FA, 152GA, 152JA

Description: Interior - UE Pair / Card Reader Lock / Closer w.stop

6	Hinge	TA2714 (size per spec) (NRP as applicable)	US26D	MK
2	Manual Flush Bolt	555 / 557 (As Required)	US26D	RO
1	Access Control Lock	70 M1-82271-12V-IPS 03 LNMU	US26D	SA
1	Core	1CF71 x match owner's existing key system	626	BE
1	Door Closer w/stop	CPS7500	689	NO
2	Kick Plate	K1050 10" high 4BE CSK	US32D	RO
2	Hinge Pin Stop	528	NP	RO
2	Silencer	608		RO
1	ElectroLynx Harness	QC-C3000P		MK
1	Wiring Diagram	WD-SYSPK (Elevations and Point to Point)		
1	Electric Power Transfer	EL-CEPT		SU
1	Door Wire Harness	QC-C*** x Length / Type as Required)		MK
1	Position Switch	DPS-M / W-BK		SU

Notes: * Closer on active leaf only.
* DPS on active leaf is built into the lockset.

* DPS on the inactive leaf is auxiliary DPS to be utilized by security, if needed.
* All access control & electrified hardware to be coordinated with Section 28 16 43.
* Lay-out and hardware to match access control lay-out in Phase 1.
* Coordinate all wiring & conduit with the electrical contractor.
* Electronic opening to operate as follows: Outside, Card reader (Integrated in trim) signals power supply to release fail secure electric lock allowing entry by lever. Key override. Inside, Free egress at all times by lever.

Set: 15.0

Doors: 151GB

Description: Interior - Classroom Lock / Closer w.stop

3	Hinge	TA2714 (size per spec) (NRP as applicable)	US26D	MK
1	Classroom Lock	70 8237 LNMU	US26D	SA
1	Core	1CF71 x match owner's existing key system	626	BE
1	Door Closer w/stop	CPS7500	689	NO
1	Kick Plate	K1050 10" high 4BE CSK	US32D	RO
1	Silencer	608		RO

Set: 22.0

Doors: 116, 117, 119, 120, 121, 122, 124, 125, 131, 132, 135, 136, 137, 138, 140, 141

Description: Interior - Wood Sliding Barn Doors

1	Note	All hardware specified in 10 22 15	OT

Notes:
* All hardware to be supplied by Section 10 22 15.
* Lay-out and hardware to match Sliding Door Assemblies in Phase 1.

Set: 23.0

Doors: 115

Description: Interior - Glass Sliding Barn Doors

1	Note	All hardware specified in 10 22 15	OT

Notes:
* All hardware to be supplied by Section 10 22 15.
* Lay-out and hardware to match Sliding Door Assemblies in Phase 1.

Set: 23.1

Doors: 151A, 151B, 151C, 151D, 152A, 152B, 152C, 152D

Description: Interior - Glass Swinging Doors

1	Note	All hardware specified in 10 22 15		OT

Notes:
* All hardware to be supplied by Section 10 22 15.
* Lay-out and hardware to match Swinging Door Assemblies in Phase 1 and 2.

Set: 29.0

Doors: 100EA, 100EB, 100WA, 100WB

Description: Interior - Pair / Exit Device / Closers / EMHO (Total Door)

2	Full Height Hinges	H-13 Rigidized (Total Door - supplied by 08 17 13)		OT
2	Full Height Latch Channel	L-11 (Total Door - supplied by 08 17 13		OT
2	Exit Device	PF 200 x flush panic w/insert to match skin (Total Door - supplied by 08 17 13		OT
2	Surface Door Closer	TDC5051 (Total Door - supplied by 08 17 13	BLK	OT
2	Eletromagnetic Hold-Opens	TDH100 (Total Door - supplied by 08 17 13)		OT
1	Gasket	As required by rating & Total Door (supplied by 08 17 13)		OT

Notes:
* All hardware to be supplied by Section 08 17 13.
* Lay-out and hardware to match Total Door Assemblies in Phase 1.
* Coordinate all wiring & conduit with the electrical contractor.
* Electromagnetic Hold-Open must be tied to the fire alarm system.

END OF SECTION 087100

SECTION 088000 - GLAZING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes:

1. Glass for doors, interior borrowed lites, and storefront framing.
2. Glazing sealants and accessories.

1.3 DEFINITIONS

A. Glass Manufacturers: Firms that produce primary glass, fabricated glass, or both, as defined in referenced glazing publications.

B. Glass Thicknesses: Indicated by thickness designations in millimeters according to ASTM C 1036.

C. IBC: International Building Code.

1.4 COORDINATION

A. Coordinate glazing channel dimensions to provide necessary bite on glass, minimum edge and face clearances, and adequate sealant thicknesses, with reasonable tolerances.

1.5 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
2. Review temporary protection requirements for glazing during and after installation.

1.6 ACTION SUBMITTALS

A. Product Data: For each type of product. Include sealant manufacturer’s temperature and substrate requirements.

B. LEED Submittals:

1. Product Data for Credit IEQ 4.1: For field-applied glazing sealants, documentation including printed statement of VOC content.

C. Glazing Schedule: List glass types and thicknesses for each size opening and location. Use same designations indicated on Drawings.

D. Delegated-Design Submittal: For glass indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.7 INFORMATIONAL SUBMITTALS

A. Product Certificates: For glass.

1.8 QUALITY ASSURANCE

A. Installer Qualifications: A qualified installer who employs glass installers for this Project who are certified under the National Glass Association's Certified Glass Installer Program.

B. Glass Testing Agency Qualifications: A qualified independent testing agency accredited according to the NFRC CAP 1 Certification Agency Program.

C. Sealant Testing Agency Qualifications: An independent testing agency qualified according to ASTM C 1021 to conduct the testing indicated.

D. Mockups: Build mockups to demonstrate aesthetic effects and to set quality standards for materials and execution.

1. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Protect glazing materials according to manufacturer's written instructions. Prevent damage to glass and glazing materials from condensation, temperature changes, direct exposure to sun, or other causes.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Cardinal Glass Industries.
b. Guardian Industries Corp.; SunGuard.
c. Pilkington North America.
d. PPG Flat Glass; PPG Industries, Inc.
e. Viracon, Inc.

B. Source Limitations for Glass: Obtain from single source from single manufacturer for each glass type.

C. Source Limitations for Glazing Accessories: Obtain from single source from single manufacturer for each product and installation method.

2.2 PERFORMANCE REQUIREMENTS

A. General: Installed glazing systems shall withstand normal thermal movement and wind and impact loads (where applicable) without failure, including loss or glass breakage attributable to the following: defective manufacture, fabrication, or installation; failure of sealants or gaskets to remain watertight and airtight; deterioration of glazing materials; or other defects in construction.

B. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design glazing.

C. Structural Performance: Glazing shall withstand the following design loads within limits and under conditions indicated determined according to the IBC and ASTM E 1300.

1. Design Wind Pressures: As indicated on Drawings.
2. Thickness of Patterned Glass: Base design of patterned glass on thickness at thinnest part of the glass.
3. Maximum Lateral Deflection: For glass supported on all four edges, limit center-of-glass deflection at design wind pressure to not more than 1/50 times the short-side length or 1 inch (25 mm), whichever is less.
4. Differential Shading: Design glass to resist thermal stresses induced by differential shading within individual glass lites.

D. Safety Glazing: Where safety glazing is indicated or required by code, provide glazing that complies with 16 CFR 1201, Category II.

E. Thermal and Optical Performance Properties: Provide glass with performance properties specified, as indicated in manufacturer's published test data, based on procedures indicated below:
1. Performance requirements for glazing including, but not limited to, visible transmittance and sound requirements.
2. For monolithic-glass lites, properties are based on units with lites 6 mm thick.

2.3 GLASS PRODUCTS, GENERAL

A. Glazing Publications: Comply with published recommendations of glass product manufacturers and organizations below unless more stringent requirements are indicated. See these publications for glazing terms not otherwise defined in this Section or in referenced standards.

1. GANA Publications: "Glazing Manual."

B. Safety Glazing Labeling: Where safety glazing is indicated, permanently mark glazing with certification label of the SGCC or another certification agency acceptable to authorities having jurisdiction or manufacturer. Label shall indicate manufacturer's name, type of glass, thickness, and safety glazing standard with which glass complies.

C. Thickness: Where glass thickness is indicated, it is a minimum. Provide glass that complies with performance requirements and is not less than the thickness indicated.

D. Strength: Where annealed float glass is indicated, provide annealed float glass, heat-strengthened float glass, or fully tempered float glass as needed to comply with "Performance Requirements" Article. Where heat-strengthened float glass is indicated, provide heat-strengthened float glass or fully tempered float glass as needed to comply with "Performance Requirements" Article. Where fully tempered float glass is indicated, provide fully tempered float glass.

2.4 GLASS PRODUCTS

A. Clear Annealed Float Glass: ASTM C 1036, Type I, Class 1 (clear), Quality-Q3.

B. Fully Tempered Float Glass: ASTM C 1048, Kind FT (fully tempered), Condition A (uncoated) unless otherwise indicated, Type I, Class 1 (clear) or Class 2 (tinted) as indicated, Quality-Q3.

1. Fabrication Process: By horizontal (roller-hearth) process with roll-wave distortion parallel to bottom edge of glass as installed unless otherwise indicated. Roller distortion or ripples shall run in the same direction for the entire job. Roller distortion, measured peak to valley, shall not exceed 0.003 inches in the central area for 1/4 inch or thicker glass, or 0.008 inches within 10.5 inches of the leading or trailing edge for 1/4 inch or thicker glass. Local bow shall not exceed 1/32 inch in 12 inches.

2. Heat Soak Testing: Unless manufacturer’s standard procedures are more stringent, perform heat soak testing of all fully tempered glass lites by placing glass in an oven at temperatures of 550dF,+/-50dF for a two hour “Dwell Time” to reduce the potential for spontaneous breakage to 5 lites per 1000 (5/1000).

C. Heat-Strengthened Float Glass: ASTM C 1048, Kind HS (heat strengthened), Type I, Condition A (uncoated) unless otherwise indicated, Type I, Class 1 (clear) or Class 2 (tinted) as indicated, Quality-Q3.

1. Fabrication Process: By horizontal (roller-hearth) process with roll-wave distortion parallel to bottom edge of glass as installed unless otherwise indicated. Roller distortion or ripples shall run in the same direction for the entire job. Roller distortion, measured peak to valley, shall not exceed 0.003 inches in the central area for 1/4 inch or thicker glass, or 0.008 inches within 10.5 inches of the leading or trailing edge for 1/4 inch or thicker glass. Local bow shall not exceed 1/32 inch in 12 inches.

2.5 GLAZING SEALANTS

A. General:

1. Compatibility: Compatible with one another and with other materials they contact, including glass products, seals of insulating-glass units, and glazing channel substrates, under conditions of service and application, as demonstrated by sealant manufacturer based on testing and field experience.
2. Suitability: Comply with sealant and glass manufacturers' written instructions for selecting glazing sealants suitable for applications indicated and for conditions existing at time of installation.
3. Field-applied sealants shall have a VOC content of not more than 250 g/L.

4. Colors of Exposed Glazing Sealants: As selected by Architect from manufacturer's full range.

B. Glazing Sealant: Neutral-curing silicone glazing sealant complying with ASTM C 920, Type S, Grade NS, Class 100/50, Use NT.

2.6 GLAZING TAPES

A. Back-Bedding Mastic Glazing Tapes: Preformed, butyl-based, 100 percent solids elastomeric tape; nonstaining and nonmigrating in contact with nonporous surfaces; with or without spacer rod as recommended in writing by tape and glass manufacturers for application indicated; and complying with ASTM C 1281 and AAMA 800 for products indicated below:
   1. AAMA 806.3 tape, for glazing applications in which tape is subject to continuous pressure.
   2. AAMA 807.3 tape, for glazing applications in which tape is not subject to continuous pressure.

B. Expanded Cellular Glazing Tapes: Closed-cell, PVC foam tapes; factory coated with adhesive on both surfaces; and complying with AAMA 800 for the following types:

   1. AAMA 810.1, Type 1, for glazing applications in which tape acts as the primary sealant.
   2. AAMA 810.1, Type 2, for glazing applications in which tape is used in combination with a full bead of liquid sealant.

2.7 MISCELLANEOUS GLAZING MATERIALS

A. General: Provide products of material, size, and shape complying with referenced glazing standard, with requirements of manufacturers of glass and other glazing materials for application indicated, and with a proven record of compatibility with surfaces contacted in installation.

B. Cleaners, Primers, and Sealers: Types recommended by sealant or gasket manufacturer.

C. Setting Blocks: Elastomeric material with a Shore, Type A durometer hardness of 85, plus or minus 5.

D. Edge Blocks: Elastomeric material of hardness needed to limit glass lateral movement (side walking).

E. Cylindrical Glazing Sealant Backing: ASTM C 1330, Type O (open-cell material), of size and density to control glazing sealant depth and otherwise produce optimum glazing sealant performance.

2.8 FABRICATION OF GLAZING UNITS

A. Fabricate glazing units in sizes required to fit openings indicated for Project, with edge and face clearances, edge and surface conditions, and bite complying with written instructions of product manufacturer and referenced glazing publications, to comply with system performance requirements.

1. Allow for thermal movements from ambient and surface temperature changes acting on glass framing members and glazing components.

    a. Temperature Change: 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

B. Clean-cut or flat-grind vertical edges of butt-glazed monolithic lites to produce square edges with slight chamfers at junctions of edges and faces.

C. Grind smooth and polish exposed glass edges and corners.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine framing, glazing channels, and stops, with Installer present, for compliance with the following:

1. Manufacturing and installation tolerances, including those for size, squareness, and offsets at corners.
2. Minimum required face and edge clearances.
3. Effective sealing between joints of glass-framing members.

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

3.2 PREPARATION

A. Clean glazing channels and other framing members receiving glass immediately before glazing. Remove coatings not firmly bonded to substrates.

3.3 GLAZING, GENERAL

A. Comply with combined written instructions of manufacturers of glass, sealants, gaskets, and other glazing materials, unless more stringent requirements are indicated, including those in referenced glazing publications.

B. Protect glass edges from damage during handling and installation. Remove damaged glass from Project site and legally dispose of off Project site. Damaged glass includes glass with edge damage or other imperfections that, when installed, could weaken glass, impair performance, or impair appearance.

C. Apply primers to joint surfaces where required for adhesion of sealants, as determined by preconstruction testing.

D. Install setting blocks in sill rabbets, sized and located to comply with referenced glazing publications, unless otherwise required by glass manufacturer. Set blocks in thin course of compatible sealant suitable for heel bead.

E. Do not exceed edge pressures stipulated by glass manufacturers for installing glass lites.

F. Provide spacers for glass lites where length plus width is larger than 50 inches (1270 mm).

1. Locate spacers directly opposite each other on both inside and outside faces of glass. Install correct size and spacing to preserve required face clearances, unless gaskets and glazing tapes are used that have demonstrated ability to maintain required face clearances and to comply with system performance requirements.
2. Provide 1/8-inch (3-mm) minimum bite of spacers on glass and use thickness equal to sealant width. With glazing tape, use thickness slightly less than final compressed thickness of tape.

G. Provide edge blocking where indicated or needed to prevent glass lites from moving sideways in glazing channel, as recommended in writing by glass manufacturer and according to requirements in referenced glazing publications.

H. Set glass lites in each series with uniform pattern, draw, bow, and similar characteristics.

I. Set glass lites with proper orientation so that coatings face exterior or interior as specified.

J. Where wedge-shaped gaskets are driven into one side of channel to pressurize sealant or gasket on opposite side, provide adequate anchorage so gasket cannot walk out when installation is subjected to movement.

K. Square cut wedge-shaped gaskets at corners and install gaskets in a manner recommended by gasket manufacturer to prevent corners from pulling away; seal corner joints and butt joints with sealant recommended by gasket manufacturer.

3.4 TAPE GLAZING

A. Position tapes on fixed stops so that, when compressed by glass, their exposed edges are flush with or protrude slightly above sightline of stops.

B. Install tapes continuously, but not necessarily in one continuous length. Do not stretch tapes to make them fit opening.

C. Cover vertical framing joints by applying tapes to heads and sills first, then to jambs. Cover horizontal framing joints by applying tapes to jambs, then to heads and sills.

D. Place joints in tapes at corners of opening with adjoining lengths butted together, not lapped. Seal joints in tapes with compatible sealant approved by tape manufacturer.

E. Do not remove release paper from tape until right before each glazing unit is installed.

F. Apply heel bead of elastomeric sealant.

G. Center glass lites in openings on setting blocks, and press firmly against tape by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings.

H. Apply cap bead of elastomeric sealant over exposed edge of tape.

3.5 GASKET GLAZING (DRY)

A. Cut compression gaskets to lengths recommended by gasket manufacturer to fit openings exactly, with allowance for stretch during installation.

B. Insert soft compression gasket between glass and frame or fixed stop so it is securely in place with joints miter cut and bonded together at corners.

C. Installation with Drive-in Wedge Gaskets: Center glass lites in openings on setting blocks, and press firmly against soft compression gasket by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings. Compress gaskets to produce a weathertight seal without developing bending stresses in glass. Seal gasket joints with sealant recommended by gasket manufacturer.

D. Installation with Pressure-Glazing Stops: Center glass lites in openings on setting blocks, and press firmly against soft compression gasket. Install dense compression gaskets and pressure-glazing stops, applying pressure uniformly to compression gaskets. Compress gaskets to produce a weathertight seal without developing bending stresses in glass. Seal gasket joints with sealant recommended by gasket manufacturer.

E. Install gaskets so they protrude past face of glazing stops.

3.6 SEALANT GLAZING (WET)

A. Install continuous spacers, or spacers combined with cylindrical sealant backing, between glass lites and glazing stops to maintain glass face clearances and to prevent sealant from extruding into glass channel and blocking weep systems until sealants cure. Secure spacers or spacers and backings in place and in position to control depth of installed sealant relative to edge clearance for optimum sealant performance.

B. Force sealants into glazing channels to eliminate voids and to ensure complete wetting or bond of sealant to glass and channel surfaces.

C. Tool exposed surfaces of sealants to provide a substantial wash away from glass.

3.7 CLEANING AND PROTECTION

A. Immediately after installation remove nonpermanent labels and clean surfaces.

B. Protect glass from contact with contaminating substances resulting from construction operations. Examine glass surfaces adjacent to or below exterior concrete and other masonry surfaces at frequent intervals during construction, but not less than once a month, for buildup of dirt, scum, alkaline deposits, or stains.

1. If, despite such protection, contaminating substances do come into contact with glass, remove substances immediately as recommended in writing by glass manufacturer. Remove and replace glass that cannot be cleaned without damage to coatings.

C. Remove and replace glass that is damaged during construction period.

D. Wash glass on both exposed surfaces not more than four days before date scheduled for inspections that establish date of Substantial Completion. Wash glass as recommended in writing by glass manufacturer.

END OF SECTION 088000

SECTION 088113 - DECORATIVE GLASS GLAZING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Laminated glass.
2. Glass with decorative film overlay.

1.3 DEFINITION

A. Glass Thickness: Indicated by thickness designations in millimeters according to ASTM C 1036.

1.4 COORDINATION

A. Coordinate glazing channel dimensions to provide necessary bite on glass, minimum edge and face clearances, and adequate sealant thicknesses, with reasonable tolerances.

1.5 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
2. Review temporary protection requirements for glazing during and after installation.

1.6 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For decorative glass. Show fabrication and installation details. Include the following:

1. Size and location of penetrations.
2. Glazing method.
3. Mounting method.
4. Attachments to other work.
5. Full-size details of edge-finished profiles.

C. Glass Samples: For the following products, 12 inches (300 mm) square:

1. Each type of decorative glass.
2. Each edge treatment on type of decorative glass.
3. Each decorative film overlay on type of decorative glass.

D. Glazing Accessory Samples: For sealants, in 12-inch (300-mm) lengths. Install sealant Samples between two strips of material representative of the glazed system.

E. Decorative Glazing Schedule: List decorative glass types and thicknesses for each size opening and location. Use same designations indicated on Drawings.

F. Delegated-Design Submittal: For decorative glass indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.7 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Product Certificates: For each type of decorative glass.

C. Preconstruction adhesion and compatibility test report.

D. Sample Warranty: For special warranty.

1.8 CLOSEOUT SUBMITTALS

A. Maintenance Data: For each type of decorative glass and each decorative film overlay to include in maintenance manuals.

1.9 QUALITY ASSURANCE

A. Installer Qualifications: A qualified installer who employs glass installers for this Project who are certified under NGA's Certified Glass Installer Program.

B. Sealant Testing Agency Qualifications: An independent testing agency qualified according to ASTM C 1021 to conduct the testing indicated.

C. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.

1. Build mockups in the location and of the size indicated or, if not indicated, as directed by Architect.
2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.10 PRECONSTRUCTION TESTING

A. Preconstruction Adhesion and Compatibility Testing: Test each glass with decorative film overlay, tape sealant, gasket, glazing accessory, and glass-framing member for adhesion to and compatibility with elastomeric glazing sealants.

1. Testing is not required if data are submitted based on previous testing of current sealant products and glazing materials matching those submitted.
2. Use ASTM C 1087 to determine whether priming and other specific joint-preparation techniques are required to obtain rapid, optimum adhesion of glazing sealants to glass, tape sealants, gaskets, and glazing channel substrates.
3. Test no fewer than eight Samples of each type of material, including joint substrates, shims, sealant backings, secondary seals, and miscellaneous materials.
4. Schedule enough time for testing and analyzing results to prevent delaying the Work.
5. For materials failing tests, submit sealant manufacturer's written instructions for corrective measures including the use of specially formulated primers.

1.11 DELIVERY, STORAGE, AND HANDLING

A. Protect decorative glass and glazing materials according to manufacturer's written instructions. Prevent damage to glass and glazing materials from condensation, temperature changes, direct exposure to sun, or other causes.

B. Retain packaging and sequencing numbers for decorative-glass units.

1.12 FIELD CONDITIONS

A. Environmental Limitations: Do not deliver or install decorative glass until spaces are enclosed and weathertight, wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

B. Field Measurements: Verify actual dimensions of openings and construction contiguous with decorative glass by field measurements before fabrication.

1.13 WARRANTY

A. Special Warranty on Laminated Glass: Manufacturer agrees to replace laminated-glass units that deteriorate within specified warranty period. Deterioration of laminated glass is defined as defects developed from normal use that are not attributed to glass breakage or to maintaining and cleaning laminated glass contrary to manufacturer's written instructions. Defects include edge separation, delamination materially obstructing vision through glass, and blemishes exceeding those allowed by referenced laminated-glass standard.

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

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. AGC Glass Company North America, Inc.
2. Guardian Industries Corp.; SunGuard.
3. Pilkington North America.
4. Schott North America, Inc.
5. Vetrotech Saint-Gobain.

B. Source Limitations for Glass: Obtain each type of decorative glass from single source from single manufacturer.

C. Source Limitations for Glazing Accessories: Obtain from single source from single manufacturer, for each product and installation method.

2.2 PERFORMANCE REQUIREMENTS

A. General Performance: Installed glazing systems shall withstand normal thermal movement and impact loads (where applicable) without failure, including loss or glass breakage attributable to the following: defective manufacture, fabrication, or installation; deterioration of glazing materials; or other defects in construction.

B. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design decorative glass.

C. Structural Performance: Decorative glass installed adjacent to walking surfaces shall withstand the following design loads within limits and under conditions indicated:

1. Differential deflection of adjacent unsupported edges shall not exceed glass thickness when subjected to 50 lbf/ft. (730 N/m) applied horizontally to one panel at any point up to 42 inches (1067 mm) above the adjacent walking surface.
2. Base design on thickness at thinnest part of the glass.

D. Safety Glazing: Where safety glazing is indicated, provide glazing that complies with 16 CFR 1201, Category II.

2.3 GLASS PRODUCTS, GENERAL

A. Glazing Publications: Comply with published recommendations of glass product manufacturers and "GANA's "Glazing Manual" unless more stringent requirements are indicated. See these publications for glazing terms not otherwise defined in this Section or in referenced standards.

B. Safety Glazing Labeling: Where safety glazing is indicated, permanently mark glazing with certification label of the SGCC or another certification agency acceptable to authorities having jurisdiction. Label shall indicate manufacturer's name, type of glass, thickness, and safety glazing standard with which glass complies.

C. Thickness: Where glass thickness is indicated, it is a minimum. Provide glass lites in thicknesses as needed to comply with requirements indicated.

D. Strength: Where annealed float glass is indicated, provide annealed float glass, heat-strengthened float glass, or fully tempered float glass as needed to comply with requirements indicated. Where heat-strengthened glass is indicated, provide heat-strengthened float glass or fully tempered float glass as needed to comply with requirements indicated. Where fully tempered glass is indicated, provide fully tempered float glass.

2.4 GLASS PRODUCTS

A. Clear Annealed Float Glass: ASTM C 1036, Type I, Class 1 (clear), Quality-Q3.

B. Fully Tempered Glass: ASTM C 1048, Kind FT (fully tempered), Condition A (uncoated) unless otherwise indicated, Type I, Class 1 (clear) or Class 2 (tinted) as indicated, Quality-Q3.

1. Fabrication Process: By horizontal (roller-hearth) process with roll-wave distortion parallel to bottom edge of glass as installed unless otherwise indicated.

C. Heat-Strengthened Glass: ASTM C 1048, Kind HS (heat strengthened), Type I, Condition A (uncoated) unless otherwise indicated, Type I, Class 1 (clear) or Class 2 (tinted) as indicated, Quality-Q3.

1. Fabrication Process: By horizontal (roller-hearth) process with roll-wave distortion parallel to bottom edge of glass as installed unless otherwise indicated.

D. Laminated Glass: ASTM C 1172. Use materials that have a proven record of no tendency to bubble, discolor, or lose physical and mechanical properties after fabrication and installation.

E. Decorative Film Overlay: Translucent, dimensionally stable, polyester film, with pressure-sensitive, clear adhesive back for adhering to glass and releasable protective backing.

1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or approved equal.

2.5 GLAZING MATERIALS

A. Glazing Sealants, Tapes, and Miscellaneous Glazing Materials: As specified in Section 088000 "Glazing."

1. Colors: As selected by Architect from manufacturer's full range.

2.6 HARDWARE FOR GLASS INSTALLATION

A. Fasteners: Fabricated of same basic metal and alloy as fastened metal and matching it in finished color and texture where fasteners are exposed.

B. Gaskets: Manufacturer's standard, compatible with decorative glass type indicated.

C. Anchors and Inserts: Provide devices as required for hardware installation.

2.7 DECORATIVE-GLASS FABRICATION

A. Fabricate decorative glass and provide other glazing products in sizes required to glaze openings indicated for Project, with edge and face clearances, edge and surface conditions, and bite complying with product manufacturer's written instructions and with referenced glazing standard.

B. Decorative Film Overlay: Apply squarely aligned to glass edges, uniformly smooth, and free from tears, air bubbles, wrinkles, and rough edges, in pattern indicated on Drawings to the back face of clean glass, according to manufacturer's written instructions, including surface preparation and application temperature limitations.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine decorative-glass framing members, with Installer present, for compliance with the following:

1. Manufacturing and installation tolerances, including those for size, squareness, and offsets at corners.
2. Minimum required face or edge clearances.
3. Effective sealing between joints of decorative-glass framing members.

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

3.2 PREPARATION

A. Clean glazing channels and other framing members receiving glass immediately before glazing. Remove coatings not firmly bonded to substrates.

B. Examine glazing units to locate orientation of outer surfaces. Label or mark units as needed so that surface orientation is readily identifiable. Do not use materials that leave visible marks in the completed Work.

3.3 INSTALLATION

A. Set decorative-glass units in each series true in line with uniform orientation, pattern, draw, bow, and similar characteristics.

B. Set glass lites with proper orientation so that each outer surface faces the direction indicated on Drawings.

C. Set decorative glass in locations indicated on Drawings. Install glass with hardware and accessories according to hardware manufacturer's written instructions. Attach hardware securely to mounting surfaces.

3.4 GLAZING, GENERAL

A. Decorative Glass: Install glazing as specified in Section 088000 "Glazing."

B. Comply with combined written instructions of manufacturers of glass, gaskets, sealants, tapes, and other glazing materials unless more stringent requirements are indicated, including those in referenced glazing publications.

C. Protect glass edges from damage during handling and installation. Remove damaged glass from Project site and legally dispose of off Project site. Damaged glass is glass with edge damage or other imperfections that, when installed, could weaken glass and impair performance and appearance.

D. Apply primers to joint surfaces where required for adhesion of sealants, as determined by preconstruction testing.

E. Install setting blocks in sill rabbets, sized and located to comply with referenced glazing publications, unless otherwise required by glass manufacturer. Set blocks in thin course of compatible sealant suitable for heel bead.

F. Do not exceed edge pressures stipulated by glass manufacturers for installing glass lites.

G. Provide spacers for glass lites where length plus width is more than 50 inches (1270 mm).

1. Locate spacers directly opposite each other on both inside and outside faces of glass. Install correct size and spacing to preserve required face clearances, unless gaskets and glazing tapes are used that have demonstrated ability to maintain required face clearances, and to comply with system performance requirements.
2. Provide 1/8-inch- (3-mm-) minimum bite of spacers on glass and use thickness equal to sealant width. With glazing tape, use thickness slightly less than final compressed thickness of tape.

H. Provide edge blocking where indicated or needed to prevent glass lites from moving sideways in glazing channel, as recommended in writing by glass manufacturer and according to requirements in referenced glazing publications.

3.5 SEALANT GLAZING (WET)

A. Install continuous spacers, or spacers combined with cylindrical sealant backing, between glass lites and glazing stops to maintain glass face clearances and to prevent sealant from extruding into glass channel and blocking weep systems until sealants cure. Secure spacers or spacers and backings in place and in position to control depth of installed sealant relative to edge clearance for optimum sealant performance.

B. Force sealants into glazing channels and between glass-to-glass joints to eliminate voids and to ensure complete wetting or bond of sealant to glass and channel surfaces.

C. Tool exposed surfaces of sealants smooth.

3.6 CLEANING AND PROTECTION

A. Immediately after installation, remove nonpermanent labels and clean surfaces.

B. Protect glass from contact with contaminating substances resulting from construction operations. If, despite such protection, contaminating substances do come into contact with glass, remove substances immediately as recommended in writing by glass manufacturer.

C. Remove and replace glass that is damaged during construction period.

D. Wash glass on both exposed surfaces not more than four days before date scheduled for inspections that establish date of Substantial Completion. Wash glass as recommended in writing by glass manufacturer.

3.7 DECORATIVE GLASS SCHEDULE

A. Decorative Glass: Laminated glass. To be used in the Vivarium Animal Research Labs (ARL) and Procedure Rooms.

1. Construction: Two plies of clear, annealed float glass.
2. Tint Color: Red.
3. Thickness of Each Glass Ply: 1/8-inch.
4. Construction: Laminate glass with PVB interlayer to comply with interlayer manufacturer's written instructions.
5. Interlayer Thickness: 0.030 inch (0.76 mm). Provide thickness not less than that indicated and as needed to comply with requirements.
6. Interlayer Color and Pattern: Solar Graphics Color Rose/Chocolate 3.
7. Safety glazing required.
8. Minimal transmission below 580nm.

B. Decorative Glass Type: Glass with decorative film overlay.

1. Basis-of-Design Product: As indicated on Drawings.
2. Glass Type: Clear fully tempered float glass.
3. Glass Thickness: 6.0 mm.
4. Safety glazing required.
5. Use: Suitable for exterior and interior applications.
6. Pattern: As indicated on Drawings.

END OF SECTION 088113

SECTION 092216 - NON-STRUCTURAL METAL FRAMING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Non-load-bearing steel framing systems for interior partitions.
2. Suspension systems for interior ceilings and soffits.
3. Grid suspension systems for gypsum board ceilings.

B. Related Requirements:

1. Section 054000 "Cold-Formed Metal Framing" for exterior and interior load-bearing and exterior non-load-bearing wall studs; floor joists; roof rafters and ceiling joists; and roof trusses.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Studs and Runners: Provide documentation that framing members' certification is according to SIFA's "Code Compliance Certification Program for Cold-Formed Steel Structural and Non-Structural Framing Members."

B. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.

1.4 INFORMATIONAL SUBMITTALS

A. Evaluation Reports: For embossed steel studs and runners and firestop tracks, from ICC-ES or other qualified testing agency acceptable to authorities having jurisdiction.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Fire-Test-Response Characteristics: For fire-resistance-rated assemblies that incorporate non-load-bearing steel framing, provide materials and construction identical to those tested in assembly indicated, according to ASTM E 119 by an independent testing agency.

B. STC-Rated Assemblies: For STC-rated assemblies, provide materials and construction identical to those tested in assembly indicated, according to ASTM E 90 and classified according to ASTM E 413 by an independent testing agency.

2.2 FRAMING SYSTEMS

A. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.

B. Framing Members, General: Comply with ASTM C 754 for conditions indicated.

1. Steel Sheet Components: Comply with ASTM C 645 requirements for metal unless otherwise indicated.
2. Protective Coating: ASTM A 653/A 653M, G40 (Z120), hot-dip galvanized unless otherwise indicated. No equivalent coatings allowed.

C. Studs and Runners: ASTM C 645. Use either steel studs and runners or embossed steel studs and runners.

1. Steel Studs and Runners:

a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1) MBA Building Supplies.
2) MRI Steel Framing, LLC.
3) Phillips Manufacturing Co.
4) Steel Network, Inc. (The).
5) Telling Industries.

b. Minimum Base-Metal Thickness: As indicated on Drawings.

c. Depth: As indicated on Drawings.

2. Embossed Steel Studs and Runners:

a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1) ClarkDietrich Building Systems.
2) Marino\WARE.
3) MBA Building Supplies.
4) Phillips Manufacturing Co.
5) Steel Network, Inc. (The).

6) Telling Industries.
7) JN Linrose.

b. Minimum Base-Metal Thickness: As indicated on Drawings.

c. Depth: As indicated on Drawings.

D. Slip-Type Head Joints: Where indicated, provide one of the following:

1. Clip System: Clips designed for use in head-of-wall deflection conditions that provide a positive attachment of studs to runners while allowing 1-1/2-inch (38-mm) minimum vertical movement.

a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1) ClarkDietrich Building Systems.
2) Fire Trak Corp.
3) Steel Network, Inc. (The).

2. Single Long-Leg Runner System: ASTM C 645 top runner with 2-inch- (51-mm-) deep flanges in thickness not less than indicated for studs, installed with studs friction fit into top runner and with continuous bridging located within 12 inches (305 mm) of the top of studs to provide lateral bracing.
3. Double-Runner System: ASTM C 645 top runners, inside runner with 2-inch- (51-mm-) deep flanges in thickness not less than indicated for studs and fastened to studs, and outer runner sized to friction fit inside runner.
4. Deflection Track: Steel sheet top runner manufactured to prevent cracking of finishes applied to interior partition framing resulting from deflection of structure above; in thickness not less than indicated for studs and in width to accommodate depth of studs.

a. Products: Subject to compliance with requirements, provide one of the following:

1) ClarkDietrich Building Systems; SLP-TRK Slotted Deflection Track.
2) Metal-Lite; The System.
3) Steel Network, Inc. (The); VertiClip SLD.

E. Firestop Tracks: Top runner manufactured to allow partition heads to expand and contract with movement of structure while maintaining continuity of fire-resistance-rated assembly indicated; in thickness not less than indicated for studs and in width to accommodate depth of studs.

1. Products: Subject to compliance with requirements, provide one of the following:

a. ClarkDietrich Building Systems; BlazeFrame.
b. Fire Trak Corp; Fire Trak System attached to studs with Fire Trak Posi Klip.
c. Metal-Lite; The System.
d. Steel Network, Inc. (The); VertiTrack VT.

F. Flat Strap and Backing Plate: Steel sheet for blocking and bracing in length and width indicated.

1. Minimum Base-Metal Thickness: As indicated on Drawings.

G. Cold-Rolled Channel Bridging: Steel, 0.0538-inch (1.367-mm) minimum base-metal thickness, with minimum 1/2-inch- (13-mm-) wide flanges.

1. Depth: As indicated on Drawings.
2. Clip Angle: Not less than 1-1/2 by 1-1/2 inches (38 by 38 mm), 0.068-inch- (1.72-mm-) thick, galvanized steel.

H. Hat-Shaped, Rigid Furring Channels: ASTM C 645.
1. Minimum Base-Metal Thickness: As indicated on Drawings.
2. Depth: As indicated on Drawings.

I. Resilient Furring Channels: 1/2-inch- (13-mm-) deep, steel sheet members designed to reduce sound transmission.
1. Configuration: Asymmetrical or hat shaped.

J. Cold-Rolled Furring Channels: 0.053-inch (1.34-mm) uncoated-steel thickness, with minimum 1/2-inch- (13-mm-) wide flanges.

1. Depth: As indicated on Drawings.
2. Furring Brackets: Adjustable, corrugated-edge-type steel sheet with minimum uncoated-steel thickness of 0.0329 inch (0.8 mm).
3. Tie Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.062-inch- (1.59-mm-) diameter wire, or double strand of 0.048-inch- (1.21-mm-) diameter wire.

K. Z-Shaped Furring: With slotted or nonslotted web, face flange of 1-1/4 inches (32 mm), wall attachment flange of 7/8 inch (22 mm), minimum uncoated-metal thickness of 0.0179 inch (0.455 mm), and depth required to fit insulation thickness indicated.

2.3 SUSPENSION SYSTEMS

A. Tie Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.062-inch- (1.59-mm-) diameter wire, or double strand of 0.048-inch- (1.21-mm-) diameter wire.

B. Hanger Attachments to Concrete:

1. Expansion Anchors: Fabricated from corrosion-resistant materials, with allowable load or strength design capacities calculated according to ICC-ES AC193 and ACI 318 greater than or equal to the design load, as determined by testing per ASTM E 488/E 488M conducted by a qualified testing agency.
2. Power-Actuated Anchors: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with allowable load capacities calculated according to ICC-ES AC70, greater than or equal to the design load, as determined by testing per ASTM E 1190 conducted by a qualified testing agency.

C. Wire Hangers: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.16 inch (4.12 mm) in diameter.

D. Carrying Channels: Cold-rolled, commercial-steel sheet with a base-metal thickness of 0.0538 inch (1.367 mm) and minimum 1/2-inch- (13-mm-) wide flanges.

1. Depth: As indicated on Drawings.

E. Furring Channels (Furring Members):

1. Cold-Rolled Channels: 0.0538-inch (1.367-mm) uncoated-steel thickness, with minimum 1/2-inch- (13-mm-) wide flanges, 3/4 inch (19 mm) deep.

2. Steel Studs and Runners: ASTM C 645.

    a. Minimum Base-Metal Thickness: As indicated on Drawings.
    b. Depth: As indicated on Drawings.

3. Embossed Steel Studs and Runners: ASTM C 645.

    a. Minimum Base-Metal Thickness: As indicated on Drawings.
    b. Depth: As indicated on Drawings.

4. Hat-Shaped, Rigid Furring Channels: ASTM C 645, 7/8 inch (22 mm) deep.

    a. Minimum Base-Metal Thickness: As indicated on Drawings.

5. Resilient Furring Channels: 1/2-inch- (13-mm-) deep members designed to reduce sound transmission.

    a. Configuration: Asymmetrical or hat shaped.

F. Grid Suspension System for Gypsum Board Ceilings: ASTM C 645, direct-hung system composed of main beams and cross-furring members that interlock.

1. Products: Subject to compliance with requirements, provide one of the following:

    a. Armstrong World Industries, Inc; Drywall Grid Systems.
    b. Chicago Metallic Corporation; 640/660 Drywall Ceiling Suspension.
    c. United States Gypsum Company; Drywall Suspension System.

G. Use stainless steel hanger wires in locations subject to moisture penetration or condensation. Other support brackets and framing shall be galvanized steel.

2.4 AUXILIARY MATERIALS

A. General: Provide auxiliary materials that comply with referenced installation standards.

1. Fasteners for Metal Framing: Of type, material, size, corrosion resistance, holding power, and other properties required to fasten steel members to substrates.

B. Isolation Strip at Exterior Walls: Provide one of the following:

1. Asphalt-Saturated Organic Felt: ASTM D 226/D 226M, Type I (No. 15 asphalt felt), nonperforated.
2. Foam Gasket: Adhesive-backed, closed-cell vinyl foam strips that allow fastener penetration without foam displacement, 1/8 inch (3.2 mm) thick, in width to suit steel stud size.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and substrates, with Installer present, and including welded hollow-metal frames, cast-in anchors, and structural framing, for compliance with requirements and other conditions affecting performance of the Work.

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

3.2 PREPARATION

A. Suspended Assemblies: Coordinate installation of suspension systems with installation of overhead structure to ensure that inserts and other provisions for anchorages to building structure have been installed to receive hangers at spacing required to support the Work and that hangers will develop their full strength.

1. Furnish concrete inserts and other devices indicated to other trades for installation in advance of time needed for coordination and construction.

B. Coordination with Sprayed Fire-Resistive Materials:

1. Before sprayed fire-resistive materials are applied, attach offset anchor plates or ceiling runners (tracks) to surfaces indicated to receive sprayed fire-resistive materials. Where offset anchor plates are required, provide continuous plates fastened to building structure not more than 24 inches (610 mm) o.c.
2. After sprayed fire-resistive materials are applied, remove them only to extent necessary for installation of non-load-bearing steel framing. Do not reduce thickness of fire-resistive materials below that are required for fire-resistance ratings indicated. Protect adjacent fire-resistive materials from damage.

3.3 INSTALLATION, GENERAL

A. Installation Standard: ASTM C 754.
1. Gypsum Board Assemblies: Also comply with requirements in ASTM C 840 that apply to framing installation.

B. Install framing and accessories plumb, square, and true to line, with connections securely fastened.

C. Install supplementary framing, and blocking to support fixtures, equipment services, heavy trim, grab bars, toilet accessories, furnishings, or similar construction.

D. Install bracing at terminations in assemblies.

E. Do not bridge building control and expansion joints with non-load-bearing steel framing members. Frame both sides of joints independently.

3.4 INSTALLING FRAMED ASSEMBLIES

A. Install framing system components according to spacings indicated, but not greater than spacings required by referenced installation standards for assembly types.

1. Single-Layer Application: 16 inches (406 mm) o.c. unless otherwise indicated.
2. Multilayer Application: 16 inches (406 mm) o.c. unless otherwise indicated.

B. Where studs are installed directly against exterior masonry walls or dissimilar metals at exterior walls, install isolation strip between studs and exterior wall.

C. Install studs so flanges within framing system point in same direction.

D. Install tracks (runners) at floors and overhead supports. Extend framing full height to structural supports or substrates above suspended ceilings except where partitions are indicated to terminate at suspended ceilings. Continue framing around ducts that penetrate partitions above ceiling.

1. Slip-Type Head Joints: Where framing extends to overhead structural supports, install to produce joints at tops of framing systems that prevent axial loading of finished assemblies.
2. Door Openings: Screw vertical studs at jambs to jamb anchor clips on door frames; install runner track section (for cripple studs) at head and secure to jamb studs.

    a. Install two studs at each jamb unless otherwise indicated.

3. Other Framed Openings: Frame openings other than door openings the same as required for door openings unless otherwise indicated. Install framing below sills of openings to match framing required above door heads.
4. Fire-Resistance-Rated Partitions: Install framing to comply with fire-resistance-rated assembly indicated and support closures and to make partitions continuous from floor to underside of solid structure.

    a. Firestop Track: Where indicated, install to maintain continuity of fire-resistance-rated assembly indicated.

5. Sound-Rated Partitions: Install framing to comply with sound-rated assembly indicated.
6. Curved Partitions:

    a. Bend track to uniform curve and locate straight lengths so they are tangent to arcs.
    b. Begin and end each arc with a stud, and space intermediate studs equally along arcs. On straight lengths of no fewer than two studs at ends of arcs, place studs 6 inches (150 mm) o.c.

E. Z-Shaped Furring Members:

1. Erect insulation, specified in Section 072100 "Thermal Insulation," vertically and hold in place with Z-shaped furring members spaced 24 inches (610 mm) o.c.
2. Except at exterior corners, securely attach narrow flanges of furring members to wall with concrete stub nails, screws designed for masonry attachment, or powder-driven fasteners spaced 24 inches (610 mm) o.c.
3. At exterior corners, attach wide flange of furring members to wall with short flange extending beyond corner; on adjacent wall surface, screw-attach short flange of furring

channel to web of attached channel. At interior corners, space second member no more than 12 inches (305 mm) from corner and cut insulation to fit.

F. Installation Tolerance: Install each framing member so fastening surfaces vary not more than 1/8 inch (3 mm) from the plane formed by faces of adjacent framing.

3.5 INSTALLING SUSPENSION SYSTEMS

A. Install suspension system components according to spacings indicated, but not greater than spacings required by referenced installation standards for assembly types.

B. Isolate suspension systems from building structure where they abut or are penetrated by building structure to prevent transfer of loading imposed by structural movement.

C. Suspend hangers from building structure as follows:

1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structural or suspension system.

    a. Splay hangers only where required to miss obstructions and offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.

2. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with locations of hangers required to support standard suspension system members, install supplemental suspension members and hangers in the form of trapezes or equivalent devices.

    a. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced installation standards.

3. Wire Hangers: Secure by looping and wire tying, either directly to structures or to inserts, eye screws, or other devices and fasteners that are secure and appropriate for substrate, and in a manner that will not cause hangers to deteriorate or otherwise fail.
4. Do not attach hangers to steel roof deck.
5. Do not attach hangers to permanent metal forms. Furnish cast-in-place hanger inserts that extend through forms.
6. Do not attach hangers to rolled-in hanger tabs of composite steel floor deck.
7. Do not connect or suspend steel framing from ducts, pipes, or conduit.
8. Locate hangers and supports where they will not interfere with access to mixing boxes, fire dampers, valves, and other appurtenances requiring service.

D. Fire-Resistance-Rated Assemblies: Wire tie furring channels to supports.

E. Seismic Bracing: Sway-brace suspension systems with hangers used for support.

F. Grid Suspension Systems: Attach perimeter wall track or angle where grid suspension systems meet vertical surfaces. Mechanically join main beam and cross-furring members to each other and butt-cut to fit into wall track.

G. Installation Tolerances: Install suspension systems that are level to within 1/8 inch in 12 feet (3 mm in 3.6 m) measured lengthwise on each member that will receive finishes and transversely between parallel members that will receive finishes.

END OF SECTION 092216

SECTION 092713 - GLASS-FIBER-REINFORCED GYPSUM (GRG) FABRICATIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes factory-fabricated, glass-fiber-reinforced gypsum column enclosure fabrications for interior applications.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, weights, dimensions of individual components and profiles, and finishes.

B. Sustainable Design Submittals:

1. Product Data: For adhesives, indicating VOC content.
2. Laboratory Test Reports: For adhesives, indicating compliance with requirements for low-emitting materials.

C. Shop Drawings:

1. Include plans, elevations, sections, and attachment details.
2. Detail fabrication and assembly of glass-fiber-reinforced gypsum fabrications.
3. Indicate requirements for joint treatment.
4. Indicate location of control joints.

D. Samples: For each exposed product and for each color and texture specified.

1.4 QUALITY ASSURANCE

A. Manufacturer Qualifications: Manufacturer shall have a minimum of 5 years experience having successfully supplied GRG parts for other projects similar in scope and complexity for the work of this Contract.

B. Installer Qualifications: Installer shall have a minimum of 5 years experience having successfully installed GRG parts for other projects similar in scope and complexity for the work of this Contract.

C. The Alpha gypsum cement used to make the GRG parts is to be mined and processed in the USA with a purity of not less than 90% in accordance to ASTM C1355. Provide a Manufacturer's Certification of Raw Materials.

D. Substrates to accept GRG parts shall be installed straight and true within 1/8 in. in 8 linear ft. (3mm in 2500mm) in accordance to ASTM C1467 and shall be free of obstructions and interference that prohibits the correct alignment and attachment of the GRG parts.

E. Mockups: Build mockups to set quality standards for fabrication and installation.

1. Build mockup of each type of glass-fiber-reinforced gypsum fabrication.
2. Paint mockups to match finish indicated and to comply with requirements specified in Section 099123 "Interior Painting."
3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Comply with ASTM C 1467/C 1467M.

1.6 FIELD CONDITIONS

A. Environmental Conditions:

1. Comply with ASTM C 1467/C 1467M.
2. Do not deliver or install glass-fiber-reinforced gypsum fabrications until building is enclosed, wet-work is complete, and HVAC system is operating and continuously maintaining temperature and relative humidity at levels intended for building occupants.

B. Conditioning: Acclimatize glass-fiber-reinforced gypsum fabrications to ambient temperature and humidity of spaces in which they will be installed. Remove packaging and move units into installation spaces not less than 48 hours before installing them.

PART 2 - PRODUCTS

2.1 GLASS-FIBER-REINFORCED GYPSUM FABRICATIONS

A. Fabrications: Molded, glass-fiber-reinforced gypsum units complying with ASTM C 1381/C 1381M.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Formglas Products Ltd.; Design 1 or a comparable product by one of the following:

a. Architectural Reproductions Inc.
b. Casting Designs, Inc.
c. GRG Technologies, LLC.
d. Stromberg Architectural Products, Inc.

B. Embedments: As standard with glass-fiber-reinforced gypsum fabrication manufacturer and as required for reinforcement and for anchorage to substrates and framing.

C. Finish: Smooth for paint finish.

2.2 AUXILIARY MATERIALS

A. Adhesives: As recommended in glass-fiber-reinforced gypsum fabrication manufacturer's written instructions.

1. Adhesives shall have a VOC content of 70 g/L or less.

B. Steel Drill Screws: ASTM C 1002, unless otherwise indicated.

1. Screws complying with ASTM C 954 for fastening glass-fiber-reinforced gypsum fabrications to steel members from 0.033 to 0.112 inch (0.84 to 2.84 mm) thick.

C. Joint-Treatment Materials: ASTM C 475/C 475M.

D. Tie Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.062-inch- (1.59-mm-) diameter wire, or double strand of 0.048-inch- (1.21-mm-) diameter wire.

2.3 FABRICATION

A. Fabricate glass-fiber-reinforced gypsum units in factory to comply with ASTM C 1381/C 1381M, with smooth-finished surfaces; repair hollows, voids, scratches, and other surface imperfections. Fabricate units in lengths and sizes that will minimize number of joints between abutting units.

B. Embedments: Incorporate embedments into units to develop the full strength of glass-fiber-reinforced gypsum fabrications. Cover embedments with not less than 3/16-inch (5-mm) thickness of glass-fiber-reinforced gypsum composite.

C. Connection Hardware: Designed and fabricated to support and connect glass-fiber-reinforced gypsum fabrications to hangers, support framing, and substrates.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

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

C. Field Dimensions: Field dimensions are to be verified including those not shown on the drawings. Any discrepancies are to be brought to the attention of the Architect with resolutions to the discrepancies to be mutually agreed upon by all parties involved. Details of any changes required must be incorporated into the manufacturer’s shop drawings prior to commencing the manufacture of the GRG parts.

3.2 INSTALLATION

A. Comply with ASTM C 1467/C 1467M.

B. Install glass-fiber-reinforced gypsum fabrications level, plumb, true, and aligned with adjacent materials. Use concealed shims where required for alignment.

C. Attach glass-fiber-reinforced gypsum fabrications to framing and substrates with steel drill screws unless otherwise indicated. Do not use pneumatic staple guns. Countersink screw heads below adjoining finished surface.

1. Predrill fastener holes in units. Clean fastener holes to remove dirt and oil.
2. Locate fasteners not less than 5/16 inch (7.9 mm) from edges or ends of units.

D. Where glass-fiber-reinforced gypsum fabrications are joined to form composite units, join fabrications with adhesive. Band or brace units together until adhesive cures.

E. Install control joints between glass-fiber-reinforced gypsum fabrications where indicated.

F. Use joint-treatment materials to finish glass-fiber-reinforced gypsum fabrications to produce surfaces ready to receive primers and paint finishes specified in Section 099123 "Interior Painting."

1. Finish glass-fiber-reinforced gypsum fabrications subject to critical lighting or scheduled to receive semi-gloss decoration shall be prepared as a Level 5 finish which may require skim coats, filling, and sanding to hide imperfections inherent in GRG, in accordance to ASTM Standards C840 and C1467.
2. Repair hollows, voids, scratches, and other surface imperfections on units.

END OF SECTION 092713

SECTION 092900 - GYPSUM BOARD

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Interior gypsum board.
2. Tile backing panels.

B. Related Requirements:

1. Section 061600 "Sheathing" for gypsum sheathing for exterior walls.
2. Section 092116.23 "Gypsum Board Shaft Wall Assemblies" for metal shaft-wall framing, gypsum shaft liners, and other components of shaft-wall assemblies.
3. Section 092216 "Non-Structural Metal Framing" for non-structural steel framing and suspension systems that support gypsum board panels.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.

2. Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project and cost for each regional material.

3. Product Data: For adhesives and sealants, indicating VOC content.

4. Laboratory Test Reports: For adhesives and sealants, indicating compliance with requirements for low-emitting materials.
5. Laboratory Test Reports: For ceiling and wall materials, indicating compliance with requirements for low-emitting materials.

1.4 QUALITY ASSURANCE

A. Mockups: Build mockups of at least 100 sq. ft. (9 sq. m) in surface area to demonstrate aesthetic effects and to set quality standards for materials and execution.

1. Build mockups for the following:

    a. Each level of gypsum board finish indicated for use in exposed locations.

2. Apply or install final decoration indicated, including painting and wallcoverings, on exposed surfaces for review of mockups.
3. Simulate finished lighting conditions for review of mockups.
4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.5 DELIVERY, STORAGE AND HANDLING

A. Store materials inside under cover and keep them dry and protected against weather, condensation, direct sunlight, construction traffic, and other potential causes of damage. Stack panels flat and supported on risers on a flat platform to prevent sagging.

1.6 FIELD CONDITIONS

A. Environmental Limitations: Comply with ASTM C 840 requirements or gypsum board manufacturer's written instructions, whichever are more stringent.

B. Do not install paper-faced gypsum panels until installation areas are enclosed and conditioned.

C. Do not install panels that are wet, moisture damaged, and mold damaged.

1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Fire-Resistance-Rated Assemblies: For fire-resistance-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E 119 by an independent testing agency.

B. STC-Rated Assemblies: For STC-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E 90 and classified according to ASTM E 413 by an independent testing agency.

2.2 GYPSUM BOARD, GENERAL

A. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 50 percent.

B. Regional Materials: Products shall be manufactured within 500 miles (800 km) of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within 500 miles (800 km) of Project site.

C. Size: Provide maximum lengths and widths available that will minimize joints in each area and that correspond with support system indicated.

2.3 INTERIOR GYPSUM BOARD

A. Gypsum Wallboard: ASTM C 1396/C 1396M.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. CertainTeed Corporation.
    b. Continental Building Products, LLC.
    c. Georgia-Pacific Building Products.
    d. National Gypsum Company.
    e. United States Gypsum Company.

2. Thickness: As indicated.
3. Long Edges: Tapered.

B. Gypsum Board, Type X: ASTM C 1396/C 1396M.
1. Thickness: 5/8 inch (15.9 mm).
2. Long Edges: Tapered.

C. Gypsum Ceiling Board: ASTM C 1396/C 1396M.
1. Thickness: 1/2 inch (12.7 mm).
2. Long Edges: Tapered.

D. Impact-Resistant Gypsum Board: ASTM C 1396/C 1396M gypsum board, tested according to ASTM C 1629/C 1629M.
1. Core: 5/8 inch (15.9 mm), Type X.
2. Surface Abrasion: ASTM C 1629/C 1629M, meets or exceeds Level 3 requirements.
3. Indentation: ASTM C 1629/C 1629M, meets or exceeds Level 3 requirements.
4. Soft-Body Impact: ASTM C 1629/C 1629M, meets or exceeds Level 3 requirements.
5. Hard-Body Impact: ASTM C 1629/C 1629M, meets or exceeds Level 3 requirements according to test in Annex A1.
6. Long Edges: Tapered.
7. Mold Resistance: ASTM D 3273, score of 10 as rated according to ASTM D 3274.

E. Mold-Resistant Gypsum Board: ASTM C 1396/C 1396M. With moisture- and mold-resistant core and paper surfaces.
1. Core: 5/8 inch (15.9 mm), Type X.
2. Long Edges: Tapered.
3. Mold Resistance: ASTM D 3273, score of 10 as rated according to ASTM D 3274.

2.4 TILE BACKING PANELS

A. Cementitious Backer Units: ANSI A118.9 and ASTM C 1288 or ASTM C 1325, with manufacturer's standard edges.

1. Products: Subject to compliance with requirements, provide one of the following:

    a. CertainTeed Corporation.
    b. Custom Building Products; Wonderboard.
    c. National Gypsum Company; PermaBase BRAND Cement Board.
    d. United States Gypsum Company; DUROCK Cement Board.

2. Thickness: 5/8 inch (15.9 mm).
3. Mold Resistance: ASTM D 3273, score of 10 as rated according to ASTM D 3274.

2.5 TRIM ACCESSORIES

A. Interior Trim: ASTM C 1047.

1. Material: Galvanized or aluminum-coated steel sheet, rolled zinc, plastic, or paper-faced galvanized-steel sheet.
2. Shapes:

    a. Cornerbead.
    b. Bullnose bead.
    c. LC-Bead: J-shaped; exposed long flange receives joint compound.
    d. L-Bead: L-shaped; exposed long flange receives joint compound.
    e. U-Bead: J-shaped; exposed short flange does not receive joint compound.
    f. Expansion (control) joint.
    g. Curved-Edge Cornerbead: With notched or flexible flanges.

B. Plastic Trim: ASTM C 1047.

1. Material: Plastic.
2. Shapes:

    a. End wall “Fast Cap.” U-shaped; exposed central flange does not receive joint compound. 4-7/8” by Trim-Tex.

C. Aluminum Trim: Extruded accessories of profiles and dimensions indicated.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Fry Reglet Corporation.
    b. Gordon, Inc.
    c. Pittcon Industries.

2. Aluminum: Alloy and temper with not less than the strength and durability properties of ASTM B 221 (ASTM B 221M), Alloy 6063-T5.

D. Aluminum Partition Closure: Extruded aluminum partition closures are pre-assembled and spring loaded to provide a tight fit for vertical junctures of partitions and window walls. Finish to match mullions. Sound tested to a 38 STC rating with acoustical batts for sound attenuation.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Gordon Inc.; Mullion Mate extruded aluminum partition closure.

a. Aluminum extrusions: 6063-T5 temper, tensile strength 31 KSI (ASTM B 221, ASTM B 221 M).
b. Accessories: Acoustical Batts for sound attenuation.
c. General: Provide metals free from surface blemishes where exposed to view in finished unit. Surfaces that exhibit pitting, seam marks, roller marks, stains, and discolorations, or other imperfections on finished units are not acceptable. All metal shall be of the highest-grade commercial type.
d. Size and depth: As indicated on Drawings.

2.6 JOINT TREATMENT MATERIALS

A. General: Comply with ASTM C 475/C 475M.

B. Joint Tape:

1. Interior Gypsum Board: Paper.
2. Tile Backing Panels: As recommended by panel manufacturer.

C. Joint Compound for Interior Gypsum Board: For each coat, use formulation that is compatible with other compounds applied on previous or for successive coats.

1. Prefilling: At open joints, rounded or beveled panel edges, and damaged surface areas, use setting-type taping compound.
2. Embedding and First Coat: For embedding tape and first coat on joints, fasteners, and trim flanges, use drying-type, all-purpose compound.

    a. Use setting-type compound for installing paper-faced metal trim accessories.

3. Fill Coat: For second coat, use drying-type, all-purpose compound.
4. Finish Coat: For third coat, use drying-type, all-purpose compound.
5. Skim Coat: For final coat of Level 5 finish, use drying-type, all-purpose compound or high-build interior coating product designed for application by airless sprayer and to be used instead of skim coat to produce Level 5 finish.

D. Joint Compound for Tile Backing Panels:
1. Cementitious Backer Units: As recommended by backer unit manufacturer.

2.7 AUXILIARY MATERIALS

A. General: Provide auxiliary materials that comply with referenced installation standards and manufacturer's written instructions.

B. Laminating Adhesive: Adhesive or joint compound recommended for directly adhering gypsum panels to continuous substrate.

1. Adhesives shall have a VOC content of 50 g/L or less.

C. Steel Drill Screws: ASTM C 1002 unless otherwise indicated.

1. Use screws complying with ASTM C 954 for fastening panels to steel members from 0.033 to 0.112 inch (0.84 to 2.84 mm) thick.

2. For fastening cementitious backer units, use screws of type and size recommended by panel manufacturer.

D. Sound-Attenuation Blankets: ASTM C 665, Type I (blankets without membrane facing) produced by combining thermosetting resins with mineral fibers manufactured from glass, slag wool, or rock wool.

1. Fire-Resistance-Rated Assemblies: Comply with mineral-fiber requirements of assembly.
2. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 50 percent.

E. Acoustical Sealant: Manufacturer's standard nonsag, paintable, nonstaining latex sealant complying with ASTM C 834. Product effectively reduces airborne sound transmission through perimeter joints and openings in building construction as demonstrated by testing representative assemblies according to ASTM E 90.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Pecora Corporation; AC-20 FTR.
b. Specified Technologies, Inc.; Smoke N Sound Acoustical Sealant.
c. United States Gypsum Company; SHEETROCK Acoustical Sealant.

2. Sealant shall have a VOC content of 250 g/L or less.

F. Thermal Insulation: As specified in Section 072100 "Thermal Insulation."

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and substrates including welded hollow-metal frames and support framing, with Installer present, for compliance with requirements and other conditions affecting performance of the Work.

B. Examine panels before installation. Reject panels that are wet, moisture damaged, and mold damaged.

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

3.2 APPLYING AND FINISHING PANELS, GENERAL

A. Comply with ASTM C 840.

B. Install ceiling panels across framing to minimize the number of abutting end joints and to avoid abutting end joints in central area of each ceiling. Stagger abutting end joints of adjacent panels not less than one framing member.

C. Install panels with face side out. Butt panels together for a light contact at edges and ends with not more than 1/16 inch (1.5 mm) of open space between panels. Do not force into place.

D. Locate edge and end joints over supports, except in ceiling applications where intermediate supports or gypsum board back-blocking is provided behind end joints. Do not place tapered edges against cut edges or ends. Stagger vertical joints on opposite sides of partitions. Do not make joints other than control joints at corners of framed openings.

E. Form control and expansion joints with space between edges of adjoining gypsum panels.

F. Cover both faces of support framing with gypsum panels in concealed spaces (above ceilings, etc.), except in chases braced internally.

1. Unless concealed application is indicated or required for sound, fire, air, or smoke ratings, coverage may be accomplished with scraps of not less than 8 sq. ft. (0.7 sq. m) in area.
2. Fit gypsum panels around ducts, pipes, and conduits.
3. Where partitions intersect structural members projecting below underside of floor/roof slabs and decks, cut gypsum panels to fit profile formed by structural members; allow 1/4- to 3/8-inch- (6.4- to 9.5-mm-) wide joints to install sealant.

G. Isolate perimeter of gypsum board applied to non-load-bearing partitions at structural abutments. Provide 1/4- to 1/2-inch- (6.4- to 12.7-mm-) wide spaces at these locations and trim edges with edge trim where edges of panels are exposed. Seal joints between edges and abutting structural surfaces with acoustical sealant.

H. Attachment to Steel Framing: Attach panels so leading edge or end of each panel is attached to open (unsupported) edges of stud flanges first.

I. STC-Rated Assemblies: Seal construction at perimeters, behind control joints, and at openings and penetrations with a continuous bead of acoustical sealant. Install acoustical sealant at both faces of partitions at perimeters and through penetrations. Comply with ASTM C 919 and with manufacturer's written instructions for locating edge trim and closing off sound-flanking paths around or through assemblies, including sealing partitions above acoustical ceilings.

J. Install sound attenuation blankets before installing gypsum panels unless blankets are readily installed after panels have been installed on one side.

3.3 APPLYING INTERIOR GYPSUM BOARD

A. Install interior gypsum board in the following locations:

1. Wallboard Type: As indicated on Drawings.
2. Type X: As indicated on Drawings or where required for fire-resistance-rated assembly.
3. Ceiling Type: As indicated on Drawings.
4. Impact-Resistant Type: As indicated on Drawings.
5. Mold-Resistant Type: As indicated on Drawings.
6. Type C: As indicated on Drawings or where required for specific fire-resistance-rated assembly indicated.

B. Single-Layer Application:

1. On ceilings, apply gypsum panels before wall/partition board application to greatest extent possible and at right angles to framing unless otherwise indicated.
2. On partitions/walls, apply gypsum panels vertically (parallel to framing) unless otherwise indicated or required by fire-resistance-rated assembly, and minimize end joints.

a. Stagger abutting end joints not less than one framing member in alternate courses of panels.
b. At stairwells and other high walls, install panels horizontally unless otherwise indicated or required by fire-resistance-rated assembly.

3. On Z-shaped furring members, apply gypsum panels vertically (parallel to framing) with no end joints. Locate edge joints over furring members.
4. Fastening Methods: Apply gypsum panels to supports with steel drill screws.

C. Multilayer Application:

1. On ceilings, apply gypsum board indicated for base layers before applying base layers on walls/partitions; apply face layers in same sequence. Apply base layers at right angles to framing members and offset face-layer joints one framing member, 16 inches (400 mm) minimum, from parallel base-layer joints, unless otherwise indicated or required by fire-resistance-rated assembly.
2. On partitions/walls, apply gypsum board indicated for base layers and face layers vertically (parallel to framing) with joints of base layers located over stud or furring member and face-layer joints offset at least one stud or furring member with base-layer joints unless otherwise indicated or required by fire-resistance-rated assembly. Stagger joints on opposite sides of partitions.
3. On Z-shaped furring members, apply base layer vertically (parallel to framing) and face layer either vertically (parallel to framing) or horizontally (perpendicular to framing) with vertical joints offset at least one furring member. Locate edge joints of base layer over furring members.
4. Fastening Methods: Fasten base layers and face layers separately to supports with screws.

D. Laminating to Substrate: Where gypsum panels are indicated as directly adhered to a substrate (other than studs, joists, furring members, or base layer of gypsum board), comply with gypsum board manufacturer's written instructions and temporarily brace or fasten gypsum panels until fastening adhesive has set.

3.4 APPLYING TILE BACKING PANELS

A. Cementitious Backer Units: ANSI A108.11, at locations indicated to receive tile.

B. Where tile backing panels abut other types of panels in same plane, shim surfaces to produce a uniform plane across panel surfaces.

3.5 INSTALLING TRIM ACCESSORIES

A. General: For trim with back flanges intended for fasteners, attach to framing with same fasteners used for panels. Otherwise, attach trim according to manufacturer's written instructions.

B. Control Joints: Install control joints at locations indicated on Drawings and according to ASTM C 840 and in specific locations approved by Architect for visual effect.

C. Interior Trim: Install in the following locations:

1. Cornerbead: Use at outside corners unless otherwise indicated.

2. Bullnose Bead: Use where indicated.
3. LC-Bead: Use at exposed panel edges.
4. L-Bead: Use where indicated.
5. U-Bead: Use where indicated.

D. Aluminum Trim: Install in locations indicated on Drawings.

3.6 FINISHING GYPSUM BOARD

A. General: Treat gypsum board joints, interior angles, edge trim, control joints, penetrations, fastener heads, surface defects, and elsewhere as required to prepare gypsum board surfaces for decoration. Promptly remove residual joint compound from adjacent surfaces.

B. Prefill open joints, rounded or beveled edges, and damaged surface areas.

C. Apply joint tape over gypsum board joints, except for trim products specifically indicated as not intended to receive tape.

D. Gypsum Board Finish Levels: Finish panels to levels indicated below and according to ASTM C 840:

1. Level 1: Ceiling plenum areas, concealed areas, and where indicated.
2. Level 2: Panels that are substrate for tile.
3. Level 3: Where indicated on Drawings.
4. Level 4: At panel surfaces that will be exposed to view unless otherwise indicated.

    a. Primer and its application to surfaces are specified in Section 099123 "Interior Painting."

5. Level 5: Where a non-flat paint is indicated on Drawings or in areas of critical lighting conditions. Areas requiring high level of finish must have a pre-installation meeting to assure Contractor understands contract requirements/expectations.

    a. Primer and its application to surfaces are specified in Section 099123 "Interior Painting."

E. Cementitious Backer Units: Finish according to manufacturer's written instructions.

3.7 PROTECTION

A. Protect adjacent surfaces from drywall compound and promptly remove from floors and other non-drywall surfaces. Repair surfaces stained, marred, or otherwise damaged during drywall application.

B. Protect installed products from damage from weather, condensation, direct sunlight, construction, and other causes during remainder of the construction period.

C. Remove and replace panels that are wet, moisture damaged, and mold damaged.

1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.

2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

END OF SECTION 092900

SECTION 093013 - CERAMIC TILING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Porcelain tile.
2. Wall tile.
3. Tile backing panels.
4. Waterproof membrane for thinset applications.
5. Crack isolation membrane.

B. Related Requirements:

1. Section 079200 "Joint Sealants" for sealing of expansion, contraction, control, and isolation joints in tile surfaces.

1.3 DEFINITIONS

A. General: Definitions in the ANSI A108 series of tile installation standards and in ANSI A137.1 apply to Work of this Section unless otherwise specified.

B. ANSI A108 Series: ANSI A108.01, ANSI A108.02, ANSI A108.1A, ANSI A108.1B, ANSI A108.1C, ANSI A108.4, ANSI A108.5, ANSI A108.6, ANSI A108.8, ANSI A108.9, ANSI A108.10, ANSI A108.11, ANSI A108.12, ANSI A108.13, ANSI A108.14, ANSI A108.15, ANSI A108.16, and ANSI A108.17, which are contained in its "Specifications for Installation of Ceramic Tile."

C. Module Size: Actual tile size plus joint width indicated.

D. Face Size: Actual tile size, excluding spacer lugs.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1. Review requirements in ANSI A108.01 for substrates and for preparation by other trades.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Sustainable Design Submittals:

1. Product Data: For adhesives, indicating VOC content.

C. Shop Drawings: Show locations of each type of tile and tile pattern. Show widths, details, and locations of expansion, contraction, control, and isolation joints in tile substrates and finished tile surfaces.

D. Samples for Initial Selection: For tile, grout, and accessories involving color selection.

E. Samples for Verification:

1. Full-size units of each type and composition of tile and for each color and finish required.
2. Full-size units of each type of trim and accessory for each color and finish required.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Master Grade Certificates: For each shipment, type, and composition of tile, signed by tile manufacturer and Installer.

C. Product Certificates: For each type of product.

D. Product Test Reports: For tile-setting and -grouting products and certified porcelain tile.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match and are from same production runs as products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Tile and Trim Units: Furnish quantity of full-size units equal to 3 percent of amount installed for each type, composition, color, pattern, and size indicated.

2. Grout: Furnish quantity of grout equal to 3 percent of amount installed for each type, composition, and color indicated.

1.8 QUALITY ASSURANCE

A. Installer Qualifications:

1. Installer is a five-star member of the National Tile Contractors Association or a Trowel of Excellence member of the Tile Contractors' Association of America.
2. Installer's supervisor for Project holds the International Masonry Institute's Foreman Certification.

3. Installer employs Ceramic Tile Education Foundation Certified Installers or installers recognized by the U.S. Department of Labor as Journeyman Tile Layers.

B. Mockups: Build mockups to verify selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.

1. Build mockup of each type of floor tile installation.
2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Deliver and store packaged materials in original containers with seals unbroken and labels intact until time of use. Comply with requirements in ANSI A137.1 for labeling tile packages.

B. Store tile and cementitious materials on elevated platforms, under cover, and in a dry location.

C. Store aggregates where grading and other required characteristics can be maintained and contamination can be avoided.

D. Store liquid materials in unopened containers and protected from freezing.

1.10 FIELD CONDITIONS

A. Environmental Limitations: Do not install tile until construction in spaces is complete and ambient temperature and humidity conditions are maintained at the levels indicated in referenced standards and manufacturer's written instructions.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Source Limitations for Tile: Obtain tile of each type and color or finish from single source or producer.

1. Obtain tile of each type and color or finish from same production run and of consistent quality in appearance and physical properties for each contiguous area.

B. Source Limitations for Setting and Grouting Materials: Obtain ingredients of a uniform quality for each mortar, adhesive, and grout component from single manufacturer and each aggregate from single source or producer.

1. Obtain setting and grouting materials, except for unmodified Portland cement and aggregate, from single manufacturer.
2. Obtain waterproof membrane and crack isolation membrane, except for sheet products, from manufacturer of setting and grouting materials.

C. Source Limitations for Other Products: Obtain each of the following products specified in this Section from a single manufacturer:

1. Stone thresholds.
2. Waterproof membrane.
3. Crack isolation membrane.
4. Cementitious backer units.
5. Metal edge strips.

2.2 PRODUCTS, GENERAL

A. ANSI Ceramic Tile Standard: Provide tile that complies with ANSI A137.1 for types, compositions, and other characteristics indicated.

1. Provide tile complying with Standard grade requirements unless otherwise indicated.

B. ANSI Standards for Tile Installation Materials: Provide materials complying with ANSI A108.02, ANSI standards referenced in other Part 2 articles, ANSI standards referenced by TCNA installation methods specified in tile installation schedules, and other requirements specified.

C. Factory Blending: For tile exhibiting color variations within ranges, blend tile in factory and package so tile units taken from one package show same range in colors as those taken from other packages and match approved Samples.

2.3 TILE PRODUCTS

A. Ceramic Tile Type: Unglazed porcelain tile.

1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings. No Substitutions.
2. Certification: Tile certified by the Porcelain Tile Certification Agency.
3. Face Size: As indicated on Drawings.
4. Thickness: As indicated on Drawings.
5. Dynamic Coefficient of Friction: Not less than 0.42.
6. Tile Color, Glaze, and Pattern: As indicated on Drawings.
7. Grout Color: As indicated on Drawings.
8. Trim Units: Coordinated with sizes and coursing of adjoining flat tile where applicable and matching characteristics of adjoining flat tile. Provide shapes as follows, selected from manufacturer's standard shapes:

    a. Base Cap: Surface bullnose, module size same as adjoining flat tile.
    b. External Corners: Surface bullnose, module size same as adjoining flat tile.
    c. Internal Corners: Field-butted square corners.
    d. Tapered Transition Tile: Shape designed to effect transition between thickness of tile floor and adjoining floor finishes of different thickness, tapered to provide reduction in thickness from 1/2 to 1/4 inch (12.7 to 6.4 mm) across nominal 4-inch (100-mm) dimension.

B. Ceramic Tile Type: Wall tile.

1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings. No Substitutions.
2. Module Size: As indicated on Drawings.
3. Thickness: As indicated on Drawings.
4. Finish: As indicated on Drawings.

5. Tile Color and Pattern: As indicated on Drawings.
6. Grout Color: As indicated on Drawings.
7. Trim Units: Coordinated with sizes and coursing of adjoining flat tile where applicable and matching characteristics of adjoining flat tile. Provide shapes as follows, selected from manufacturer's standard shapes:
    a. Base for Thinset Mortar Installations: As indicated on Drawings.
    b. External Corners for Thinset Mortar Installations: Surface bullnose, same size as adjoining flat tile.
    c. Internal Corners: Field-butted square corners. For coved base and cap use angle pieces designed to fit with stretcher shapes.

2.4 THRESHOLDS

A. General: Fabricate to sizes and profiles indicated or required to provide transition between adjacent floor finishes.

1. Bevel edges at 1:2 slope, with lower edge of bevel aligned with or up to 1/16 inch (1.5 mm) above adjacent floor surface. Finish bevel to match top surface of threshold. Limit height of threshold to 1/2 inch (12.7 mm) or less above adjacent floor surface.

2.5 TILE BACKING PANELS

A. Cementitious Backer Units: ANSI A118.9 or ASTM C 1325, Type A, in maximum lengths available to minimize end-to-end butt joints.

1. Products: Subject to compliance with requirements, provide one of the following:

    a. Custom Building Products; Wonderboard.
    b. Georgia-Pacific Building Products.
    c. United States Gypsum Company; DUROCK Cement Board.

2. Thickness: As indicated on Drawings.

2.6 WATERPROOF AND CRACK-SUPPRESSION MEMBRANES FOR THIN-SET TILE

A. General: Manufacturer's standard product, selected from the following, that complies with ANSI A118.10 and is recommended by the manufacturer for the application indicated. Include reinforcement and accessories recommended by manufacturer.

B. Fabric-Reinforced, Fluid-Applied Membrane: System consisting of liquid-latex rubber or elastomeric polymer and continuous fabric reinforcement.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Custom Building Products; Trowel & Seal Waterproofing and Anti-Fracture Membrane.
    b. LATICRETE International Inc.; Laticrete 9235 Waterproof Membrane.
    c. MAPEI Corporation; PRP M19.
    d. Summitville Tiles, Inc.; S-9000.

2.7 SHOWER PAN LINER

A. Flexible pan liner for use in tile shower.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Oatey; CPE Shower Pan Liner or approved equal.

    a. Meets ASTM D 4068.
    b. 40 mil thickness. Color: Black.
    c. Provide all necessary accessories for a complete and waterproof installation including bonding adhesives and dam corners.
    d. Provide Oatey Perfect Slope White Styrene Shower Kit for use under liner.

2.8 SETTING MATERIALS

A. Modified Dry-Set Mortar (Thinset): ANSI A118.4.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Bonsal American, an Oldcastle company.
    b. Bostik, Inc.
    c. Custom Building Products.
    d. H.B. Fuller Construction Products Inc. / TEC.
    e. LATICRETE SUPERCAP, LLC.
    f. MAPEI Corporation.
    g. Southern Grouts & Mortars, Inc.
    h. Summitville Tiles, Inc.

2. Provide prepackaged, dry-mortar mix containing dry, redispersible, vinyl acetate or acrylic additive to which only water must be added at Project site.
3. For wall applications, provide mortar that complies with requirements for nonsagging mortar in addition to the other requirements in ANSI A118.4.
4. Basis-of-Design Product for use at large format tiles: Custom Building Products; MegaLite Ultimate Rapid Setting Crack Prevention Large Format Tile Mortar or comparable product by another approved manufacturer.

2.9 GROUT MATERIALS

A. Sand-Portland Cement Grout: ANSI A108.10, consisting of white or gray cement and white or colored aggregate as required to produce color indicated.

B. Standard Cement Grout: ANSI A118.6.

1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or approved equal.

C. Stain Resistant Grout Additive:

1. Latex Additive: Manufacturer's standard acrylic resin or styrene-butadiene-rubber water emulsion, serving as replacement for part or all of gaging water, of type specifically

recommended by latex-additive manufacturer for use with field-mixed portland cement and aggregate mortar bed.

a. Grout Boost by H.B. Fuller Construction Products Inc.

2.10 MISCELLANEOUS MATERIALS

A. Trowelable Underlayments and Patching Compounds: Latex-modified, portland cement-based formulation provided or approved by manufacturer of tile-setting materials for installations indicated.

B. Metal Edge Strips: Angle or L-shaped, height to match tile and setting-bed thickness, metallic or combination of metal and PVC or neoprene base, designed specifically for flooring applications; stainless-steel, ASTM A 666, 300 Series exposed-edge material.

C. Tile Cleaner: A neutral cleaner capable of removing soil and residue without harming tile and grout surfaces, specifically approved for materials and installations indicated by tile and grout manufacturers.

2.11 MIXING MORTARS AND GROUT

A. Mix mortars and grouts to comply with referenced standards and mortar and grout manufacturers' written instructions.

B. Add materials, water, and additives in accurate proportions.

C. Obtain and use type of mixing equipment, mixer speeds, mixing containers, mixing time, and other procedures to produce mortars and grouts of uniform quality with optimum performance characteristics for installations indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions where tile will be installed, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

1. Verify that substrates for setting tile are firm; dry; clean; free of coatings that are incompatible with tile-setting materials, including curing compounds and other substances that contain soap, wax, oil, or silicone; and comply with flatness tolerances required by ANSI A108.01 for installations indicated.
2. Verify that concrete substrates for tile floors installed with thinset mortar comply with surface finish requirements in ANSI A108.01 for installations indicated.

    a. Verify that surfaces that received a steel trowel finish have been mechanically scarified.
    b. Verify that protrusions, bumps, and ridges have been removed by sanding or grinding.

c. In areas of thinset large format tiles: maximum allowable variation in the tile substrate is 1/8” in 10’ from the required plane, with no more than 1/16” variation in 24” when measured from the high points in the surface.

3. Verify that installation of grounds, anchors, recessed frames, electrical and mechanical units of work, and similar items located in or behind tile has been completed.
4. Verify that joints and cracks in tile substrates are coordinated with tile joint locations; if not coordinated, adjust joint locations in consultation with Architect.

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

3.2 PREPARATION

A. Fill cracks, holes, and depressions in concrete substrates for tile floors installed with thinset mortar with trowelable leveling and patching compound specifically recommended by tile-setting material manufacturer.

B. Where indicated, prepare substrates to receive waterproofing by applying a reinforced mortar bed that complies with ANSI A108.1A and is sloped 1/4 inch per foot (1:50) toward drains.

C. Blending: For tile exhibiting color variations, verify that tile has been factory blended and packaged so tile units taken from one package show same range of colors as those taken from other packages and match approved Samples. If not factory blended, either return to manufacturer or blend tiles at Project site before installing.

3.3 CERAMIC TILE INSTALLATION

A. Comply with TCNA's "Handbook for Ceramic, Glass, and Stone Tile Installation" for TCNA installation methods specified in tile installation schedules. Comply with parts of the ANSI A108 series "Specifications for Installation of Ceramic Tile" that are referenced in TCNA installation methods, specified in tile installation schedules, and apply to types of setting and grouting materials used.

1. For the following installations, follow procedures in the ANSI A108 series of tile installation standards for providing 95 percent mortar coverage:

a. Tile floors consisting of tiles 8 by 8 inches (200 by 200 mm) or larger.

B. Extend tile work into recesses and under or behind equipment and fixtures to form complete covering without interruptions unless otherwise indicated. Terminate work neatly at obstructions, edges, and corners without disrupting pattern or joint alignments.

C. Accurately form intersections and returns. Perform cutting and drilling of tile without marring visible surfaces. Carefully grind cut edges of tile abutting trim, finish, or built-in items for straight aligned joints. Fit tile closely to electrical outlets, piping, fixtures, and other penetrations so plates, collars, or covers overlap tile.

D. Provide manufacturer's standard trim shapes where necessary to eliminate exposed tile edges.

E. Where accent tile differs in thickness from field tile, vary setting-bed thickness so that tiles are flush.

F. Jointing Pattern: Lay tile in grid pattern unless otherwise indicated. Lay out tile work and center tile fields in both directions in each space or on each wall area. Lay out tile work to minimize the use of pieces that are less than half of a tile. Provide uniform joint widths unless otherwise indicated.

1. For tile mounted in sheets, make joints between tile sheets same width as joints within tile sheets so joints between sheets are not apparent in finished work.
2. Where adjoining tiles on floor, base, walls, or trim are specified or indicated to be same size, align joints.
3. Where tiles are specified or indicated to be whole integer multiples of adjoining tiles on floor, base, walls, or trim, align joints unless otherwise indicated.

G. Joint Widths: Unless otherwise indicated, install tile with the following joint widths:
1. Porcelain Tile: 1/8 inch.

H. Lay out tile wainscots to dimensions indicated or to next full tile beyond dimensions indicated.

I. Expansion Joints: Provide expansion joints and other sealant-filled joints, including control, contraction, and isolation joints, where indicated. Form joints during installation of setting materials, mortar beds, and tile. Do not saw-cut joints after installing tiles.

1. Where joints occur in concrete substrates, locate joints in tile surfaces directly above them.

J. Metal Edge Strips: Install at locations indicated.

3.4 TILE BACKING PANEL INSTALLATION

A. Install panels and treat joints according to ANSI A108.11 and manufacturer's written instructions for type of application indicated. Use modified dry-set mortar for bonding material unless otherwise directed in manufacturer's written instructions.

3.5 WATERPROOFING INSTALLATION

A. Install waterproofing to comply with ANSI A108.13 and manufacturer's written instructions to produce waterproof membrane of uniform thickness that is bonded securely to substrate.

B. Allow waterproofing to cure and verify by testing that it is watertight before installing tile or setting materials over it.

3.6 CRACK ISOLATION MEMBRANE INSTALLATION

A. Install crack isolation membrane to comply with ANSI A108.17 and manufacturer's written instructions to produce membrane of uniform thickness that is bonded securely to substrate.

B. Allow crack isolation membrane to cure before installing tile or setting materials over it.

3.7 SHOWER PAN LINER INSTALLATION

A. Install shower pan liner to comply with manufacturer's written instructions.

3.8 ADJUSTING AND CLEANING

A. Remove and replace tile that is damaged or that does not match adjoining tile. Provide new matching units, installed as specified and in a manner to eliminate evidence of replacement.

B. Cleaning: On completion of placement and grouting, clean all ceramic tile surfaces so they are free of foreign matter.

1. Remove grout residue from tile as soon as possible.
2. Clean grout smears and haze from tile according to tile and grout manufacturer's written instructions but no sooner than 10 days after installation. Use only cleaners recommended by tile and grout manufacturers and only after determining that cleaners are safe to use by testing on samples of tile and other surfaces to be cleaned. Protect metal surfaces and plumbing fixtures from effects of cleaning. Flush surfaces with clean water before and after cleaning.

3.9 PROTECTION

A. Protect installed tile work with kraft paper or other heavy covering during construction period to prevent staining, damage, and wear. If recommended by tile manufacturer, apply coat of neutral protective cleaner to completed tile walls and floors.

B. Prohibit foot and wheel traffic from tiled floors for at least seven days after grouting is completed.

C. Before final inspection, remove protective coverings and rinse neutral protective cleaner from tile surfaces.

END OF SECTION 093013

SECTION 095113 - ACOUSTICAL PANEL CEILINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes acoustical and metal panels and exposed suspension systems for interior ceilings.

B. Products furnished, but not installed under this Section, include anchors, clips, and other ceiling attachment devices to be cast in concrete.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.

C. Samples for Initial Selection: For components with factory-applied finishes.

D. Samples for Verification: For each component indicated and for each exposed finish required, prepared on Samples of sizes indicated below:

1. Acoustical and Metal Panels: Set of 6-inch- (150-mm-) square Samples of each type, color, pattern, and texture.
2. Exposed Suspension-System Members, Moldings, and Trim: Set of 6-inch- (150-mm-) long Samples of each type, finish, and color.
3. Clips: Full-size hold-down, impact and seismic clips.

E. Delegated-Design Submittal: For seismic restraints for ceiling systems.

1. Include design calculations for seismic restraints including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.5 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-system members.
2. Structural members to which suspension systems will be attached.
3. Method of attaching hangers to building structure.

    a. Furnish layouts for cast-in-place anchors, clips, and other ceiling attachment devices whose installation is specified in other Sections.

4. Carrying channels or other supplemental support for hanger-wire attachment where conditions do not permit installation of hanger wires at required spacing.
5. Size and location of initial access modules for acoustical panels.
6. Items penetrating finished ceiling and ceiling-mounted items including the following:

    a. Lighting fixtures.
    b. Diffusers.
    c. Grilles.
    d. Speakers.
    e. Sprinklers.
    f. Access panels.
    g. Perimeter moldings.

7. Show operation of hinged and sliding components covered by or adjacent to acoustical panels.
8. Minimum Drawing Scale: 1/8 inch = 1 foot (1:96).

B. Qualification Data: For testing agency.

C. Product Test Reports: For each acoustical and metal panel ceiling, for tests performed by a qualified testing agency.

D. Evaluation Reports: For each acoustical and metal panel ceiling suspension system and anchor and fastener type, from ICC-ES.

E. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: For finishes to include in maintenance manuals.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials, from the same product run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Acoustical and Metal Ceiling Units: Full-size panels equal to 2 percent of quantity installed.
2. Suspension-System Components: Quantity of each exposed component equal to 2 percent of quantity installed.

3. Hold-Down Clips: Equal to 2 percent of quantity installed.
4. Impact Clips: Equal to 2 percent of quantity installed.

1.8 QUALITY ASSURANCE

A. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.

1. Build mockup of typical ceiling area as shown on Drawings.
2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Deliver panels, suspension-system components, and accessories to Project site and store them in a fully enclosed, conditioned space where they will be protected against damage from moisture, humidity, temperature extremes, direct sunlight, surface contamination, and other causes.

B. Before installing panels, permit them to reach room temperature and a stabilized moisture content.

1.10 FIELD CONDITIONS

A. Environmental Limitations: Do not install panel ceilings until spaces are enclosed and weathertight, wet-work in spaces is complete and dry, work above ceilings is complete, and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.

1. Pressurized Plenums: Operate ventilation system for not less than 48 hours before beginning panel ceiling installation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Source Limitations: Obtain each type of ceiling panel and its supporting suspension system from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design seismic restraints for ceiling systems.

B. Seismic Performance: Suspended ceilings shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

C. Surface-Burning Characteristics: Comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Flame-Spread Index: Class A according to ASTM E 1264.
2. Smoke-Developed Index: 50 or less.

D. Fire-Resistance Ratings: Comply with ASTM E 119; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Indicate design designations from UL or from the listings of another qualified testing agency.

2.3 ACOUSTICAL PANELS

A. Basis-of-Design Product: Subject to compliance with requirements, provide products indicated on Drawings. No Substitutions.

B. Acoustical Panel Standard: Provide manufacturer's standard panels according to ASTM E 1264 and designated by type, form, pattern, acoustical rating, and light reflectance unless otherwise indicated.

C. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 40 percent.

D. Classification: Provide panels as follows:

1. Type and Form: As indicated on Drawings.
2. Pattern: As indicated on Drawings.

E. Color: As indicated on Drawings.

F. Light Reflectance (LR): As indicated on Drawings.

G. Ceiling Attenuation Class (CAC): As indicated on Drawings.

H. Noise Reduction Coefficient (NRC): As indicated on Drawings.

I. Edge/Joint Detail: As indicated on Drawings.

J. Thickness: As indicated on Drawings.

K. Modular Size: As indicated on Drawings.

L. Antimicrobial Treatment: Manufacturer's standard broad spectrum, antimicrobial formulation that inhibits fungus, mold, mildew, and gram-positive and gram-negative bacteria and showing no mold, mildew, or bacterial growth when tested according to ASTM D 3273, ASTM D 3274, or ASTM G 21 and evaluated according to ASTM D 3274 or ASTM G 21.

2.4 METAL PANELS

A. Basis-of-Design Product: Subject to compliance with requirements, provide products indicated on Drawings. No Substitutions.

B. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.

C. Classification: Provide panels as follows:

1. Type and Form: Type XX.
2. Pattern: G (smooth). Unperforated.

D. Color: White.

E. Light Reflectance (LR): As indicated on Drawings.

F. Edge/Joint Detail: Square.

G. Thickness: As indicated on Drawings.

H. Modular Size: As indicated on Drawings.

2.5 METAL SUSPENSION SYSTEM

A. Metal Suspension-System Standard: Provide manufacturer's standard, direct-hung, metal suspension system and accessories according to ASTM C 635/C 635M and designated by type, structural classification, and finish indicated.

1. High-Humidity Finish: Where indicated, provide coating tested and classified for "severe environment performance" according to ASTM C 635/C 635M.

B. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 20 percent.

C. Wide-Face, Capped, Double-Web, Steel Suspension System: Main and cross runners roll formed from cold-rolled steel sheet; prepainted, electrolytically zinc coated, or hot-dip galvanized, G30 (Z90) coating designation; with prefinished 15/16-inch- (24-mm-) wide metal caps on flanges.

1. Structural Classification: Intermediate-duty system.
2. End Condition of Cross Runners: Override (stepped) or butt-edge type.
3. Face Design: Flat, flush.
4. Cap Material: Cold-rolled steel.
5. Cap Finish: Painted white.

2.6 FIBERGLASS CEILING SUSPENSION SYSTEM

A. Basis-of-Design Product: Subject to compliance with requirements, provide Life Science Products, Inc.; Gridlock Fiberglass and Polymer Ceiling Suspension System “SA” with Standard Finish Polymer Core 2 Panels. No Substitutions.

B. All suspension grid components shall be of pultruded PVC fiberglass construction with UL # 723 Flame Spread Rate of less than 25, Smoke development of 425, USDA accepted.

C. The grid deflection shall not exceed 1/360 with a 6 pound per foot loading in a 4 foot span. DO NOT support weight of lights, diffusers or equipment with grid. Equipment must have independent support.

D. Assembly clips shall be manufactured from Grade 1, Type 2 virgin PVC must comply with UL 94 V-0 and be USDA accepted.

E. The grid system shall receive self adhesive EDPM D-profile gaskets made of 100% cellular rubber prior to installation of panels. The EDPM gasket material must remain flexible at - 40° F. The perimeter of the panels shall rest evenly on the gasket so the gasket can serve as the seal.

F. Ceiling Panels shall be 7.5 mm in overall thickness with fiberglass reinforcement on both the top and bottom sides. Finish shall be Class 1 Fire Rated halogenated polyester resin and gel coat. Panels shall be square edge construction with polymer core insensitive to moisture. The panels shall have the following properties:

1. Fire rating Class 1 ASTM E84
2. Light reflectance coefficient LR-1, 0.75 or greater
3. Minimum weight of 2.0 lb. per square foot
4. Standard finish

G. The panel finish face shall possess the following characteristics:

1. Impact Resistance (kj/m2): 64
2. Reinforcement (gm/m sq.): 500 W.R. + 450 + 30 tissue
3. Total Weight (lbs/ft sq.): 2.0
4. Proportion of reinforcement (% by weight): 34
5. Tensile Strength (MPa): 120
6. Compressive Strength (MPa): 220
7. Flexural Strength (MPa): 170
8. Interlaminar Shear (MPa): 22
9. Youngs Modulus (E GPa): 9.0
10. Thermal Conductivity (W/mK): 0.16 at 20 degrees C.
11. Thermal Transmittance (W/m2K): 5.7 at 20 degrees C.
12. Coefficient of linear expansion: 22-40 x 10 -6/K at 20 degrees C.
13. Operating Temperature: - 40 C. to + 50 C.

H. Ceiling panels shall be locked and held in place by Grid-Lock clips which shall be of resinous composition and require no tools for access from below. The remaining panels shall be locked in place using removable PVC clips applied to the grid from above.

2.7 ACCESSORIES

A. Attachment Devices: Size for five times the design load indicated in ASTM C 635/C 635M, Table 1, "Direct Hung," unless otherwise indicated. Comply with seismic design requirements.

1. Anchors in Concrete: Anchors of type and material indicated below, with holes or loops for attaching hangers of type indicated and with capability to sustain, without failure, a load equal to five times that imposed by ceiling construction, as determined by testing

according to ASTM E 488/E 488M or ASTM E 1512 as applicable, conducted by a qualified testing and inspecting agency.

a. Type: Cast-in-place anchors.
b. Corrosion Protection: Carbon-steel components zinc plated according to ASTM B 633, Class SC 1 (mild) service condition.

B. Wire Hangers, Braces, and Ties: Provide wires as follows:

1. Zinc-Coated, Carbon-Steel Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper.
2. Stainless-Steel Wire: ASTM A 580/A 580M, Type 304, nonmagnetic.
3.
4. Size: Wire diameter sufficient for its stress at three times hanger design load (ASTM C 635/C 635M, Table 1, "Direct Hung") will be less than yield stress of wire, but not less than 0.106-inch- (2.69-mm-) diameter wire.

C. Hanger Rods: Mild steel, zinc coated or protected with rust-inhibitive paint.

D. Flat Hangers: Mild steel, zinc coated or protected with rust-inhibitive paint.

E. Angle Hangers: Angles with legs not less than 7/8 inch (22 mm) wide; formed with 0.04-inch- (1-mm-) thick, galvanized-steel sheet complying with ASTM A 653/A 653M, G90 (Z275) coating designation; with bolted connections and 5/16-inch- (8-mm-) diameter bolts.

F. Hold-Down Clips: Manufacturer's standard hold-down.

G. Impact Clips: Manufacturer's standard impact-clip system designed to absorb impact forces against panels.

H. Seismic Clips: Manufacturer's standard seismic clips designed to secure panels in place during a seismic event.

I. Seismic Stabilizer Bars: Manufacturer's standard perimeter stabilizers designed to accommodate seismic forces.

J. Seismic Struts: Manufacturer's standard compression struts designed to accommodate seismic forces.

2.8 METAL EDGE MOLDINGS AND TRIM

A. Roll-Formed, Sheet-Metal Edge Moldings and Trim: Type and profile indicated or, if not indicated, manufacturer's standard moldings for edges and penetrations that comply with seismic design requirements; formed from sheet metal of same material, finish, and color as that used for exposed flanges of suspension-system runners.

1. Edge moldings shall fit acoustical and metal panel edge details and suspension systems indicated and match width and configuration of exposed runners unless otherwise indicated.
2. For lay-in panels with reveal edge details, provide stepped edge molding that forms reveal of same depth and width as that formed between edge of panel and flange at exposed suspension member.
3. For circular penetrations of ceiling, provide edge moldings fabricated to diameter required to fit penetration exactly.

B. Extruded-Aluminum Edge Moldings and Trim: Where indicated, provide manufacturer's extruded-aluminum edge moldings and trim of profile indicated or referenced by manufacturer's designations, including splice plates, corner pieces, and attachment and other clips, complying with seismic design requirements.
   1. Baked-Enamel or Powder-Coat Finish: Minimum dry film thickness of 1.5 mils (0.04 mm). Comply with ASTM C 635/C 635M and coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, including structural framing to which acoustical and metal panel ceilings attach or abut, with Installer present, for compliance with requirements specified in this and other Sections that affect ceiling installation and anchorage and with requirements for installation tolerances and other conditions affecting performance of acoustical and metal panel ceilings.

B. Examine panels before installation. Reject panels that are wet, moisture damaged, or mold damaged.

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

3.2 PREPARATION

A. Measure each ceiling area and establish layout of panels to balance border widths at opposite edges of each ceiling. Avoid using less-than-half-width panels at borders unless otherwise indicated, and comply with layout shown on reflected ceiling plans.

B. Layout openings for penetrations centered on the penetrating items.

3.3 INSTALLATION

A. Install acoustical and metal panel ceilings according to ASTM C 636/C 636M, seismic design requirements, and manufacturer's written instructions.

B. All work above an area with lay-in ceiling must be coordinated and installed so there is a minimum of 4 inches between the top of the ceiling grid main runners and the bottom of the installation. Installation shall not obstruct equipment access space or equipment removal space. Also conduit and pipe attached to the wall must be above the 4 inch minimum level.

C. Suspend ceiling hangers from building's structural members and as follows:

   1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structure or of ceiling suspension system.
   2. Splay hangers only where required to miss obstructions; offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.
   3. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with location of hangers at spacings required to support standard

suspension-system members, install supplemental suspension members and hangers in form of trapezes or equivalent devices.

4. Secure wire hangers to ceiling-suspension members and to supports above with a minimum of three tight turns. Connect hangers directly to structure or to inserts, eye screws, or other devices that are secure and appropriate for substrate and that will not deteriorate or otherwise fail due to age, corrosion, or elevated temperatures.
5. Secure flat, angle, channel, and rod hangers to structure, including intermediate framing members, by attaching to inserts, eye screws, or other devices that are secure and appropriate for both the structure to which hangers are attached and the type of hanger involved. Install hangers in a manner that will not cause them to deteriorate or fail due to age, corrosion, or elevated temperatures.
6. Do not support ceilings directly from permanent metal forms or floor deck. Fasten hangers to cast-in-place hanger inserts that extend through forms into concrete.
7. When steel framing does not permit installation of hanger wires at spacing required, install carrying channels or other supplemental support for attachment of hanger wires.
8. Do not attach hangers to steel deck tabs.
9. Do not attach hangers to steel roof deck. Attach hangers to structural members.
10. Space hangers not more than 48 inches (1200 mm) o.c. along each member supported directly from hangers unless otherwise indicated; provide hangers not more than 8 inches (200 mm) from ends of each member.
11. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced standards.
12. Light fixtures shall be supported from the building structure and not by the ceiling system.

D. Secure bracing wires to ceiling suspension members and to supports with a minimum of four tight turns. Suspend bracing from building's structural members as required for hangers, without attaching to permanent metal forms, steel deck, or steel deck tabs. Fasten bracing wires into concrete with cast-in-place or postinstalled anchors.

E. Install edge moldings and trim of type indicated at perimeter of ceiling area and where necessary to conceal edges of panels.

1. Apply acoustical sealant in a continuous ribbon concealed on back of vertical legs of moldings before they are installed.
2. Screw attach moldings to substrate at intervals not more than 16 inches (400 mm) o.c. and not more than 3 inches (75 mm) from ends. Miter corners accurately and connect securely.
3. Do not use exposed fasteners, including pop rivets, on moldings and trim.

F. Install suspension-system runners so they are square and securely interlocked with one another. Remove and replace dented, bent, or kinked members.

G. Install panels with undamaged edges and fit accurately into suspension-system runners and edge moldings. Scribe and cut panels at borders and penetrations to provide precise fit.

1. Arrange directionally patterned panels as follows:

   a. As indicated on reflected ceiling plans.

2. For square-edged panels, install panels with edges fully hidden from view by flanges of suspension-system runners and moldings.
3. For reveal-edged panels on suspension-system runners, install panels with bottom of reveal in firm contact with top surface of runner flanges.

4. Paint cut edges of panel remaining exposed after installation; match color of exposed panel surfaces using coating recommended in writing for this purpose by panel manufacturer.
5. Install hold-down impact and seismic clips in areas indicated; space according to panel manufacturer's written instructions unless otherwise indicated.

    a. Hold-Down Clips: Space 24 inches (610 mm) o.c. on all cross runners.

6. Protect lighting fixtures and air ducts according to requirements indicated for fire-resistance-rated assembly.

3.4 ERECTION TOLERANCES

A. Suspended Ceilings: Install main and cross runners level to a tolerance of 1/8 inch in 12 feet (3 mm in 3.6 m), non-cumulative.

B. Moldings and Trim: Install moldings and trim to substrate and level with ceiling suspension system to a tolerance of 1/8 inch in 12 feet (3 mm in 3.6 m), non-cumulative.

3.5 FIELD QUALITY CONTROL

A. Special Inspections: Owner will engage a qualified special inspector to perform the following special inspections:

1. Periodic inspection during the installation of suspended ceiling grids according to ASCE/SEI 7.

B. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

C. Perform the following tests and inspections of completed installations of acoustical and metal panel ceiling hangers and anchors and fasteners in successive stages and when installation of ceiling suspension systems on each floor has reached 20 percent completion, but no panels have been installed. Do not proceed with installations of acoustical and metal panel ceiling hangers for the next area until test results for previously completed installations of acoustical and metal panel ceiling hangers show compliance with requirements.

1. Within each test area, testing agency will select one of every 10 power-actuated fasteners and postinstalled anchors used to attach hangers to concrete and will test them for 200 lbf (890 N) of tension; it will also select one of every two postinstalled anchors used to attach bracing wires to concrete and will test them for 440 lbf (1957 N) of tension.
2. When testing discovers fasteners and anchors that do not comply with requirements, testing agency will test those anchors not previously tested until 20 pass consecutively and then will resume initial testing frequency.

D. Acoustical and metal panel ceiling hangers, anchors, and fasteners will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports.

3.6 CLEANING

A. Clean exposed surfaces of panel ceilings, including trim, edge moldings, and suspension-system members. Comply with manufacturer's written instructions for cleaning and touchup of minor finish damage.

B. Remove and replace ceiling components that cannot be successfully cleaned and repaired to permanently eliminate evidence of damage.

END OF SECTION 095113

SECTION 096513 - RESILIENT BASE AND ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Resilient base.
2. Resilient stair accessories.
3. Resilient molding accessories.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Sustainable Design Submittals:

1. Product Data: For adhesives, indicating VOC content.

C. Samples: For each exposed product and for each color and texture specified, not less than 12 inches (300 mm) long.

D. Product Schedule: For resilient base and accessory products. Use same designations indicated on Drawings.

1.4 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Furnish not less than 10 linear feet (3 linear m)] for every 500 linear feet (150 linear m) or fraction thereof, of each type, color, pattern, and size of resilient product installed.

1.5 QUALITY ASSURANCE

A. Mockups: Build mockups to verify selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.

1. Coordinate mockups in this Section with mockups specified in other Sections.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Store resilient products and installation materials in dry spaces protected from the weather, with ambient temperatures maintained within range recommended by manufacturer, but not less than 50 deg F (10 deg C) or more than 90 deg F (32 deg C).

1.7 FIELD CONDITIONS

A. Maintain ambient temperatures within range recommended by manufacturer, but not less than 70 deg F (21 deg C) or more than 95 deg F (35 deg C), in spaces to receive resilient products during the following time periods:

1. 48 hours before installation.
2. During installation.
3. 48 hours after installation.

B. After installation and until Substantial Completion, maintain ambient temperatures within range recommended by manufacturer, but not less than 55 deg F (13 deg C) or more than 95 deg F (35 deg C).

C. Install resilient products after other finishing operations, including painting, have been completed.

PART 2 - PRODUCTS

2.1 THERMOPLASTIC-RUBBER BASE

A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or approved equal.

B. Product Standard: ASTM F 1861, Type TP (rubber, thermoplastic).

1. Group: I (solid, homogeneous).
2. Style and Location:

a. Style A, Straight: Provide in areas with carpet.
b. Style B, Cove: Provide in areas with resilient flooring.

C. Thickness: 0.125 inch (3.2 mm).

D. Height: As indicated on Drawings.

E. Lengths: Coils in manufacturer's standard length.

F. Outside Corners: Preformed.

G. Inside Corners: Preformed.

H. Colors: as indicated on Drawings.

2.2 RUBBER STAIR ACCESSORIES

A. Fire-Test-Response Characteristics: As determined by testing identical products according to ASTM E 648 or NFPA 253 by a qualified testing agency.

1. Critical Radiant Flux Classification: Class I, not less than 0.45 W/sq. cm.

B. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or approved equal.

C. Photoluminescent Stair Treads: ASTM F 2169.

1. Type: TS (rubber, vulcanized thermoset).
2. Class: 2 (pattern; embossed, grooved, or ribbed).
3. Group: 2 (with contrasting color for the visually impaired). Visually impaired treads will have 2” wide contrasting photoluminescent color tape insert.
4. Nosing Style: As indicated on Drawings.
5. Nosing Height: As indicated on Drawings.
6. Size: Lengths and depths to fit each stair tread in one piece.
7. Integral Risers: Smooth, flat; in height that fully covers substrate.

D. Landing Tile: Matching treads; produced by same manufacturer as treads and recommended by manufacturer for installation with treads.

E. Locations: Provide rubber stair accessories in areas indicated.

F. Colors and Patterns: As indicated on Drawings.

2.3 RUBBER MOLDING ACCESSORY

A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or approved equal.

B. Description: Rubber carpet edge for glue-down applications nosing for carpet nosing for resilient flooring reducer strip for resilient flooring joiner for tile and carpet transition strips.

C. Profile and Dimensions: As indicated on Drawings.

D. Locations: Provide rubber molding accessories in areas indicated.

E. Colors and Patterns: As indicated on Drawings.

2.4 INSTALLATION MATERIALS

A. Trowelable Leveling and Patching Compounds: Latex-modified, portland cement based or blended hydraulic-cement-based formulation provided or approved by resilient-product manufacturer for applications indicated.

B. Adhesives: Water-resistant type recommended by resilient-product manufacturer for resilient products and substrate conditions indicated.

1. Adhesives shall have a VOC content of 50 g/L or less and 60 g/L or less for rubber stair treads.

C. Stair-Tread Nose Filler: Two-part epoxy compound recommended by resilient stair-tread manufacturer to fill nosing substrates that do not conform to tread contours.

D. Metal Edge Strips: Extruded aluminum with mill finish of width shown, of height required to protect exposed edges of flooring, and in maximum available lengths to minimize running joints.

E. Floor Polish: Provide protective, liquid floor-polish products recommended by resilient stair-tread manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, with Installer present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.

1. Verify that finishes of substrates comply with tolerances and other requirements specified in other Sections and that substrates are free of cracks, ridges, depressions, scale, and foreign deposits that might interfere with adhesion of resilient products.

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

1. Installation of resilient products indicates acceptance of surfaces and conditions.

3.2 PREPARATION

A. Prepare substrates according to manufacturer's written instructions to ensure adhesion of resilient products.

B. Concrete Substrates for Resilient Stair Accessories: Prepare horizontal surfaces according to ASTM F 710.

1. Verify that substrates are dry and free of curing compounds, sealers, and hardeners.
2. Remove substrate coatings and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, using mechanical methods recommended by manufacturer. Do not use solvents.
3. Alkalinity and Adhesion Testing: Perform tests recommended by manufacturer. Proceed with installation only after substrate alkalinity falls within range on pH scale recommended by manufacturer in writing, but not less than 5 or more than 9 pH.
4. Moisture Testing: Proceed with installation only after substrates pass testing according to manufacturer's written recommendations, but not less stringent than the following:

    a. Perform anhydrous calcium chloride test according to ASTM F 1869. Proceed with installation only after substrates have maximum moisture-vapor-emission rate of 3 lb of water/1000 sq. ft. (1.36 kg of water/92.9 sq. m) in 24 hours.
    b. Perform relative humidity test using in situ probes according to ASTM F 2170. Proceed with installation only after substrates have maximum 75 percent relative humidity level.

C. Fill cracks, holes, and depressions in substrates with trowelable leveling and patching compound; remove bumps and ridges to produce a uniform and smooth substrate.

D. Do not install resilient products until they are the same temperature as the space where they are to be installed.

1. At least 48 hours in advance of installation, move resilient products and installation materials into spaces where they will be installed.

E. Immediately before installation, sweep and vacuum clean substrates to be covered by resilient products.

3.3 RESILIENT BASE INSTALLATION

A. Comply with manufacturer's written instructions for installing resilient base.

B. Apply resilient base to walls, columns, pilasters, casework and cabinets in toe spaces, and other permanent fixtures in rooms and areas where base is required.

C. Install resilient base in lengths as long as practical without gaps at seams and with tops of adjacent pieces aligned.

D. Tightly adhere resilient base to substrate throughout length of each piece, with base in continuous contact with horizontal and vertical substrates.

E. Do not stretch resilient base during installation.

F. On masonry surfaces or other similar irregular substrates, fill voids along top edge of resilient base with manufacturer's recommended adhesive filler material.

G. Preformed Corners: Install preformed corners before installing straight pieces.

3.4 RESILIENT ACCESSORY INSTALLATION

A. Comply with manufacturer's written instructions for installing resilient accessories.

B. Resilient Stair Accessories:

1. Use stair-tread-nose filler to fill nosing substrates that do not conform to tread contours.
2. Tightly adhere to substrates throughout length of each piece.
3. For treads installed as separate, equal-length units, install to produce a flush joint between units.

C. Resilient Molding Accessories: Butt to adjacent materials and tightly adhere to substrates throughout length of each piece. Install reducer strips at edges of floor covering that would otherwise be exposed.

3.5 CLEANING AND PROTECTION

A. Comply with manufacturer's written instructions for cleaning and protecting resilient products.

B. Perform the following operations immediately after completing resilient-product installation:

1. Remove adhesive and other blemishes from exposed surfaces.
2. Sweep and vacuum horizontal surfaces thoroughly.
3. Damp-mop horizontal surfaces to remove marks and soil.

C. Protect resilient products from mars, marks, indentations, and other damage from construction operations and placement of equipment and fixtures during remainder of construction period.

D. Floor Polish: Remove soil, visible adhesive, and surface blemishes from resilient stair treads before applying liquid floor polish.

1. Apply three coat(s).

E. Cover resilient products subject to wear and foot traffic until Substantial Completion.

END OF SECTION 096513

SECTION 096516 - RESILIENT SHEET FLOORING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes vinyl sheet flooring.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Sustainable Design Submittals:

1. Product Data: For adhesives, indicating VOC content.
2. Laboratory Test Reports: For adhesives, indicating compliance with requirements for low-emitting materials.
3. Laboratory Test Reports: For flooring products, indicating compliance with requirements for low-emitting materials.
4. Product Data for Credit IEQ 4.3: For resilient flooring, documentation from an independent testing agency indicating compliance with the FloorScore standard.

C. Shop Drawings: For each type of flooring. Include flooring layouts, locations of seams, edges, columns, doorways, enclosing partitions, built-in furniture, cabinets, and cutouts.

1. Show details of special patterns.

D. Samples: For each exposed product and for each color and texture specified in manufacturer's standard size, but not less than 6-by-9-inch (150-by-230-mm) sections.

1. For heat-welding bead, manufacturer's standard-size Samples, but not less than 9 inches (230 mm) long, of each color required.

E. Welded-Seam Samples: For seamless-installation technique indicated and for each resilient sheet flooring product, color, and pattern required; with seam running lengthwise and in center of 6-by-9-inch (150-by-230-mm) Sample applied to a rigid backing and prepared by Installer for this Project.

F. Product Schedule: For resilient sheet flooring. Use same designations indicated on Drawings.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For each type of resilient sheet flooring to include in maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Resilient Sheet Flooring: Furnish not less than 10 linear feet (3 linear m) for every 500 linear feet (150 linear m) or fraction thereof, in roll form and in full roll width for each type, color, and pattern of flooring installed.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: A qualified installer who employs workers for this Project who are competent in techniques required by manufacturer for resilient sheet flooring installation and seaming method indicated.

1. Engage an installer who employs workers for this Project who are trained or certified by resilient sheet flooring manufacturer for installation techniques required.

B. Mockups: Build mockups to verify selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.

1. Build mockups for resilient sheet flooring including accessories.

a. Size: Minimum 100 sq. ft. (9.3 sq. m) for each type, color and pattern in locations directed by Architect.

2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Store resilient sheet flooring and installation materials in dry spaces protected from the weather, with ambient temperatures maintained within range recommended by manufacturer, but not less than 50 deg F (10 deg C) or more than 90 deg F (32 deg C). Store rolls upright.

1.9 FIELD CONDITIONS

A. Maintain ambient temperatures within range recommended by manufacturer, but not less than 70 deg F (21 deg C) or more than 85 deg F (29 deg C), in spaces to receive resilient sheet flooring during the following time periods:

1. 48 hours before installation.
2. During installation.

3. 48 hours after installation.

B. After installation and until Substantial Completion, maintain ambient temperatures within range recommended by manufacturer, but not less than 55 deg F (13 deg C) or more than 95 deg F (35 deg C).

C. Close spaces to traffic during resilient sheet flooring installation.

D. Close spaces to traffic for 48 hours after resilient sheet flooring installation.

E. Install resilient sheet flooring after other finishing operations, including painting, have been completed.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Fire-Test-Response Characteristics: For resilient sheet flooring, as determined by testing identical products according to ASTM E 648 or NFPA 253 by a qualified testing agency.

1. Critical Radiant Flux Classification: Class I, not less than 0.45 W/sq. cm.

2.2 UNBACKED RUBBER SHEET FLOORING

A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings. No Substitutions.

B. Product Standard: ASTM F 1859.

1. Type: Type I (homogeneous rubber sheet).
2. Thickness: As indicated on Drawings..
3. Hardness: Manufacturer's standard hardness, measured using Shore, Type A durometer per ASTM D 2240.

C. Wearing Surface: Smooth.

D. Sheet Width: As standard with manufacturer.

E. Seamless-Installation Method: Heat welded.

F. Colors and Patterns: As indicated on Drawings.

2.3 INSTALLATION MATERIALS

A. Trowelable Leveling and Patching Compounds: Latex-modified, portland cement based or blended hydraulic-cement-based formulation provided or approved by resilient sheet flooring manufacturer for applications indicated.

B. Adhesives: Water-resistant type recommended by flooring and adhesive manufacturers to suit resilient sheet flooring and substrate conditions indicated.

1. Adhesives shall have a VOC content of 50 g/L or less.

C. Seamless-Installation Accessories:

1. Heat-Welding Bead: Manufacturer's solid-strand product for heat welding seams.

a. Color: As selected by Architect from manufacturer's full range.

D. Integral-Flash-Cove-Base Accessories:

1. Cove Strip: 1-inch (25-mm) radius provided or approved by resilient sheet flooring manufacturer.
2. Cap Strip: Square metal, vinyl, or rubber cap provided or approved by resilient sheet flooring manufacturer.
3. Corners: Metal inside and outside corners and end stops provided or approved by resilient sheet flooring manufacturer.

E. Floor Polish: Provide protective, liquid floor-polish products recommended by resilient sheet flooring manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, with Installer present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.

1. Verify that finishes of substrates comply with tolerances and other requirements specified in other Sections and that substrates are free of cracks, ridges, depressions, scale, and foreign deposits that might interfere with adhesion of resilient sheet flooring.

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

3.2 PREPARATION

A. Prepare substrates according to resilient sheet flooring manufacturer's written instructions to ensure adhesion of resilient sheet flooring.

B. Concrete Substrates: Prepare according to ASTM F 710.

1. Verify that substrates are dry and free of curing compounds, sealers, and hardeners.
2. Remove substrate coatings and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, using mechanical methods recommended by resilient sheet flooring manufacturer. Do not use solvents.
3. Alkalinity and Adhesion Testing: Perform tests recommended by resilient sheet flooring manufacturer. Proceed with installation only after substrate alkalinity falls within range on pH scale recommended by manufacturer in writing, but not less than 5 or more than 9 pH.

4. Moisture Testing: Proceed with installation only after substrates pass testing according to resilient sheet flooring manufacturer's written recommendations, but not less stringent than the following:

    a. Perform anhydrous calcium chloride test according to ASTM F 1869. Proceed with installation only after substrates have maximum moisture-vapor-emission rate of 3 lb of water/1000 sq. ft. (1.36 kg of water/92.9 sq. m) in 24 hours.
    b. Perform relative humidity test using in situ probes according to ASTM F 2170. Proceed with installation only after substrates have a maximum 85 percent relative humidity level.

C. Fill cracks, holes, and depressions in substrates with trowelable leveling and patching compound; remove bumps and ridges to produce a uniform and smooth substrate.

D. Do not install resilient sheet flooring until it is the same temperature as the space where it is to be installed.

1. At least 48 hours in advance of installation, move flooring and installation materials into spaces where they will be installed.

E. Immediately before installation, sweep and vacuum clean substrates to be covered by resilient sheet flooring.

3.3 RESILIENT SHEET FLOORING INSTALLATION

A. Comply with manufacturer's written instructions for installing resilient sheet flooring.

B. Unroll resilient sheet flooring and allow it to stabilize before cutting and fitting.

C. Lay out resilient sheet flooring as follows:

1. Maintain uniformity of flooring direction.
2. Minimize number of seams; place seams in inconspicuous and low-traffic areas, at least 6 inches (152 mm) away from parallel joints in flooring substrates.
3. Match edges of flooring for color shading at seams.
4. Avoid cross seams.

D. Scribe and cut resilient sheet flooring to butt neatly and tightly to vertical surfaces, permanent fixtures, and built-in furniture including cabinets, pipes, outlets, and door frames.

E. Extend resilient sheet flooring into toe spaces, door reveals, closets, and similar openings.

F. Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating on resilient sheet flooring as marked on substrates. Use chalk or other nonpermanent marking device.

G. Install resilient sheet flooring on covers for telephone and electrical ducts and similar items in installation areas. Maintain overall continuity of color and pattern between pieces of flooring installed on covers and adjoining flooring. Tightly adhere flooring edges to substrates that abut covers and to cover perimeters.

H. Adhere resilient sheet flooring to substrates using a full spread of adhesive applied to substrate to produce a completed installation without open cracks, voids, raising and puckering at joints, telegraphing of adhesive spreader marks, and other surface imperfections.

I. Seamless Installation:

1. Heat-Welded Seams: Comply with ASTM F 1516. Rout joints and heat weld with welding bead to permanently fuse sections into a seamless flooring. Prepare, weld, and finish seams to produce surfaces flush with adjoining flooring surfaces.

J. Integral-Flash-Cove Base: Cove resilient sheet flooring to dimension indicated up vertical surfaces. Support flooring at horizontal and vertical junction with cove strip. Butt at top against cap strip.

1. Install metal corners at inside and outside corners.

3.4 CLEANING AND PROTECTION

A. Comply with manufacturer's written instructions for cleaning and protecting resilient sheet flooring.

B. Perform the following operations immediately after completing resilient sheet flooring installation:

1. Remove adhesive and other blemishes from surfaces.
2. Sweep and vacuum surfaces thoroughly.
3. Damp-mop surfaces to remove marks and soil.

C. Protect resilient sheet flooring from mars, marks, indentations, and other damage from construction operations and placement of equipment and fixtures during remainder of construction period.

D. Floor Polish: Remove soil, adhesive, and blemishes from flooring surfaces before applying liquid floor polish.

1. Apply three coat(s).

E. Cover resilient sheet flooring until Substantial Completion.

END OF SECTION 096516

SECTION 096519 - RESILIENT TILE FLOORING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Polyester composition floor tile.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Sustainable Design Submittals:

1. Product Data: For adhesives, indicating VOC content.
2. Product Data: For sealants, indicating VOC content.

C. Shop Drawings: For each type of resilient floor tile.

1. Include floor tile layouts, edges, columns, doorways, enclosing partitions, built-in furniture, cabinets, and cutouts.
2. Show details of special patterns.

D. Samples: Full-size units of each color, texture, and pattern of floor tile required.

E. Product Schedule: For floor tile. Use same designations indicated on Drawings.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For each type of floor tile to include in maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials, from the same product run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Floor Tile: Furnish one box for every 50 boxes or fraction thereof, of each type, color, and pattern of floor tile installed.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are competent in techniques required by manufacturer for floor tile installation and seaming method indicated.

1. Engage an installer who employs workers for this Project who are trained or certified by floor tile manufacturer for installation techniques required.

B. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.

1. Coordinate mockups in this Section with mockups specified in other Sections.

a. Size: Minimum 100 sq. ft. (9.3 sq. m) for each type, color, and pattern in locations directed by Architect.

2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Store floor tile and installation materials in dry spaces protected from the weather, with ambient temperatures maintained within range recommended by manufacturer, but not less than 50 deg F (10 deg C) or more than 90 deg F (32 deg C). Store floor tiles on flat surfaces.

1.9 FIELD CONDITIONS

A. Maintain ambient temperatures within range recommended by manufacturer, but not less than 70 deg F (21 deg C) or more than 95 deg F (35 deg C), in spaces to receive floor tile during the following periods:

1. 48 hours before installation.
2. During installation.
3. 48 hours after installation.

B. After installation and until Substantial Completion, maintain ambient temperatures within range recommended by manufacturer, but not less than 55 deg F (13 deg C) or more than 95 deg F (35 deg C).

C. Close spaces to traffic during floor tile installation.

D. Close spaces to traffic for 48 hours after floor tile installation.

E. Install floor tile after other finishing operations, including painting, have been completed.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Fire-Test-Response Characteristics: For resilient floor tile, as determined by testing identical products according to ASTM E 648 or NFPA 253 by a qualified testing agency.

1. Critical Radiant Flux Classification: Class I, not less than 0.45 W/sq. cm.

2.2 POLYESTER COMPOSITION FLOOR TILE

A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or approved equal

B. Bio-flooring tile shall conform to the requirements of ASTM F 2982 Standard Specification for Polyester Composition Floor Tile.

C. Wearing Surface: Smooth.

D. Thickness: As indicated on Drawings.

E. Size: As indicated on Drawings.

F. Colors and Patterns: As indicated on Drawings.

2.3 INSTALLATION MATERIALS

A. Trowelable Leveling and Pathing Compounds: Latex-modified, portland-cement-based or blended hydraulic-cement-based formulation provided or approved by floor tile manufacturer for applications indicated.

B. Adhesives: Water-resistant type recommended by floor tile and adhesive manufacturers to suit floor tile and substrate conditions indicated.

1. Adhesives shall have a VOC content of 50 g/L or less.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, with Installer present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.

1. Verify that finishes of substrates comply with tolerances and other requirements specified in other Sections and that substrates are free of cracks, ridges, depressions, scale, and foreign deposits that might interfere with adhesion of floor tile.

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

3.2 PREPARATION

A. Prepare substrates according to floor tile manufacturer's written instructions to ensure adhesion of resilient products.

B. Concrete Substrates: Prepare according to ASTM F 710.

1. Verify that substrates are dry and free of curing compounds, sealers, and hardeners.
2. Remove substrate coatings and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, using mechanical methods recommended by floor tile manufacturer. Do not use solvents.
3. Alkalinity and Adhesion Testing: Perform tests recommended by floor tile manufacturer. Proceed with installation only after substrate alkalinity falls within range on pH scale recommended by manufacturer in writing, but not less than 5 or more than 9 pH.
4. Moisture Testing: Perform tests so that each test area does not exceed 1000 sq. ft. (304.8 sq. m), and perform no fewer than three tests in each installation area and with test areas evenly spaced in installation areas.

    a. Anhydrous Calcium Chloride Test: ASTM F 1869. Proceed with installation only after substrates have maximum moisture-vapor-emission rate of 5 lb of water/1000 sq. ft. (1.36 kg of water/92.9 sq. m) in 24 hours.
    b. Relative Humidity Test: Using in-situ probes, ASTM F 2170. Proceed with installation only after substrates have a maximum 80 percent relative humidity level measurement.

C. Fill cracks, holes, and depressions in substrates with trowelable leveling and patching compound; remove bumps and ridges to produce a uniform and smooth substrate.

D. Do not install floor tiles until materials are the same temperature as space where they are to be installed.

1. At least 48 hours in advance of installation, move resilient floor tile and installation materials into spaces where they will be installed.

E. Immediately before installation, sweep and vacuum clean substrates to be covered by resilient floor tile.

3.3 FLOOR TILE INSTALLATION

A. Comply with manufacturer's written instructions for installing floor tile.

B. Lay out floor tiles from center marks established with principal walls, discounting minor offsets, so tiles at opposite edges of room are of equal width. Adjust as necessary to avoid using cut widths that equal less than one-half tile at perimeter.

1. Lay tiles as indicated on Drawings.

C. Match floor tiles for color and pattern by selecting tiles from cartons in the same sequence as manufactured and packaged, if so numbered. Discard broken, cracked, chipped, or deformed tiles.

1. Lay tiles in pattern of colors and sizes indicated on Drawings.

D. Scribe, cut, and fit floor tiles to butt neatly and tightly to vertical surfaces and permanent fixtures including built-in furniture, cabinets, pipes, outlets, and door frames.

E. Extend floor tiles into toe spaces, door reveals, closets, and similar openings. Extend floor tiles to center of door openings.

F. Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating on floor tiles as marked on substrates. Use chalk or other nonpermanent marking device.

G. Install floor tiles on covers for telephone and electrical ducts, building expansion-joint covers, and similar items in installation areas. Maintain overall continuity of color and pattern between pieces of tile installed on covers and adjoining tiles. Tightly adhere tile edges to substrates that abut covers and to cover perimeters.

H. Adhere floor tiles to substrates using a full spread of adhesive applied to substrate to produce a completed installation without open cracks, voids, raising and puckering at joints, telegraphing of adhesive spreader marks, and other surface imperfections.

3.4 CLEANING AND PROTECTION

A. Comply with manufacturer's written instructions for cleaning and protecting floor tile.

B. Perform the following operations immediately after completing floor tile installation:

1. Remove adhesive and other blemishes from surfaces.
2. Sweep and vacuum surfaces thoroughly.
3. Damp-mop surfaces to remove marks and soil.

C. Protect floor tile from mars, marks, indentations, and other damage from construction operations and placement of equipment and fixtures during remainder of construction period.

D. Cover floor tile until Substantial Completion.

END OF SECTION 096519

SECTION 096726 – RESINOUS FLOORING

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SECTION INCLUDES

A. Labor, products, equipment and services necessary for resinous flooring work in mechanical spaces and penthouse spaces as indicated on Drawings covering the following components:

.1 Optional Primer: Sikafloor® 161.

.2 Base Coat: Sikafloor® 265.

.3 Wear Coat: Sikafloor® 265 with Broadcast Quartz to Rejection.

.4 Top Coat: Sikafloor® 264.

.5 Optional Top Coat: Sikafloor® 315.

1.3 RELATED SECTIONS

A. Section 03 30 00 - Cast-in-Place Concrete.

1.4 REFERENCES

A. ASTM C579, Standard Test Methods for Compressive Strength of Chemical-Resistant Mortars, Grouts, Monolithic Surfacings, and Polymer Concretes.

B. ASTM D2240, Standard Test Method for Rubber Property—Durometer Hardness.

C. ASTM D2369, Standard Test Method for Volatile Content of Coatings.

D. ASTM D4060, Standard Test Method for Abrasion Resistance of Organic Coatings by the Taber Abraser.

E. ASTM D4541, Standard Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers.

F. For additional standards please refer to Product Data Sheets

1.5 SUBMITTALS

A. Product Data: Submit manufacturer's product data, including physical properties and colors available.

B. Manufacturer’s Safety Data Sheet for each product being used.

C. Product Samples: Submit Architectural Standard samples representative of the final finish, as applied. The Standard shall be approved in writing by the Architect and shall be the final standard of acceptance of the finish.

D. Maintenance Instructions: Submit manufacturer's maintenance instructions.

1.6 QUALITY ASSURANCE

A. Installer Qualifications:

.1 Pre-Qualification: Each bidder for this project shall be pre-qualified and approved in writing by the material manufacturer.

.2 Applicator Experience: Each bidder must have a minimum 5 years experience in the application of the type of system specified. Contractor shall submit a list of five projects of similar size, scope and complexity.

B. Mock-Up:

.1 Construct one 100 sq.ft. (10 sq.m.) mock-up of each type and color of resinous flooring in location acceptable to Architect to demonstrate quality of finished system, complying with manufacturer's instructions. Include 96-inch (2400-mm) length of integral cove base with inside and outside corner. Simulate finished lighting conditions for Architect's review of mockups.

.2 Arrange for Architect's review and acceptance, obtain written acceptance before proceeding with Work.

.3 Upon acceptance, mock-up shall serve as a minimum standard of quality for the balance of the work of this Section. Mock-up shall be left in place for the duration of the work.

C. Pre-application Meeting: Convene a pre-application meeting two (2) weeks before start of application of floor coating. Require attendance of parties directly affecting work of this section, including Contractor, Architect, applicator, and manufacturer's representative. Review surface preparation, priming, application, curing, protection, and coordination with other work.

1.7 DELIVERY, STORAGE AND HANDLING

A. Delivery:

.1 Deliver materials to site in manufacturer's original, unopened containers and packaging, with labels clearly identifying product name, manufacturer, batch or lot number, and date of manufacture.

.2 Material should be delivered to job site and checked for completeness and shipping damage prior to job start.

B. Storage:

.1 Store materials in accordance with manufacturer’s written instructions.

.2 Keep containers sealed until ready for use. Material should be stored in a dry, enclosed, protected area from the elements.

.3 Do not subject material to excessive heat or freezing.

.4 Shelf life: Established based on manufacturer’s written recommendation for each material being used.

C. Handling: Protect materials during handling and application to prevent damage or contamination.

D. Condition materials for use accordingly to manufacturer’s written instructions prior to application.

E. Record material lot number and quantity delivered to jobsite/storage.

1.8 SITE CONDITIONS

A. Do not install the Work of this Section outside of the following environmental ranges with Manufacturers' written acceptance:

.1 Material Temperature: Precondition material for at least 24 hours between 65° to 75°F (18° to 24°C)

.2 Ambient Temperature: Minimum/Maximum 50˚/85˚F (10˚/30˚C)

.3 Substrate Temperature: Minimum/Maximum 50˚/85˚F (10˚/30˚C). Substrate temperature must be at least 5˚F (3˚C) above measured Dew Point.

.4 Mixing and Application attempted at Material, Ambient and/or Substrate Temperature conditions less than 65˚F (18˚C) will result in a decrease in product workability and slower cure rates.

.5 Relative Ambient Humidity: Minimum ambient humidity 30%, maximum ambient humidity 75% (during application and curing)

.6 Measure and confirm Substrate Moisture Content, Ambient Relative Humidity, Ambient and Surface Temperature and Dew Point.

B. Substrate moisture:

.1 Moisture content of concrete substrate must be ≤ 4% by mass as measured with a Tramex® CME/CMExpert type concrete moisture meter.

.2 Additionally, relative humidity tests may be conducted per ASTM F2170 and values must be ≤ 85%.

.3 If moisture content of concrete substrate is > 4% by mass as measured with Tramex® CME/CMExpert type and/or if relative humidity tests per ASTM F2170 exceed values > 85%, consider moisture mitigation systems or moisture tolerant primer.

C. Utilities, including electric, water, HVAC and permanent lighting to be supplied by General Contractor

D. Maintain constant ambient room temperature of plus or minus 15ºF (plus or minus 7ºC) with a minimum temperature of 50ºF (10ºC) and maximum temperature of 85ºF (30ºC). Maintain constant ambient room temperature for 48 hours before, during and after installation, or until cured. Do not apply while ambient and temperatures are rising.

E. Erect suitable barriers and post legible signs at points of entry to prevent traffic and trades from entering the work area during application and cure period of the floor.

F. Protection of finished floor from damage by subsequent trades shall be the responsibility of the General Contractor.

G. Insure adequate ventilation and air flow.

1.9 WARRANTY

A. Manufacturer's warranty covering the resinous flooring against defects in materials for one year from Date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURER

A. Source Limitations: Obtain primary resinous flooring materials, including primers, resins, hardening agents, grouting coats, and topcoats, from single source from single manufacturer. Obtain secondary materials, including patching and fill material, joint

sealant, and repair materials, of type and from manufacturer recommended in writing by manufacturer of primary materials.

B. Manufacturer shall be certified under ISO 9001: 2008 All liquid materials, including primers, resins, curing agents, finish coats, and sealants are manufactured and tested under an ISO 9001:2008 registered quality system.

C. Basis-of-Design Manufacturer; Sika Corporation. No Substitutions.

2.2 SYSTEM

A. Resinous Flooring System RES-1: Sikafloor Merflex broadcast is a monolithic, flexible, abrasion and slip resistant flooring system that is designed for areas requiring a combined water protection membrane and higher traffic wearing surface applied between 56 to 90 mils thick. System to consist of the following components:

.1 Optional Primer: Sikafloor 161 applied between 8 – 10 mils.

.2 Base Coat: Sikafloor 265 applied at 20 mils.

.3 Wear Coat: Sikafloor 265 applied between 20 – 30 mils with Broadcast Quartz to Rejection.

.4 Top Coat: Sikafloor 264 applied between 8 – 10 mils..

.5 Optional top coat: Sikafloor 315 applied between 3 – 3.5 mils.

2.3 MATERIALS

A. Urethane Cement (where indicated on Drawings): 22na PurCem, a seamless, self-leveling, solid color, neutral odor, high strength, water based polyurethane cement floor screed system that provides improved thermal shock resistance, excellent chemical, impact and abrasion resistance. 22N PurCem is broadcast to rejection with 30 mesh aggregate, allowed to cure, and subsequent decorative treatment applied. 22n PurCem may utilize an optional waterbased epoxy primer to prevent outgassing

B. Primer: Sikafloor 161 is a two part, epoxy resin for priming and leveling mortars with the following properties:

.1 Pull-off Strength (ASTM D4541): > 400 psi (2.7 MPa) with 100% concrete failure.

.2 Shore D Hardness (ASTM D2240): 76 at 7 days.

.3 Solid Content: ~ 100% (by volume) / ~ 100% (by weight).

.4 VOC Content (ASTM D2369): ≤ 50 g/L.

.5 Permeability (ASTM E96): 9.0 g/m² (24 hours / +75°F).

.6 Water Absorption (ASTM D570): 0.14 g/h - m2.

.7 Viscosity (approximately) of Components A + B: 775 (SP2/100).

C. Base Coat and Wear Coat: Sikafloor 265 is a two component, high solids, flexible epoxy for use as a seamless waterproof membrane. This unique, elastomeric polymer system maximizes flexibility and elongation to provide crack bridging capabilities with the following properties:

.1 Tensile Strength (ASTM D638): 1,050 psi (7.2 MPa)

.2 Strength (ASTM D4541): 520 psi (3.6 Mpa) 100 % concrete failure

.3 Elongation % (ASTM D638): 125 %

.4 Shore D Hardness (ASTM D2240): 40

.5 Impact Resistance (ASTM D2794): 160 in - lbs. (1.8 kg-m.) direct and reverse

.6 Flammability (ASTM D635): Self Extinguishing

.7 VOC Content (ASTM D2369): ≤ 50 g/L

.8 Modulus of Elasticity (ASTM D638): 246,000 psi (1,697 MPa)

.9 Tear Strength (ASTM D1938): 90 lbs (0.40)

.10 Thermal Cycling (24 hrs) (ASTM C884): No Cracking -6° to 77°F; -21° to 25°C.

D. Broadcast Aggregate: Quartz aggregate.

E. Top Coat: Sikafloor 264 is a pigmented two part, low viscosity, self-priming, epoxy coating binder in color selected by Architect from manufacturer's full range of color selections with the following properties:

.1 Pull-off Strength (ASTM D4541): > 400 psi (2.7 MPa) with 100% concrete failure.

.2 Shore D Hardness (ASTM D2240): 76 at 7 days.

.3 Solid Content: ~ 100% (by volume) / ~ 100% (by weight).

.4 VOC Content (ASTM D2369): ≤ 50 g/L.

.5 Compressive Strength (ASTM C579): 7,250 psi (50 N/mm²) at 28 days.

.6 Flexural Strength (ASTM C580): 2,900 psi (20 N/mm²) at 28 days

F. Top Coat: Sikafloor 315 is a high solids, low VOC abrasion resistant, aliphatic polyurethane coating in color selected by Architect from manufacturer's full range of color selections with the following properties:

.1 Pull-off Strength to Primed Concrete (ASTM D4541): > 400 psi (2.76 MPa) with 100% concrete failure.

.2 Hardness (ASTM D 3363 Pencil): 2H to 3H concrete failure.

.3 VOC Content (ASTM D2369): With Wear Aggregate ≤ 100 g/L, With Sikafloor Urethane Color Add Only ≤ 50 g/L.

.4 Tensile Strength (ASTM D2370): 2,882 psi.

.5 Elongation: 2.29.

.6 Abrasion Resistance (ASTM D4060): 0.01 - 0.02 grams (CS-17 Wheel, 1000 gm load, 1000 cycles).

.7 Coefficient Of Friction (ASTM D2047): 0.6 - 0.7.

.8 Slip Resistance: Equivalent to ASTM D2047 Passes.

G. Cove base: Epoxy mortar cove based.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine surfaces to receive flooring system. Notify Construction Manager if surfaces are not acceptable. Do not begin surface preparation or application until unacceptable conditions have been corrected. Do not apply to substrate treatments for moisture, repair, or leveling not of the same Manufacturer.

B. Surface must be clean, sound and dry. Remove dust, laitance, grease, curing compounds bond inhibiting impregnations, waxes and any other contaminants. All projections, rough spots, etc. should be dressed off to achieve a level surface prior to the application.

C. Concrete substrate to have a minimum compressive strength of 3,500 psi (24 MPa) at 28 days and a minimum of 215 psi (1.5 MPa) in tension at time of application.

D. Verify that concrete substrates are dry and moisture-vapor emissions are within acceptable levels according to manufacturer's written instructions.

a. Anhydrous Calcium Chloride Test: ASTM F 1869. Proceed with application of resinous flooring only after substrates have maximum moisture-vapor-emission rate of 3 lb of water/1000 sq. ft. (1.36 kg of water/92.9 sq. m) of slab area in 24 hours.
b. Plastic Sheet Test: ASTM D 4263. Proceed with application only after testing indicates absence of moisture in substrates.
c. Relative Humidity Test: Use in situ probes, ASTM F 2170. Proceed with installation only after substrates have a maximum 75 percent relative humidity level measurement.

E. Alkalinity and Adhesion Testing: Verify that concrete substrates have pH within acceptable range. Perform tests recommended by manufacturer. Proceed with application only after substrates pass testing.

F. Ensure concrete substrate conforms to the minimum requirements of the flooring manufacturer.

G. Flooring system shall not be applied to sand-cement setting beds. Sand-cement beds shall be removed to structural concrete substrate and re-leveled/sloped as necessary to achieve grade and/or adequate drainage.

H. Flooring system shall not be applied to asphaltic or bitumen membranes, soft wood, aluminum, copper or fiberglass reinforced polyester/vinyl ester composites.

I. Application to glazed or vitrified brick and tile, structural wood, steel shall only be permitted with Manufacturer’s written recommendation.

3.2 SURFACE PREPARATION

A. Prepare surface to receive flooring systems in accordance with manufacturer's written instructions.

B. Remove dirt, oil, grease, wax, laitance, curing compounds, water-soluble concrete hardeners, and other surface contaminants. Remove sealers, finishes, and paints. Remove unsound concrete by appropriate mechanical means.

C. Concrete: Shall be cleaned and prepared to achieve laitance-free and contaminant-free, open textured surface by shot blasting or equivalent mechanical means (CSP level as per ICRI guidelines and manufacturer’s written recommendation).

D. Chemical Surface Preparation: Chemical surface preparation (acid etching) is unacceptable and will void Manufacturer’s warranty.

E. Control joints and cracks: Provide repair and treatment of control joints and surface cracks utilizing manufacturer’s standard materials and installation details.

3.3 APPLICATION

A. Mix and apply material with strict adherence to manufacturer’s written installation procedures and coverage rates.

B. Follow Manufacturer’s written recommendations on terminations and connections to walls, drains, doorways, columns and floor-to-floor transitions.

C. Do not apply while ambient and substrate temperatures are rising.

D. Apply resinous flooring with care to ensure that no laps, voids, or other marks or irregularities are visible, and with an appearance of uniform color, sheen and texture, all within limitations of materials and areas concerned.

E. Match colors and textures of approved samples.

F. Install cove base in accordance with manufacturer's written instructions and as indicated on Drawings.

3.4 CLEAN UP

A. Disposal of this product, solution and any by-products should at all times comply with the requirements of environmental protection and waste disposal legislation and any regional local authority requirements.

B. Empty containers should be taken to an approved waste handling site for recycling or disposal.

3.5 PROTECTION

A. Freshly applied material should be protected from dampness, condensation and water for at least 72 hrs.

B. Beware of air flow and changes in air flow. Introduction of dust, debris, and particles, etc. may result in surface imperfections and other defects.

C. Follow manufacturer's written recommendation with respect to cure, wait time and return to service.

3.6 FIELD QUALITY CONTROL

A. Material Sampling: Owner may, at any time and any number of times during resinous flooring application, require material samples for testing for compliance with requirements.

.1 Owner will engage an independent testing agency to take samples of materials being used. Material samples will be taken, identified, sealed, and certified in presence of Contractor.

.2 Testing agency will test samples for compliance with requirements, using applicable referenced testing procedures or, if not referenced, using testing procedures listed in manufacturer's product data.

.3 If test results show applied materials do not comply with specified requirements, pay for testing, remove noncomplying materials, prepare surfaces coated with unacceptable materials, and reapply flooring materials to comply with requirements.

B. Core Sampling: At the direction of Owner and at locations designated by Owner, take one core sample per 1000 sq. ft. (92.9 sq. m) of resinous flooring, or portion of, to verify thickness. For each sample that fails to comply with requirements, take two additional samples. Repair damage caused by coring. Correct deficiencies in installed flooring as indicated by testing.

END OF SECTION 096726

SECTION 096813 - TILE CARPETING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes modular carpet tile.

B. Related Requirements:

1. Section 024119 "Selective Demolition" for removing existing floor coverings.
2. Section 096513 "Resilient Base and Accessories" for resilient wall base and accessories installed with carpet tile.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1. Review methods and procedures related to carpet tile installation including, but not limited to, the following:

a. Review delivery, storage, and handling procedures.
b. Review ambient conditions and ventilation procedures.
c. Review subfloor preparation procedures.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include manufacturer's written data on physical characteristics, durability, and fade resistance.
2. Include manufacturer's written installation recommendations for each type of substrate.

B. Sustainable Design Submittals:

1. Product Data: For adhesives, indicating VOC content.
2. Product Data: For carpet tile, documentation indicating compliance with testing and product requirements of CRI's "Green Label Plus" program.
3. Product Data for Credit MR 4: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content. Include statement indicating costs for each product having recycled content.
4. Laboratory Test Reports: For adhesives, indicating compliance with requirements for low-emitting materials.

C. Shop Drawings: For carpet tile installation, plans showing the following:

1. Columns, doorways,enclosing walls or partitions, built-in cabinets, and locations where cutouts are required in carpet tiles.
2. Carpet tile type, color, and dye lot.
3. Type of subfloor.
4. Type of installation.
5. Pattern of installation.
6. Pattern type, location, and direction.
7. Pile direction.
8. Type, color, and location of insets and borders.
9. Type, color, and location of edge, transition, and other accessory strips.
10. Transition details to other flooring materials.

D. Samples: For each of the following products and for each color and texture required. Label each Sample with manufacturer's name, material description, color, pattern, and designation indicated on Drawings and in schedules.

1. Carpet Tile: Full-size Sample.
2. Exposed Edge, Transition, and Other Accessory Stripping: 12-inch- (300-mm-) long Samples.

E. Samples for Initial Selection: For each type of carpet tile.

1. Include Samples of exposed edge, transition, and other accessory stripping involving color or finish selection.

F. Samples for Verification: For each of the following products and for each color and texture required. Label each Sample with manufacturer's name, material description, color, pattern, and designation indicated on Drawings and in schedules.

1. Carpet Tile: Full-size Sample.
2. Exposed Edge, Transition, and Other Accessory Stripping: 12-inch- (300-mm-) long Samples.

G. Product Schedule: For carpet tile. Use same designations indicated on Drawings.

H. Sustainable Product Certification: Provide ANSI/NSF 140 certification for carpet products.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Product Test Reports: For carpet tile, for tests performed by a qualified testing agency.

C. Sample Warranty: For special warranty.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: For carpet tiles to include in maintenance manuals. Include the following:

1. Methods for maintaining carpet tile, including cleaning and stain-removal products and procedures and manufacturer's recommended maintenance schedule.
2. Precautions for cleaning materials and methods that could be detrimental to carpet tile.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials, from the same product run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Carpet Tile: Full-size units equal to 5 percent of amount installed for each type indicated, but not less than 10 sq. yd. (8.3 sq. m).

1.8 QUALITY ASSURANCE

A. Installer Qualifications: An experienced installer who is certified by the International Certified Floorcovering Installers Association at the Commercial II Master II certification level.

B. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for fabrication and installation.

1. Build mockups at locations and in sizes shown on Drawings.
2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Comply with CRI's "CRI Carpet Installation Standard."

1.10 FIELD CONDITIONS

A. Comply with CRI's "CRI Carpet Installation Standard" for temperature, humidity, and ventilation limitations.

B. Environmental Limitations: Do not deliver or install carpet tiles until spaces are enclosed and weathertight, wet-work in spaces is complete and dry, and ambient temperature and humidity conditions are maintained at levels planned for building occupants during the remainder of the construction period.

C. Do not install carpet tiles over concrete slabs until slabs have cured and are sufficiently dry to bond with adhesive and concrete slabs have pH range recommended by carpet tile manufacturer.

D. Where demountable partitions or other items are indicated for installation on top of carpet tiles, install carpet tiles before installing these items.

1.11 WARRANTY

A. Special Warranty for Carpet Tiles: Manufacturer agrees to repair or replace components of carpet tile installation that fail in materials or workmanship within specified warranty period.

1. Warranty does not include deterioration or failure of carpet tile due to unusual traffic, failure of substrate, vandalism, or abuse.
2. Failures include, but are not limited to, the following:

    a. More than 10 percent edge raveling, snags, and runs.
    b. Dimensional instability.
    c. Excess static discharge.
    d. Loss of tuft-bind strength.
    e. Loss of face fiber.
    f. Delamination.

3. Warranty Period: 15 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 CARPET TILE

A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings. No Substitutions.

B. Color: As indicated on Drawings.

C. Pattern: As indicated on Drawings.

D. Size: As indicated on Drawings.

E. Applied Treatments:

1. Soil-Resistance Treatment: Manufacturer's standard treatment.
2. Antimicrobial Treatment: Manufacturer's standard treatment that protects carpet tiles as follows:

    a. Antimicrobial Activity: Not less than 2-mm halo of inhibition for gram-positive bacteria, not less than 1-mm halo of inhibition for gram-negative bacteria, and no fungal growth, according to AATCC 174.

F. Sustainable Design Requirements:

1. Sustainable Product Certification: Silver level certification according to ANSI/NSF 140.
2. Carpet shall comply with testing and product requirements of CRI's "Green Label Plus" testing program.

G. Performance Characteristics:
1. Critical Radiant Flux Classification: Not less than 0.45 W/sq. cm according to NFPA 253.
2. Dimensional Tolerance: Within 1/32 inch (0.8 mm) of specified size dimensions, as determined by physical measurement.
3. Dimensional Stability: 0.2 percent or less according to ISO 2551 (Aachen Test).
4. Colorfastness to Crocking: Not less than 4, wet and dry, according to AATCC 165.

2.2 INSTALLATION ACCESSORIES

A. Trowelable Leveling and Patching Compounds: Latex-modified, hydraulic-cement-based formulation provided or recommended by carpet tile manufacturer.

B. Adhesives: Water-resistant, mildew-resistant, nonstaining, pressure-sensitive type to suit products and subfloor conditions indicated, that comply with flammability requirements for installed carpet tile, and are recommended by carpet tile manufacturer for releasable installation.

1. Adhesives shall have a VOC content of 50 g/L or less.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for maximum moisture content, alkalinity range, installation tolerances, and other conditions affecting carpet tile performance.

B. Examine carpet tile for type, color, pattern, and potential defects.

C. Concrete Slabs: Verify that finishes comply with requirements specified in Section 033000 "Cast-in-Place Concrete" and that surfaces are free of cracks, ridges, depressions, scale, and foreign deposits.

1. Moisture Testing: Perform tests so that each test area does not exceed 1000 sq. ft. (304.8 sq. m), and perform no fewer than three tests in each installation area and with test areas evenly spaced in installation areas.

a. Anhydrous Calcium Chloride Test: ASTM F 1869. Proceed with installation only after substrates have maximum moisture-vapor-emission rate of 3 lb of water/1000 sq. ft. (1.36 kg of water/92.9 sq. m) in 24 hours.
b. Relative Humidity Test: Using in situ probes, ASTM F 2170. Proceed with installation only after substrates have a maximum 75 percent relative humidity level measurement.
c. Perform additional moisture tests recommended in writing by adhesive and carpet tile manufacturers. Proceed with installation only after substrates pass testing.

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

3.2 PREPARATION

A. General: Comply with CRI's "Carpet Installation Standards" and with carpet tile manufacturer's most current written installation instructions for preparing substrates indicated to receive carpet tile.

B. Use trowelable leveling and patching compounds, according to manufacturer's written instructions, to fill cracks, holes, depressions, and protrusions in substrates. Fill or level cracks, holes and depressions 1/8 inch (3 mm) wide or wider, and protrusions more than 1/32 inch (0.8 mm) unless more stringent requirements are required by manufacturer's written instructions.

C. Concrete Substrates: Remove coatings, including curing compounds, and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, without using solvents. Use mechanical methods recommended in writing by adhesive and carpet tile manufacturers.

D. Broom and vacuum clean substrates to be covered immediately before installing carpet tile.

3.3 INSTALLATION

A. General: Comply with CRI's "CRI Carpet Installation Standard," Section 18, "Modular Carpet" and with carpet tile manufacturer's most current written installation instructions.

B. Installation Method: Glue down; install every tile with full-spread, releasable, pressure-sensitive adhesive.

C. Maintain dye-lot integrity. Do not mix dye lots in same area.

D. Maintain pile-direction patterns indicated on Drawings.

E. Cut and fit carpet tile to butt tightly to vertical surfaces, permanent fixtures, and built-in furniture including cabinets, pipes, outlets, edgings, thresholds, and nosings. Bind or seal cut edges as recommended by carpet tile manufacturer.

F. Extend carpet tile into toe spaces, door reveals, closets, open-bottomed obstructions, removable flanges, alcoves, and similar openings.

G. Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating on carpet tile as marked on subfloor. Use nonpermanent, nonstaining marking device.

H. Install pattern parallel to walls and borders.

3.4 CLEANING AND PROTECTION

A. Perform the following operations immediately after installing carpet tile:

1. Remove excess adhesive and other surface blemishes using cleaner recommended by carpet tile manufacturer.
2. Remove yarns that protrude from carpet tile surface.
3. Vacuum carpet tile using commercial machine with face-beater element.

B. Protect installed carpet tile to comply with CRI's "Carpet Installation Standard," Section 20, "Protecting Indoor Installations."

C. Protect carpet tile against damage from construction operations and placement of equipment and fixtures during the remainder of construction period. Use protection methods indicated or recommended in writing by carpet tile manufacturer.

END OF SECTION 096813

SECTION 097200 - WALL COVERINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Wall covering.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include data on physical characteristics, durability, fade resistance, and fire-test-response characteristics.

B. Sustainable Design Submittals:

1. Product Data: For adhesives, indicating VOC content.
2. Laboratory Test Reports: For adhesives, indicating compliance with requirements for low-emitting materials.

C. Shop Drawings: Show location and extent of each wall-covering type. Indicate pattern placement, seams and termination points.

D. Samples: For each type of wall covering and for each color, pattern, texture, and finish specified, full width by 36-inch- (914-mm-) long in size.

1. Wall-Covering Sample: From same production run to be used for the Work, with specified treatments applied. Show complete pattern repeat. Mark top and face of fabric.

E. Product Schedule: For wall coverings. Use same designations indicated on Drawings.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For testing agency.

B. Product Test Reports: For each wall covering, for tests performed by a qualified testing agency.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: For wall coverings to include in maintenance manuals.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials, from the same product run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Wall-Covering Materials: For each type, color, texture, and finish, full width by length to equal to 5 percent of amount installed.

1.8 QUALITY ASSURANCE

A. Mockups: Build mockups to verify selections made under Sample submittals and to demonstrate aesthetic effects and to set quality standards for installation.

1. Build mockups for each type of wall covering on each substrate required. Comply with requirements in ASTM F 1141 for appearance shading characteristics.
2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.9 FIELD CONDITIONS

A. Environmental Limitations: Do not deliver or install wall coverings until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above ceilings is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at levels intended for occupants after Project completion during the remainder of the construction period.

1. Wood-Veneer Wall Coverings: Condition spaces for not less than 48 hours before installation.

B. Lighting: Do not install wall covering until lighting that matches conditions intended for occupants after Project completion is provided on the surfaces to receive wall covering.

C. Ventilation: Provide continuous ventilation during installation and for not less than the time recommended by wall-covering manufacturer for full drying or curing.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Fire-Test-Response Characteristics: As determined by testing identical wall coverings applied with identical adhesives to substrates according to test method indicated below by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Surface-Burning Characteristics: Comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

a. Flame-Spread Index: 25 or less.
b. Smoke-Developed Index: 50 or less.

2.2 WALL COVERING

A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings. No Substitutions.

B. Colors, Textures, and Patterns: As indicated on Drawings.

2.3 ACCESSORIES

A. Adhesive: Mildew-resistant, nonstaining, strippable adhesive, for use with specific wall covering and substrate application indicated and as recommended in writing by wall-covering manufacturer.

1. Adhesives shall have a VOC content of 50 g/L or less.

B. Primer/Sealer: Mildew resistant, complying with requirements in Section 099123 "Interior Painting" and recommended in writing by primer/sealer and wall-covering manufacturers for intended substrate.

C. Wall Liner: Nonwoven, synthetic underlayment and adhesive as recommended in writing by wall-covering manufacturer.

1. Adhesives shall have a VOC content of 50 g/L or less.

D. Seam Tape: As recommended in writing by wall-covering manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements for levelness, wall plumbness, maximum moisture content, and other conditions affecting performance of the Work.

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

3.2 PREPARATION

A. Comply with manufacturer's written instructions for surface preparation.

B. Clean substrates of substances that could impair bond of wall covering, including dirt, oil, grease, mold, mildew, and incompatible primers.

C. Prepare substrates to achieve a smooth, dry, clean, structurally sound surface free of flaking, unsound coatings, cracks, and defects.
   1. Gypsum Board: Prime with primer as recommended in writing by primer/sealer manufacturer and wall-covering manufacturer.
   2. Painted Surfaces: Treat areas susceptible to pigment bleeding.

D. Check painted surfaces for pigment bleeding. Sand gloss, semigloss, and eggshell finish with fine sandpaper.

E. Remove hardware and hardware accessories, electrical plates and covers, light fixture trims, and similar items.

F. Acclimatize wall-covering materials by removing them from packaging in the installation areas not less than 24 hours before installation.

3.3 WALL LINER INSTALLATION

A. Install wall liner, without gaps or overlaps. Form smooth wrinkle-free surface for finished installation. Do not begin wall-covering installation until wall liner has dried.

3.4 WALL-COVERING INSTALLATION

A. Comply with wall-covering manufacturers' written installation instructions applicable to products and applications indicated.

B. Cut wall-covering strips in roll number sequence. Change the roll numbers at partition breaks and corners.

C. Install strips in same order as cut from roll.

   1. For solid-color, even-texture, or random-match wall coverings, reverse every other strip.

D. Install wall covering without lifted or curling edges and without visible shrinkage.

E. Install seams vertical and plumb at least 6 inches (150 mm) from outside corners and 3 inches (75 mm) from inside corners unless a change of pattern or color exists at corner. Horizontal seams are not permitted.

F. Trim edges and seams for color uniformity, pattern match, and tight closure. Butt seams without overlaps or gaps between strips.

G. Fully bond wall covering to substrate. Remove air bubbles, wrinkles, blisters, and other defects.

3.5 CLEANING

A. Remove excess adhesive at seams, perimeter edges, and adjacent surfaces.

B. Use cleaning methods recommended in writing by wall-covering manufacturer.

C. Replace strips that cannot be cleaned.

D. Reinstall hardware and hardware accessories, electrical plates and covers, light fixture trims, and similar items.

END OF SECTION 097200

SECTION 099123 - INTERIOR PAINTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes surface preparation and the application of paint systems on interior substrates.

B. Related Requirements:

1. Section 055000 "Metal Fabrications" for shop priming metal fabrications.
2. Section 099300 "Staining and Transparent Finishing" for surface preparation and the application of wood stains and transparent finishes on interior wood substrates.

1.3 DEFINITIONS

A. MPI Gloss Level 1: Not more than five units at 60 degrees and 10 units at 85 degrees, according to ASTM D 523.

B. MPI Gloss Level 2: Not more than 10 units at 60 degrees and 10 to 35 units at 85 degrees, according to ASTM D 523.

C. MPI Gloss Level 3: 10 to 25 units at 60 degrees and 10 to 35 units at 85 degrees, according to ASTM D 523.

D. MPI Gloss Level 4: 20 to 35 units at 60 degrees and not less than 35 units at 85 degrees, according to ASTM D 523.

E. MPI Gloss Level 5: 35 to 70 units at 60 degrees, according to ASTM D 523.

F. MPI Gloss Level 6: 70 to 85 units at 60 degrees, according to ASTM D 523.

G. MPI Gloss Level 7: More than 85 units at 60 degrees, according to ASTM D 523.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product. Include preparation requirements and application instructions.

1. Include Printout of current "MPI Approved Products List" for each product category specified, with the proposed product highlighted.
2. Indicate VOC content.

B. Sustainable Design Submittals:

1. Product Data: For paints and coatings, indicating VOC content.

C. Samples for Initial Selection: For each type of topcoat product.

D. Samples for Verification: For each type of paint system and in each color and gloss of topcoat.

1. Submit Samples on rigid backing, 8 inches (200 mm) square.
2. Apply coats on Samples in steps to show each coat required for system.
3. Label each coat of each Sample.
4. Label each Sample for location and application area.

E. Product List: Cross-reference to paint system and locations of application areas. Use same designations indicated on Drawings and in schedules. Include color designations.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials, from the same product run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Paint: 5 percent, but not less than 1 gal. (3.8 L) of each material and color applied.

1.6 QUALITY ASSURANCE

A. Mockups: Apply mockups of each paint system indicated and each color and finish selected to verify preliminary selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.

1. Architect will select one surface to represent surfaces and conditions for application of each paint system.

a. Vertical and Horizontal Surfaces: Provide samples of at least 100 sq. ft. (9 sq. m).
b. Other Items: Architect will designate items or areas required.

2. Final approval of color selections will be based on mockups.

a. If preliminary color selections are not approved, apply additional mockups of additional colors selected by Architect at no added cost to Owner.

3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than 45 deg F (7 deg C).

1. Maintain containers in clean condition, free of foreign materials and residue.
2. Remove rags and waste from storage areas daily.

1.8 FIELD CONDITIONS

A. Apply paints only when temperature of surfaces to be painted and ambient air temperatures are between 50 and 95 deg F (10 and 35 deg C).

B. Do not apply paints when relative humidity exceeds 85 percent; at temperatures less than 5 deg F (3 deg C) above the dew point; or to damp or wet surfaces.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

1. Behr Process Corporation.
2. Benjamin Moore & Co.
3. PPG Architectural Coatings.
4. Sherwin-Williams Company (The).

2.2 PAINT, GENERAL

A. MPI Standards: Products shall comply with MPI standards indicated and shall be listed in its "MPI Approved Products Lists."

B. Material Compatibility:

1. Materials for use within each paint system shall be compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
2. For each coat in a paint system, products shall be recommended in writing by topcoat manufacturers for use in paint system and on substrate indicated.

C. VOC Content: For field applications that are inside the weatherproofing system, paints and coatings shall comply with VOC content limits of authorities having jurisdiction and the following VOC content limits:

1. Flat Paints and Coatings: 50 g/L.
2. Nonflat Paints and Coatings: 150 g/L.
3. Dry-Fog Coatings: 400 g/L.
4. Primers, Sealers, and Undercoaters: 200 g/L.
5. Anticorrosive and Antirust Paints Applied to Ferrous Metals: 250 g/L.
6. Zinc-Rich Industrial Maintenance Primers: 340 g/L.
7. Pretreatment Wash Primers: 420 g/L.
8. Shellacs, Clear: 730 g/L.
9. Shellacs, Pigmented: 550 g/L.

D. Colors: As indicated on Drawings.

2.3 SOURCE QUALITY CONTROL

A. Testing of Paint Materials: Owner reserves the right to invoke the following procedure:

1. Owner will engage the services of a qualified testing agency to sample paint materials. Contractor will be notified in advance and may be present when samples are taken. If paint materials have already been delivered to Project site, samples may be taken at Project site. Samples will be identified, sealed, and certified by testing agency.
2. Testing agency will perform tests for compliance with product requirements.
3. Owner may direct Contractor to stop applying paints if test results show materials being used do not comply with product requirements. Contractor shall remove noncomplying paint materials from Project site, pay for testing, and repaint surfaces painted with rejected materials. Contractor will be required to remove rejected materials from previously painted surfaces if, on repainting with complying materials, the two paints are incompatible.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.

B. Maximum Moisture Content of Substrates: When measured with an electronic moisture meter as follows:

1. Concrete: 12 percent.
2. Masonry (Clay and CMUs): 12 percent.
3. Wood: 15 percent.
4. Gypsum Board: 12 percent.
5. Plaster: 12 percent.

C. Gypsum Board Substrates: Verify that finishing compound is sanded smooth.

D. Plaster Substrates: Verify that plaster is fully cured.

E. Verify suitability of substrates, including surface conditions and compatibility, with existing finishes and primers.

F. Proceed with coating application only after unsatisfactory conditions have been corrected.

1. Application of coating indicates acceptance of surfaces and conditions.

3.2 PREPARATION

A. Comply with manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual" applicable to substrates and paint systems indicated.

B. Remove hardware, covers, plates, and similar items already in place that are removable and are not to be painted. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and painting.

1. After completing painting operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection if any.

C. Clean substrates of substances that could impair bond of paints, including dust, dirt, oil, grease, and incompatible paints and encapsulants.

1. Remove incompatible primers and reprime substrate with compatible primers or apply tie coat as required to produce paint systems indicated.

D. Concrete Substrates: Remove release agents, curing compounds, efflorescence, and chalk. Do not paint surfaces if moisture content or alkalinity of surfaces to be painted exceeds that permitted in manufacturer's written instructions.

E. Masonry Substrates: Remove efflorescence and chalk. Do not paint surfaces if moisture content or alkalinity of surfaces or mortar joints exceeds that permitted in manufacturer's written instructions.

F. Steel Substrates: Remove rust, loose mill scale, and shop primer, if any. Clean using methods recommended in writing by paint manufacturer. but not less than the following:

1. SSPC-SP 2.
2. SSPC-SP 3.
3. SSPC-SP 7/NACE No. 4.
4. SSPC-SP 11.

G. Shop-Primed Steel Substrates: Clean field welds, bolted connections, and areas where shop paint is abraded. Paint exposed areas with the same material as used for shop priming to comply with SSPC-PA 1 for touching up shop-primed surfaces.

H. Galvanized-Metal Substrates: Remove grease and oil residue from galvanized sheet metal by mechanical methods to produce clean, lightly etched surfaces that promote adhesion of subsequently applied paints.

I. Wood Substrates:

1. Scrape and clean knots, and apply coat of knot sealer before applying primer.
2. Sand surfaces that will be exposed to view, and dust off.
3. Prime edges, ends, faces, undersides, and backsides of wood.
4. After priming, fill holes and imperfections in the finish surfaces with putty or plastic wood filler. Sand smooth when dried.

3.3 APPLICATION

A. Apply paints according to manufacturer's written instructions and to recommendations in "MPI Manual."

1. Use applicators and techniques suited for paint and substrate indicated.

2. Paint surfaces behind movable equipment and furniture same as similar exposed surfaces. Before final installation, paint surfaces behind permanently fixed equipment or furniture with prime coat only.
3. Paint front and backsides of access panels, removable or hinged covers, and similar hinged items to match exposed surfaces.
4. Do not paint over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.
5. Primers specified in painting schedules may be omitted on items that are factory primed or factory finished if acceptable to topcoat manufacturers.

B. Tint each undercoat a lighter shade to facilitate identification of each coat if multiple coats of same material are to be applied. Tint undercoats to match color of topcoat, but provide sufficient difference in shade of undercoats to distinguish each separate coat.

C. If undercoats or other conditions show through topcoat, apply additional coats until cured film has a uniform paint finish, color, and appearance.

D. Apply paints to produce surface films without cloudiness, spotting, holidays, laps, brush marks, roller tracking, runs, sags, ropiness, or other surface imperfections. Cut in sharp lines and color breaks.

E. Painting Fire Suppression, Plumbing, HVAC, Electrical, Communication, and Electronic Safety and Security Work:

1. Paint the following work where exposed in equipment rooms:

    a. Equipment, including panelboards and switch gear.
    b. Uninsulated metal piping.
    c. Uninsulated plastic piping.
    d. Pipe hangers and supports.
    e. Metal conduit.
    f. Plastic conduit.
    g. Tanks that do not have factory-applied final finishes.
    h. Duct, equipment, and pipe insulation having cotton or canvas insulation covering or other paintable jacket material.

2. Paint the following work where exposed in occupied spaces:

    a. Equipment, including panelboards.
    b. Uninsulated metal piping.
    c. Uninsulated plastic piping.
    d. Pipe hangers and supports.
    e. Metal conduit.
    f. Plastic conduit.
    g. Duct, equipment, and pipe insulation having cotton or canvas insulation covering or other paintable jacket material.
    h. Other items as directed by Architect.

3. Paint portions of internal surfaces of metal ducts, without liner, behind air inlets and outlets that are visible from occupied spaces.

3.4 FIELD QUALITY CONTROL

A. Dry Film Thickness Testing: Owner may engage the services of a qualified testing and inspecting agency to inspect and test paint for dry film thickness.

1. Contractor shall touch up and restore painted surfaces damaged by testing.
2. If test results show that dry film thickness of applied paint does not comply with paint manufacturer's written recommendations, Contractor shall pay for testing and apply additional coats as needed to provide dry film thickness that complies with paint manufacturer's written recommendations.

3.5 CLEANING AND PROTECTION

A. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.

B. After completing paint application, clean spattered surfaces. Remove spattered paints by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.

C. Protect work of other trades against damage from paint application. Correct damage to work of other trades by cleaning, repairing, replacing, and refinishing, as approved by Architect, and leave in an undamaged condition.

D. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

3.6 INTERIOR PAINTING SCHEDULE

A. Steel Substrates: HM doors and frames.

1. Institutional Low-Odor/VOC Latex System MPI INT 5.1S:

a. Prime Coat: Primer, rust inhibitive, water based MPI #107.

b. Intermediate Coat: Latex, interior, institutional low odor/VOC, matching topcoat.

c. Topcoat: Latex, interior, institutional low odor/VOC, semi-gloss (MPI Gloss Level 5), MPI #147.

1) Sherwin Williams ProMar 200 Zero VOC Latex Semi-Gloss, B31-2600 Series, at 4.0 mils wet, 1.6 mils dry, per coat.

B. Wood Substrates: Wood trim.

1. Institutional Low-Odor/VOC Latex System MPI INT 6.3V:

a. Prime Coat: Primer, latex, for interior wood, MPI #39.

b. Intermediate Coat: Latex, interior, institutional low odor/VOC, matching topcoat.

c. Topcoat: Latex, interior, institutional low odor/VOC, semi-gloss (MPI Gloss Level 5), MPI #147.

1) Sherwin Williams ProMar 200 Zero VOC Latex Semi-Gloss, B31-2600 Series, at 4.0 mils wet, 1.6 mils dry, per coat.

C. Gypsum Board and Plaster Substrates:

1. Institutional Low-Odor/VOC Latex System MPI INT 9.2M:

a. Prime Coat: Primer sealer, interior, institutional low odor/VOC, MPI #149.

1) Sherwin Williams; Premium Wall and Wood Primer B28W8111.

b. Intermediate Coat: Latex, interior, institutional low odor/VOC, matching topcoat.
c. Topcoat: Latex, interior, institutional low odor/VOC, flat (MPI Gloss Level 1)**,** MPI #143. Ceilings and where indicated.

1) Sherwin Williams; ProMar 200 Zero VOC Latex Flat, B30-2600 Series at 4.0 mils wet, 1.6 mils dry, per coat.

d. Topcoat: Latex, interior, institutional low odor/VOC (MPI Gloss Level 2), MPI #144. Walls and where indicated.

1) Sherwin Williams; ProMar 200 Zero VOC Low Sheen Eg-Shel B24W02651 at 4.0 mils wet, 1.6 mils dry, per coat.

END OF SECTION 099123

SECTION 099300 - STAINING AND TRANSPARENT FINISHING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes surface preparation and application of wood stains and transparent finishes**.**

1.3 DEFINITIONS

A. MPI Gloss Level 1: Not more than 5 units at 60 degrees and 10 units at 85 degrees, according to ASTM D 523.

B. MPI Gloss Level 4: 20 to 35 units at 60 degrees and not less than 35 units at 85 degrees, according to ASTM D 523.

C. MPI Gloss Level 5: 35 to 70 units at 60 degrees, according to ASTM D 523.

D. MPI Gloss Level 6: 70 to 85 units at 60 degrees, according to ASTM D 523.

E. MPI Gloss Level 7: More than 85 units at 60 degrees, according to ASTM D 523.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product. Include preparation requirements and application instructions.

1. Include printout of current "MPI Approved Products List" for each product category specified, with the proposed product highlighted.
2. Indicate VOC content.

B. Sustainable Design Submittals:

1. Product Data: For paints and coatings, indicating VOC content.

C. Samples for Initial Selection: For each type of product.

D. Samples for Verification: For each type of finish system and in each color and gloss of finish required.

1. Submit Samples on representative samples of actual wood substrates, 8 inches (200 mm) square or 8 inches (200 mm) long.
2. Apply coats on Samples in steps to show each coat required for system.

3. Label each coat of each Sample.
4. Label each Sample for location and application area.

E. Product List: Cross-reference to finish system and locations of application areas. Use same designations indicated on Drawings and in schedules. Include color designations.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials, from the same product run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Stains and Transparent Finishes: 5 percent, but not less than 1 gal. (3.8 L) of each material and color applied.

1.6 QUALITY ASSURANCE

A. Mockups: Apply mockups of each finish system indicated and each color selected to verify preliminary selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.

1. Architect will select one surface to represent surfaces and conditions for application of each type of finish system and substrate.

a. Vertical and Horizontal Surfaces: Provide samples of at least 100 sq. ft. (9 sq. m).
b. Other Items: Architect will designate items or areas required.

2. Final approval of stain color selections will be based on mockups.

a. If preliminary stain color selections are not approved, apply additional mockups of additional stain colors selected by Architect at no added cost to Owner.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than 45 deg F (7 deg C).

1. Maintain containers in clean condition, free of foreign materials and residue.
2. Remove rags and waste from storage areas daily.

1.8 FIELD CONDITIONS

A. Apply finishes only when temperature of surfaces to be finished and ambient air temperatures are between 50 and 95 deg F (10 and 35 deg C).

B. Do not apply finishes when relative humidity exceeds 85 percent, at temperatures less than 5 deg F (3 deg C) above the dew point, or to damp or wet surfaces.

C. Do not apply exterior finishes in snow, rain, fog, or mist.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Benjamin Moore & Co.
2. PPG Architectural Coatings.
3. Sherwin-Williams Company (The).

2.2 MATERIALS, GENERAL

A. MPI Standards: Products shall comply with MPI standards indicated and shall be listed in its "MPI Approved Products List."

B. Material Compatibility:

1. Materials for use within each paint system shall be compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
2. For each coat in a paint system, products shall be recommended in writing by manufacturers of topcoat for use in paint system and on substrate indicated.

C. VOC Content: For field applications that are inside the weatherproofing system, paints and coatings shall comply with VOC content limits of authorities having jurisdiction and the following VOC content limits:

1. Clear Wood Finishes, Varnishes: 350 g/L.
2. Clear Wood Finishes, Lacquers: 550 g/L.
3. Shellacs, Clear: 730 g/L.
4. Stains: 250 g/L.

D. Stain Colors: As indicated on Drawings.

2.3 SOURCE QUALITY CONTROL

A. Testing of Materials: Owner reserves the right to invoke the following procedure:

1. Owner will engage the services of a qualified testing agency to sample wood finishing materials. Contractor will be notified in advance and may be present when samples are taken. If materials have already been delivered to Project site, samples may be taken at Project site. Samples will be identified, sealed, and certified by testing agency.
2. Testing agency will perform tests for compliance with product requirements.
3. Owner may direct Contractor to stop applying wood finishes if test results show materials being used do not comply with product requirements. Contractor shall remove noncomplying materials from Project site, pay for testing, and refinish surfaces finished with rejected materials. Contractor will be required to remove rejected materials from previously finished surfaces before refinishing with complying materials if the two finishes are incompatible or produce results that, in the opinion of the Architect, are aesthetically unacceptable.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.

B. Maximum Moisture Content of Interior Wood Substrates: 10 percent, when measured with an electronic moisture meter.

C. Verify suitability of substrates, including surface conditions and compatibility with existing finishes and primers.

D. Proceed with finish application only after unsatisfactory conditions have been corrected.

1. Beginning finish application constitutes Contractor's acceptance of substrates and conditions.

3.2 PREPARATION

A. Comply with manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual" applicable to substrates indicated.

B. Remove hardware, covers, plates, and similar items already in place that are removable. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and finishing.

1. After completing finishing operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection if any.

C. Clean and prepare surfaces to be finished according to manufacturer's written instructions for each substrate condition and as specified.

1. Remove dust, dirt, oil, and grease by washing with a detergent solution; rinse thoroughly with clean water and allow to dry. Remove grade stamps and pencil marks by sanding lightly. Remove loose wood fibers by brushing.
2. Remove mildew by scrubbing with a commercial wash formulated for mildew removal and as recommended by stain manufacturer.

D. Interior Wood Substrates:

1. Scrape and clean knots, and apply coat of knot sealer before applying primer.
2. Apply wood filler paste to open-grain woods, as defined in "MPI Architectural Painting Specification Manual," to produce smooth, glasslike finish.
3. Sand surfaces exposed to view and dust off.
4. After priming, fill holes and imperfections in the finish surfaces with putty or plastic wood filler. Sand smooth when dry.

3.3 APPLICATION

A. Apply finishes according to manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual."

1. Use applicators and techniques suited for finish and substrate indicated.
2. Finish surfaces behind movable equipment and furniture same as similar exposed surfaces.
3. Do not apply finishes over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.

B. Apply finishes to produce surface films without cloudiness, holidays, lap marks, brush marks, runs, ropiness, or other surface imperfections.

3.4 CLEANING AND PROTECTION

A. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.

B. After completing finish application, clean spattered surfaces. Remove spattered materials by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.

C. Protect work of other trades against damage from finish application. Correct damage by cleaning, repairing, replacing, and refinishing, as approved by Architect, and leave in an undamaged condition.

D. At completion of construction activities of other trades, touch up and restore damaged or defaced finished wood surfaces.

3.5 INTERIOR WOOD -FINISH-SYSTEM SCHEDULE

A. Wood Substrates: Wood trim, architectural woodwork and wood board paneling.

1. Water-Based Varnish over Stain System MPI INT 6.3W:

a. Stain Coat: Stain, semitransparent, for interior wood, MPI #90.
b. First Intermediate Coat: Water-based varnish matching topcoat.
c. Second Intermediate Coat: Water-based varnish matching topcoat.
d. Topcoat: Varnish, water based, clear, satin (MPI Gloss Level 4), MPI #128.
e. Topcoat: Varnish, water based, clear, semi-gloss (MPI Gloss Level 5), MPI #129.
f. Topcoat: Varnish, water based, clear, gloss (MPI Gloss Level 6), MPI #130.

2. Polyurethane Varnish over Stain System MPI INT 6.3E:

a. Stain Coat: Stain, semitransparent, for interior wood, MPI #90.
b. First Intermediate Coat: Polyurethane varnish matching topcoat.
c. Second Intermediate Coat: Polyurethane varnish matching topcoat.
d. Topcoat: Varnish, interior, polyurethane, oil modified, satin (MPI Gloss Level 4), MPI #57.
e. Topcoat: Varnish, interior, polyurethane, oil modified, gloss (MPI Gloss Level 6), MPI #56.

END OF SECTION 099300

SECTION 101100 - VISUAL DISPLAY UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Visual display board assemblies.
2. Tackable wallcovering.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, finishes, and accessories for visual display units.

B. Sustainable Design Submittals:

1. Product Data: For installation adhesives, indicating VOC content.
2. Laboratory Test Reports: For installation adhesives, indicating compliance with requirements for low-emitting materials.

C. Shop Drawings: For visual display units.

1. Include plans, elevations, sections, details, and attachment to other work.
2. Show locations of panel joints. Show locations of field-assembled joints for factory-fabricated units too large to ship in one piece.
3. Show locations and layout of special-purpose graphics.
4. Include sections of typical trim members.

D. Samples for Initial Selection: For each type of visual display unit indicated, for units with factory-applied color finishes, and as follows:

1. Samples of facings for each visual display panel type, indicating color and texture.
2. Actual factory-finish color samples, applied to aluminum substrate.
3. Include accessory Samples to verify color selected.

E. Samples for Verification: For each type of visual display unit indicated.

1. Visual Display Panel and Tackable Wallcoverings: Not less than 8-1/2 by 11 inches (215 by 280 mm), with facing, core, and backing indicated for final Work. Include one panel for each type, color, and texture required.
2. Trim: 6-inch- (150-mm-) long sections of each trim profile.
3. Display Rail: 6-inch- (150-mm-) long section of each type.
4. Accessories: Full-size Sample of each type of accessory.

F. Product Schedule: For visual display units. Use same designations indicated on Drawings**.**

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer.

B. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for surface-burning characteristics of tackboards.

C. Sample Warranties: For special warranties.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: For visual display units to include in maintenance manuals.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.

B. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for fabrication and installation.

1. Build mockup of typical visual display unit as shown on Drawings. Include accessories.
2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver factory-fabricated visual display units completely assembled in one piece. If dimensions exceed maximum manufactured unit size, or if unit size is impracticable to ship in one piece, provide two or more pieces with joints in locations indicated on approved Shop Drawings.

1.9 PROJECT CONDITIONS

A. Environmental Limitations: Do not deliver or install visual display units until spaces are enclosed and weathertight, wet-work in spaces is complete and dry, work above ceilings is complete, and

temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

B. Field Measurements: Verify actual dimensions of construction contiguous with visual display units by field measurements before fabrication.

1. Allow for trimming and fitting where taking field measurements before fabrication might delay the Work.

1.10 WARRANTY

A. Special Warranty for Porcelain-Enamel Face Sheets: Manufacturer agrees to repair or replace porcelain-enamel face sheets that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Surfaces lose original writing and erasing qualities.
b. Surfaces exhibit crazing, cracking, or flaking.

2. Warranty Period: 50 years from date of Substantial Completion.
3. Warranty Period: Life of the building.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Source Limitations: Obtain each type of visual display unit from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Surface-Burning Characteristics: Comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Flame-Spread Index: 25 or less.
2. Smoke-Developed Index: 50 or less.

2.3 VISUAL DISPLAY BOARD ASSEMBLY

A. Basis-of-Design Product: Subject to compliance with requirements, provide Steelcase PolyVision 110 Series or comparable product by one of the following:

1. A-1 Visual Systems.
2. Claridge Products and Equipment, Inc.
3. Egan Visual Inc.
4. EverWhite.
5. Ghent Manufacturing, Inc.
6. Marsh Industries, Inc.

7. Newline Products, Inc.
8. Peter Pepper Products, Inc.
9. Platinum Visual Systems.

B. Visual Display Board Assembly: Factory fabricated.

1. Assembly: Markerboard.
2. Corners: Square.
3. Width: As indicated on Drawings.
4. Height: As indicated on Drawings.
5. Mounting Method: Direct to wall.

C. Markerboard Panel: PolyVision e3 Ceramic Steel markerboard panel on core indicated.

1. Color: As selected by Architect from full range of industry colors.

D. Aluminum Frames and Trim: Fabricated from not less than 0.062-inch- (1.57-mm-) thick, extruded aluminum; of size and shape indicated on Drawings.
1. Aluminum Finish: Clear anodic finish.

E. Joints: Make joints only where total length exceeds maximum manufactured length. Fabricate with minimum number of joints, as indicated on approved Shop Drawings.

F. Chalktray: Manufacturer's standard; continuous.

1. Solid Type: Extruded aluminum with ribbed section and smoothly curved exposed ends.

2.4 TACKABLE WALLCOVERINGS

A. Basis-of-Design Product: Subject to compliance with requirements, provide the following:

1. Walltalkers, a Division of RJF International Corporation; tac-wall.

B. Tackable wall covering: Uni-color, resilient, homogeneous, tackable linoleum surface consisting of linseed oil, granulated cork, rosin binders ,and dry pigments calendared onto natural burlap backing. Color shall extend through thickness of material.

1. Color: As indicated on Drawings.

C. Aluminum Frames and Trim: Fabricated from not less than 0.062-inch- (1.57-mm-) thick, extruded aluminum; of size and shape indicated on Drawings.

1. Field-Applied Trim: Manufacturer's standard, snap-on trim with no visible screws or exposed joints.
2. Aluminum Finish: Clear anodic finish.

D. Joints: Make joints only where total length exceeds maximum manufactured length. Fabricate with minimum number of joints, as indicated on approved Shop Drawings.

E. Adhesive: Solvent-free, SBR type linoleum adhesive (L-910) or polyvinyl acetate dispersion type (contact adhesive) when used in press

2.5 MATERIALS

A. Porcelain-Enamel Face Sheet: PEI-1002, with face sheet manufacturer's standard two- or three-coat process.

B. Extruded Aluminum: ASTM B 221 (ASTM B 221M), Alloy 6063.

2.6 GENERAL FINISH REQUIREMENTS

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

C. Appearance of Finished Work: Noticeable variations in same piece are unacceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.7 ALUMINUM FINISHES

A. Clear Anodic Finish: AAMA 611, AA-M12C22A31, Class II, 0.010 mm or thicker.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements for installation tolerances, surface conditions of wall, and other conditions affecting performance of the Work.

B. Examine walls and partitions for proper preparation and backing for visual display units.

C. Examine walls and partitions for suitable framing depth where sliding visual display units will be installed.

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

3.2 PREPARATION

A. Comply with manufacturer's written instructions for surface preparation.

B. Clean substrates of substances, such as dirt, mold, and mildew, that could impair the performance of and affect the smooth, finished surfaces of visual display boards.

C. Prepare surfaces to achieve a smooth, dry, clean surface free of flaking, unsound coatings, cracks, defects, projections, depressions, and substances that will impair bond between visual display units and wall surfaces.

3.3 INSTALLATION

A. General: Install visual display surfaces in locations and at mounting heights indicated on Drawings. Keep perimeter lines straight, level, and plumb. Provide grounds, clips, backing materials, adhesives, brackets, anchors, trim, and accessories necessary for complete installation.

B. Factory-Fabricated Visual Display Board Assemblies: Attach concealed clips, hangers, and grounds to wall surfaces and to visual display board assemblies with fasteners at not more than 16 inches (400 mm) o.c. Secure tops and bottoms of boards to walls.

3.4 CLEANING AND PROTECTION

A. Clean visual display units according to manufacturer's written instructions. Attach one removable cleaning instructions label to visual display unit in each room.

B. Touch up factory-applied finishes to restore damaged or soiled areas.

C. Cover and protect visual display units after installation and cleaning.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain motorized, sliding visual display units.

END OF SECTION 101100

SECTION 102215 – FIXED GLASS PANEL PARTITIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes fixed, frameless glass panel partitions with swinging and sliding glass doors.

B. Related Requirements: Related project requirements can be found in the following documents:

1. Section 055000 "Metal Fabrications" for overhead supports that attach glass panel partition tracks to structure.

2. Section 081416 “Flush Wood Doors” for sliding wood door requirements.

3. Division 8 and Division 28 for security access system providing control for door access and intrusion detection systems interfacing with glass panel partition door controls.

1.3 REFERENCE STANDARDS

A. American Architectural Manufacturers Association (AAMA): www.aama.org:

1. AAMA 611 Voluntary Specification for Anodized Architectural Aluminum

B. American Society of Civil Engineers/Structural Engineering Institute (ASCE/SEI): www.asce.org:

1. ASCE/SEI 7 Minimum Design Loads for Buildings and Other Structure

C. ASTM International (ASTM): www.astm.org:

1. ASTM A666 Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar
2. ASTM B221/ASTM B221M Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes
3. ASTM C1048 Standard Specification for Heat-Strengthened and Fully Tempered Flat Glass
4. ASTM C1172 Standard Specification for Laminated Architectural Flat Glass
5. ASTM E90 Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements
6. ASTM E413 Classification for Rating Sound Insulation
7. ASTM E557 Guide for the Installation of Operable Partitions

D. Builders Hardware Manufacturers Association (BHMA): www.buildershardware.com:

1. ANSI/BHMA A156 Series

E. Code of Federal Regulations

1. 16 CFR 1201 Safety Standard for Architectural Glazing Materials

F. International Code Council (ICC): www.iccsafe.org:

1. ICC A117.1 Accessible and Usable Buildings and Facilities (ANSI)

G. U.S. Architectural & Transportation Barriers Compliance Board: www.access-board.gov:

1. Americans with Disabilities Act (ADA) and Architectural Barriers Act (ABA) Accessibility Guidelines for Buildings and Facilities

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate installation of glass panel partitions with installation of floor, wall, and ceiling construction to comply with substrate tolerance requirements of partition manufacturer.
2. Coordinate installation of anchors and secondary structural members indicated on approved glass panel partition shop drawings and specified in other sections.

B. Preinstallation Conference: Conduct conference at Project Site.

1.5 ACTION SUBMITTALS

A. Product Data: For each glass panel partition and door component specified, including:

1. Glass panels.
2. Frame and sill tracks.
3. Door hardware and accessories.

B. Sustainable Design Submittals:

1. Product Data: For sealants, indicating VOC content.
2. Laboratory Test Reports: For sealants, indicating compliance with requirements for low-emitting materials.

C. Shop Drawings: For fixed glass panel partitions.

1. Include plans, elevations, sections, and details. Provide numbered panel installation sequence.
2. Show locations and requirements for tracks, bracing, blocking, and attachments to other work.

D. Samples for Verification: For each exposed component including hardware, for each color and finish selected, of size indicated below:

1. Glass: Units 12 inches (300 mm) square.
2. Exposed Frame, Track, and Sill Members: Not less than 6 inches (150 mm) long.
3. Hardware: One of each type of exposed door hardware items.

E. Delegated-Design Submittal: For fixed glass panel partitions systems indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified installer.

B. Warranty: Sample of unexecuted manufacturer warranty.

1.7 CLOSEOUT SUBMITTALS

A. Maintenance Data: For all-glass systems to include in maintenance manuals.

1.8 QUALITY ASSURANCE

A. Installer Qualifications: Experienced Installer equipped and trained for installation of glass panel partitions required for this Project with record of successful completion of not less than five projects of similar scope.

B. Single Source Responsibility: Provide glass panel partitions and associated hardware by a single manufacturer through a single source.

C. Mockups: Provide mockup consisting of initial sections of tracks, frames, and glass panels with operating doors and hardware, in location as directed by Architect. Proceed with work upon approval of mockup by Architect.

1.9 WARRANTY

A. Special Manufacturer's Warranty: Standard form in which manufacturer agrees to repair or replace components of glass panel partitions that demonstrate deterioration or faulty operation due to defects in materials or workmanship under normal use within warranty period specified.

1. Warranty Period: Five years from the date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Basis-of-Design Product: Provide PURE Frameless glass panel partitions with sliding and swinging glass doors, manufactured by DORMA USA, Inc. No Substitutions.

2.2 PERFORMANCE REQUIREMENTS

A. Acoustical Performance: Provide glass panel partition tested by qualified testing agency as follows:

1. Sound-Transmission Requirements: Tested for laboratory sound-transmission loss performance according to ASTM E90, determined by ASTM E413, and rated for not less than STC indicated.

B. Seismic Performance: All-glass entrances and storefronts shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

2.3 GLASS PANEL PARTITIONS

A. Fixed Glass Panel Partitions: Frameless glass panel partition with top track and bottom sill guide, with butt-glazed dry joint between panels, and equipped with sliding doors where indicated.

1. Partition Top Track: Aluminum extrusion, low-profile.
2. Sill Guide: Aluminum extrusion.

2.4 GLASS PANELS AND DOORS

A. Glass Panels, General: Provide glass panels that comply with 16 CFR 1201, Category II requirements for safety glazing. Permanently mark glazing with certification label of the SGCC.

1. Glass and Door Panel Thickness: Thickness required for size of panel based upon manufacturer's written recommendations, but not less than 12 mm.
2. Exposed Edges: Machine ground and flat polished.
3. Butt Edges: Flat ground.
4. Corner Edges: Lap-joint corners with exposed edges polished.

B. Fully Tempered Clear Float Glass: ASTM C1048, Kind FT, Condition A, Type I, Class 1, Quality-Q3; thickness 12.0 mm.

2.5 SLIDING DOORS

A. Accessibility Standard: Comply with applicable provisions in ADA-ABA Accessibility Guidelines for Buildings and Facilities and ICC A117.1.

B. Doors: Glass panel matching partition panel material and thickness, of size indicated on Drawings.

C. Sliding Door Track: Extruded aluminum track designed for operation, size, and weight of glass panel door, with factory-finished head closure trim and seals as required for acoustical performance indicated.

D. Track Mounting:

1. Ceiling surface-mounted.

E. Door Panel Carriers: Trolley system designed for operation, size, and weight of glass panel door, with ball-bearing wheels.

F. Manual Sliding Door Operation:

1. Single door.

a. Basis of Design: DORMA MANET.

2.6 MATERIALS

A. Aluminum: ASTM B221 (ASTM B221M), with strength and durability characteristics of not less than Alloy 6063-T5.

B. Stainless Steel: ASTM A666, Type 304.

2.7 FINISHES

A. Stainless Steel Finishes: No. 4 directional satin finish.

2.8 DOOR HARDWARE AND FITTINGS

A. Door Hardware, General: All-glass door hardware units in types, sizes, quantities, and mounting locations recommended by manufacturer for glass door types, sizes, and operation. For exposed components, match metal and finish of exposed partition fittings unless otherwise noted.

B. Locking Ladder Pull: Pair of tubular lockable pull handles with thumb turns, Grade 316L stainless steel, accommodating key cylinder, with head-mounted deadbolt.

1. Basis of Design: DORMA, Locking Ladder Pulls.

2. Unit Length: Refer to Door Schedule for unit length.

C. Pulls and Handles: Back-to-back, minimum 1-3/8 inch diameter.

1. Design: Round.

D. Mechanical Locks and Latches:

1. Center Housing Locks: BHMA A156.13; Grade 1.

a. Basis of Design: DORMA, M9000 Series.

2. Lock and Latch Housings: Patch mounting to glass panel door, with matching strike mounted in housing on adjacent glass panel.

a. Design: As selected by Architect from manufacturer's standard designs.

E. Lock Cylinders: Tumbler type, constructed from brass or bronze, stainless steel, or nickel silver; BHMA A156.5, Grade 1, permanent removable cores; with face finish matching lockset, keyed to master key system.

F. Patch Fittings for Swinging Doors: At head and sill on pivot side, and at lock and strike at swing side.

1. Basis of Design: DORMA, PURE Pivot Header.

G. Concealed Overhead Closers and Bottom Pivots: Center hung; BHMA A156.4, Grade 1. Provide housings, bottom arms, top walking beam pivots, mounting plates, and accessories.

1. Basis of Design: DORMA, floating header.
2. Swing: Single acting, with positive dead stop.
3. Opening Force: Comply with interior door operating force of authorities having jurisdiction for accessibility requirements and egress doors .

H. Accessory Fittings: Overhead doorstop.

2.9 BUTT-GLAZING SEALANTS

A. Single-Component, Nonsag, Acid-Curing Silicone Joint Sealant: ASTM C 920, Type S, Grade NS, Class 25, for Uses NT, G, and A.

1. Sealant shall have a VOC content of 250 g/L or less.

2.10 FABRICATION

A. Provide holes and cutouts in glass to receive hardware, fittings, and accessory fittings before tempering glass. Do not cut, drill, or make other alterations to glass after tempering.

1. Fully temper glass using horizontal (roller-hearth) process, and fabricate so that when glass is installed, roll-wave distortion is parallel with bottom edge of door or lite.

B. Factory assemble components and factory install hardware and fittings to greatest extent possible.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine partition substrates to determine if work is within glass panel partition manufacturer's required tolerances and ready to receive work. Proceed with installation of partitions once conditions affecting installation and performance of partitions meet manufacturer's requirements.

B. Verify that partition construction adjacent to acoustically-rated glass panel partitions complies with requirements of ASTM E557.

3.2 PARTITION INSTALLATION

A. General: Comply with glass panel partition manufacturer's written installation instructions and approved shop drawings.

B. Install glass panel partitions after other finishing operations have been completed.

C. Set units level, plumb, and true to line, with uniform joints.

D. Fasten glass panel partition track and sill to building structure and supports as indicated on approved shop drawings, utilizing approved fasteners and spacing.

E. Set, seal, and grout floor closer cases.

3.3 ADJUSTING

A. Adjust door closers to required timing and force.

B. Adjust latches and locks for smooth operation.

C. Test and adjust hardware linked to access control system.

D. Replace damaged panels and accessories.

E. Adjust doors and hardware to produce smooth operation and tight, uniform fit.

3.4 CLEANING

A. Clean glass panels in accordance with glass manufacturer's written instructions. Do not use cleaning agents or methods not approved by glass manufacturer.

B. Clean exposed metal surfaces to factory new appearance.

Hardware Set : 22.0 (Wood Sliding Barn Doors)
Door Openings: 116, 117, 119, 120, 121, 122, 124, 125, 131, 132, 135, 136, 137, 138, 140, 141

1 ea.	Sliding Door Track Assembly	Dorma Manet	Dorma
1 ea	Locking Ladder Pulls	Top Locking Back to Back Mounting	Dorma
1 ea.	Cylinder		Dorma

* All Hardware for these door openings to be provided under this section.
* Lay-out and hardware to match Sliding Door Assemblies in Phase 1 & Phase 2.

Hardware Set : 23.0 (Glass Sliding Barn Doors)
Door Openings: 115

1 ea.	Sliding Door Track Assembly/ Guides	Dorma Manet	Dorma
1 set	Ladder Pulls	Back to Back Mounting	Dorma

* All Hardware for these door openings to be provided under this section.
* Lay-out and hardware to match Sliding Door Assemblies in Phase 1 & Phase 2.
* GC and supplying distributor to coordinate and verify changes made in the field to glass sliding doors

Hardware Set: 23.1 (Swinging Glass Door)
Door Openings: 151A, 151B, 151C, 151D, 152A, 152B, 152C, 152D

2 ea.	Ladder Pulls Back to Back Mounting
1 ea.	Floating Header with Concealed Closer Dorma
1 ea.	Top and Bottom Pivots Dorma

* All Hardware for these door openings to be provided under this section.
* Lay-out and hardware to match Swinging Door Assemblies in Phase 1 & Phase 2.

END OF SECTION 102215

SECTION 102600 - WALL AND DOOR PROTECTION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Wall guards.
2. Corner guards.

B. Related Requirements:

1. Section 055000 "Metal Fabrications" for steel angle corner guards.
2. Section 087100 "Door Hardware" for metal protective trim units, according to BHMA A156.6, used for armor, kick, mop, and push plates.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, impact strength, dimensions of individual components and profiles, and finishes.

B. Shop Drawings: For each type of wall and door protection showing locations and extent.

1. Include plans, elevations, sections, and attachment details.

C. Samples for Verification: For each type of exposed finish on the following products, prepared on Samples of size indicated below:

1. Wall Guards: 12 inches (300 mm) long. Include examples of joinery, corners, and field splices.
2. Corner Guards: 12 inches (300 mm) long. Include example top caps.

1.4 INFORMATIONAL SUBMITTALS

A. Product Certificates: For each type of handrail.

B. Material Certificates: For each type of exposed plastic material.

C. Sample Warranty: For special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For each type of wall and door protection product to include in maintenance manuals.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Store wall and door protection in original undamaged packages and containers inside well-ventilated area protected from weather, moisture, soiling, extreme temperatures, and humidity.

1. Maintain room temperature within storage area at not less than 70 deg F (21 deg C) during the period plastic materials are stored.

1.7 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of wall- and door-protection units that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Structural failures including detachment of components from each other or from the substrates, delamination, and permanent deformation beyond normal use.
b. Deterioration of metals, metal finishes, plastics, and other materials beyond normal use.

2. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Source Limitations: Obtain wall- and door-protection products of each type from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Regulatory Requirements: Comply with applicable provisions in the U.S. Architectural & Transportation Barriers Compliance Board's ADA-ABA Accessibility Guidelines for Buildings and Facilities and ICC A117.1.

2.3 WALL GUARDS

A. Aluminum Wall Rail.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Life Science Products, Inc.; Aluminum Sani-Rail ASR-2 or approved equal.

a. Rail: No thru-rail penetrations for mounting rail to brackets

(1) Material: Material shall be 1/4 inch 6061-T6511 alloy extruded rectangular aluminum bar with 1/8 inch radius edge and 5/16 inch-18 x I/2 inch 5086 alloy studs welded to the back side of rail for attachment of rail to bracket. Federal specification QQA-200/8.
(2) Finish: Clear sulfuric anodized to military specification A8625 Type II. Note: anodizing to be performed after all cutting, drilling, stud welding and bending.
(3) Packaging Rail to be covered with 4-mil vinyl on all surfaces and packed in plywood crates for shipping to site.
(4) Each rail component shall be stamped with it's own unique identification number on the back of the component which will match the numbered section on the installation drawings which must be maintained on file with the manufacturer for future reference.

b. Bracket Material.
(1) Material: 6061-T6511extruded aluminum, federal specification QQA-200/16 with .200 radius vertical flange to eliminate 90 degree edges at points of possible hand contact.
(2) Finish: Finish: Clear sulfuric anodized to military specification A8625 type II. Material is to be anodized only after fabrication is completed.

c. Bracket Dimensions: (3" Brackets)
(1) For CMU and concrete surfaces, wood or metal doors, and gypsum with metal blocking: 3 inch offset from wall to back of rail; .13" inch web thickness; .20" flange thickness; 2.5 x 3.0 inch bracket face at rail; 2.5 inch x 3.0 inch bracket face at wall.
(2) For drywall and hollow walls without 16 gauge metal blocking: 27 degree flared bracket; 3.0 inch offset from wall to back of rail; .13 inch web thickness; .20 inch flange thickness; 2.5 inch x 3.0 inch bracket face at rail; 2.5 inch x 5.5 inch bracket face at wall.

d. Fabrication
(1) Terminal end section shall have a 3" radius bend continuing from the plane of the rail face toward the wall and shall terminate 1/2" from the wall. The last1.375" of the terminal end shall be straight. The arc of the radius shall be 54 degrees.
(2) The entire rail configuration shall be continuous, with terminations being installed only at doors, electrical panels, fire extinguishers and other in-wall mounted apparatus that local codes prohibit from blockage. The continuous contour shall be maintained around all other wall configurations, protrusions, abutments and interruptions in such a manner as to maintain the established 3 inch distance from the wall at any point.
(3) Mounting brackets shall be placed no greater than 4 feet apart. Exact bracket placement is to be determined by the manufacturer at the time of fabrication.

2.4 CORNER GUARDS

A. Surface-Mounted, Metal Corner Guards: Fabricated as one piece from formed or extruded metal with formed edges; with 90- or 135-degree turn to match wall condition. Provide crimped edge where indicated.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Construction Specialties, Inc.
b. InPro Corporation (IPC).
c. Pawling Corporation.
d. Life Science Products, Inc.

2. Material: Stainless-steel sheet, Type 304.

a. Thickness: Minimum 16 ga. (0.063”).
b. Finish: Directional satin, No. 4.

3. Wing Size: 1-1/2 by 1-1/2 inches (38 by 38 mm).
4. Corner Radius: 1/8 inch (3 mm).
5. Mounting: Adhered and mechanical attached using flat-head, countersunk screws through factory-drilled mounting holes, unless otherwise indicated.

2.5 FABRICATION

A. Fabricate wall and door protection according to requirements indicated for design, performance, dimensions, and member sizes, including thicknesses of components.

2.6 FINISHES

A. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

B. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and wall areas, with Installer present, for compliance with requirements for installation tolerances, fire rating, and other conditions affecting performance of the Work.

B. Examine walls to which wall and door protection will be attached for blocking, grounds, and other solid backing that have been installed in the locations required for secure attachment of support fasteners.

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

3.2 PREPARATION

A. Complete finishing operations, including painting, before installing wall and door protection.

B. Before installation, clean substrate to remove dust, debris, and loose particles.

3.3 INSTALLATION

A. Installation Quality: Install wall and door protection according to manufacturer's written instructions, level, plumb, and true to line without distortions. Do not use materials with chips, cracks, voids, stains, or other defects that might be visible in the finished Work.

B. Mounting Heights: Install wall and door protection in locations and at mounting heights indicated on Drawings.

C. Accessories: Provide splices, mounting hardware, anchors, trim, joint moldings, and other accessories required for a complete installation.

END OF SECTION 102600

SECTION 104413 - FIRE PROTECTION CABINETS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Fire-protection cabinets for the following:

a. Portable fire extinguishers.

B. Related Requirements:

1. Section 104416 "Fire Extinguishers."

1.3 PREINSTALLATION CONFERENCE

A. Preinstallation Conference: Conduct conference at Project site.

1. Review methods and procedures related to fire-protection cabinets including, but not limited to, the following:

a. Schedules and coordination requirements.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product. Show door hardware, cabinet type, trim style, and panel style. Include roughing-in dimensions and details showing recessed-, semirecessed-, or surface-mounting method and relationships of box and trim to surrounding construction.

B. Shop Drawings: For fire-protection cabinets. Include plans, elevations, sections, details, and attachments to other work.

C. Samples: For each type of exposed finish required.

D. Product Schedule: For fire-protection cabinets. Indicate whether recessed, semirecessed, or surface mounted. Coordinate final fire-protection cabinet schedule with fire-extinguisher schedule to ensure proper fit and function.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For fire-protection cabinets to include in maintenance manuals.

1.6 COORDINATION

A. Coordinate size of fire-protection cabinets to ensure that type and capacity of fire extinguishers indicated are accommodated.

B. Coordinate sizes and locations of fire-protection cabinets with wall depths.

PART 2 - PRODUCTS

2.1 RECESSED FIRE-PROTECTION CABINET

A. Cabinet Type: Suitable for fire extinguisher.

1. Basis-of-Design Product: Subject to compliance with requirements, provide JL Industries, Inc.; a division of the Activar Construction Products Group; Embassy Series, Model No. 5634. No Substitutions.

B. Cabinet Construction: Nonrated.

C. Cabinet Material: Cold-rolled steel sheet.

D. Recessed Cabinet:

1. Trimless with Hidden Flange: Flange of same metal and finish as box overlaps surrounding wall finish and is concealed from view by an overlapping door.

E. Door Material: Stainless-steel sheet.

F. Door Style: Flush opaque panel, frameless, with no exposed hinges.

G. Door Hardware: Manufacturer's standard door-operating hardware of proper type for cabinet type, trim style, and door material and style indicated.

1. Provide manufacturer's standard.
2. Provide concealed hinge permitting door to open 180 degrees.

H. Accessories:

1. Mounting Bracket: Manufacturer's standard steel, designed to secure fire extinguisher to fire-protection cabinet, of sizes required for types and capacities of fire extinguishers indicated, with plated or baked-enamel finish.
2. Identification: Lettering complying with authorities having jurisdiction for letter style, size, spacing, and location. Locate as directed by Architect.

a. Identify fire extinguisher in fire-protection cabinet with the words "FIRE EXTINGUISHER"

1) Location: Applied to cabinet door.
2) Application Process: Silk-screened.
3) Lettering Color: Black.
4) Orientation: Vertical.

I. Materials:

1. Cold-Rolled Steel: ASTM A 1008/A 1008M, Commercial Steel (CS), Type B.

a. Finish: Baked enamel or powder coat.
b. Color: As selected by Architect from full range of industry colors and color densities.

2. Stainless Steel: ASTM A 666, Type 304.

a. Finish: No. 4 directional satin finish.

2.2 SURFACE-MOUNTED FIRE-PROTECTION CABINET

A. Cabinet Type: Suitable for fire extinguisher.

1. Basis-of-Design Product: Subject to compliance with requirements, provide JL Industries, Inc.; a division of the Activar Construction Products Group; Ambassador Series, Model No. 1013. No Substitutions.

B. Cabinet Construction: Nonrated.

C. Cabinet Material: Cold-rolled steel sheet.

D. Surface-Mounted Cabinet: Cabinet box fully exposed and mounted directly on wall with no trim.

E. Door Material: Steel sheet.

F. Door Style: Solid opaque panel with frame.

G. Door Hardware: Manufacturer's standard door-operating hardware of proper type for cabinet type, trim style, and door material and style indicated.

1. Provide manufacturer's standard.
2. Provide continuous hinge, permitting door to open 180 degrees.

H. Accessories:

1. Mounting Bracket: Manufacturer's standard steel, designed to secure fire extinguisher to fire-protection cabinet, of sizes required for types and capacities of fire extinguishers indicated, with plated or baked-enamel finish.
2. Identification: Lettering complying with authorities having jurisdiction for letter style, size, spacing, and location. Locate as indicated.

a. Identify fire extinguisher in fire-protection cabinet with the words "FIRE EXTINGUISHER."

1) Location: Applied to cabinet door.

2) Application Process: Silk-screened.
3) Lettering Color: Black.
4) Orientation: Vertical.

I. Materials:

1. Cold-Rolled Steel: ASTM A 1008/A 1008M, Commercial Steel (CS), Type B.

a. Finish: Baked enamel or powder coat.
b. Color: As selected by Architect from full range of industry colors and color densities.

2.3 FABRICATION

A. Fire-Protection Cabinets: Provide manufacturer's standard box (tub) with trim, frame, door, and hardware to suit cabinet type, trim style, and door style indicated.

1. Weld joints and grind smooth.
2. Provide factory-drilled mounting holes.

B. Cabinet Doors: Fabricate doors according to manufacturer's standards, from materials indicated and coordinated with cabinet types and trim styles.

1. Fabricate door frames with tubular stiles and rails and hollow-metal design, minimum 1/2 inch (13 mm) thick.
2. Fabricate door frames of one-piece construction with edges flanged.
3. Miter and weld perimeter door frames.

2.4 GENERAL FINISH REQUIREMENTS

A. Comply with NAAMM's AMP 500, "Metal Finishes Manual for Architectural and Metal Products," for recommendations for applying and designating finishes.

B. Protect mechanical finishes on exposed surfaces of fire-protection cabinets from damage by applying a strippable, temporary protective covering before shipping.

C. Finish fire-protection cabinets after assembly.

D. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine walls and partitions for suitable framing depth and blocking where recessed cabinets will be installed.

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

3.2 PREPARATION

A. Prepare recesses for recessed fire-protection cabinets as required by type and size of cabinet and trim style.

3.3 INSTALLATION

A. General: Install fire-protection cabinets in locations and at mounting heights indicated or, if not indicated, at heights acceptable to authorities having jurisdiction.

B. Fire-Protection Cabinets: Fasten cabinets to structure, square and plumb.

1. Unless otherwise indicated, provide recessed fire-protection cabinets.
2. Fasten mounting brackets to inside surface of fire-protection cabinets, square and plumb.

3.4 ADJUSTING AND CLEANING

A. Remove temporary protective coverings and strippable films, if any, as fire-protection cabinets are installed unless otherwise indicated in manufacturer's written installation instructions.

B. Adjust fire-protection cabinet doors to operate easily without binding.

C. On completion of fire-protection cabinet installation, clean interior and exterior surfaces as recommended by manufacturer.

D. Touch up marred finishes, or replace fire-protection cabinets that cannot be restored to factory-finished appearance. Use only materials and procedures recommended or furnished by fire-protection cabinet and mounting bracket manufacturers.

E. Replace fire-protection cabinets that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION 104413

SECTION 104416 - FIRE EXTINGUISHERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes portable, hand-carried fire extinguishers and mounting brackets for fire extinguishers.

B. Owner-Furnished Material: Hand-carried fire extinguishers.

C. Related Requirements:

1. Section 104413 "Fire Protection Cabinets."

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1. Review methods and procedures related to fire extinguishers including, but not limited to, the following:

a. Schedules and coordination requirements.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product. Include rating and classification, material descriptions, dimensions of individual components and profiles, and finishes for fire extinguisher and mounting brackets.

B. Product Schedule: For fire extinguishers. Coordinate final fire-extinguisher schedule with fire-protection cabinet schedule to ensure proper fit and function. Use same designations indicated on Drawings.

1.5 INFORMATIONAL SUBMITTALS

A. Warranty: Sample of special warranty.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For fire extinguishers to include in maintenance manuals.

1.7 COORDINATION

A. Coordinate type and capacity of fire extinguishers with fire-protection cabinets to ensure fit and function.

1.8 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace fire extinguishers that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Failure of hydrostatic test according to NFPA 10.
b. Faulty operation of valves or release levers.

2. Warranty Period: Six years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. NFPA Compliance: Fabricate and label fire extinguishers to comply with NFPA 10, "Portable Fire Extinguishers."

B. Fire Extinguishers: Listed and labeled for type, rating, and classification by an independent testing agency acceptable to authorities having jurisdiction.

1. Provide fire extinguishers approved, listed, and labeled by FM Global.

2.2 PORTABLE, HAND-CARRIED FIRE EXTINGUISHERS

A. Fire Extinguishers: Type, size, and capacity for each fire-protection cabinet and mounting bracket indicated.

1. Basis-of-Design Product: Subject to compliance with requirements, provide JL Industries, Inc.; a division of the Activar Construction Products Group; Cosmic 5e. No Substitutions.

2. Valves: Manufacturer's standard.
3. Handles and Levers: Manufacturer's standard.
4. Instruction Labels: Include pictorial marking system complying with NFPA 10, Appendix B, and bar coding for documenting fire-extinguisher location, inspections, maintenance, and recharging.
5. Fire extinguishers shall be compatible with Amerex Model B456 spare parts.

B. Multipurpose Dry-Chemical Type in Steel Container: UL-rated 3-A:40-B:C, 5-lb (2.3-kg) nominal capacity, with monoammonium phosphate-based dry chemical in enameled-steel container.

C. Purple-K Dry-Chemical Type in Aluminum Container: UL-rated 120-B:C, 20-lb (9.1-kg) nominal capacity, with potassium bicarbonate-based dry chemical in enameled-aluminum container.

2.3 MOUNTING BRACKETS

A. Mounting Brackets: Manufacturer's standard galvanized steel, designed to secure fire extinguisher to wall or structure, of sizes required for types and capacities of fire extinguishers indicated, with plated or baked-enamel finish.

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

a. JL Industries, Inc.; a division of the Activar Construction Products Group.

B. Identification: Lettering complying with authorities having jurisdiction for letter style, size, spacing, and location. Locate as indicated by Architect.

1. Identify bracket-mounted fire extinguishers with the words "FIRE EXTINGUISHER" in red letter decals applied to mounting surface.

a. Orientation: Vertical.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine fire extinguishers for proper charging and tagging.

1. Remove and replace damaged, defective, or undercharged fire extinguishers.

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

3.2 INSTALLATION

A. General: Install fire extinguishers and mounting brackets in locations indicated and in compliance with requirements of authorities having jurisdiction.

B. Mounting Brackets: Fasten mounting brackets to surfaces, square and plumb, at locations indicated.

END OF SECTION 104416

SECTION 113100 - APPLIANCES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Cooking appliances.
2. Refrigeration appliances.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include installation details, material descriptions, dimensions of individual components, and finishes for each appliance.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished accessories.

B. Sustainable Design Submittals:

1. Product Data: For indicated products, indicating compliance with requirements for ENERGY STAR product labeling.

C. Product Schedule: For appliances. Use same designations indicated on Drawings.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For manufacturer.

B. Product Certificates: For each type of appliance.

C. Field quality-control reports.

D. Sample Warranties: For manufacturers' special warranties.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For each appliance to include in operation and maintenance manuals.

1.7 WARRANTY

A. Microwave Oven: Full warranty, including parts and labor, for on-site service.

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

B. Refrigerator/Freezer, Sealed System: Full warranty, including parts and labor, for on-site service on the product.

1. Warranty Period for Sealed Refrigeration System: Five years from date of Substantial Completion.
2. Warranty Period for Other Components: Two years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Source Limitations: Obtain appliances from single source and each type of appliance from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Electrical Appliances: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Accessibility: Where residential appliances are indicated to comply with accessibility requirements, comply with applicable provisions in the DOJ's 2010 ADA Standards for Accessible Design, the ABA standards of the Federal agency having jurisdiction and ICC A117.1.

2.3 MICROWAVE OVENS

A. Microwave Oven:

1. Basis-of-Design Product: Subject to compliance with requirements, provide KitchenAid; a division of Whirlpool Corporation; Model No. KCMS2255BSS 12200-Watt Countertop Microwave Oven. No Substitutions.

2. Mounting: Countertop.
3. Type: Conventional.
4. Capacity: 2.2 cu. ft..
5. Oven Door: Door with observation window and pushbutton latch release.
6. Microwave Power Rating: 1200 W.
7. Electric Power Supply: 120 V, 60 Hz, 1 phase, 15 A.

8. Controls: Digital panel controls and timer display.
9. Other Features: Turntable and lock-out feature.
10. Material: Stainless steel.

    a. Color/Finish: Black.

2.4 REFRIGERATOR/FREEZERS

A. Refrigerator/Freezer: Two-door refrigerator/freezer with freezer on bottom and complying with AHAM HRF-1.

1. Basis-of-Design Product: Subject to compliance with requirements, provide KitchenAid; a division of Whirlpool Corporation; Model No. KRFC300ESS Counter-Depth French Door Refrigerator with Interior Dispenser. No Substitutions.

2. Type: Freestanding.

3. Storage Capacity:

    a. Refrigeration Compartment Volume: 14.38 cu. ft.
    b. Freezer Volume: 5.62 cu. ft.

4. General Features:

    a. Interior water dispenser for cold water.
    b. Built-in water-filtration system.
    c. Dual refrigeration systems.
    d. LED lighting.

5. Refrigerator Features:

    a. Interior light in refrigeration compartment.
    b. Compartment Storage: Wine racks, vegetable crisper and meat compartment.
    c. Door Storage: Modular compartments, Gallon- (3.8-L) milk-container storage.
    d. Temperature-controlled full width pantry.

6. Freezer Features: One freezer compartment(s) configured as pull-out drawer(s).

    a. Automatic defrost.
    b. Interior light in freezer compartment.
    c. Automatic icemaker and storage bin.

7. ENERGY STAR: Provide appliances that qualify for the EPA/DOE ENERGY STAR product-labeling program.

8. Appliance Color/Finish: Stainless steel.

B. Refrigerator: One-door refrigerator.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Summit Appliances; Model No. FF7BSSHVADA. No Substitutions.

2. Type: Undercounter.

3. Storage Capacity:

   a. Refrigeration Compartment Volume: 5.5 cu. ft.

4. General Features:

   a. One piece interior liner.
   b. Adjustable glass shelves
   c. Adjustable thermostat.
   d. Automatic defrost.
   e. Interior light on rocker switch.

5. ENERGY STAR: Provide appliances that qualify for the EPA/DOE ENERGY STAR product-labeling program.

6. Appliance Color/Finish: Stainless steel.

2.5 GENERAL FINISH REQUIREMENTS

A. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

B. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, power connections, and other conditions affecting installation and performance of residential appliances.

B. Examine roughing-in for piping systems to verify actual locations of piping connections before appliance installation.

C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.

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

3.2 INSTALLATION

A. Install appliances according to manufacturer's written instructions.

B. Freestanding Equipment: Place units in final locations after finishes have been completed in each area. Verify that clearances are adequate to properly operate equipment.

3.3 FIELD QUALITY CONTROL

A. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

1. Perform visual, mechanical, and electrical inspection and testing for each appliance according to manufacturers' written recommendations. Certify compliance with each manufacturer's appliance-performance parameters.
2. Leak Test: After installation, test for leaks. Repair leaks and retest until no leaks exist.
3. Operational Test: After installation, start units to confirm proper operation.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and components.

B. An appliance will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

3.4 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain residential appliances.

END OF SECTION 113100

SECTION 114001 - MISCELLANEOUS LABORATORY EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of contract, including General and Supplementary Conditions and Division Specification sections, apply to the work of this section.

1.2 WORK INCLUDED

A. Furnish all labor, materials, tools, equipment and services for all equipment as indicated in accord with provisions of Contract Documents.

B. Completely coordinate with work of all other trades.

C. Although such work is not specifically shown or specified, furnish and install all supplementary or miscellaneous items, appurtenances and devices incidental to or necessary for a sound, secure and complete installation.

D. Equipment in this section includes the following:

Section	Equipment Description
2.01 UCGW:	Undercounter Glassware Washer
2.02 MW:	Modular Wall
2.03 ICE:	Ice Flaker

1.3 RELATED WORK

A. Relevant trade contractors will provide all rough openings, pits, substrate preparation and blocking for all equipment installations.

B. Mechanical contractor will provide exhaust rough-ins and final connections for all equipment installations.

C. Plumbing contractor will provide all supply/return service lines, drain and vent rough-ins and final connections for all equipment installations.

D. Electrical contractor will provide all electrical service rough-ins and final connections for all equipment installations.

1.4 QUALITY ASSURANCE

A. Use adequate numbers of skilled workmen who are thoroughly trained and experienced in the necessary crafts and who are completely familiar with the specified requirements and methods needed for proper performance of the work of this section.

B. Dimensions, voltages, electrical power requirements, and utility connections are based on the items specified. Manufacturer is responsible for all costs for dimensional adjustments.

C. Equipment may be inspected by Owner at manufacturer's plant prior to shipment. Equipment found not in accord with specifications and approved drawings may be rejected. Replace rejected equipment at no cost to Owner. Provide Owner's Representative two (2) week prior notice to all factory testing.

D. Electric operated and/or heated equipment must comply with applicable standards of National Electrical Manufacturer's Association (NEMA), National Electric Code (NEC), Underwriters' Laboratories, Inc. (UL) or Electrical Testing Lab (ETL).

E. Manufacturer Qualifications: Manufacturer shall be a firm having an established organization and factory, with production facilities specializing in the type of equipment specified, having an experienced engineering department and an established history of similar installations of equal scope and complexity. Manufacturer shall have the demonstrated ability to produce the specified equipment of the required quality and a proven capacity to complete an installation of this size and type within the required time limits. Service response time to a telephone inquiry shall be same day (or within 4 hours, whichever is less) followed up by a factory trained technician at the site within 24 hours of the telephone inquiry; all serviceable components warehoused or readily available to service personnel; and fast access to shop drawings of all equipment in field.

F. Acceptable Manufacturers.

1. Each piece of equipment listed includes the manufacturer's name and catalog number, establishing levels of quality, specific construction features, operating conditions and desired features and accessories.
2. By indicating other manufacturer's names does not relieve perspective bidders of their obligation to prove that their submissions are equal to specified equipment in size, construction, performance, basic features, options and accessories prior to award.

G. Installer Qualifications. Manufacturer, or approved in writing by manufacturer.

1.5 SUBMITTALS

A. Specification Compliance. Submit copy of relevant item specification section (from this document) and clearly note in bold print any substitutions, modifications or objections.

B. Samples.

1. Interior finish.
2. Exterior finish.
3. Color samples (if applicable).

C. Shop Drawings. Submit shop drawings for all items in this section, showing in large scale, methods of construction, joining, dimensions, materials, thicknesses, finishes of materials, installation, and relation to adjoining work and all other details to fully illustrate the work. Provide roughing-in drawings for mechanical and electrical services.

D. Product Data. Submit manufacturer's specifications and installation instructions for each item of laboratory equipment furnished.

E. Operational and Maintenance Data. Submit operating and maintenance instructions and parts listing for each item of fixed laboratory equipment. Include this data, product data, shop drawings, wiring diagrams, and any other data required by Owner, in three-ring maintenance manual. Prepare draft copy of operation and maintenance manual for Owner's review. Submit four (4) copies of final, accepted manual for Owner's use.

F. Applicable standards approval from NEMA, NEC, UL, and ETL or as specified with the individual equipment items.

1.6 DEVIATION FROM DRAWINGS AND SPECIFICATION

A. It must be distinctly understood that all such deviations shall be subject at all times to written approval prior to receipt of bid. If no written communication is received prior to bidding, it is assumed that bidder will be in total compliance with specifications and will be held responsible for default or delay.

B. All requests for a substitution must be made directly to the Architect's office for consideration no later than fifteen (15) working days prior to bid date.

C. All variances approved prior to bid date will be handled as an addendum to the specifications and will be sent to all bidders.

1.7 EQUIPMENT DELIVERY, STORAGE, HANDLING AND INSTALLATION REQUIREMENTS

A. All equipment in this specification shall be Contractor Furnished/Contractor Installed (CFCI). Certain equipment items will include Manufacturer's Installation Supervision (MIS) or Manufacturer's Equipment Demonstration (MED).

B. Contractor Furnished/Contractor Installed (CFCI): Construction Manager and/or relevant trade contractor (both identified as the "Contractor) to purchase, receive, store, unpack, set-in-place, install and clean up equipment. Deliver to site in manufacturer's original labeled containers. Contractor to provide any fasteners, supports or other miscellaneous items necessary for complete installation. All rough-ins and final connections by contractor. Contractor to use all means necessary to protect materials of this section before, during and after installation and to protect installed work and materials of all other trades. Contractor to confirm in writing that installed equipment meets or exceeds manufacturer's specifications. Contractor to provide owner's representative with rough-in and installation drawings of installed equipment. Where specified (MIS or MED), contractor will coordinate with manufacturer installation supervision and/or on-site equipment demonstrations. Scheduling of on-site equipment demonstrations to be at the convenience of the Owner.

C. Manufacturer's Equipment Demonstration (MED). Where noted in the specifications (i.e.: MED), the manufacturer shall provide two (1) one-day trips to the job site to instruct Owner on proper operation and maintenance of the equipment.

D. Manufacturer's Installation Supervision (MIS): Where noted in the specifications (i.e.: Vendor to provide installation supervision), the vendor shall provide adequate installation supervision personnel for as long as it takes to complete the installation to the satisfaction of the owner's representative. Vendor's field personnel may or may not be union depending on the conditions of the site. If the schedule demands it, vendor to agree to have their field personnel work overtime at no additional cost. Vendor installation supervision to include the following:

1. Trip(s) to the job site to coordinate specific technical project requirements.
2. Trip(s) to the job site to instruct equipment installation crews.
3. Trip(s) to the job site to check final installation, trouble-shoot and start-up equipment.
4. Three (3) trips to the job site to instruct Owner on proper operation and maintenance of the equipment.

E. Contractor Installed (CI): Relevant trade contractor (the "Contractor") to unpack, set-in-place, stall and clean up. Contractor to provide any fasteners, supports or other miscellaneous items

necessary for complete installation. All final connections by Construction Manager. Deliver to site in manufacturer's original labeled containers. Protect exposed surfaces and edges until work is completed. Construction Manager to confirm in writing that installed equipment meets or exceeds manufacturer's specifications. Construction Manager to provide Owner with rough-in and installation drawings of installed equipment. Where specified, Construction Manager will coordinate with manufacturer on site equipment demonstrations for the Owner.

1.8 WARRANTY

A. Except where more stringent warranty requirements are noted in the individual equipment descriptions, all equipment furnished under this section to be guaranteed for a minimum of one (1) year, parts and labor, from date of final acceptance against defective materials, design and workmanship. Defects to be promptly rectified after notification by Architect and at no additional cost to Owner.

1.9 JOB CONDITIONS

A. Drawings show arrangement and location of items of equipment. If it is necessary to vary from arrangement shown, because of structural, mechanical, electrical or other considerations, make such variations only after approval of Architect and at no additional cost to Owner.

B. Verify all dimensions at building.

C. Measure all recesses and openings at building and provide all trim pieces, fillers and closures in sizes required.

D. Confirm that all equipment will be able to be moved through the building in order to reach its designated location.

E. Compressed air is not an available service. Provide integral air compressor on all equipment requiring this service. Location for air compressor for washers and/or sterilizers will need to be coordinated. Air compressor will be floor mounted.

F. All equipment listed in this section shall meet local seismic restraint requirements, if applicable. Vendor shall determine whether the design and/or installation must be modified to meet this requirement and take appropriate action.

PART 2 - PRODUCTS

2.1 UCGW: UNDERCOUNTER GLASSWARE WASHER

A. Product Description.

1. Under counter model with viewing window. The viewing window allows observation of the cycle in progress. Made of clear tempered safety glass, 7.0" x 14.27". A 25 Watt chamber interior light is also provided.
2. Chamber and interior door is constructed of Type 316L stainless steel with polished finish. Four leveling feet are provided.
3. Fiberglass blanket surrounds the chamber. Aluminum-backed acoustic material is located at strategic locations.
4. 10 factory preset programs with a minimum of additional five (5) user set programs:

a. RINSE ONLY: 1 tap water rinse, no drying.
b. PLASTIC: Two washes, two rinses (tap or pure water), water temperature set point 122F (50C), 15 minute dry time.
c. GLASS: Two washes, 3 rinses (tap or pure water), water temperature set point 140F (60C), 30 minute dry time.
d. GLASS PLUS: Two washes, 10 minute steam cycle, 4 rinses (tap or pure water), water temperature set point 140F (60C), 30 minute dry time.
e. SCIENTIFIC: Two washes, 4 rinses (tap or pure water), water temperature set point 158F (70C), 40 minute dry time.
f. SCIENTIFIC PLUS: Two washes, 10 minute steam cycle, 4 rinses (tap or pure water), water temperature set point 158F (70C), 40 minute dry time.
g. INTENSE: Three washes, 5 rinses (tap or pure water), water temperature set point 180F (82C), 50 minute dry time.
h. INTENSE PLUS: Three washes, 10 minute steam cycle, 5 rinses (tap or pure water), water temperature set point 180F (82C), 50 minute dry time.
i. EXTREME: Three washes, 10 minute steam cycle, 6 rinses (tap or pure water), water temperature set point 199F (93C), 60 minute dry time.
j. DRY ONLY: Dry time set for 60 minutes.

5. Purified water pump brings pressurized or non-pressurized purified water from an external source into the tank for up to 6 pure water rinses. Selection or cancellation of purified water is from the control panel.
6. Purified water inlet valve is equipped with a plastic serrated hose connection to accommodate 3/8" ID flexible plastic or rubber hose.
7. RS232 port transmits data including time, temperature, cycle phase, alarms, and water conductivity to a user-supplied computer or chart recorder.
8. Forced air drying system includes a 99.97% efficient HEPA Filter.
9. A detergent dispenser holds liquid and uses a peristaltic pump to automatically draw a programmed amount of liquid detergent from a container located in the built in side compartment.
10. A liquid rinse aid dispenser uses a peristaltic pump to automatically draw a programmed amount of rinse aid or other chemicals from a one-liter container located in the built-in side compartment.
11. Non-vented System.
12. Drain discharge cooldown kit to provide plumbing components including solenoid valve to mix cold tap water with hot sump water so as to cool to house drain system to less than 140F.
13. Utility Requirements.
    a. E1 1/60/208V/ 16 Amp; high heat
    b. HW 3/4” NPT; 20-120 PSIG dyn, 120°F-140°F, 1.25 GPM
    c. CW 3/4” NPT; 20-120 PSIG dyn, 54°F Max. 3.5 GPM
    d. RGW 3/4” NPT; 0-120 PSIG dyn, 0.9 GPM flow rate
    e. D 2” or larger NPT, 7.0 GPM flow rate

B. Equipment item(s) shall be CFCI with MIS.

C. Unit(s) shall be equal to Steris Reliance 100LS Undercounter Model. Unit(s) manufactured by Getinge, Miele, Steelco or Others will be considered as equal provided that they meet the requirements of this specification.

2.2 MW: MODULAR WALL

A. Product Description.

1. Modular wall panel box sections shall be finished on one side with type 302/304 stainless steel, #3 finish, and infilled with a moisture-resistant, sound-deadening insulation.
2. Sectional modular wall shall be as indicated on the Drawings (length and height shall be field verified) and nominally 2" thick. Manufacturer will coordinate and provide rough openings for Undercounter Glassware Washer (UCGW) Steam Sterilizer (ST1 & ST2). Modular wall shall completely seal openings between equipment, walls, floors and ceiling.
3. Provide louvers in wall above each appliance to capture vapor and steam and allow them to be drawn into the enclosure created by walls.
4. Provide all necessary ceiling and wall trim angles, integral leveling devices (attached to vertical panels and concealed by base; shims will not be acceptable), vertical panels, horizontal panels and sanitary bases (at floor/wall intersection) for a complete and tight installation. All components to be 302/304 stainless steel.
5. Unit to meet local seismic design requirements.
6. Coordinate all equipment cutouts with selected vendor's submittal data.
7. Unit(s) shall be equal to Steris - Amsco Modular Wall. Unit(s) manufactured by Getinge, Clad Industries and Lynx, shall be considered as equal provided that they meet the requirements of this specification.

2.3 ICE: ICE FLAKER

A. Product Description

1. Modular, 22"W x 27.5"H x 26"D, ice flaker with minimum of 110-pound capacity separate insulated storage bin. Unit shall produce 970 pounds of ice per day (24 hours) at an ambient room air temperature of 70°F and a water inlet temperature of 50°F.
2. Ice making mechanism to have a heavy duty, hermetically sealed compressor; automatic expansion valve refrigerant control; safety control thermostat to turn off ice maker should inlet water pressure become insufficient for ice production or if storage bin reaches maximum capacity. Evaporator to be close tolerance brass cylinder with brass shell, stainless steel auger, completely insulated with polyurethane foam. Auger to be powered by belt-driven single reduction worm gear. Condensing unit shall be water cooled.
3. Unit shall be provided with a minimum of two (2) year parts and labor warranty and a five (5) year compressor warranty.

B. Utility Requirements:

1. E 1/60/115V.
2. CW 3/8" O.D.
3. D 3/4" I.D. plastic tubing.

C. Equipment item(s) shall be CFCI.

D. Modular ice flaker shall be equal to Hoshizaki F-1001MWJ with storage bin. Unit(s) manufactured by Ice –O-Matic and Scotsman, shall be considered equal provided that they meet the requirements of this specification.

PART 3 - EXECUTION

3.1 INSPECTION

A. Check for shipping damage. Reject units with scratches, dents or other defects that cannot be readily corrected.

B. Check job site to ensure that rough-ins and substrates are correct, and that equipment will fit as indicated on Drawings.

C. Do not proceed with installation until defects or oversights are corrected.

3.2 INSTALLATION

A. Deliver equipment to the job site freight paid.

B. Uncrate all equipment and place in locations shown on Drawings. Remove all crating materials and packing debris.

C. Install all items in accordance with Manufacturer's standards. Provide all accessories necessary for a complete installation.

D. Verify plumbing, ventilation and electrical connection requirements for all equipment with manufacturer and coordinate connections with work of Divisions 22, 23 and 26.

3.3 ADJUST AND CLEAN

A. Check operation and installation of equipment. Make adjustments as necessary to meet Manufacturer's or Owner's (whichever is more stringent) specifications.

B. Replace items which do not operate properly, have defacing marks or damage which cannot be satisfactorily repaired as determined by the Owner's Representative.

C. Clean and polish equipment in accordance with Manufacturer's recommendations before and after demonstration for Owner. Leave ready for use with copy of instruction manual attached to equipment in a manner to be specified by Owner's Representative.

END OF SECTION 114001

FOR BID & PERMITSECTION 115313 - LABORATORY FUME HOODS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:

1. Bench-top laboratory fume hoods.
2. Fittings for piped services and electrical service fittings in fume hoods.
3. Piping and wiring within fume hoods for service fittings, light fixtures, blower switches and other electrical devices.
4. Shop and field testing of fume hoods.

B. Related Sections include the following:

1. Division 09 Section for reinforcements in metal-framed gypsum board partitions for anchoring fume hoods.
2. Division 09 Section for resilient base applied to fume hood base cabinets.
3. Division 12 Section "Laboratory Casework for fume hood base cabinets.
4. Division 23 Section "Testing, Adjusting, and Balancing".
5. Division 23 Sections for fume hood duct connections, including ducts.
6. Division 22 and 26 Sections for connecting service utilities at back of fume hoods. Piping and wiring within fume hoods are specified in this Section.

1.3 DEFINITIONS

A. “Service Fixtures” are defined as gas, air, and vacuum cocks, hot, cold, reagent grade water faucets, remote control valves, electrical receptacles with necessary flush mounting boxes, conduits or pedestals and plates, fluorescent and/or incandescent light fixtures, light switches and/or motor switches for hoods and other items which serve as a functional part of the equipment.

B. “Service Lines” are defined as gas, air, vacuum, hot, cold, reagent grade and reference grade water piping, drain lines, fittings and shut off valves necessary to carry respective services from building roughing-in floors or walls through equipment to “service fixture”.

C. “Service Lines” also include conduit, junction boxes, conduit fitting, wire disconnect switches and fuse or circuit breakers necessary to carry electrical services from building roughing-in outlets in floors or walls through equipment to “service fixtures.”

1.4 EXCEPTIONS TO DRAWINGS AND SPECIFICATION

A. All exceptions shall be subject to written approval prior to receipt of bid. If no written communication is received prior to receipt of bid and approval indicated in an addendum, it is

assumed that bidder will be in total compliance with specifications and will be held responsible for default or delay, regardless of any statement to the contrary in their written proposal.

B. Requests for a substitution must be made directly to the Owner's Representative's office for consideration no later than fifteen (15) working days prior to bid receipt date. Fume Hood ASHRAE Test Reports and confirmation of load performance for stands certified by an independent nationally recognized testing laboratory shall be submitted along with the request for a substitution.

C. Requests for a substitution following the bid opening will be rejected.

D. Substitutions approved prior to bid date will be handled as an addendum and be sent to all bidders.

1.5 PERFORMANCE REQUIREMENTS

A. Fume hoods must meet the testing requirements set forth in the National Institutes of Health (NIH) On Site Testing for Constant Volume Fume Hoods or Variable Air Volume (VAV) Fume Hoods as necessary and in accordance with the latest published testing criteria.

B. In addition to the NIH test requirements, a heat load must be placed on the hood during testing. Heat shall be applied to hood using hot plates and temperatures maintained at 90^{o} F (32.2^{o} C) measured 3 feet above working surface of the hood; and 1 foot from back of hood.

C. VAV fume hoods, tests shall be run at 60, 80 and 100 feet per minute (FPM).

D. Test results must be submitted to the Office of Environmental and Occupational Health & Safety for review and approval. Approved hoods will be considered acceptable for use in OSU buildings and laboratories.

E. Final as-installed testing will be completed upon installation through a third party, certified to perform the following test(s). As-installed testing shall meet the NIH On Site Testing requirements listed in 2.1 of this section.

F. Chemical fume hoods, auxiliary hoods, canopy hoods, glove boxes, and horizontal flow (clean benches) are not to be permitted without careful review and approval by the Office of Environmental and Occupational Health and Safety. Performance and maintenance problems associated with these hood designs, necessitates this policy.

G. Static-Pressure Loss: Not more than 1/4-inch wg at 80-fpm face velocity when tested according to Paragraph 6.4.2.4 in SEFA 1.2, "Laboratory Fume Hoods--Recommended Practices."

H. Structural Performance: Provide fume hood components capable of withstanding the following loads without permanent deformation, excessive deflection, or binding of cabinet drawers and doors:

1. Fume Hood Countertops: 200 lb/ft.
2. Base Cabinets of Fume Hoods: 75 lb/ft. within cabinets, 50-lb/ft. countertop, 200 lb/ft. on countertop, plus weight of hood.

I. Seismic Performance: If required by local code, provide fume hood anchorages capable of withstanding the effects of earthquake motions determined according to ASCE 7, "Minimum Design Loads for Buildings and Other Structures": Section 9, "Earthquake Loads."

J. Electrical Performance: UL 1805 Classified

1.6 SUBMITTALS

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

B. Shop Drawings: For laboratory fume hoods. Include plans, elevations, sections, details, and attachments to other work.

1. Indicate details for anchoring fume hoods to permanent building construction including locations of blocking and other supports. Include calculations demonstrating that anchorages comply with seismic performance requirements.
2. Indicate locations and types of service fittings together with associated service supply connection required.
3. Indicate duct connections, electrical connections, and locations of access panels.
4. Include roughing-in information for mechanical, plumbing, and electrical connections.
5. Show adjacent walls, doors, windows, other building components, laboratory casework, and other laboratory equipment. Indicate clearances from above items.
6. Include layout of fume hoods in relation to lighting fixtures and air-conditioning registers and grilles.
7. Include coordinated dimensions for laboratory equipment specified in other Sections.

C. Samples: for Initial Selection: For factory-applied finishes, epoxy countertops and other pre-finishes equipment and accessories for selection by Owner/Architect.

D. Samples for Verification: For factory-applied finishes, interior lining and countertop material, in manufacturer's standard sizes.

E. Product Test Reports: Based on evaluation of comprehensive tests according to SEFA 1.2, "Laboratory Fume Hoods--Recommended Practices" and ASHRAE 110 performed by manufacturer and witnessed by a qualified independent testing agency, for fume hoods.

1.7 QUALITY ASSURANCE

A. Source Limitations: Obtain laboratory fume hoods through one source from a single manufacturer.

B. Product Standard: Comply with SEFA 1.2, "Laboratory Fume Hoods--Recommended Practices."

C. Safety Glass: Products complying with testing requirements in 16 CFR 1201 for Category II materials.

D. Pre-installation Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management and Coordination."

1.8 DELIVERY, STORAGE AND HANDLING

A. Protect finished surfaces during handling and installation with protective covering of polyethylene film or other suitable material.

1.9 PROJECT CONDITIONS

A. Environmental Limitations: Do not deliver or install fume hoods until building is enclosed, wet work and utility roughing-in are complete, and HVAC system is operating and maintaining temperature and relative humidity at occupancy levels during the remainder of the construction period.

B. It is the fume hood manufacturer's responsibility to verify field measurements and that equipment will fit through entryways, corridors and door openings enabling a smooth flow of equipment to its proper location in the building.

1.10 COORDINATION

A. Coordinate installation of fume hoods with laboratory casework, fume hood exhaust ducts, and plumbing and electrical work.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Basis of Design Products/Manufacturer(s): Subject to compliance with requirements, provide fume hoods as manufactured by Mott Manufacturing or comparable products from one of the following:

1. Labconco Corporation
2. Kewaunee Scientific Corporation
3. Bedcolab

2.2 MATERIALS

A. Steel Sheet: Cold-rolled commercial steel sheet, complying with ASTM A 1008/A 1008M; matte finish; suitable for exposed applications.

B. Stainless-Steel Sheet: ASTM A 666, Type 304; stretcher-leveled standard of flatness.

C. Glass-Fiber-Reinforced Polyester: Polyester laminate complying with ASTM D 4357, with a chemical-resistant gel coat on the exposed face, and having a flame-spread index of 25 or less per ASTM E 84.

D. Epoxy: Factory molded of modified epoxy-resin formulation complying with Division 12 Section Wood Laboratory Casework and having a flame-spread index of 25 or less per ASTM E 84.

E. Laminated Safety Glass: ASTM C 1172, Kind LT, Condition A, Type I, Class I, Quality q3 with clear, polyvinyl butyl interlayer.

F. Phenolic Composite: Solid, high-pressure decorative laminate, complying with NEMA LD 3, Grade CGS.

G. Fasteners: Interior fastenings are to be concealed. Exposed screws or screw head caps as not acceptable.

2.3 RESTRICTED BYPASS FUME HOODS

A. Provide fume hoods with partial compensating bypass above sash, which opens after sash is closed to less than 40 percent open. Design partial bypass to maintain sufficient exhaust air volume through hood to adequately dilute hazardous fumes regardless of sash position. Restricted bypass shall be configured as hereinafter specified.

1. Variable-Air-Volume Control: Fume hoods shall be variable volume. All controls and alarms shall be furnished and installed by other sections of this specification.

B. Safety Monitor/Alarm System:

1. Variable Air Volume Hoods:
   a. Each fume hood shall be equipped with a velocity control and safety audible/visual alarm unit which is to be coordinated with the building's HVAC control system (Div. 23).

2.4 FABRICATION

A. General: Pre-assemble fume hoods in factory to greatest extent possible. Disassemble fume hoods only as necessary for shipping and handling limitations. Fume hoods shall be capable of movement through a 41" x 83" door opening.

B. Steel Exterior: Fabricate from steel sheet, not less than 0.0478 inch thick, with component parts screwed together to allow removal of end panels, front fascia, and airfoil and to allow access to plumbing lines and service fittings. Apply chemical-resistant finish to interior and exterior surfaces of component parts before assembly.

C. Ends: Fabricate with double-wall end panels without projecting corner posts or other obstructions to interfere with smooth, even airflow. Close area between double walls at front of fume hood and as needed to house sash counterbalance weights, utility lines, and remote-control valves.

1. Access to fixture valves concealed in the wall shall be provided by exterior removable access panels and gasketed access panels on the inside liner walls. Exterior side panel member fastening devices to be exposed corrosion resistant, non-metallic material creating a positive mechanical latch. Exposed connectors to match hood body in color.

D. Access Opening Perimeter: Airfoil or streamlined shape with all right angle corners radiused or angled. Bottom horizontal foil shall provide a nominal one inch bypass when the sash is in the closed position. The bottom foil shall not be removable without the use of special tools. Bottom foil shall provide access area sufficient in size to pass through hospital grade electrical plugs. The bottom foil shall be steel with urethane powder coating to increase acid and abrasions resistance, except type 316 stainless steel, #4 finish. The airfoil and sill shall be flush with the height of the interior work surface. A secondary containment trough shall be located in front of the work surface and extend below the airfoil sill.

E. Fume hood liner: Reinforced polyester panel; smooth finish and white color in final appearance. Flexural strength: 14,000 psi. Flame spread: 15 or less per U.L. 723 and ASTM E84-80. Baffle must be same material as liner. Metallic baffles, brackets or supports on hood interior – not acceptable

F. Baffles: Baffles providing controlled air vectors into and through the fume hood must be fabricated of the same material as the liner. Provide minimal exhaust slots full height on vertical sides of the baffle. High performance 2-piece baffle will be used. Baffle shall

incorporate exhaust slots located to purge the upper and lower area of the hood. Baffle to be non-adjustable. Baffles with manual or automatic adjustment are not acceptable. Minimum depth of 19" for interior workspace is required at the extreme upper portion of the fume hood to provide maximum interior work area. All baffles, supports, and brackets to be non-metallic.

G. Exhaust Plenum: Full width of fume hood and with adequate volume to provide uniform airflow from hood, of same material as hood lining, and with duct stub for exhaust connection.

1. Duct-Collar Material: 4" high stainless steel type 316 collar spun to create a bell mouth configuration. Provide stainless steel transition if manufacturer's standard exhaust collar does not meet this requirement. Engineer shall determine the specific outlet diameter.

H. Restricted bypass shall enter hood through top of bypass chamber and enter the hood in a down-flow direction. The chamber shall protect the user from expelled particulate in the event of an adverse internal reaction.

I. Sashes: Provide operable sashes of type indicated.

1. Vertical sash access with a 35" high sight line. Sash frame on bottom and sides must be no more than 1.5" thick and radiused to minimize turbulence. Area above the 28" high vertical sash opening shall be glazed with 3/8" thick laminated safety glass.

2. Counter balance system: Single weight, sprocket and chain, counter balance system which prevents sash tilting and permits ease of operation at any point along full width pull. Maximum 7 pounds pull required to raise or lower sash throughout its full length of operating sash opening. Design system to hold sash at any position without creep and to prevent sash drop in the event of cable failure. Open and close sash against rubber bumper stops.

3. Airfoil: The airfoil will be flush to the work surface with ample room for electrical hospital grade cords to fit beneath the airfoil. Sill to be ergonomically radiused on front edge. Sill must pivot forward to provide cord and trough access. Airfoil sills that are not flush with the top plane of the work surface are not acceptable.

4. Sash Controller: Fume hood shall be equipped with an occupancy sensor connected to a motor-driven closing device that lowers the sash to a fully closed position when no movement is detected in front of the fume hood.

J. Light Fixtures: Provide vapor proof, two-tube, rapid-start, fluorescent light fixtures, of longest practicable length; complete with tubes at each fume hood. Shield tubes from hood interior with 1/4-inch- thick laminated glass, sealed into hood with chemical-resistant rubber gaskets. Provide units with fluorescent tubes easily replaceable from outside of fume hood.

K. Base Cabinets: Shall be furnished under Division 12 Section **"**Laboratory Casework".

L. Countertops

1. Resin Countertops: Fabricate with front overhang of 1 inch over base cabinets, continuous drip groove on underside 1/2 inch from edge, and factory cutouts for sinks.

a. Countertop Material: Epoxy Resin, uniform throughout full thickness.
b. Countertop Configuration: Raised (marine) edge, 1-1/4 inches thick at raised edge, with rounded edge and corners.

M. Filler Strips: Provide as needed to close spaces between fume hoods and adjacent building construction. Fabricate from same material and with same finish as fume hoods. Filler strips shall match in size any fillers associated with base cabinetry furnished under Section 12 35 53.

N. Comply with requirements in Divisions 22 and 26 Sections for installing laboratory gas service fittings, piping, electrical devices, and wiring. Install according to Shop Drawings. Securely anchor fittings, piping, and conduit to fume hoods, unless otherwise indicated. Electrical devices shall be GFI.

2.5 SERVICE FIXTURES

A. Plumbing fixtures (CW, G, A, N, V) to be factory mounted, including connection between front loading valve and hose end, on side wall(s) of hood indicated on drawings. All fixtures to be remote control front-loading type with interior fittings coated with color-coded epoxy powder coated finish.

B. Vacuum Breakers. ASSE 1035 Integral vacuum breakers shall be supplied on all domestic water fixtures. The fixture shall be exposed 7 ft A.F.F. on face of hood (exposed vacuum breaker and piping to have same finish as other fixtures.

C. Electrical fixtures (receptacles, light switch, lights, alarm) to be factory mounted and pre-wired to a junction box located on top of fume hood for final connection under Div 26. Piped services shall be factory mounted and pre-piped. Piping shall extend 6” beyond the top of fume hood and be capped for final connection under Div 22 & Div 23.

2.6 CHEMICAL-RESISTANT FINISH

A. Preparation: Clean steel surfaces, other than stainless steel, of mill scale, rust, oil, and other contaminants. After cleaning, apply a conversion coating suited to the organic coating to be applied over it.

B. Chemical-Resistant Finish: Immediately after cleaning and pre-treating, apply fume hood manufacturer's standard two-coat, chemical-resistant, baked-on finish consisting of prime coat and thermosetting topcoat. Comply with coating manufacturer's written instructions for applying and baking to achieve a minimum dry film thickness of 2 mils.

1. Chemical and Physical Resistance of Finish System: Finish complies with acceptance levels of cabinet surface finish tests in SEFA 8. Acceptance level for chemical spot test shall be no more than four Level 3 conditions.
2. Colors for Fume Hood Finish: As selected by Architect

2.7 ACCESSORIES

A. Service Fittings: Comply with requirements in Division 12 Section Wood Laboratory Casework

1. Provide service fittings with exposed surfaces, including fittings, escutcheons, and trim, finished with acid- and solvent-resistant, baked-on clear coating.
2. Service Valves per Division 12 specification.

B. Volume Controls, Airflow Indicators and Alarms shall be furnished by other trades and installed in the field. Review Divisions 23 and 26 for requirements. Provide cutouts and wiring access as required for installation by respective trades.

C. Sash Stops: Provide fume hoods with sash stops to limit hood opening to 50 percent of sash height. Sash stops can be manually released to open sash fully for cleaning fume hood and for placing large apparatus within fume hood.

2.8 SOURCE QUALITY CONTROL

A. Certify fume hood performance in compliance with ASHRAE 110, as manufactured, before shipment.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of fume hoods.

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

3.2 INSTALLATION

A. General: Install fume hoods according to Shop Drawings and manufacturer's written instructions. Install level, plumb, and true; shim as required, using concealed shims, and securely anchor to building and adjacent laboratory casework. Securely attach access panels, but provide for easy removal and secure reattachment. Where fume hoods abut other finished work, apply filler strips and scribe for accurate fit, with fasteners concealed where practical.

B. Comply with requirements in Division 12 Section Wood Laboratory Casework for installing fume hood base cabinets, countertops, and sinks.

3.3 FIELD QUALITY CONTROL

A. Field test installed fume hoods according to National Institute of Health (NIH) On Site Testing for Constant Volume Fume Hoods or Variable Air Volume (VAV) Fume Hoods in accordance with Part 1 "Performance Requirements" Article to verify compliance with performance requirements.

1. Adjust fume hoods, hood exhaust fans, and building's HVAC system, or replace hoods and make other corrections until tested hoods perform as specified.
2. After making corrections, retest fume hoods that failed to perform as specified.

3.4 ADJUSTING AND CLEANING

A. Adjust moving parts for smooth, near silent, accurate sash operation with one hand. Adjust sashes for uniform contact of rubber bumpers. Verify that counterbalances operate without interference.

B. Clean finished surfaces, including both sides of glass; touch up as required; and remove or refinish damaged or soiled areas to match original factory finish, as approved by Architect.

C. Furnish complete touchup kit for each type and color of fume hood finish provided. Include fillers, primers, paints, and other materials necessary to perform permanent repairs to damaged fume hood finish.

3.5 WARRANTY

A. In accordance with Division 01 General and Supplementary General Conditions, furnish a written warranty the Work performed under this section to be and remain free from defects as to materials and workmanship for a period of one (1) year from date of acceptance. Defects in materials and workmanship that may develop within this time are to be replaced without expense to the Owner.

END OF SECTION 115313

SECTION 116202 - LABORATORY STERILIZERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of contract, including General and Supplementary Conditions and Division Specification sections, apply to the work of this section.

1.2 WORK INCLUDED

A. Furnish all labor, materials, tools, equipment and services for all equipment as indicated in accord with provisions of Contract Documents.

B. Completely coordinate with work of all other trades.

C. Although such work is not specifically shown or specified, furnish and install all supplementary or miscellaneous items, appurtenances and devices incidental to or necessary for a sound, secure and complete installation.

D. Equipment in this section includes the following:

Section	Equipment Description	
2.1	ST1 & ST2	Steam Sterilizers

1.3 RELATED WORK

A. Relevant trade contractors will provide all rough openings, pits, substrate preparation and blocking for all equipment installations.

B. Mechanical contractor will provide exhaust rough-ins and final connections for all equipment installations.

C. Plumbing contractor will provide all supply/return service lines, drain and vent rough-ins and final connections for all equipment installations.

D. Electrical contractor will provide all electrical service rough-ins and final connections for all equipment installations.

1.4 QUALITY ASSURANCE

A. Use adequate numbers of skilled workmen who are thoroughly trained and experienced in the necessary crafts and who are completely familiar with the specified requirements and methods needed for proper performance of the work of this section.

B. Dimensions, voltages, electrical power requirements, and utility connections are based on the items specified. Manufacturer is responsible for all costs for dimensional adjustments.

C. Equipment may be inspected by Owner at manufacturer's plant prior to shipment. Equipment found not in accord with specifications and approved drawings may be rejected. Replace rejected equipment at no cost to Owner. Provide Owner's Representative two (2) week prior notice to all factory testing.

D. Electric operated and/or heated equipment must comply with applicable standards of National Electrical Manufacturer's Association (NEMA), National Electric Code (NEC), Underwriters' Laboratories, Inc. (UL) or Electrical Testing Lab (ETL).

E. Manufacturer Qualifications: Manufacturer shall be a firm having an established organization and factory, with production facilities specializing in the type of equipment specified, having an experienced engineering department and an established history of similar installations of equal scope and complexity. Manufacturer shall have the demonstrated ability to produce the specified equipment of the required quality and a proven capacity to complete an installation of this size and type within the required time limits. Service response time to a telephone inquiry shall be same day (or within 4 hours, whichever is less) followed up by a factory trained technician at the site within 24 hours of the telephone inquiry; all serviceable components warehoused or readily available to service personnel; and fast access to shop drawings of all equipment in field.

F. Acceptable Manufacturers.

1. Each piece of equipment listed includes the manufacturer's name and catalog number, establishing levels of quality, specific construction features, operating conditions and desired features and accessories.
2. By indicating other manufacturer's names does not relieve perspective bidders of their obligation to prove that their submissions are equal to specified equipment in size, construction, performance, basic features, options and accessories prior to award.

G. Installer Qualifications. Manufacturer, or approved in writing by manufacturer.

1.5 SUBMITTALS

A. Specification Compliance. Submit copy of relevant item specification section (from this document) and clearly note in bold print any substitutions, modifications or objections.

B. Samples.
1. Interior finish.
2. Exterior finish.
3. Color samples (if applicable).

C. Shop Drawings. Submit shop drawings for all items in this section, showing in large scale, methods of construction, joining, dimensions, materials, thicknesses, finishes of materials, installation, and relation to adjoining work and all other details to fully illustrate the work. Provide roughing-in drawings for mechanical and electrical services.

D. Product Data. Submit manufacturer's specifications and installation instructions for each item of laboratory equipment furnished.

E. Operational and Maintenance Data. Submit operating and maintenance instructions and parts listing for each item of fixed laboratory equipment. Include this data, product data, shop drawings, wiring diagrams, and any other data required by Owner, in three-ring maintenance manual. Prepare draft copy of operation and maintenance manual for Owner's review. Submit four (4) copies of final, accepted manual for Owner's use.

F. Applicable standards approval from NEMA, NEC, UL, and ETL or as specified with the individual equipment items.

1.6 DEVIATION FROM DRAWINGS AND SPECIFICATION

A. It must be distinctly understood that all such deviations shall be subject at all times to written approval prior to receipt of bid. If no written communication is received prior to bidding, it is assumed that bidder will be in total compliance with specifications and will be held responsible for default or delay.

B. All requests for a substitution must be made directly to the Architect's office for consideration no later than fifteen (15) working days prior to bid date.

C. All variances approved prior to bid date will be handled as an addendum to the specifications and will be sent to all bidders.

1.7 EQUIPMENT DELIVERY, STORAGE, HANDLING AND INSTALLATION REQUIREMENTS

A. All equipment in this specification shall be Contractor Furnished/Contractor Installed (CFCI). Certain equipment items will include Manufacturer's Installation Supervision (MIS) or Manufacturer's Equipment Demonstration (MED).

B. Contractor Furnished/Contractor Installed (CFCI): Construction Manager and/or relevant trade contractor (both identified as the "Contractor) to purchase, receive, store, unpack, set-in-place, install and clean up equipment. Deliver to site in manufacturer's original labeled containers. Contractor to provide any fasteners, supports or other miscellaneous items necessary for complete installation. All rough-ins and final connections by contractor. Contractor to use all means necessary to protect materials of this section before, during and after installation and to protect installed work and materials of all other trades. Contractor to confirm in writing that installed equipment meets or exceeds manufacturer's specifications. Contractor to provide owner's representative with rough-in and installation drawings of installed equipment. Where specified (MIS or MED), contractor will coordinate with manufacturer installation supervision and/or on-site equipment demonstrations. Scheduling of on-site equipment demonstrations to be at the convenience of the Owner.

C. Manufacturer's Equipment Demonstration (MED). Where noted in the specifications (i.e.: MED), the manufacturer shall provide two (1) one-day trips to the job site to instruct Owner on proper operation and maintenance of the equipment.

D. Manufacturer's Installation Supervision (MIS): Where noted in the specifications (i.e.: Vendor to provide installation supervision), the vendor shall provide adequate installation supervision personnel for as long as it takes to complete the installation to the satisfaction of the owner's representative. Vendor's field personnel may or may not be union depending on the conditions of the site. If the schedule demands it, vendor to agree to have their field personnel work overtime at no additional cost. Vendor installation supervision to include the following:

1. Trip(s) to the job site to coordinate specific technical project requirements.
2. Trip(s) to the job site to instruct equipment installation crews.
3. Trip(s) to the job site to check final installation, trouble-shoot and start-up equipment.
4. Three (3) trips to the job site to instruct Owner on proper operation and maintenance of the equipment.

E. Contractor Installed (CI): Relevant trade contractor (the “Contractor”) to unpack, set-in-place, stalls and clean up. Contractor to provide any fasteners, supports or other miscellaneous

items necessary for complete installation. All final connections by Construction Manager. Deliver to site in manufacturer's original labeled containers. Protect exposed surfaces and edges until work is completed. Construction Manager to confirm in writing that installed equipment meets or exceeds manufacturer's specifications. Construction Manager to provide Owner with rough-in and installation drawings of installed equipment. Where specified, Construction Manager will coordinate with manufacturer on site equipment demonstrations for the Owner.

1.8 WARRANTY

A. Except where more stringent warranty requirements are noted in the individual equipment descriptions, all equipment furnished under this section to be guaranteed for a minimum of one (1) year, parts and labor, from date of final acceptance against defective materials, design and workmanship. Defects to be promptly rectified after notification by Architect and at no additional cost to Owner.

1.9 JOB CONDITIONS

A. Drawings show arrangement and location of items of equipment. If it is necessary to vary from arrangement shown, because of structural, mechanical, electrical or other considerations, make such variations only after approval of Architect and at no additional cost to Owner.

B. Verify all dimensions at building.

C. Measure all recesses and openings at building and provide all trim pieces, fillers and closures in sizes required.

D. Confirm that all equipment will be able to be moved through the building in order to reach its designated location.

E. If compressed air is not an available service. Provide integral air compressor on all equipment requiring this service. Location for air compressor for washers and/or sterilizers will need to be coordinated. Air compressor will be floor mounted.

F. All equipment listed in this section shall meet local seismic restraint requirements, if applicable. Vendor shall determine whether the design and/or installation must be modified to meet this requirement and take appropriate action.

1.10 MANUFACTURER LISTING

A. Some manufacturers listed in these specifications can be contacted at the following telephone numbers:

1. Steris Corporation (800.548.4873)

PART 2 - PRODUCTS

2.1 ST1 & ST2: STEAM STERILIZERS

A. Product Description

1. PLC controlled automatic steam sterilizer equipped to employ both high vacuum (accomplished with a mechanical vacuum pump to achieve minimum 27" Hg in 5 minutes or less) and gravity displacement method of air removal. PLC shall control all

system functions, monitor system operations, visually and audibly alert operator of cycle malfunctions, and, on command, visually indicate chamber temperature and pressure. Integrity of piping and door seals monitored with preprogrammed leak test. Impact printer shall document and record each cycle's performance with such data as time and date that unit is opened, cycle number, set points and cycle selected. Full controls, as described above, on load side and partial controls, cycle selection only, on unload side (double door units only). RS232 or RS 485 port to down load cycle data to a remote computer. All data from control system to communications port in ASCII format compatible with PC/DOS support software. Provide 0.1-amp Form C dry contacts to communicate with building DDC system and send a signal when unit is turned on or off and a door is opened or closed.

2. Unit design shall allow for general purpose steam sterilization of unwrapped equipment, wrapped instruments and utensils, and liquids in vented or unsealed containers at temperatures ranging from 100 - 138°C (212 - 280°F). Temperature uniformity within chamber +/-1°C during cycles. Unit designed to meet or exceed Federal Specification GG-SS-1340A; Underwriter's Laboratory (UL) as certified by ETL Testing Laboratories; ASME Code, Section VIII, Division 1 (U-1 stamp of compliance).
3. Sterilizer chamber constructed of solid type 316L stainless steel with an internal glass bead finish and jacketing constructed of type 316L stainless steel. Chamber completely insulated with minimum 1” fiberglass insulation sleeve held in place with Velcro closure. Unit configured per Equipment Schedule with all exposed surfaces stainless steel. All installations continuously silicone caulked around perimeter of fascia if required to seal the transition. All serviceable components accessible from front and one side of unit. Provide manual (chambers 20”x20” or less) or power (chambers 26”x26” or more) operated sliding doors with automatic sealing, safety interlocks. PLC control system must have automatic door seal maintenance cycle built into PLC for ease of door seal change-out. Door seal shall be guaranteed for 1 year of continuous duty.
4. Resistance Temperature Detectors (RTD): Installed in chamber drain line and chamber jacket to sense and control temperature variations within the chamber.
5. Electronic Water Saving Control: To control the amount of water used in condensing exhausted chamber steam.
6. Optimal Solution Cooling: To safely cool various liquids in vented, borosilicate glass containers with minimum liquid loss due to boil-over, and to keep normal evaporation loss below 5 percent.
7. Automatic Utilities Startup/Shutdown: To shut off all utility valves, permitting slow cooling of the entire vessel and load. Programmed and manual restart options.
8. Steam Bleed: Constant steam flow supplied across chamber RTD to assure even temperature distribution and temperature control.
9. Steam Purge: To assist in air removal and to preheat load.
10. Automatic Steam Shutoff to Jacket: For isothermal and liquid cycles; to allow operation of cycles at lower temperatures and more efficient load cooling.
11. One-piece Insulation Sleeve: Fitted around exterior of sterilizer vessel.
12. Lighted DIN Connectors: Installed on all steam, water, and exhaust valves for reliability and ease of maintenance.
13. Control Lockout Switch: Limit switch on chamber door to prevent cycle from starting unless door seal is tight against the door.
14. Chamber Float Switch: To activate alarm, abort cycle, and safely vent chamber with a controlled exhaust if excessive condensate is detected in vessel chamber.
15. Door Interlocks (Double Door units only): To allow only one door to be opened at a time, and to prevent non-operating end door from being opened until a satisfactory cycle is complete.
16. Pressure Relief Valve: To limit the amount of pressure buildup so that the rated pressure in the vessel is not exceeded.

17. Chamber Drain System: To prevent pollutants from entering into the water supply system and sterilizer. Automatic stainless steel plate-type condensing system to convert chamber steam to condensate and to dispose it to waste.
18. Vacuum System: Mechanical vacuum pump to reduce chamber pressure during the prevacuum and post-drying phase. Air to be drawn from the chamber through the vacuum system following the dry phase, chamber vacuum to be relieved to atmospheric pressure by admitting air through a bacteria-retentive filter.
19. Provide with each unit:

    a. Rack and two (2) shelves for ST1
    b. One (1) loading car and transfer carriage for ST2.
    c. Drain discharge cool-down system to reduce discharges to 140°F or less.
    d. Integral air compressor with vibration mounting, if required.

20. Unit shall carry a three (3) year parts and labor warranty and vessel to carry a fifteen (15) year warranty.
21. Utility Requirements:

a.	E1	3/60/480V/15.0 A for vacuum pump.
b.	E2	1/60/120V/2 A for controls
c.	CW	15 GPM; 3/4" NPT. 20-50 PSIG Dynamic
d.	A	1/4" FNPT 80-120 PSIG.
e.	D1	2" NPT (vacuum system output; air gap at floor drain, only one connection required).
f.	Spcl	Dry contacts for DDC.
g.	S1	1" NPT, 75 PSIG minimum dynamic pressure, 400 lbs/hr.

B. Equipment item(s) shall be CFCI with MIS.

C. Steris Century Prevacuum Medium Steam Sterilizer.

D. Equipment Schedule:

Eqmt #	Comments
ST2	a. Steris Century Prevacuum Medium Sterilizer b. Chamber Size: 26"W x 26"H x 39"D c. Configuration: Single vertical power sliding door, recessed through one wall. d. Provide integral air compressor, if required.

Eqmt #	Comments
ST1	a. Steris Century Prevacuum Medium Sterilizer b. Chamber Size: 20"W x 20"H x 38"D c. Configuration: Single door, recessed through one wall. d. Provide integral air compressor, if required.

PART 3 - EXECUTION

3.1 INSPECTION

A. Check for shipping damage. Reject units with scratches, dents or other defects that cannot be readily corrected.

B. Check job site to ensure that rough-ins and substrates are correct, and that equipment will fit as indicated on Drawings.

C. Do not proceed with installation until defects or oversights are corrected.

3.2 INSTALLATION

A. Deliver equipment to the job site freight paid.

B. Uncrate all equipment and place in locations shown on Drawings. Remove all crating materials and packing debris.

C. Install all items in accordance with Manufacturer's standards. Provide all accessories necessary for a complete installation.

D. Verify plumbing, ventilation and electrical connection requirements for all equipment with manufacturer and coordinate connections with work of Divisions 22, 23 and 26.

3.3 ADJUST AND CLEAN

A. Check operation and installation of equipment. Make adjustments as necessary to meet Manufacturer's or Owner's (whichever is more stringent) specifications.

B. Replace items which do not operate properly, have defacing marks or damage which cannot be satisfactorily repaired as determined by the Owner's Representative.

C. Clean and polish equipment in accordance with Manufacturer's recommendations before and after demonstration for Owner. Leave ready for use with copy of instruction manual attached to equipment in a manner to be specified by Owner's Representative.

END OF SECTION 116202

SECTION 122413 - ROLLER WINDOW SHADES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Manually operated roller shades with single rollers.

B. Related Requirements:

1. Section 061053 "Miscellaneous Rough Carpentry" for wood blocking and grounds for mounting roller shades and accessories.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, features, finishes, and operating instructions for roller shades.

B. Shop Drawings: Show fabrication and installation details for roller shades, including shadeband materials, their orientation to rollers, and their seam and batten locations.

C. Samples: For each exposed product and for each color and texture specified, 10 inches (250 mm) long.

D. Product Schedule: For roller shades. Use same designations indicated on Drawings.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Product Certificates: For each type of shadeband material.

C. Product Test Reports: For each type of shadeband material, for tests performed by a qualified testing agency.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For roller shades to include in maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Roller Shades: Full-size units equal to 5 percent of quantity installed for each size, color, and shadeband material indicated, but no fewer than two units.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: Fabricator of products. Installer for roller shade system shall be trained and certified by the Manufacturer with a minimum of ten years experience in installing products comparable to those specified in this section.

B. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for fabrication and installation.

1. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver roller shades in factory packages, marked with manufacturer, product name, and location of installation using same designations indicated on Drawings.

1.9 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace roller window shades that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Failure to meet performance requirements.
b. Faulty operation.

2. Warranty Period:
a. 15 years from date of Substantial Completion.

1.10 FIELD CONDITIONS

A. Environmental Limitations: Do not install roller shades until construction and finish work in spaces, including painting, is complete and dry and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.

B. Field Measurements: Where roller shades are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication and indicate

measurements on Shop Drawings. Allow clearances for operating hardware of operable glazed units through entire operating range. Notify Architect of installation conditions that vary from Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Source Limitations: Obtain roller shades from single source from single manufacturer.

2.2 MANUALLY OPERATED SHADES WITH SINGLE ROLLERS

A. Basis-of-Design Product: Subject to compliance with requirements, provide MechoShade Systems, Inc; Mecho/5 with extended bracket without fascia.No Substitutions.

B. Chain-and-Clutch Operating Mechanisms: With continuous-loop bead chain and clutch that stops shade movement when bead chain is released; permanently adjusted and lubricated.

1. Bead Chains: Stainless steel.

    a. Loop Length: Full length of roller shade.
    b. Limit Stops: Provide upper and lower ball stops.
    c. Chain-Retainer Type: Chain tensioner, jamb mounted .

2. Spring Lift-Assist Mechanisms: Manufacturer's standard for balancing roller shade weight and for lifting heavy roller shades.

    a. Provide for shadebands that weigh more than 10 lb (4.5 kg) or for shades as recommended by manufacturer, whichever criterion is more stringent.

C. Rollers: Corrosion-resistant steel or extruded-aluminum tubes of diameters and wall thicknesses required to accommodate operating mechanisms and weights and widths of shadebands indicated without deflection. Provide with permanently lubricated drive-end assemblies and idle-end assemblies designed to facilitate removal of shadebands for service.

1. Roller Drive-End Location: As indicated on Drawings.
2. Direction of Shadeband Roll: Regular, from back (exterior face) of roller.
3. Shadeband-to-Roller Attachment: Manufacturer's standard method. Any method of attaching shade band to roller tube that requires the use of: adhesive, adhesive tapes, staples, and/or rivets, does not meet the performance requirements of this specification and shall not be accepted.

D. Mounting Hardware: Brackets or endcaps, corrosion resistant and compatible with roller assembly, operating mechanism, installation accessories, and mounting location and conditions indicated. Provide shade hardware constructed of minimum 1/8-inch (3.18 mm) thick plated steel or heavier as required to support 150 percent of the full weight of each shade. Provide positive mechanical engagement of drive mechanism to shade roller tube. Friction fit connectors for drive mechanism connection to shade roller tube are not acceptable.

E. Roller-Coupling Assemblies: Coordinated with operating mechanism and designed to join up to three inline rollers into a multiband shade that is operated by one roller drive-end assembly.

F. Shadebands:

1. Shadeband Material: Light-filtering fabric.
2. Shadeband Bottom (Hem) Bar: Steel or extruded aluminum.

a. Type: Enclosed in sealed pocket of shadeband material.
b. Color and Finish: As indicated on Drawings.

G. Installation Accessories:

1. Endcap Covers: To cover exposed endcaps.

2. Closure Panel and Wall Clip: Removable aluminum panel designed for installation at bottom of site-constructed ceiling recess or pocket and for snap-in attachment to wall clip without fasteners. Provide closure piece both at the shade itself and areas where no shade is required. Refer to Drawings.

a. Closure-Panel Width: As indicated on Drawings.

3. Installation Accessories Color and Finish: As selected from manufacturer's full range.

2.3 SHADEBAND MATERIALS

A. Shadeband Material Flame-Resistance Rating: Comply with NFPA 701. Testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

B. Light-Filtering Fabric: Woven fabric, stain and fade resistant.

1. Source: Roller shade manufacturer.
2. Type: As indicated on Drawings
3. Weave: Mesh.
4. Thickness: As indicated on Drawings.
5. Weight: As indicated on Drawings.
6. Orientation on Shadeband: As indicated on Drawings.
7. Openness Factor: As indicated on Drawings.
8. Color: As indicated on Drawings.

2.4 ROLLER SHADE FABRICATION

A. Product Safety Standard: Fabricate roller shades to comply with WCMA A 100.1, including requirements for flexible, chain-loop devices; lead content of components; and warning labels.

B. Unit Sizes: Fabricate units in sizes to fill window and other openings as follows, measured at 74 deg F (23 deg C):

1. Between (Inside) Jamb Installation: Width equal to jamb-to-jamb dimension of opening in which shade is installed less 1/4 inch (6 mm) per side or 1/2-inch (13-mm) total, plus or minus 1/8 inch (3.1 mm). Length equal to head-to-sill or -floor dimension of opening in which shade is installed less 1/4 inch (6 mm), plus or minus 1/8 inch (3.1 mm).

2. Outside of Jamb Installation: Width and length as indicated, with terminations between shades of end-to-end installations at centerlines of mullion or other defined vertical separations between openings.

C. Shadeband Fabrication: Fabricate shadebands without battens or seams to extent possible, except as follows:

1. Vertical Shades: Where width-to-length ratio of shadeband is equal to or greater than 1:4, provide battens and seams at uniform spacings along shadeband length to ensure shadeband tracking and alignment through its full range of movement without distortion of the material.
2. Railroaded Materials: Railroad material where material roll width is less than the required width of shadeband and where indicated. Provide battens and seams as required by railroaded material to produce shadebands with full roll-width panel(s) plus, if required, one partial roll-width panel located at top of shadeband.
3. Fabricate shade cloth to hang flat without buckling or distortion. Fabricate with heat-sealed trimmed edges to hang straight without curling or raveling. Fabricate unguided shadecloth to roll true and straight without shifting sideways more than 1/8 inch (3.18 mm) in either direction per 8 feet (2438 mm) of shade height due to warp distortion or weave design.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, operational clearances, and other conditions affecting performance of the Work.

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

3.2 ROLLER SHADE INSTALLATION

A. Install roller shades level, plumb, and aligned with adjacent units according to manufacturer's written instructions.

B. Roller Shade Locations: As indicated on Drawings.

3.3 ADJUSTING

A. Adjust and balance roller shades to operate smoothly, easily, safely, and free from binding or malfunction throughout entire operational range.

3.4 CLEANING AND PROTECTION

A. Clean roller shade surfaces, after installation, according to manufacturer's written instructions.

B. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer, that ensure that roller shades are without damage or deterioration at time of Substantial Completion.

C. Replace damaged roller shades that cannot be repaired, in a manner approved by Architect, before time of Substantial Completion.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain roller shades.

END OF SECTION 122413

SECTION 123553 – LABORATORY CASEWORK

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 WORK INCLUDED

A. Furnishing of materials, products, accessories, tools, equipment, services, scaffolding, ladders, transportation, supervision, labor, product protection, and other items that may not be specifically mentioned, but are necessary for the fabrication and installation of laboratory casework.

B. Furnish and install laboratory casework including, but not limited to, counter tops, reagent shelves, tables, standards, slotted studs, filler panels, scribes, knee space panels, accessories, casework in environmental rooms, utility space framing, utility space closure panels between base cabinets and at exposed ends of utility spaces, laboratory sinks, cup sinks, cup drains, strainers, overflows and sink outlets with integral or separate tail pieces and miscellaneous items of equipment as listed in these specifications and as shown on drawings, including delivery to the building, unpacking, installing, leveling and scribing to walls and floors as required.

C. Furnish and deliver packed in boxes for receipt, handling and installation by others; electrical service fixtures, task lights including fluorescent bulbs, electrical receptacles and switches listed in these specifications and as shown on drawings as part of the laboratory casework. The above-defined items are to be supplied, not attached, and loose in boxes, properly marked for tailgate delivery.

D. Furnish and set in place for installation by other trades; service fittings where part of the laboratory casework, listed in the specifications or shown on drawings. Tailpieces shall be furnished less couplings required to connect to the trap or drain piping system. Install service fittings “finger tight”.

E. Furnish and mount plumbing and electrical fixtures on fume hood superstructure.

1.3 RELATED WORK BY OTHER SPECFICATION SECTIONS

A. Furnishing, installation and connection of “Service Lines” within and/or attached to equipment, slotted studs, partitions, service tunnels or service turrets, through, under or along backs of working surfaces as required for “Service Fixtures.”

B. Final installation, tightening and connecting “Service Fixtures” furnished by laboratory casework manufacturer including the pulling of wire and connecting of electrical fixtures in service lines.

C. Connecting separate laboratory sinks, cup sinks or drains, overflows, sink outlets and tail-pieces furnished by the laboratory casework manufacturer.

D. Furnishing, installing and connecting vents and drain lines.

E. Furnishing, installing, setting and connecting special electrical and plumbing fixtures and piping to meet local codes, even though not specifically called for in specifications and shown on drawings.

F. Furnishing, installing and connecting of ducts from fume hoods to blowers and from blowers to atmosphere.

G. Furnishing, handling and installing fans with motors (blowers).

H. Furnishing, and installation of framing or reinforcements for wall, floors and ceilings to adequately support laboratory equipment and brick, plaster, metal or wood grounds required for proper anchoring of the equipment.

I. Furnishing and installation of pipe hangers.

J. Furnishing and installation of resilient base on walls and fixed laboratory casework after laboratory casework installation is completed.

K. Related Sections include the following:

1. Division 06 Section “Rough Carpentry” for wood blocking for anchoring casework.
2. Division 09 Section “Gypsum Plaster” for reinforcements in metal- framed plaster partitions for anchoring casework.
3. Division 09 Section “Gypsum Wallboard Assemblies” for reinforcements in gypsum board partitions for anchoring casework.
4. Division 09 Section “Resilient Wall Base and Accessories” for resilient base applied to casework.
5. Division 11 Section “Laboratory Fume Hoods”
6. Division 22 and 26 Sections for installing service fittings specified in this section.
7. Divisions 22, 23 and 26 for connecting service utilities at indicated points. Piping and wiring for service fittings within casework up to point of connection are specified in this Section.

1.4 DEFINITIONS

A. “Add-A-Drawer” refers to a generic system of laboratory casework; it does not refer to a particular brand or manufacturer.

B. “Laboratory Casework Contractor” is defined as the manufacturer and/or manufacturer’s representative furnishing and installing the laboratory casework, equipment, and accessories listed under these specifications, laboratory equipment schedule and/or shown on drawings.

C. “Service Fixtures” are defined as gas, air, and vacuum cocks, hot, cold, reagent grade water faucets, remote control valves, electrical receptacles with necessary flush mounting boxes, conduits or pedestals and plates, fluorescent and/or incandescent light fixtures, light switches and/or motor switches for hoods and other items which serve as a functional part of the equipment.

D. “Service Lines” are defined as gas, air, vacuum, hot, cold, reagent grade and reference grade water piping, drain lines, fittings and shut off valves necessary to carry respective services from building roughing-in floors or walls through equipment to “service fixture”.

E. "Service Lines" also include conduit, junction boxes, conduit fitting, wire disconnect switches and fuse or circuit breakers necessary to carry electrical services from building roughing-in outlets in floors or walls through equipment to "service fixtures."

F. "Standards" are wall mounted, single and twin-tracked shelf supports.

G. Exposed Portions of Cabinets: Surfaces visible when doors and drawers are closed, including bottoms of cabinets more than 48" above floor, and surfaces visible in open cabinets.

H. Semi-exposed Portions of Cabinets: Surfaces behind opaque doors, such as interiors of cabinets, shelves, dividers, interiors and sides of drawers, and interior faces of doors. Tops of cases 78" or more above floor are defined as semi-exposed.

I. Concealed Portions of Cabinets: Surfaces nor usually visible after installation, including sleepers, web frames, dust panels, and ends and backs that are placed directly against walls or other cabinets.

1.5 REFERENCE STANDARDS

A. REFERENCE Scientific Equipment & Furniture Association (SEFA)

1. SEFA 1.2 Laboratory Fume Hoods
2. SEFA 2.3 Scientific Laboratory Furniture And Equipment
3. SEFA 3 Work surfaces
4. SEFA 7 Laboratory and Hospital Fixtures
5. SEFA 8 Laboratory Furniture-Casework-Shelving and Tables – Recommended Practices

B. American Society for Testing and Materials (ASTM)

1. A240-Heat Resistant Chromium and Chromium – Nickel Stainless Steel Plate, Sheet, and Strip for pressure Vessels
2. A312-Seamless and Welded Austenitic Stainless Steel Pipe
3. D570-Water Adsorption of Plastics
4. D695-Compressive Properties of Rigid Plastics
5. D790-Fluctural Properties of Un-reinforced and Reinforced Plastics and Electrical Insulating Materials
6. E84-Test Method for Surface Burning Characteristics of Building Materials
7. A554 Standard Specification for Welded Stainless Steel Mechanical Tubing
8. A513 Standard Specification for Electric-Resistance Welded Carbon and Alloy Steel Mechanical Tubing

C. Builders Hardware Manufacturers Association (BHMA)

D. National Electrical Manufacturers Association (NEMA)

E. American National Standards Institute (ANSI)

F. National Fire Protection Association (NFPA) 30 Flammable Liquid Storage

G. National Fire Protection Association (NFPA) 70 Electrical Components, Devices and Accessories.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: An authorized representative of the casework manufacturer for installation and maintenance of units required for this Project.

B. Source limitations: Obtain all casework, including countertops, sinks, service fittings and accessories through one source from a single manufacturer. Obtain through same source from same manufacturer as fume hoods specified herein.

C. Flammable Liquid Storage: Where cabinets are indicated for solvent or flammable liquid storage, provide units that are listed and labeled as complying with requirements of NFPA 30 by UL or another testing and inspecting agency acceptable to authorities having jurisdiction.

1. Electrical components, Devices and Accessories: Listed and labeled as define in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction and marked for intended use.

2. Pre-installation Conference: Conduct a conference at the Project Site to comply with requirements in Division 01 Section “Project Management and Coordination.

D. Product Standard: Comply with SEFA 8, “Laboratory Furniture-Casework, Shelving and Tables-Recommended Practices”.

E. Laboratory furniture systems and systems components must be UL 962 submitted, approved and listed. Products must bear the UL Mark and shall be identified to those products that were evaluated by UL and found to comply with UL’s requirements. The testing standard shall include Dielectric, Grounding Impedance, Stability, Strain Relief and Strength tests.

1.7 SUBMITTALS

A. Refer to submittal section of the General and Supplementary Specification in Division 01 for requirements and procedures. Fabrication or purchase of any items prior to approval will be at the manufacturer’s risk.

B. Product Data: For each type of product listed.

C. Equipment Samples:

1. Laboratory casework manufacturer shall submit the following samples for approval by the Owner’s Representative:

   a. One (1) 24” wide full height base cabinet consisting of one (1) drawer, one (1) door, one (1) cupboard with adjustable full depth shelf and related hardware (pulls, hinges, etc.), complete with finish.
   b. One (1) 24” wide Add-A-Drawer base cabinet consisting of one (1) drawer, one (1) door, one (1) cupboard with adjustable full depth shelf and related hardware (pulls, hinges, etc.), complete with finish.
   c. One (1) 30” long standard, and one (1) end bracket, with specified finish.
   d. Service Fixtures: one of each fixture type required for project.
   e. Adhesives and sealants.
   f. Countertop material (one of each specified): 12”x12”x1” thick, showing top, front edge and backsplash construction.

2. Reviewed samples will be retained by the Owner’s Representative.

D. Color and Finish Samples.

1. Color for miscellaneous items shall be selected by the Architect. The laboratory furniture manufacturer shall furnish color and finish samples on same material from which the miscellaneous items will be constructed for approval before fabrication of casework starts. Samples shall be clearly identified. The Architect will specify the color of the following furniture components (multiple colors may be selected at no change in contract sum):

    a. Slotted standards
    b. Slotted studs
    c. Adjustable shelves and desktops
    d. Adjustable shelf and bracket and rear curb.

E. Shop Drawings. For metal laboratory casework. Include plans, elevations, sections, details, and attachments to other work.

1. Indicate locations of blocking and reinforcements required for installing laboratory casework.
2. Indicate locations and types of service fittings, together with associated service supply connection required.
3. Include details of utility spaces showing supports for conduits and piping.
4. Include details of support framing system.
5. Include details of exposed conduits, if required, for service fittings.
6. Indicate locations of and clearances from adjacent walls, doors, windows, other building components, and other laboratory equipment.
7. Include coordinated dimensions for laboratory equipment specified in other Sections.

F. Qualification Data: For testing agency.

G. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, indicating compliance of laboratory casework finishes and countertops with requirements specified for chemical and physical resistance.

1.8 EXCEPTIONS TO DRAWINGS AND SPECIFICATION

A. All exceptions shall be subject to written approval prior to receipt of bid. If no written communication is received prior to receipt of bid and approval indicated in an addendum, it is assumed that bidder will be in total compliance with specifications and will be held responsible for default or delay, regardless of any statement to the contrary in their written proposal.

B. Requests for a substitution must be made directly to the Owner's Representative's office for consideration no later than fifteen (15) working days prior to bid receipt date.

C. Requests for a substitution following the bid opening will be rejected.

D. Substitutions approved prior to bid date will be handled as an addendum and be sent to all bidders.

1.9 WARRANTY

A. Furnish a written warranty that work performed under this Section shall remain free from defects as to materials and workmanship for a period of one (1) year from date of acceptance. Defects in materials and workmanship that may develop within this time are to be replaced without cost or expense to the Owner. Defects include, but are not limited to:

1. Ruptured, cracked
2. Discoloration or lack of finish integrity
3. Cracking or peeling of finish
4. Slippage, shift, or failure of attachment to wall, floor, or ceiling
5. Weld or structural failure (visible weld marks)
6. Warping or unloaded deflection of components
7. Failure of hardware

1.10 TESTING

A. The laboratory casework manufacturer shall be required to include in their initial submittals, certified test reports indicating compliance of their laboratory casework finish and work top materials with requirements specified for chemical and physical resistance; and confirmation of load performance for movable tables. The material test reports shall be performed by an independent testing agency qualified for testing indicated, as documented according to ASTM E548.

1.11 FIELD MEASUREMENTS

A. It is the laboratory casework manufacturer's responsibility to verify field measurements and that equipment will fit through entryways, corridors and door openings enabling a smooth flow of equipment to its proper location in the building. Wall-to-wall counter tops are to be installed with a maximum ¼" gap.

1.12 DELIVERY, STORAGE AND HANDLING

A. Deliver casework only after painting, utility rough-ins and similar operations that could damage, soil or deteriorate casework have been completed in installation areas. If casework must be stored in other than installation areas, store only in areas where environmental conditions meet requirements specified in "Project Conditions" Article of this specification section.

B. Keep finished surfaces covered with polyethylene film or other protective covering during handling and installation.

1.13 PROJECT CONDITIONS

A. Environmental Limitations: Do not deliver or install casework until building is enclosed, wet work is complete and HVAC system is operating and maintaining temperature and relative humidity at occupancy levels during the remainder of the construction period.

B. Field Measurements: Where casework is indicated to fit to other construction, verify dimensions by field measurements before fabrication and indicate measurements on Shop Drawings.

1. Established Dimensions: Where field measurements cannot be made without delaying the Work, establish dimensions and proceed with fabricating the casework without field

measurements. Coordinate construction to ensure that actual dimensions correspond to established dimensions.

1.14 COORDINATION

A. Coordinate layout of metal framing and reinforcements in wall assemblies for support of the casework.

B. Coordinate installation of casework with installation of fume hoods and other laboratory equipment including rough-in locations and requirements.

1.15 EXTRA MATERIALS

A. Furnish complete touch-up kit for each type and finish of the casework provided. Include scratch fillers, stains, finishes, and other materials necessary to perform permanent repairs to damages casework finish.

1.16 PERFORMANCE REQUIREMENTS

A. Structural Performance: Provide metal laboratory casework and support framing capable of withstanding the effects of the following gravity loads and stresses per support framing module without permanent deformation, excessive deflection, or binding of drawers and doors:

1.	Top of Support Framing System:	500 lbs.
	Wall Cabinets:	300 lbs. This is based on a 12" deep wall cabinets with 100 pounds uniformly loaded on the top, shelf and bottom of the cabinet.
2.	Shelves (Up to 12 Inches Deep):	180 lbs.
3.	Work Surface	600 lbs.
4.	Suspended Base Cabinets:	350 lbs.
5.	Total for Wall Unit:	1680 lbs.

B. Seismic Performance: Metal laboratory casework and support framing shall meet local seismic restraint requirements

1.17 MOCK-UP

A. Laboratory casework manufacturer shall erect a laboratory casework mock-up at the location indicated on the Drawings. Once selected, the assembly shall be constructed and assembled in accordance with the construction documents. Modifications required to meet this specification shall be incorporated into the overall design of the project without change in contract sum.

B. Once installed and approved. The mock-up shall be maintained at the project site during construction as a standard for judging the completed work.

PART 2 - PRODUCT

2.1 MANUFACTURERS

A. Metal Casework:

1. Mott Manufacturing Ltd. (Brantford, ON, Canada)
2. Bedcolab (Laval, Quebec, Canada).
3. Kewaunee Scientific Corp. (Statesville, NC)
4. NEOS Science (Pickering, Ontario, Canada)

B. Epoxy Resin Countertops and Sinks:

1. Durcon Corporation (Plymouth, MI)
2. Kewaunee Scientific Corporation (2700 West Front Street, 704-873-7202)

C. Phenolic Resin:

1. NuLab Furniture Corporation (Englishtown, NJ)
2. JHC Lab resin Casework (Brooklyn, NY)
3. Trespa North America, Ltd

D. The naming of a manufacturer and designation of a product is for the purpose of identifying a basis of design. Other manufacturers capable of producing the same appearance and having the same quality, durability, and performance may be proposed for use on this project subject to approval of the Owner's Representative, prior to the receipt of bid.

2.2 CASEWORK RELATED MATERIALS

A. Metal: Cold-rolled commercial steel sheet, complying with ASTM A 1008/A 1008M; matte finish; suitable for exposed applications.

1. Minimum Metal Thickness:
   a. Sides, Ends, Fixed Backs, Bottoms, Tops, Soffits, and Items Not Otherwise Indicated: 0.0428 inch. Except for flammable liquid-storage cabinets, bottoms may be 0.0329 inch if reinforced.
   b. Back Panels, Doors, Drawer Fronts and Bodies, and Shelves: 0.0329 inch except 0.0428 inch for back panels and doors of flammable liquid-storage cabinets and for un-reinforced shelves more than 36 inches long.
   c. Intermediate Horizontal Rails, Table Aprons and Cross Rails, Center Posts, and Top Gussets: 0.0528 inch.
   d. Leveling and Corner Gussets: 0.0966 inch.

B. Stainless Steel:

1. Counter tops, sinks, stainless steel accessories, shelves and shelf supports noted on drawings as "Stainless Steel" shall be type 302/304, austenitic chromium nickel stainless steel in accordance with A.I.S.I. specification containing 8% nickel and 18% chromium. Where noted as such, stainless steel components and shelf supports shall be constructed exactly as those fabricated of cold rolled sheet steel and the same gages. Exposed surfaces shall have #4 finish.

2. Counter tops and sinks noted on drawings as "Type 316 Stainless Steel" shall be similar to type 302/304 except molybdenum is added to improve the general corrosion and pitting resistance.

C. Glass. Glass for glazed doors shall be ¼" thick clear laminated safety glass, complying with ASTM C1172, Kind LT, Condition A, Type 1, Class 1 with 2 lites not less than 3.0mm thick with clear, polyvinyl butyl interlayer.

D. Phenolic Resin:

1. Where indicated on drawings as "Phenolic Casework" board material shall equal to Trespa Corporation, Poway, CA, -Athlone. Board material shall consist of layers of phenolic impregnated kraft papers that are compressed in a flat press at pressures exceeding 100 psi and at 300 deg and a melamine colored top surface.

2. The material shall meet the following requirements:

a.	Density:	85.9 lb./cuft
b.	Surface Hardness:	85-95 Rockwell D Scale
c.	Flexural Strength (ASTM D-790):	22,000 PSI Machine Direction
d.	Abrasion Resistance (NEMA LD3-3.01):	1400 Cycles
e.	Flame Spread Index Surface Burning (ASTM E-84-UL723):	30
f.	Flame Spread Index Radiant Heat Source (ASTM E-162):	17

2.3 COUNTER TOPS AND CURBS

A. General: Counter tops shall be 1" thick. Curbs shall be ¾" thick of the same material as the counter top and shall be provided at the rear of counter tops and on end returns. Laboratory counter tops shall be epoxy resin unless otherwise noted on the drawings. Epoxy and stainless steel counter tops to be installed without field cutting or drilling. The gap between the curb and wall is to be sealed with silicone sealant, color matched to the counter top. Sink counter tops shall be fabricated in one piece and have a marine edge around the four sides to create a dished top. Counter tops shall be cut to maximum lengths possible. Provide front and end overhang of 1" with continuous drip groove on underside ½" from edge.

B. Epoxy Resin. Epoxy resin counter tops and curbs shall be molded from a modified epoxy resin especially compounded and cured to give optimum physical and chemical resistant properties. Material shall be a uniform mixture throughout the full thickness. Materials shall have a non-specular finish. Color to be selected by the Architect. Exposed edges shall have a 1/8" radius on front top edge and at vertical corners. Curbs shall typically be 4" high, unless otherwise noted on Drawings, and shall be ¾" thick bonded to the surface of the top to form a square joint. Epoxy resin tops shall be 1" thick except in fume hoods where they will be 1¼" thick. Joints between tops shall be smooth, even, square, 1/8" wide maximum and shall be watertight by use of a silicone adhesive with corrosion-resistant quality.

1. Physical Properties:

   a. Flexural Strength: Not less than 10,000 psi.
   b. Modulus of Elasticity: Not less than 2,000,000 psi.
   c. Hardness: Not less than 100.
   d. Water Absorption (24 Hours): Not more than 0.02 percent.
   e. Heat Distortion Point: Not less than 260 deg F.

2. Chemical Resistance: Epoxy-resin material has the following ratings when tested with indicated reagents according to NEMA LD 3, Test Procedure 3.4.5:

   a. No Effect: Acetic acid (98 percent), acetone, ammonium hydroxide (28 percent), benzene, carbon tetrachloride, dimethyl formamide, ethyl acetate, ethyl alcohol, ethyl ether, methyl alcohol, nitric acid (70 percent), phenol, sulfuric acid (60 percent), and toluene.
   b. Slight Effect: Chromic acid (60 percent) and sodium hydroxide (50 percent).

3. Countertop Fabrication: Fabricate with factory cutouts for sinks and with butt joints assembled with epoxy adhesive and pre-fitted, concealed metal splines.

4. Countertop Configuration: Raised (marine) edge, 1" thick at raised edge, with beveled edge and corners, and with applied ¾" thick backsplash.

5. Sink Fabrication: Molded in 1 piece with radiused corners, and bottom sloped to outlet with integral side mounted overflows; ½" minimum thickness producing a smooth finish, the same color as the surrounding counter top.

   a. Provide with polypropylene strainers and tailpieces.

C. Stainless Steel. Counter tops and curbs noted on drawings as "Stainless Steel", (Type 302/304) Stainless steel shall be constructed of 16-gauge nominal thickness, stainless steel sheet, ASTM A666. Exposed surfaces shall have #4 satin finish.

1. Extend top down 1" at edges with a ½" return flange under frame. Apply heavy coating of heat-resistant, sound-deadening mastic to undersurface.
2. Form curb coved to and integral with top surface of one piece, without seams or joints. The top of the curb shall be chamfered 45 degrees.
3. Provide raised (marine) edge around perimeter of countertops containing sinks; pitch two ways to sink to provide drainage without channeling or grooving.
4. Reinforce underside of countertop with channels where necessary to insure rigidity without deflection and coat with a sound deadening material where not exposed to view.
5. Tops shall be as long as practical to permit access to the building and room. Where field-made joints are required, provide continuous channels welded to the underside of the counter for reinforcing and aligning the butt-joints.
6. Electrically weld shop and field made joints, and grind and polish surfaces to produce uniform, directionally textured finish, free of cross scratches. When polishing is completed rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.
7. Where stainless steel sinks or cup sinks occur in stainless-steel countertops, factory weld into one integral unit, grind welds smooth, polish and rinse. Tops shall be adequately reinforced to accept sinks.
8. Sinks: Made not less that 0.050 inch thick. Fabricate with corners rounded and coved to at least 5/8" radius. Slope sink bottom to outlet. Provide double wall construction for sink partitions with top edge rounded to at least ½" diameter. Provide continuous butt-welded joints, grind smooth and polish surfaces to produce non-directional #4 satin finish, free of scratches. When polishing is completed rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean. Provide factory punching for fittings, stainless steel strainers and tailpieces. Provide integral rims when not used with stainless steel counter tops.
9. Cup Sinks: 3" x 6" nominal size of equal quality and material as the sinks. Provide stainless steel strainers and integral tailpieces.

2.4 ADJUSTABLE SHELVES

A. GENERAL. Adjustable shelves shall be constructed from one of the following as indicated on the Drawings.

1. Metal Shelving. Adjustable painted steel shelves shall be formed down 3/4", returned back 7/8" and up 1/4" into a channel formation front and rear and formed down 3/4" at each end. Shelves over 42" long shall be further reinforced with a channel formation

welded to underside of shelf. Shelves shall be adjustable on not more than 1" increments.

2. Wire Shelving. Material shall be steel wire with polished chrome finish. Each shelf shall support up to 400 lbs. Unit shall be equal to Metro Wire Corporation.

B. Adjustable shelves shall be 12” deep, unless otherwise noted on the Drawings.

C. Adjustable shelves shall be mounted to surface type steel standards (wall condition). Adjustable shelves shall be supported by steel shelf brackets not to exceed 48” on center. Brackets shall be cold rolled steel with epoxy powder coated finish, complying with BHMA A156.9, Types B04102 and B04112. Shelves shall be fastened to brackets with two stainless steel screws per bracket.

2.5 CABINET DESIGN

A. Casework shall be fabricated as sectional units, ready for placement in the laboratory as a complete integral rigid unit permitting relocation at any subsequent time.

B. Base cabinets must be capable of supporting an equipment load of at least 500lb. per running foot above and beyond the weight of the assembly including the counter top when tested in accordance with the test procedures as outlined in SEFA 8 Section 4.

C. Where noted as such, provide wall-mounted casework that matches all other laboratory casework in design and material. The assembly must be capable of supporting an equipment load of at least 150 lb. per running foot above and beyond the weight of the assembly when tested in accordance with test procedures as outlined in SEFA 8, section 9.

2.6 CABINET CONTSTRUCTION

A. General: Assemble and finish units at point of manufacture. Use precision dies for interchangeability of like-size drawers, doors, and similar parts. Perform assembly on precision jigs to provide units that are square. Reinforce units with angles, gussets, and channels. Integrally frame and weld to form a dirt and vermin-resistant enclosure. Where applicable, reinforce base cabinets for sink support. Maintain uniform clearance around door and drawer fronts of 1/16 to 3/32 inch.

B. Flush overlay construction: Surfaces of doors and drawers shall overlay the cabinet ends, top or bottom rails. Horizontal and vertical case shell members (panels, top rails and bottoms) shall be concealed behind drawer and door fronts. Reveals shall be a uniform 1/8", vertically and horizontally, between adjacent drawer and door's fronts. Reveals shall be a uniform 1/8" horizontally between drawer and door fronts.

C. Flush Doors: Outer and inner pans that nest into box formation, with full-height channel reinforcements at center of door. Fill doors with noncombustible, sound-deadening material.

D. Glazed Doors: Hollow-metal stiles and rails of similar construction as flush doors, with glass held in resilient channels or gasket material.

E. Hinged Doors: Mortise for hinges and reinforce with angles welded inside inner pans at hinge edge.

F. Drawers: Fronts made from outer and inner pans that nest into box formation, with no raw metal edges at top. Sides, back, and bottom fabricated in one piece with rolled or formed top of sides for stiffening and comfortable grasp for drawer removal. Weld drawer front to sides and

bottom to form a single, integral unit. Provide drawers with rubber bumpers, ball-bearing slides, and positive stops to prevent metal-to-metal contact or accidental removal.

G. Adjustable Shelves: Front, back, and ends formed down, with edges returned horizontally at front and back to form reinforcing channels.

1. Adjustable shelves shall be 12” deep, unless otherwise noted on the drawings.

2. Adjustable shelves shall be mounted to surface type steel standards (wall condition) or slotted studs. Adjustable shelves shall be supported by steel shelf brackets. Brackets shall be cold rolled steel with epoxy powder coated finish, complying with BHMA A156.9, Types B04102 and B04112. Shelves shall be fastened to brackets with two stainless steel screws per bracket.

3. Adjustable shelves mounted on slotted studs shall be supplied with a continuous 2” high band to create a 1” high curb at rear of shelf. The curb along the back shall be of similar material as the shelf.

H. Toe Space: Fully enclosed, 4 inches high by 3 inches deep, with no open gaps or pockets.

I. Table Legs: Welded tubing, not less than 2 inches (50 mm) square with stretchers where needed to comply with product standard. Weld or bolt leg stretchers to legs and cross-stretchers and bolt legs to table aprons. Provide leveling device welded to bottom of each leg.

J. Utilities: Provide space, cutouts, and holes for pipes, conduits, and fittings in cabinet bodies to accommodate utility services and their support-strut assemblies.

K. Utility-Space Framing: Laboratory casework manufacturer's standard steel framing units consisting of 2 steel slotted channels complying with MFMA-2, not less than 1-5/8 inches (41 mm) square by 0.0966-inch (2.5 mm) thick and connected together at top and bottom by U-shaped brackets made from 1-1/4-by-1/4-inch (32-by-6-mm) steel flat bars. Framing units may be made by welding specified channel material into rectangular frames instead of using U-shaped brackets.

L. Filler Strips and Utility-Space Closure Panels: Provide as needed to close spaces between cabinets and walls, ceilings, and indicated equipment. Fabricate from same material and with same finish as cabinets and with hemmed or flanged edges.

M. Acid Storage Cabinet:

1. ¼” thick white polypropylene lining on interior surfaces.
2. Removable black panel
3. No self-closing or bi-fold doors
4. Adjustable plastic lined shelf supported with nylon "locking" clips to avoid inadvertent removal. Shelf to can support 150 lbs. without deflection.
5. One (1) 1" deep liquid tight drip pan to cover the entire floor area of the lined cabinet compartment. Pan to be fabricated of ¼” thick white polypropylene with seams heat welded.
6. Fasteners and shelf supports to be plastic.
7. Apply silkscreen signage, color: red, to cabinet doors indicating “CORROSIVE CHEMICALS”.

N. Fume Hood Cup Sink /Plumbing Cabinet:

1. Fabricate an independent cabinet to house the cup sink and related plumbing package. Unit shall have an 8" high rear panel and removable floor.
2. The cabinet shall be the same height as the adjacent hood base cabinet and match in material, construction detail and hardware.

O. Flammable Storage Cabinet:

1. Conform to NFPA 30 in term of material and construction detail.
2. Removable back panel
3. No self-closing or bi-fold doors
4. Ground (to structure) and bond cabinet
5. Adjustable expanded metal shelf supported with "locking" clips to avoid inadvertent removal
6. Apply silkscreen signage, color: red, to cabinet doors indicating "FLAMMABLE - KEEP FIRE AWAY"
7. Three-point locking mechanism integrated into lever handle
8. Cabinet shall not be ventilated unless required by local authorities. Opening provided by the manufacturer shall be sealed with bungs.

    a. Provide Flame arrestor on cabinet vent outlets.

2.7 ADD-A-DRAWER BASE CABINETS

A. Add-A-Drawer Base Cabinets: Cabinets with casters or otherwise noted must incorporate "Add-A-Drawer" design to allow casework to be used in both standing and sitting height configuration and shall be constructed as follows:

B. Base cabinet shall be nominally 31" high. Top of the base cabinet shall be same material with plastic laminate (color selected by Architect).

C. A 6" high, fully enclosed drawer box made same width as cabinet below, shall sit on top of each base cabinet to create a standing height cabinet. Top of the apron shall be same material with plastic laminate (color selected by Architect).

D. Apron shall be aligned with two (2) threaded zinc pins that engage cabinet's top rail through pre-drilled holes with full diameter threaded zinc metal inserts. In addition (1) camlock mechanism equal to Hafele #26105902/993/984 shall be located at the rear of the base cabinet to lock the add-a-drawer apron to the cabinet.

E. Table height, to top of counter top, shall be set at either 31" or 37" to allow a refrigerator to be installed below. The table shall have a 2" solid apron front and 7" solid apron on sides and back.

F. Drawer units must be equipped with an anti-tip/anti-trick mechanism that shall include a drawer interlock mechanism so that only one drawer in a vertical stack can be opened at one time. Base cabinets shall have a finished 12 gage metal plate across the full bottom face of the cabinet through which casters shall be attached.

2.8 MOVABLE TABLES:

A. Movable tables shall be constructed as indicated on the Drawings.

B. Movable tables shall have 2" solid apron front and 7" solid apron sides and back. Front upright member is 2" outside diameter tube and 1.75" inner telescoping leg steel tubing. Capable of vertical adjustment in 2" increments. Fasteners to be stainless steel pan head screws. Provide a stainless steel 3/8-16 thread stainless steel machined nut and 2-1/4inch long stainless steel slot fat head screw in each leg. Each leg shall be fitted with a 1-1/2" diameter adjustable non-marring floor glides with 1" micro-adjustment capability complete with grater clip and 3/8-16 thread hex lock nut.

C. Moveable tables shall have the ability to be adjusted in height from 31" to 38" in 1" increments inclusive of 1" thick counter top.

D. Movable tables shall be installed at height indicated on Drawings. Fixed section of leg shall be set at height appropriate for a 31" high table top. Coordinate the under-counter clearance with casework and undercounter refrigerators and glassware washers.

E. Movable tables shall be reinforced with a deep welded steel channel frame and corner brackets appropriate for the load bearing requirements. Load capacity of tables shall be 50lb. uniform design load and support a 250 lb. concentrated load at mid-space with deflection not to exceed 1/8".

F. Movable table shall be equipped with an epoxy counter top unless otherwise noted.

2.9 METAL FINISH:

A. Preparation: After assembly, clean surfaces of mill scale, rust, oil, and other contaminants. After cleaning, apply a conversion coating suited to the organic coating to be applied over it.

B. Finish: Immediately after cleaning and pre-treating, apply laboratory casework manufacturer's standard two-coat, chemical-resistant, baked-on finish consisting of prime coat and thermosetting topcoat. Comply with coating manufacturer's written instructions for applying and baking to achieve a minimum dry film thickness of 2 mils without sags, runs or over spray.

C. Chemical and Physical Resistance of Finish System: Finish complies with acceptance levels of cabinet surface finish tests in SEFA 8. Acceptance level for chemical spot test shall be no more than four Level 3 conditions. Cured films shall be unaffected by 2 ft-lbs impact or ½" mandrel bend when supported on 18-gauge steel panel and shall have a pencil hardness of 8H to 9H. The finished product shall have a smooth, hard and flexible finish that has superior resistance to abrasion, corrosion and chemical activity. The polymerized film shall resist the action of the following reagents without any effect other than loss of luster or slight discoloration when subjected to a one c.c. puddle test for one hour.

1.	Acetic Acid;	1% to glacial
2.	Sulfuric Acid;	25%
3.	Sulfuric Acid:	50%
4.	Sulfuric Acid:	85%
5.	Hydrochloric Acid:	10%
6.	Hydrochloric Acid:	37%
7.	Nitric Acid:	10%
8.	Nitric Acid:	25%
9.	Nitric Acid:	60%
10.	Phosphoric Acid:	85%
11.	Perchloric Acid:	60%
12.	Formaldehyde:	37%
13.	Phenol:	85%
14.	Ammonium Hydroxide Concentrate	

15. Carbon Tetrachloride
16. Chloroform
17. Acetone
18. Xylol
19. Furfural
20. Sodium Hypochlorite

D. Colors for Metal Laboratory Casework Finish: As selected by Architect from manufacturer's full range.

2.10 PHENOLIC RESIN CASEWORK

A. General:

1. Construction and design shall develop maximum strength and rigidity in each sectional unit. Each sectional unit shall be completely fabricated ready for placement in the laboratory casework and equipment assembly and shall be a complete integral rigid unit in itself to permit relocation at any subsequent time. Component parts of the sectional unit shall be jig assembled for accurate alignment insuring uniformity and interchangeability. The entire cabinet shall be fabricated of phenolic resin.
2. The cabinet shall incorporate the over face design in which posts and rails are concealed behind the doors and drawers. Doors and drawer heads shall create a 1/8” horizontal and vertical reveal at end of each cabinet. The cabinet shall be fabricated in two (2) sections with a removable 6" high drawer apron at the top of 24 1/2" high (not including 1” counter top) cabinets except as noted herein.
3. Sectional units to be located on the laboratory floor shall be equipped with leveling devices easily adjustable from within the units, to compensate for unevenness in the laboratory floor. Access to leveling bolts shall be through holes in the cabinet bottoms directly above the leveling bolts. These access holes shall be provided with removable Snap-On covers. Cabinet shall be equipped with a screw type polystyrene leveling device in each corner accessible from within the cabinet. Access holes shall be capped once leveling activity is completed.
4. Base cabinets to be constructed to achieve a height of 30" or 36", not including the 1" counter top, without raising the cabinet off the floor beyond the height required for normal leveling conditions (1" nominal). Vivarium base cabinets to be constructed and mounted 12” AFF to bottom of cabinet, mounted to wall, unless otherwise noted on drawings. Top of cabinets, including 1” counter top should be 37” AFF.
5. Cabinets with casters shall be constructed without toe spaces. The cabinet shall be constructed with a reinforced base capable of supporting a 4" high caster assembly in each corner. Casters shall be heavy-duty, swivel locking type with non-marring tread, rated for minimum 250 pounds load each and washable to 190°F. The entire assembly shall be reinforced to permit mobility without twisting. Allow sufficient clearance between top of cabinet and underside of countertop or apron to facilitate movement. Cabinets with casters shall be completely finished on all four sides and top since all surfaces are considered visible. Cabinets with casters shall be provided with a continuous wrap-around rubber bumper on back and sides, two recessed hand pulls on sides and solid, non-removable back.

6. Each cabinet shall be of assembled incorporating mortise and tendon construction. Vertical and horizontal members shall be keyed and then phenol seal bonded and mechanically fastened. Exposed edges on cabinet components, doors and drawer heads shall be sanded and polished to a satin smooth finish. Underside and toe space shall be enclosed.

7. Component Thickness Schedule:

a.	Cabinet sides and bottoms:	0.5”
b.	Door and drawer heads:	0.5”
c.	Horizontal Rail Supports:	1.0”
d.	Cabinet Backs	0.125”
e.	Wall Cabinet Backs:	0.125”
f.	Cabinet Shelves	0.75”

8. Component Color Schedule:

a.	Cabinet Exterior:	Color to be selected by Architect
b.	Cabinet Interior:	White
c.	Drawer Interior:	White Drawer
d.	Exterior:	White
e.	Phenolic Resin Material Edging:	Black
f.	Ext. Door Surface and Drawer Head:	Color to be selected by Architect.

9. Exposed edges on all cabinet components shall be rounded and polished smooth.

B. Drawer and Cupboard Units:
1. Each unit shall consist of drawers or cupboard or a combination thereof as shown and shall harmoniously fit into the laboratory assembly. Units, unless otherwise specified, shall have backs with removable panels from the inside, for access to the pipe spaces at the rear of the units. Removable panels shall be provided in sides of units where units occur in the corners of the rooms and access is required to the pipe spaces. These removable panels shall be designed to permit removal through the fronts of the units.
2. Cupboards in which sinks are mounted shall be provided with removable bottoms.
3. Cupboard shelves shall be equipped with grip type shelf clip supports to lock shelves in place and avoid slippage. Adjustable shelves shall be adjustable on 1/2" centers, supported on adjustable clips engaging in slotted members so designed that dust cannot accumulate at the bottoms of these members. These shelves are split to allow for either full or half depth adjustable shelves.
4. Sectional units shall have 4" high by 3" deep toe space members, unless otherwise noted on drawings.
5. Access to the leveling bolts shall be through holes in the cupboard bottoms directly above the leveling bolts. These access holes in the cupboard bottoms shall be provided with removable Snap-On covers.
6. Drawers shall have full box construction and fabricated of ½” thick. Bottoms of drawers shall be matching ¼’ material. Drawer heads shall be applied to box structure and fastened.

C. Knee Space Sectional Units:

1. These units shall be plain, plain with a computer keyboard tray or contain drawers as specified. Drawers shall be constructed as herein before specified. Removable enclosure panels shall be provided at the rear of the knee spaces below.

D. Wall and Floor Storage Cabinets and Cases:

1. Wall and floor storage cabinets shall match in design and construction the sectional units as specified previously. Cabinets and cases to be located on the floor shall be equipped with leveling devices.
2. The tops shall have integral door strikes at the front. Bottoms shall have integral door strikes at the fronts for hinged doors. Glazed doors shall have a hinged continuous wall

frame. Glazing strips shall be easily removable and held securely in place by special fasteners. Stiles and rails of glazed doors shall be 2-1/2" by 3/4" thick. Glass lites shall be provided with continuous neoprene rubber channel shaped gaskets.

3. Wall cabinets shall be nominally 12" in overall depth unless otherwise noted on drawings.
4. Hinged doors shall be hung on a pair of concealed hinges and be provided with pulls. Doors over 48" high shall be hung on two pairs of hinges. Pulls shall be conveniently located for easy reach and of matching design to the base cabinets.
5. Storage cabinets and cases shall be provided with shelves notched on underside to accept shelf clip supports to lock shelves in place and avoid slippage. Adjustable shelves shall be adjustable on 1/2" centers, supported on adjustable clips engaging in slotted members so designed that dust cannot accumulate at the bottoms of these members.

2.11 MOVEABLE LABORATORY TABLE SYSTEM

A. General

1. Work surface support frame: 11 gage ASTM 513 cold rolled steel.
2. Finish: Chemical resistant urethane powder paint finish in custom color selected by Architect.

B. Work Surface Table Frame:

1. Nominal table frame dimensions:
   a. Widths and Depths as indicated on the drawings
   b. Adjustable Height: 30” to 37” AFF including 1” thick work surface.

2. Front upright member is 2” outside diameter tube and 1.75” inner telescoping leg steel tubing. Capable of vertical adjustment in 1” increments. Fasteners to be stainless steel pan head screws.

3. Provide 3/8” - 16 NC x 2.5” long levelers with non-marring floor glides at each leg complete with locking nut.

4. Rear corners shall have 2.25” diameter x 6” high 11-gage collar. Front half of the collar shall be welded to the work surface frame and the back half mechanically fastened to the rear uprights with socket head button cap and bolt.

5. Back stop angle, with full length bumper, shall be located under the work surface frame to position the 22” deep mobile base cabinet 1” behind the front edge of the work surface.

6. Load Rating: 100 lbs. per linear foot of width to maximum of 800 lbs. With 800 lbs. of uniformly distributed load applied to an 8’ wide work surface, the maximum allowable deflection shall be .125” measured at the front center rail.

C. Rear Frame Support Structure:

1. Nominal dimensions:
   a. Width: As indicated on the drawings.
   b. Height: 90”
2. Upright supports shall be 11 gauge cold rolled steel formed to a 2”x6” structural support with a full-height removable side cover. Gas piping shall be in the opposite and separate vertical upright from electrical and data cabling. Electrical and data cable vertical upright shall have two channels to separate low voltage and high voltage.

3. Levelers are 3/8" – 16 NC x 3.5" long, model # 23015T56 as manufactured by McMaster-Carr Supply Company, New Brunswick, NJ.
4. Rear frames - All units over 60" wide shall have a center support to accommodate split shelving.
5. Uprights have slots punched on 1" increments starting at nominal 55" above the floor to the top of the upright.
6. Upper and lower horizontal cross rails shall be 14 gage steel.
7. Lower structural cross rail shall support an integral two-channel raceway.
8. Provide one, separately circuited raceway above each countertop at lab bench. Raceway to have (2) 20-amp hospital grade duplex receptacles on 48" and 60" wide units, (3) 20-amp hospital grade duplex receptacles on 72" wide units, and 20-amp duplex receptacles located in the vertical upright under the work surface, as indicated on the drawings.
9. Wiring, rated at 120V, 20 amps and duplex receptacles, rated at 120V, 25 amps and data cabling, are in one upright with plumbing in the opposite upright support. Each duplex receptacle located in the vertical upright shall be on a separate circuit.
10. Each movable shared frame table shall have (2) NEMA L5-20 plug ends (2 circuits).

D. Plumbing Fixtures:

1. Maximum of three plumbing services available.
2. Needle Valves – brass straight pattern instrumentation needle with serrated hose end and coated with satin chromium plated finish with a clear epoxy coating.
3. Plumbing lines –Shared frame (3/8" OD wall) polyethylene tubing with tube-to-tube union attached to the tube with compression fittings at the top of the upright.
4. All service valves and quick connects shall be media keyed and color coded. Keyed media connects cannot be accidentally switched.

E. Service Connections

1. All services (plumbing, power) terminate at the top of the plumbing and upright support.
2. Power services shall have a 20-amp twist lock plug with a 4' cord above the top of the upright.
3. The plumbing lines quick disconnects are to be arranged so services cannot be intermixed.

F. Ceiling service panel:

1. General requirements – Ceiling service panel shall be mounted within a painted metal box which is supported from the underside of structure above as indicated on the architectural drawings or suspended from an acoustical ceiling panel grid system.
2. Ceiling service panel box shall provide a means to mount and connect electrical outlets; data outlets and quick connect service fixtures.
3. Ceiling service panels will ship with junction boxes factory attached. Electrical outlets, cover plates and service fixtures shall be shipped separately and field installed. Data outlets and cover plates to be provided by others.
4. Ceiling service panel shall be minimum 18-gauge cold rolled steel with a urethane powder coat finish.
5. Nominal dimensions as indicated on the architectural drawings.
6. Ceiling service panel system shall be equipped with quick disconnect fitting for service tube ends. Each keyed disconnect shall include nipple and coupler with color-keyed band marking media.
7. Service lines: polyurethane for non-burning gases and braided stainless steel for burning gases will attach to quick-connects and/or tube-to-tube unions from the ceiling utility panel and the rear frame disconnects.

G. Shelves:

1. All shelf and shelf supports shall be powder coated cold rolled steel.
2. Shelves shall overhang as indicated on the architectural drawings.
3. Shelf brackets shall be 11-gauge cold rolled powder coated steel.
4. Vertical shelf adjustment to be in 1" increments.
5. Load capacity shall be 30 lbs. per linear foot
6. Adjustable shelves shall be supplied with a continuous 2" high band to create a 1" high curb at rear of shelf. The curb along the back shall be of similar material as the shelf.

H. Work Surfaces

1. General
   a. All work surface table frames supports and backsplash support hardware shall be available in powder coated cold rolled steel.
   b. Work surfaces shall be 1" thick epoxy resin.
   c. Work surfaces shall be corner notched to the tube profile and hang behind the face of the vertical tubular support as indicated on the architectural drawings.

I. Task Lights

1. Task light shall be as specified under Electrical Fixtures in this specification section (Refer to 2.14-D).

J. Service Line Assembly

1. Parker Parflex 90, Durometer UFS-42 Tubing. 3/8" O.D. x 1/16" wall thickness.
2. Keyed Quick Couplings by Parker Hannifin or WaterSaver. Chromed brass couplers can only connect with properly keyed mate. Couplers to be color-coded to identify different key combinations.

2.12 HARDWARE AND ACCESSORIES

A. General: Provide laboratory casework manufacturer's standard satin-finish, commercial grade quality, and heavy-duty hardware complying with requirements indicated for each type.

B. Drawer and Door. Door and drawer pulls shall be 4" wire type, satin chrome plated finish, fastened from the back with two pan head machine screws. Drawer and pullout board pulls shall be installed horizontally, door pulls shall be installed vertically. Wall cabinet and floor storage cabinet pulls should be located for reaching convenience and ADA accessibility guidelines. Two pulls shall be required on all drawers over 24" wide.

C. Rollers and Sheaves: Rollers and sheaves shall be cadmium plated hardened steel or nylon, specifically designed for their application. Sliding door sheaves shall have a special contour for engagement with the one-piece double "V" stainless steel tracks. The positive ball bearing sliding door retainers shall be adjustable for removal of the doors when required.

D. Hinges:

1. Hinge shall be capable of supporting a 150 lb. dynamic load, 100 lbs. on each side of the door located 12" from the hinge. Provide (2) hinges for 36" high doors, (3) for 48" high doors and (4) for 84" high doors.

E. Door Catches: Hafele hinges have integral door catch mechanism. Catches shall be provided on hinged doors and shall be spring-loaded nylon roller types with a steel strike plate. Double doors without locks shall have a catch on each door. Tall cases shall have latching devices located on the structurally fixed center shelf. The left-hand door shall have a positive catch and the right-hand door shall have a roller type catch. Where locks are used, catches and strike plates shall be used on left hand doors of double door cases and shall be steel, cadmium plated.

F. Leg Shoes. Leg shoes shall be provided on all table legs, unless otherwise specified, to conceal leveling device. Leg shoes shall be pliable 2.5" high, coved to the floor at the bottom and shall be cemented tightly at the floor with clear silicone sealant.

G. Toe space filler. At gap created between the cabinet or ledge static panel and the floor due to leveling conditions, mechanically fasten (flat head screw) a 4" wide 18 gage galvanized steel plate to the cabinet behind the base molding to support its application. Provide continuous clear silicone sealant at intersection of floor/wall and steel plate.

H. Drawer slides.

1. Drawer slides are so fabricated as to create full extension zinc plated, feature on drawers in which the entire drawer body is exposed and physically accessible. It shall be designed to allow easy removal of the drawer yet prevent inadvertent drawer removal. Provide progressive slides with 150 lb. dynamic load for file drawers, bin drawers and drawers that are wider than 36". In all other cases, cabinets to have epoxy coated assemblies shall be rated at 100 lbs. Dynamic load capacity. Drawer slides shall be manufactured by Precision Slide, Accuride or Waterloo.
2. Drawer slides for file or bin drawers shall be nylon tired, ball bearing, full extension zinc plated assembly that will allow the drawer body to be completely exposed and physically accessible, complying with BHMA A156.9, Type B05091. Drawer slides shall have an integral stop mechanism to avoid inadvertent removal. Assembly shall be typically rated for 150 lb. at full extension, dynamic load. Slides shall be as manufactured by Precision, Accuride, Waterloo or equal.

I. Shelf Adjustment. Adjustable shelf support clips inside wall, floor and base cabinets shall be designed for adjusting shelves on 2" centers and shall be nylon complying with BHMA A156.9, Type B04013. Clip shall be configured to clamp top and bottom of shelf to avoid movement. Clip may have one or two pins. In addition to shelf clips required for initial assembly, six (6) dozen additional clips to be provided to the owner. Clips shall be Hafele #282.47.402 clear.

J. Locks: Locks to be furnished where noted on the Drawings. Drawer and door locks shall be brass, five-pin tumbler type, complying with BHMA A156.11, Type EO7281 having para-centric keys. The exposed face shall be chromium plated with satin finish. Locks shall be mounted in special housing so designed as to prevent removal when in locked position. The locks and lock housings shall be fully concealed within the drawer heads and doors. The lock tongues shall engage the rails or stiles when in locked position. Sliding door locks shall be push-type operating in sleeves and engaging both doors when in locked position and provided with positive door holding device. Locks shall be separately keyed except cabinets with multiple locks. Supply (5) master keys, (100) sub-master keys and (144) individual keys for all locks.

K. Standards: Surface mounted adjustable shelves, shall be mounted to twin-tracked standards. Standards shall be coated with an epoxy powder coating complying with BHMA A156.9 Types B04102 with a nominal cross section of 1-1/2" x ½". Acceptable manufacturers shall be Reeve, Fixture Hardware Manufacturing Corporation, and Knape and Vogt. Standards and slotted studs shall have a fully compatible slot pattern. Fasten standards to concrete masonry walls or

properly blocked steel studded walls with appropriate flat head screws. Adjustable shelves, wall cabinets and pegboards will be furnished with integral mounting brackets or clips.

L. File Drawers. File drawers shall be furnished with Pendaflex metal inserts to hold files in a front-to-back configuration. File drawer shall be notched appropriately to accept metal inserts.

M. Grommets. Black ABS plastic wire access grommets shall be designed to accommodate computer and computer peripherals plugs up to 2¼" wide. Unit shall be 3" OD require a 2½" hole and shall be configured with a separate and removable cap that completely covers the grommet liner. Unit shall be equal to Doug Mockett & Company #EDP Grommet.

N. Glazing in doors shall be installed on a foam cushion with the glazing tape installed on sides trimmed below the level of the frame and glazing stops. Glazing stops shall be of the same material and finish as the cabinet door.

O. Levelers are 3/8" – 16 NC x 3.5" long, model # 23015T56 as manufactured by McMaster-Carr Supply Company, New Brunswick, NJ.

P. Casters shall be equal to Algood, model S5033-SRG with ball bearings and wheel covers.

Q. Corner base guards: 4" high #304 stainless steel corner guards.

R. Magnetic Coat Hooks: Shall be equal to Magnuson Group, Tubulus H, Model # TUB-H, 1" H x 1 5/16" W x 2 1/16" D with a brushed stainless steel finish.

2.13 MECHANICAL SERVICE FITTINGS

A. Mechanical service fixtures shall comply with SEFA 7, "Laboratory and Hospital Fixtures-Recommended Practices. Fixtures for liquids and gaseous mixtures shall have lettered and colored indexes for each service. Handles shall be the color-coded plastic bonnet type, with color tabs identifying utility. Serrated hose ends shall have seven (7) serrations. Fixtures for gas, air and vacuum shall be needle valve, large type. Water fixtures shall be compression type. Drain fittings shall be polypropylene unless otherwise noted. Fixtures that serve special gases (N2, O2, NO2, etc.) and instrument air shall be lubricated, cleaned, capped protected and delivered certified for "Oxygen" service.

B. Provide fittings complete with washers, locknuts, nipples and other installation accessories. Include the deck flanges, escutcheons; handle extension rods and similar items.

C. Materials: Plumbing fixtures, except for drain fixtures and fittings, shall be a forged red-brass composition containing at least 85% copper with washers and seats, of maximum wear resistant materials for the specific use. Reagent grade water fixture to be brass gooseneck type with an internal polypropylene lining.

D. Ball Valves. Valve shall have a chrome plated brass ball and molded TFE seals. Where used for gas service, valves shall be certified by the American Gas Association under ANSI Z21.15, Manually Operated Gas Valves.

E. Faucet Accessories. Hot and cold water combination sink faucets shall have aerator tips. Cup sink and reagent grade water faucets to have serrated hose ends. Faucets are to be swivel type except reagent grade water.

F. Vacuum Breakers. ASSE 1035 Integral vacuum breakers shall be supplied on all domestic water fixtures. The fume hood fixture shall have the vacuum breaker exposed 7 ft A.F.F. on

face of hood (exposed vacuum breaker and piping to have same finish as other fixtures). The vacuum breaker for the eye wash fixture shall be located under the sink cabinet, visible when the cabinet doors are open.

G. Service Identification. Index buttons mounted in fixture handles shall identify the following services. Buttons shall be color-coded and lettered.

1.	Hot Water	HW	Red
2.	Cold Water	CW	Green
3.	Gas	Gas	Blue
4.	Air	Air	Orange
5.	Vacuum	Vac	Yellow
6.	Reagent Grade Water	RG	White
7.	Steam	STM	Black
8.	Nitrogen	N2	Brown
9.	Carbon Dioxide	CO2	Pink

H. Service Fixture Finish. Laboratory brass service fixtures shall be ground smooth, coated with satin chromium plated finish except where corrosion resistant finish is indicated. Fixtures shall receive multiple applications of coating and are baked for polymerization. Units must be assembled before coating and pressure tested before shipment.

I. Fixture Shipment. Fixtures shall be assembled in factory and supplied loose except for fume hood factory mounted fixtures.

J. Manufacturers. Service fittings shall be manufactured by Water Saver Corporation.

K. Hand Held-Eyewash and Drench Hose: Where indicated with designation “EW” on floor plans, provide unit as manufactured by WaterSaver –ColorTech.

2.14 SINKS

A. General: Provide sinks and accessories as shown on the Drawings and as specified herein.

B. Sink Supports. Epoxy sinks and stainless steel sinks mounted in epoxy resin tops, shall be supported on steel channels attached to the ends of sink cabinets, under the sink and adjustable by screw type rods to insure tight fit to the underside of the table with a waterproof compound. Sinks installed in dissimilar material counter tops shall have self-rimming design.

C. Sink Outlets, Tailpieces and Overflows. Sinks shall be equipped with an integral overflow that is connected directly to the tailpiece. Overflow shall consist of an outlet located 2” below counter top and ½” diameter tygon tubing to connect overflow to tailpiece which shall be modified to accept tubing.

D. Traps. Furnished under Division 22 Mechanical.

E. Cup Sinks. Cup sinks in counter tops shall be 3” x 6”. Mount cup sink on the surface of the counter top in order to avoid discharge of chemicals in waste stream.

F. Pegboards.
1. Pegboards shall be fabricated of 1” thick, epoxy resin. All surfaces to be polished, edges radiused 1/8”, and the color shall be black throughout. In sizes as indicated on the Drawings.

2. Pegboards shall be furnished with integral clips to attach to standards. Pegboard size and configuration shall be as indicated on the Drawings.
3. Provide continuous silicone sealant at intersection between pegboard and trough.

2.15 ELECTRICAL FIXTURES

A. General. Provide electrical fixtures as indicated in accordance with requirements in Division 26, complete with metal enclosure boxes, receptacles, terminals, switches, pilot lights, device plates, accessories and grommets. Cover plates to be acid resistant thermoplastic (color to be selected by architect.

B. Standard receptacles shall be white; receptacles connected to emergency power shall be red.

C. Electrical Raceways.

1. Electrical raceways mounted directly to partitions will be supplied and installed under Division 26 Electrical. Color and finish of electrical raceway shall match laboratory casework.
2. Electrical raceways mounted to the laboratory table system shall be furnished and installed by the electrical contractor.

D. Task Lights.

1. Task lights located at moveable laboratory table systems will be located on the front edge of the top shelf as per the architectural drawings shall be supplied and installed by the lab casework manufacturer. Units shall be as follows:
   a. Provide quantity of fixtures as indicated on the architectural drawings.
   b. Provide one (1) power supply and one (1) occupancy sensor for each fixture.
   c. Provide one (1) additional 28-inch fixture connector wire and cable management hardware for every two power supplies.
   d. Nominally 1” high, 2” deep linear LED shelf light fixture with 3500K color temperature. Provide length as per architectural drawings.
   e. Polycarbonate lens; extruded aluminum housing.
   f. 24V power supply with 2-foot-long, 3-wire AC power cord and plug.
   g. 14” long, low-voltage wire for each fixture to connect fixtures to power supplies and occupancy sensors to power supplies. Refer to 2.13, D, 2, for operational summary.
   h. 120 volt
   i. Task lighting should provide an average of 60 foot-candles of luminance at the bench top.
   j. The forward lighting cutoff should coincide with the front edge of the bench top. The rear cutoff should be maximized to illuminate as much bench as possible.
   k. Unit as manufactured by New England Lab, Brighton Series Linear LED Shelf Light. Units manufactured by others, including Vode Lighting LLC, shall be considered equal provided that they meet the requirements of this specification.
2. Operational Summary:
   a. At shelving integral with movable laboratory table systems.
      1) Fixtures will plug into receptacles provided with the table system.
      2) Each fixture will have an integral occupancy sensor.
      3) Remote switch to be located in the table frame as per the architectural drawings.
   b. At wall mounted shelving located above standalone laboratory tables.
      1) Each fixture will plug into a dedicated wall mounted receptacle furnished under Division 26.

2) Each receptacle will be wired to a dedicated, combination occupancy sensor/switch device near the respective work surface. All work furnished under Division 26.

3. Sequence of Operation for Occupancy Sensor:
   a. Light stays on with motion.
   b. If no motion is sensed during a 10-minute period, the light shuts off.
   c. If during the next 45 minutes, motion is detected, the light will turn on and reset.
   d. If no motion is detected in a 45-minute period, the fixture will power down completely. This will require an occupant to use the switch to turn the light on.
   e. At any time, an occupant can turn off the light using the switch.

2.16 CYLINDER RACKS

A. General: Furnish and install wall mounted cylinder racks, in locations indicated on the Drawings.

B. Products similar to the Unistrut P1000 series, 12 gauge, in lengths indicated on the Drawings along with associated accessories, including but limited to bolts and spring nuts. Channels and parts shall be furnished to laboratory casework manufacturer in their standard acid resistant epoxy powder coat finish. Color to be selected by Architect.

1. Accessories: Cylinder strap holders angle fittings, two per cylinder column, with one-inch nylon strapping, safety belt buckle and quick disconnect similar to Model # 29695T56 / 29695T66 as manufactured by McMaster-Carr Supply Company (New Brunswick, NJ.)

2.17 Mobile Ladder

A. Ladder to be fabricated and assembled with the following parts:

1. Solid stainless steel rail MiniMax ST 2000.20.
2. Seamless rail connector MiniMax ST 2020.MM for MWE rails MiniMax at Ø20 mm
3. Wall mount MiniMax ST 2100.MM for MW E 20 dia. mm rails; wall mounts delivered incl. bolts with metal threads and appropriate anchors suitable for metal applications.
4. Hook-in ladder Klassik up to 3000 mm SL.6001.KL. Stainless steel ladder with stringers 30mm tube.
5. Flat stainless steel step including attachments for circular MWE sliding ladders

B. Finishes:

1. Brushed stainless steel

C. Unit shall be equal to MWE Stainless Steel Ladder, distributed by:

1. Specialty Doors Inc.
   2609 Manhattan Beach Blvd.
   Redondo Beach, CA 90278

PART 3 - EXECUTION

3.1 JOB SITE CONDITIONS

A. Carefully examine the installed work of others and verify that such work is complete to the point where this installation may properly commence. Coordinate with the General Contractor/Construction Manager to verify that required backing and reinforcements are in place, secure, and accurately located and that project is ready for the installation of the laboratory casework.

B. Proceed with work when conditions permit Work to be installed in complete accordance with the original design, accepted submittals, and the manufacturer's written instructions.

C. In the event of discrepancy, immediately notify the Architect in writing. Do not proceed with the installation in areas of discrepancy until issues have been resolved.

3.2 INSTALLATION

A. Base Cabinet Casework shall be located in their designated positions, leveled, and plumbed true and straight by means of the micro-adjustment device located in each bottom corner of the cabinet. Adjust top rails and sub-tops within 1/16" of a single plane. Fasten cabinets to utility space framing, partition framing, blocking or reinforcements in partitions with fasteners spaced not more than 24" o.c. Align similar adjoining doors to a tolerance of 1/16".

B. Counter top lengths shall be fabricated as specified and indicated on the drawings with ends abutting tightly and sealed with corrosion resistant sealants. The horizontal surface shall be smooth and level with no raised edges at the joints. Tops shall be anchored to base cabinets.

C. Install miscellaneous filler panels and scribe as required for a continuous tight and accurate fitting installation with fasteners concealed where practical, without gaps or spaces between cabinetwork or counters and adjoining surfaces. All back splashes to be sealed at wall surfaces with corrosion resistant sealants.

D. Assemblies are to be fastened together with devices of adequate strength to support cabinet or shelf fully loaded. Fully loaded will be defined as twenty-five (25) pounds per linear foot per shelf for enclosed wall cabinets or open adjustable shelves not inclusive of cabinet, shelf and bracket weight. Securely fasten wall-mounted items to solid supporting material only.

E. Wall Cabinets: Adjust fronts and bottoms within 1/16" of a single plane. Fasten to hanging strips, masonry, partition framing, blocking or reinforcements in partitions. Fasten each cabinet through back, near top, at not less than 24" o.c. Align similar adjoining doors to a tolerance of 1/16".

F. Install hardware uniformly and precisely. Set hinges snug and flat in mortises.

G. Adjust laboratory casework and hardware so doors and drawers align and operate smoothly without warp or bind and contact points meet accurately. Lubricate joints only where shown on Shop Drawings.

3.3 COUNTER TOP INSTALLATION

A. Counter top lengths shall be fabricated as specified and indicated on the drawings with ends abutting tightly in a hairline joints, single true plane, smooth and level with no raised edges at

the joints with supports place to prevent deflection. All joints are to be sealed with corrosion resistant sealants.

B. Make field jointing in same manner as factory jointing using dowels, splines, adhesives, and fasteners recommended by manufacturer. Locate field joints as shown on accepted submittal drawings. Joints shall be factory prepared requiring no job site processing of top and edge surfaces.

C. Tops shall be anchored to base cabinets. Secure tops to cabinets/supports with concealed “Z” type angles or equal fastening devices spaced no more that 24” on center, with one located within 6” of front and back edge. Tighten according to manufacturer’s written instructions to exert a uniform heavy pressure at joints. Countersink exposed heads approximately 1/8” and plug flush with material equal in chemical resistant, color, harshness and texture to adjoining surface. Where work surface in intended to be moveable use a clamping device that is removable. Counter tops to be installed with a maximum 1/8” gap. Secure epoxy countertops to cabinets with epoxy cement, applied at each corner and along perimeter edges at not more than 48” o.c.

D. Provide holes and cutouts as required for equipment and service fittings and fixtures. Verify size of opening with actual size of item to be used, prior to making openings. Form inside corners to a radius of not less than 1/8”. After cutting, rout and file cutouts to ensure smooth, crack-free edges. Seal exposed edges after cutting with a chemical resistant sealer recommended by the manufacturer.

E. Provide scribe moldings for closures at junctures of countertop, curb and splash with walls as recommended by manufacturer for materials involved. Match materials and finish to adjacent laboratory casework. Use chemical-resistant, permanently elastic sealing compound where recommended by manufacturer.

F. Carefully dress joints smooth, remove surface scratches and clean entire surface.

3.4 INSTALLATION OF ACCESSORIES

A. Install in accordance with manufacturer’s directions. Turn screws to a flat seat; do not drive. Adjust moving parts to operate freely without excessive bind.

B. Securely fasten adjustable shelving supports, shelves and pegboards to partition framing, blocking or reinforcements in partitions.

3.5 CLEANING

A. Repair or remove and replace defective, damaged or soiled work to match original factory finish.

B. Clean finished surfaces, including wiping of drawers and cabinet shelves, touch up as required.

C. Clean counter tops leaving tops free of grease and streaks. Use no wax or oils.

3.6 PROTECTION

A. Protect against soiling and deterioration during remainder of construction period.

B. Protect counter tops and ledges for the remainder of the construction period with ¼" corrugated cardboard or equal completely covering the top and securely taped to edges. Mark cardboard in large lettering "No Standing".

END OF SECTION 123553

SECTION 123623.13 - PLASTIC-LAMINATE-CLAD COUNTERTOPS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes plastic-laminate countertops.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.
2. Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project and cost for each regional material.
3. Chain-of-Custody Certificates: For certified wood products. Include statement of costs.
4. Product Data: For adhesives, indicating that product contains no urea formaldehyde.
5. Product Data: For installation adhesives, indicating VOC content.
6. Product Data: For composite wood products, indicating that product contains no urea formaldehyde.

C. Shop Drawings: Show location of each item, dimensioned plans and elevations, large-scale details, attachment devices, and other components.

1. Show locations and sizes of cutouts and holes for plumbing fixtures and other items installed in plastic-laminate countertops.

D. Samples for Initial Selection:

1. Plastic laminates.

E. Samples for Verification:

1. Plastic laminates, 8 by 10 inches (200 by 250 mm), for each type, color, pattern, and surface finish, with one sample applied to core material and specified edge material applied to one edge.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer and fabricator.

B. Product Certificates: For each type of product.

1.5 QUALITY ASSURANCE

A. Fabricator Qualifications: Shop that employs skilled workers who custom fabricate products similar to those required for this Project and whose products have a record of successful in-service performance.

B. Installer Qualifications: Fabricator of products

1.6 DELIVERY, STORAGE, AND HANDLING

A. Do not deliver countertops until painting and similar operations that could damage countertops have been completed in installation areas. If countertops must be stored in other than installation areas, store only in areas where environmental conditions comply with requirements specified in "Field Conditions" Article.

1.7 FIELD CONDITIONS

A. Environmental Limitations: Do not deliver or install countertops until building is enclosed, wet work is complete, and HVAC system is operating and maintaining temperature between 60 and 90 deg F (16 and 32 deg C) and relative humidity between 25 and 55 percent during the remainder of the construction period.

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

C. Established Dimensions: Where countertops are indicated to fit to other construction, establish dimensions for areas where countertops are to fit. Provide allowance for trimming at site, and coordinate construction to ensure that actual dimensions correspond to established dimensions.

PART 2 - PRODUCTS

2.1 PLASTIC-LAMINATE COUNTERTOPS

A. Quality Standard: Unless otherwise indicated, comply with the "Architectural Woodwork Standards" for grades indicated for construction, installation, and other requirements.

B. Grade: Premium.

C. Regional Materials: Wood products shall be manufactured within 500 miles (800 km) of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within 500 miles (800 km) of Project site.

D. Certified Wood: Wood products shall be certified as "FSC Pure" or "FSC Mixed Credit" according to FSC STD-01-001 and FSC STD-40-004.

E. High-Pressure Decorative Laminate: NEMA LD 3, Grade HGS.

1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings.

F. Chemical-Resistant, High-Pressure Decorative Laminate: NEMA LD 3, Grade HGP, and as follows:

1. Laminate has the following ratings when tested with indicated reagents according to NEMA LD 3, Test Procedure 3.9.5:

a. Nitric Acid (30 Percent): Moderate effect.
b. Sulfuric Acid (77 Percent): Moderate effect.
c. Hydrochloric Acid (37 Percent): Moderate effect.
d. Phosphoric Acid (75 Percent): No effect.
e. Acetic Acid (98 Percent): No effect.
f. Formaldehyde: No effect.
g. Ethyl Acetate: No effect.
h. Ethyl Ether: No effect.
i. Phenol (85 Percent): Moderate effect.
j. Benzene: No effect.
k. Xylene: No effect.
l. Butyl Alcohol: No effect.
m. Furfural: No effect.
n. Methyl Ethyl Ketone: No effect.
o. Sodium Hydroxide (25 Percent): No effect.
p. Sodium Sulfide (15 Percent): No effect.
q. Ammonium Hydroxide (28 Percent): No effect.
r. Zinc Chloride: No effect.
s. Gentian Violet: No effect.
t. Methyl Red: No effect.

G. Colors, Patterns, and Finishes: Provide materials and products that result in colors and textures of exposed laminate surfaces complying with the following requirements:

1. As indicated on Drawings.

H. Edge Treatment: As indicated on Drawings.

I. Core Material: Particleboard made with exterior glue.

J. Core Material at Sinks: Particleboard made with exterior glue.

K. Core Thickness: 3/4 inch (19 mm).

1. Build up countertop thickness to 1-1/2 inches (38 mm) at front, back, and ends with additional layers of core material laminated to top.

L. Backer Sheet: Provide plastic-laminate backer sheet, NEMA LD 3, Grade BKL, on underside of countertop substrate.

M. Paper Backing: Provide paper backing on underside of countertop substrate.

2.2 WOOD MATERIALS

A. Wood Products: Provide materials that comply with requirements of referenced quality standard unless otherwise indicated.

1. Wood Moisture Content: 5 to 10 percent.

B. Composite Wood and Agrifiber Products: Provide materials that comply with requirements of referenced quality standard for each type of woodwork and quality grade specified unless otherwise indicated.

1. Composite Wood Products: Products shall be made without urea formaldehyde.
2. Recycled Content of Particleboard: Postconsumer recycled content plus one-half of preconsumer recycled content not less than percent.
3. High-Density Particleboard: ANSI A208.1, Grade M-2-Exterior Glue. 1-1/2-inch thick.
4. Plywood: DOC PS 1. 1-inch thick.

2.3 ACCESSORIES

A. Grommets for Cable Passage through Countertops: 2-inch (51-mm) OD, black, molded-plastic grommets and matching plastic caps with slot for wire passage.

B. Work Surface Supports: Basis-of-Design: Doug Mockett & Company, Inc.
1. SWS2 – 18-1/8” Inter-Arc Work support
   a. Finish: Select by Architect from Manufacturer’s standard.
2. SWS4 – 24-1/4” Large Basic Work Surface Support
   a. Finish: White powder coat.

C. Concealed Brackets: Basis-of-Design: A&M Hardware, Inc.

2.4 MISCELLANEOUS MATERIALS

A. Adhesives: Do not use adhesives that contain urea formaldehyde.

B. Installation Adhesive:

1. Adhesives shall have a VOC content of 70 g/L or less.

2.5 FABRICATION

A. Fabricate countertops to dimensions, profiles, and details indicated. Provide front and end overhang of 1 inch (25 mm) over base cabinets. Ease edges to radius indicated for the following:

B. Complete fabrication, including assembly, to maximum extent possible before shipment to Project site. Disassemble components only as necessary for shipment and installation. Where necessary for fitting at site, provide ample allowance for scribing, trimming, and fitting.

1. Trial fit assemblies at fabrication shop that cannot be shipped completely assembled. Install dowels, screws, bolted connectors, and other fastening devices that can be removed after trial fitting. Verify that various parts fit as intended and check measurements of assemblies against field measurements before disassembling for shipment.

C. Shop cut openings to maximum extent possible to receive appliances, plumbing fixtures, electrical work, and similar items. Locate openings accurately and use templates or roughing-in diagrams to produce accurately sized and shaped openings. Sand edges of cutouts to remove splinters and burrs.

1. Seal edges of openings in countertops with a coat of varnish.

PART 3 - EXECUTION

3.1 PREPARATION

A. Before installation, condition countertops to average prevailing humidity conditions in installation areas.

B. Before installing countertops, examine shop-fabricated work for completion and complete work as required, including removal of packing and backpriming.

3.2 INSTALLATION

A. Grade: Install countertops to comply with same grade as item to be installed.

B. Assemble countertops and complete fabrication at Project site to the extent that it was not completed in the shop.

1. Provide cutouts for appliances, plumbing fixtures, electrical work, and similar items.
2. Seal edges of cutouts by saturating with varnish.

C. Field Jointing: Where possible, make in the same manner as shop jointing, using dowels, splines, adhesives, and fasteners recommended by manufacturer. Prepare edges to be joined in shop so Project-site processing of top and edge surfaces is not required. Locate field joints where shown on Shop Drawings.

1. Secure field joints in plastic-laminate countertops with concealed clamping devices located within 6 inches (150 mm) of front and back edges and at intervals not exceeding 24 inches (600 mm). Tighten according to manufacturer's written instructions to exert a constant, heavy-clamping pressure at joints.

D. Install countertops level, plumb, true, and straight. Shim as required with concealed shims. Install level and plumb to a tolerance of 1/8 inch in 96 inches (3 mm in 2400 mm).

E. Scribe and cut countertops to fit adjoining work, refinish cut surfaces, and repair damaged finish at cuts.

F. Countertops: Anchor securely by screwing through corner blocks of base cabinets or other supports into underside of countertop.

1. Install countertops with no more than 1/8 inch in 96-inch (3 mm in 2400-mm) sag, bow, or other variation from a straight line. Grommets shall be installed only after casework is in place and in consultation with ITS personnel and the end users. Provide grommets at 4'-0" OC max. Final quantity and location as directed by Architect.
2. Secure backsplashes to tops with concealed metal brackets at 16 inches (400 mm) o.c. and to walls with adhesive.
3. Seal junctures of tops, splashes, and walls with mildew-resistant silicone sealant or another permanently elastic sealing compound recommended by countertop material manufacturer.

3.3 ADJUSTING AND CLEANING

A. Repair damaged and defective countertops, where possible, to eliminate functional and visual defects; where not possible to repair, replace woodwork. Adjust joinery for uniform appearance.

B. Clean countertops on exposed and semiexposed surfaces. Touch up shop-applied finishes to restore damaged or soiled areas.

END OF SECTION 123623.13

SECTION 123661.19 - QUARTZ AGGLOMERATE COUNTERTOPS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Quartz agglomerate countertops.
2. Quartz agglomerate backsplashes.
3. Quartz agglomerate end splashes.
4. Quartz agglomerate wall protection.

B. Related Requirements:

1. Section 123623.13 "Plastic-Laminate-Clad Countertops" for accessories.

1.3 ACTION SUBMITTALS

A. Product Data: For countertop materials.

B. Sustainable Design Submittals:

1. Product Data: For adhesives, indicating VOC content.
2. Product Data: For composite wood products, indicating that product contains no urea formaldehyde.

C. Shop Drawings: For countertops. Show materials, finishes, edge and backsplash profiles, methods of joining, and cutouts for plumbing fixtures.

1. Show locations and details of joints.
2. Show direction of directional pattern, if any.

D. Samples for Verification: For the following products:

1. Countertop material, 6 inches (150 mm) square.
2. One full-size quartz agglomerate countertop, with front edge and backsplash, 8 by 10 inches (200 by 250 mm), of construction and in configuration specified.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For fabricator.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For quartz agglomerate countertops to include in maintenance manuals. Include Product Data for care products used or recommended by Installer and names, addresses, and telephone numbers of local sources for products.

1.6 QUALITY ASSURANCE

A. Fabricator Qualifications: Shop that employs skilled workers who custom-fabricate countertops similar to that required for this Project, and whose products have a record of successful in-service performance.

B. Installer Qualifications: Fabricator of countertops.

C. Mockups: Build mockups to demonstrate aesthetic effects and to set quality standards for fabrication and execution.

1. Build mockup of typical countertop as shown on Drawings.
2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.7 FIELD CONDITIONS

A. Field Measurements: Verify dimensions of countertops by field measurements after base cabinets are installed but before countertop fabrication is complete.

1.8 COORDINATION

A. Coordinate locations of utilities that will penetrate countertops or backsplashes.

1.9 WARRANTY

A. Provide manufacturer’s 10-year warranty against defects in materials.

PART 2 - PRODUCTS

2.1 QUARTZ AGGLOMERATE COUNTERTOP MATERIALS

A. Quartz Agglomerate: Solid sheets consisting of quartz aggregates bound together with a matrix of filled plastic resin and complying with ICPA SS-1, except for composition.

1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings.

2. Colors and Patterns: As indicated on Drawings.

B. Composite Wood Products: Products shall be made without urea formaldehyde.

C. Particleboard: ANSI A208.1, Grade M-2-Exterior Glue.

2.2 COUNTERTOP FABRICATION

A. Fabricate countertops according to quartz agglomerate manufacturer's written instructions and the AWI/AWMAC/WI's "Architectural Woodwork Standards."

1. Grade: Premium.

B. Countertops: 1 1/8-inch- thick, quartz agglomerate with front edge built up with same material.

C. Backsplashes: 3/4-inch- (19-mm-) thick, quartz agglomerate.

D. Wall Protection Panel System: Wall panel system at backsplashes and alcoves where indicated on Drawings:
1. Seaming: Chemically hard seamed joints: Butt joints; Outside corner joints; inside corner joints.
2. Thickness: As indicated on Drawings.
3. Adhesive attachment.
4. Colors: As indicated on Drawings.
5. Field measurements: Required for all installation locations.
6. Tolerance for installation: 1/16 inch in both directions.

E. Fabricate tops with shop-applied edges and backsplashes unless otherwise indicated. Comply with quartz agglomerate manufacturer's written instructions for adhesives, sealers, fabrication, and finishing.

1. Fabricate with loose backsplashes for field assembly.

F. Joints: Fabricate countertops in sections for joining in field, with joints at locations indicated.

1. Joint Locations: Not within 18 inches (450 mm) of a sink or cooktop and not where a countertop section less than 36 inches (900 mm) long would result, unless unavoidable.
2. Joint Type: Bonded, 1/32 inch (0.8 mm) or less in width.
3. Splined Joints: Accurately cut kerfs in edges at joints for insertion of metal splines to maintain alignment of surfaces at joints. Make width of cuts slightly more than thickness of splines to provide snug fit. Provide at least three splines in each joint**.**

G. Cutouts and Holes:

1. Undercounter Plumbing Fixtures: Make cutouts for fixtures in shop using template or pattern furnished by fixture manufacturer. Form cutouts to smooth, even curves.

a. Provide vertical edges, slightly eased at juncture of cutout edges with top and bottom surfaces of countertop and projecting 3/16 inch (5 mm) into fixture opening.
b. Provide vertical edges, rounded to 3/8-inch (10-mm) radius at juncture of cutout edges with top surface of countertop, slightly eased at bottom, and projecting 3/16 inch (5 mm) into fixture opening.
c. Provide 3/4-inch (20-mm) full bullnose edges projecting 3/8 inch (10 mm) into fixture opening.

2. Counter-Mounted Plumbing Fixtures: Prepare countertops in shop for field cutting openings for counter-mounted fixtures. Mark tops for cutouts and drill holes at corners of cutout locations. Make corner holes of largest radius practical.
3. Fittings: Drill countertops in shop for plumbing fittings, undercounter soap dispensers, and similar items.

2.3 INSTALLATION MATERIALS

A. Adhesive: Product recommended by quartz agglomerate manufacturer.

1. Adhesives shall have a VOC content of 70 g/L or less.

B. Sealant for Countertops: Comply with applicable requirements in Section 079200 "Joint Sealants."

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates to receive quartz agglomerate countertops and conditions under which countertops will be installed, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of countertops.

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

3.2 INSTALLATION

A. Install countertops level to a tolerance of 1/8 inch in 8 feet (3 mm in 2.4 m), 1/4 inch (6 mm) maximum. Do not exceed 1/64-inch (0.4-mm) difference between planes of adjacent units.

B. Fasten countertops by screwing through corner blocks of base units into underside of countertop. Predrill holes for screws as recommended by manufacturer. Align adjacent surfaces and, using adhesive in color to match countertop, form seams to comply with quartz agglomerate manufacturer's written instructions. Carefully dress joints smooth, remove surface scratches, and clean entire surface.

C. Fasten subtops to cabinets by screwing through subtops into cornerblocks of base cabinets. Shim as needed to align subtops in a level plane.

D. Secure countertops to subtops with adhesive according to quartz agglomerate manufacturer's written instructions. Align adjacent surfaces and, using adhesive in color to match countertop, form seams to comply with quartz agglomerate manufacturer's written instructions. Carefully dress joints smooth, remove surface scratches, and clean entire surface.

E. Bond joints with adhesive and draw tight as countertops are set. Mask areas of countertops adjacent to joints to prevent adhesive smears.

1. Install metal splines in kerfs in countertop edges at joints where indicated. Fill kerfs with adhesive before inserting splines and remove excess immediately after adjoining units are drawn into position.

2. Clamp units to temporary bracing, supports, or each other to ensure that countertops are properly aligned and joints are of specified width.

F. Install backsplashes and end splashes by adhering to wall and countertops with adhesive. Mask areas of countertops and splashes adjacent to joints to prevent adhesive smears.

G. Install aprons to backing and countertops with adhesive. Mask areas of countertops and splashes adjacent to joints to prevent adhesive smears. Fasten by screwing through backing. Predrill holes for screws as recommended by manufacturer.

H. Complete cutouts not finished in shop. Mask areas of countertops adjacent to cutouts to prevent damage while cutting. Make cutouts to accurately fit items to be installed, and at right angles to finished surfaces unless beveling is required for clearance. Ease edges slightly to prevent snipping.

1. Seal edges of cutouts in particleboard subtops by saturating with varnish.

I. Apply sealant to gaps at walls; comply with Section 079200 "Joint Sealants."

3.3 WALL PROTECTION PANEL INSTALLATION

A. Install wall cladding panels plumb, level, and true according to approved shop drawings and manufacturer’s published installation instructions. Shim as required during installation process. Use woodworking and specialized fabrication tools acceptable to manufacturer.

B. Rout all wall cladding panels to size; sawcuts are not permissible. Cutouts must also be routed with eased edges.

C. Ease all exposed outside corners and edges. Provide eased panel edges where specified silicone sealant is required to fill gap between panels.

D. Install panels to heights shown on the drawings with no horizontal seaming.

E. Install panels with the maximum panel dimension available to minimize vertical seams.

F. Where possible in short panel runs, install full width and height with seams occurring only at the inside corners of the wall area.

G. Scribe, finish sand and cut countertop to fit adjoining work, refinish cut surfaces, and repair damaged finish at cuts.

H. Attach wall cladding panels to substrate with specified construction adhesive. Apply a non-continuous bead of adhesive around perimeter of solid surface panels, approximately 2 inches from panel edge according to manufacturer’s published installation instructions. Apply another bead of adhesive across the center forming an X. Utilize panel manufacturer recommended hot melt glue for temporary adhesion of panels to substrate while adhesive cures. Provide temporary bracing until adhesive has to set to proper strength. Promptly remove excess adhesive.

I. Form wall cladding joint seams for multiple panels with specified seam adhesive. Seams in locations shown on approved shop drawings and acceptable to manufacturer. Promptly remove excess adhesive.

J. Provide specified silicone sealant to fill gaps in the following locations and as required by manufacturer:
   1. Wall panel joints indicated to receive silicone sealant.
   2. At inside corners.
   3. Between finished floor and ceiling for full height wall cladding.
   4. Not greater than 12 feet on center for any wall cladding length or height.

K. Coordinate with Contractors all wall-mounted items, cabinets, and mechanical, electrical, plumbing and fire protection device cut out locations. Provide trimmed and finished installation, as described above, for all devices. Field cut panels as required

L. Allow panels to cure for 24 hours, minimum, before exposure to moisture or pressure.

3.4 SOLID SURFACE REPAIR

A. If permissible to Architect, minor surface marring may be repaired according to manufacturer's published installation instructions.

B. Remove and replace wall panel components that are damaged and cannot be satisfactorily repaired.

3.5 CLEANING AND PROTECTION

A. Clean components according to manufacturer's published maintenance instructions. Completely remove excess adhesives and sealants from finished surfaces.

B. Protect completed work from damage during remainder of construction period.

END OF SECTION 123661.19

SECTION 132100 – CONTROLLED ENVIRONMENTAL ROOMS

PART 1 - GENERAL

1.1 WORK INCLUDED

A. The work under this section of the specifications shall include all labor, services, materials and equipment, and the performance of all work as necessary and required to furnish and install all prefabricated environmental rooms as indicated on the drawings and as specified.

B. Environmental room shall be furnished complete and ready for installation with all accessories required for installation.

C. The equipment locations, as shown on the plans, shall be checked by the environmental room manufacturer. Exact locations shall be determined by the dimensions of the equipment approved and the layout before apparatus is installed. The environmental room manufacturer shall be solely responsible for the accurate installation and correct operational aspects of his equipment and shall correct deficiencies without any recourse to the Owner. Consult the architectural and structural drawings for all dimensions, locations of partitions, locations of pipes and duct work.

D. They shall furnish shop drawings for all equipment being furnished and shall also prepare and submit for approval scaled shop drawings representing the actual manner in which the systems and equipment are to be installed. Shop drawings shall show accurately and in detail the dimensions, section, arrangements and elevations of all prefabricated environmental rooms and shall include all measurements, roughing-in diagrams and other necessary details for use by other trades. The environmental room manufacturer shall obtain the Owner's Representative's approval for all routing and the foregoing before any materials or equipment are purchased, fabricated, assembled or installed.

E. The environmental room manufacturer shall have a factory trained field service technician on the premises to supervise the installation of all equipment and assist the other trades as to the proper piping rough-in for equipment.

F. A factory trained representative of the equipment manufacturer shall provide one (1) on-site equipment demonstration to Owner.

G. The environmental room manufacturer shall be responsible for providing and field wiring all electrical devices (Condensing units, evaporator coils, digital thermometers, alarms, recorders, lighting and above counter electrical receptacles inside environmental room.) to two points of power (one for the control panel and one for the condensing unit).

H. The environmental room manufacturer shall be responsible for all refrigeration piping/hook ups (Refers to refrigeration gas piping) between condensing unit and evaporator and terminating condensate drain line at condensate drain. Location of condenser and routing of condensate drain line to condensate drain shall be coordinated with Owner's Representative and General Contractor. Drain line shall not exceed 10ft and be gravity fed.

I. They shall be responsible for blocking in the pre-fabricated partitions to mount adjustable shelves and distillation racks (If required).

J. Delivery and installation of the equipment shall be so performed as to avoid delay to the work of other contractors. The environmental room contractor shall be responsible for receiving,

uncrating, and setting-in-place this equipment. Refrigeration hook up and condensate drain line to be installed by environmental room contractor. All internal wiring relevant to the unit's operation, including light fixtures, are to be supplied and installed by the environmental room contractor and terminated at a single point for final connection by relevant trade contractor.

K. The environmental room contractor shall coordinate their work with the General contractor and all supporting contractors, providing all information and supervision necessary as required to assure proper and timely installation without delay to the project or other contractors.

L. Available voltage in building is 110, 208. Condensing units shall be 208/3/60 and control panel to be 208/1/60.

M. Environmental room shall meet local seismic restraint requirements, if applicable. Vendor shall determine whether the design and/or installation must be modified to meet this requirement and take appropriate action.

1.2 RELATED WORK

A. The following labor, services and materials required or incidental to complete the following work shall be provided under other divisions of these specifications.

1. Division 08: Door Hardware
2. Division 09: Walls and ceiling construction enclosing the environmental rooms. Including drop ceilings, painting, patching, enclosures etc.
3. Division 23: Ductwork, including supply and exhaust air register, grills, dampers and diffusers inside rooms and final duct connections when in-room ventilation is specified. All cutouts for supply and exhaust air will be 4" diameter in controlled environmental room ceiling. Division 23 will be responsible for all ductwork to and from dehumidifier including transition pieces.
4. Division 26: Electrical rough-in, disconnects, transformers and final connections for all environmental rooms and this work must be within 5' of all condensing units and control panels.
5. Division 22: Condenser water supply, return and condensate drain rough-in piping and final connections including the dehumidifier condensate drain. Division 22 must insulate all water lines inside the environmental rooms and install strainers before and after water regulating valves. Provide and install either a two or three-way water regulating valves.
6. Division 22: Service lines to counter top mounted plumbing fixtures including final connections of fixtures.
7. Division 21: Fire suppression systems and devices. Sealing of all sprinkler heads and fire suppression devices. All sprinkler heads inside environmental rooms should be dry pendant heads. Cutouts for fire suppression devices are by Division 22.
8. Division 22: Sealing of all penetrations to room structure, inside and outside, with silicone to avoid leakage and condensation.
9. Remote monitoring and control through DDC system.
10. Division 12: Laboratory casework inclusive of counter tops, table frames, base cabinets, sinks, faucets, plumbing fixtures and distillation racks and wall mounted shelving and full height zinc plated channel for mounting shelving and or cantilevered counter tops (Spec. Section 123553).
11. Provide suitable refrigeration equipment supports and coordinate location with architect.
12. Epoxy toweled floor covering if no insulated floor is required by others.
13. Fireproofing and fire stopping of penetrations by others.

1.3 RELATED DOCUMENTS

A. Drawings and general provisions of Contract; including General and Supplementary Conditions and Division Specifications, apply to work of this section.

1.4 QUALIFICATIONS

A. Submit a statement of qualification showing adequate experience in manufacturing equipment of the type and scope called for with a minimum of 10 years experience. The statement of qualification shall also include a list of at least fifty (50) comparable recent installations.

B. Service and Maintenance: Vendor shall be a manufacturer of environmental rooms which maintains factory parts and service. An extended warranty service contract shall be tendered at least one month prior to the end of the warranty periods for consideration by the Owner.

C. Standards: The environmental room design and installation shall conform to applicable codes, ordinances and regulations governing the use and safety of refrigerants, including, but not necessarily limited to the following:

1. ASHRAE/ANSI Standard 15-70, ARI 520-78, ANSI B9. 1-1971 and MEMA-70.
2. National Sanitation Foundation Testing Laboratory and Class One Building Type Construction of FM approved standard #4880 for insulated wall construction.
3. Approval by Underwriter's Laboratory (UL), labeled and listed, for all components of the environmental room assembly.
4. Local code approval for panels.
5. Local electrical code approval for doors.
6. Local health, sanitary and safety codes.

D. For panel components and refrigeration, comply with the reduced CFC content regulations mandated as part of the 1989 Montreal Protocol Agreement.

1.5 SUBMITTALS

A. Qualification Data: Prior to executing a contract for the work of this Section, submit qualification data for proposed manufacturer as specified under "Qualification" to demonstrate its capabilities and experience. Include list of completed projects, and other information specified. Include manufacturer's technical data and specifications in sufficient detail for Architect and Owner to assess quality and suitability of products proposed.

B. Deviations: Any deviations from the Specifications, including type of finishes as set forth herein, must be listed in detail, separate from the literature furnished with the bid such that the Architect does not have to expend inordinate time in evaluating competitive bids. In bids, manufacturers should understand that the right is reserved to reject any and all bids. Any bid will rightfully be construed as being based on supplying the design, construction, and materials specified herein.

C. Product Data: Submit manufacturer's technical product data for each item; include installation instructions, roughing-in dimensions, service connection requirements, performances, materials, manufacturer's model numbers, furnished accessories, power/fuel requirements and other similar information.

1. Include documentation indicating compliance with referenced standards.
2. Include copies of manufacturer's standard product warranties.

D. Shop Drawings: Submit shop drawings for environmental rooms, showing floor and ceiling plans, elevations, cross-sections, service run spaces; details and location of anchorage's and fitting to floors, walls and ceiling; details of features and furnishings within room; control panel

design; sensor location; layout of units with relationship to surrounding walls, doors, lighting and ventilation fixtures, and other building components.

1. Include on the drawing, the performance requirements for each room.
2. Include service connection information for other trades.
3. The manufacturer/installer shall obtain the Architect/Engineer's approval for all routing and the foregoing before any materials or equipment are purchased, fabricated, assembled or installed.

E. Samples. Submit the following material, finish and color samples:

1. Insulated wall panel with exterior and interior finish.
2. Insulated floor panel with exterior and interior finish.
3. Flooring finish.

F. Operation and Maintenance Manual: Include instructions for sequential operation, start-up and shut down, with pertinent control data and schematics, room arrangement, and recommended maintenance of equipment. At completion of work, submit one copy of 3-ring binder containing: “as-built” drawings, product data and operation and maintenance information listed above. After Architect's acceptance is received, submit 4 copies for Owner's use.

G. Certificates. Submit certified statement by issuing agencies that manufacturer has been issued the following certificates:

1. CFC Compliance. Insulated panels shall comply with current EPA Regulations and the Clean Air Act. Manufacturer shall supply Notarized Affidavit that the insulated panels are a Class I foam type that conforms to current statutes in effect at date of job site arrival. CFC emission compliance foam type must be Factory Mutual Standard 4880, including full scale corner test; UL E-84; MEA 80-81M, the New York toxicity standard. The affidavit shall hold harmless and indemnify the owner, the architect, the engineer and the equipment consultant from any fines, summons or liabilities which may result from a violation.
2. EPA Venting Issue. The manufacturer shall submit a certificate that one (1) job site mechanic has received accredited training conforming to the EPA and Clean-Air Act of July 1, 1992. Any sub-manufacturer and/or general refrigeration manufacturer shall assume full responsibility for the actions of the employees or casual helpers in respect to "venting" of EPA regulated refrigerant gases. Furthermore, manufacturer will supply an affidavit which specifically indemnifies and holds harmless the owner, the architect, the engineer and the equipment consultant from any fines, summonses or liabilities which may result from "Venting Controlled Refrigerants".

H. No portion of the work requiring a shop drawing or sample submission shall be commenced until the submission has been approved by the Owner's Representative. All such portions of the work shall be in accordance with approved shop drawings and samples.

1.6 FIELD MEASUREMENTS

A. The environmental room contractor is responsible for physically measuring the area to assure that their equipment will fit in the designated location. Any dimensional corrections will be accomplished at no change in contract sum.

1.7 WARRANTY

A. Submit warranty signed by Manufacturer and countersigned by Contractor, agreeing to replace/repair/restore defective equipment, components, materials and workmanship of work during the periods indicated for each item from date of Owner's acceptance. "Defective" is hereby defined to include, but not by way of limitation, operation or control system failures, performance below required standards, excessive wear, unusual deterioration or aging of materials of finishes, the need for excessive maintenance, and similar unusual, unexpected and unsatisfactory conditions. Prominently display in each room the name of installer/service agency to be contacted during warranty period.

1. Compressor units: five (5) years.
2. Panels or room construction: Ten (10) years.

1.8 DEFINITION OF ENVIRONMENTAL ASSEMBLY CRITERIA

A. Walk-in Environmental Room Laboratory: is an enclosed space that maintains temperature control uniformity at +/- 1.0°C. This room requires ventilation because it can be occupied space.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Sterling Environments Inc.
471 N. Broadway, Suite 250
Jericho, NY 11753
(800) 608-9110 v
(800) 608-2760 f

B. Environmental Growth Chambers
510 East Washington Street
Chagrin Falls, OH 44022
800-321-6854 v

C. Thermolinear
1820 Central Parkway
Cincinnati, OH 45214
(800) 587-5067 v

2.2 INSULATION

A. Insulation shall be rigid urethane foam poured-in-place, not frothed. Overall thickness shall be 4" minus metal skins.

B. All construction shall conform to the requirements of the National Sanitation Foundation Testing Laboratory, Underwriters Laboratories, and Class One Building Type construction of Factory Mutual approval standard #4880 for insulated wall construction and shall be conspicuously labeled on each component and listed on environmental rooms. It shall conform to ASTM Fire Hazard Materials Test Numbers E8461 and E16267, and have a low flame spread rating of 25 or less for a 10-minute time period. Environmental room manufacturer shall supply with their bid a certified statement by issuing agencies that the environmental room manufacturer has been issued certificates that certify compliance.

C. All panel components shall conform to the reduced CFC content regulations mandated as part of the Montreal Protocol and shall bear a label conspicuously affixed to each component part.

D. Panels shall conform to the requirements of the locally recognized building code.

2.3 WALL AND CEILING CONSTRUCTION

A. Environmental rooms shall be prefabricated, all metal clad, sectional constructed and designed for easy and accurate field assembly.

B. Sections shall be made of 11½", 23", 34½" and 46" widths and to be interchangeable for fast, easy assembly. Sections shall be made without internal wood or metal structural members with 100% of each section, exclusive of metal skins, being urethane insulation. Section edges must have tongue and groves foamed-in-place with gaskets on each edge to assure airtight joints. Other panel widths may be required to assure the desired dimensions specified.

C. Walk-in sections shall be assembled with double strapped cam locks. Distance between locks shall not exceed 46". At least three locks shall be used for all vertical joints.

D. To assure perfect alignment and maximum strength, 90-degree angled panels shall be provided for each corner. The exterior horizontal dimension of each side of this corner shall be 12". Interior Corner Panels are to have radius corners.

2.4 FLOOR CONSTRUCTION

A. Floor sections shall be similar to all other sections but shall be made to withstand uniformly distributed floor loads. Load bearing shall be 500 psf for 2" thick floor utilizing a 14 ga. galvanized steel interior surface.

B. Floor shall be a maximum of 2" inches thick.

2.5 FLOOR COVERING

A. All environmental room floors shall be covered with a crevice-free, non-absorbent, slip-resistant, abrasive vinyl (90% virgin vinyl matrix) floor covering equal to Walkway 20 manufactured by Altro Corporation, San Francisco, CA. Material shall have temperature stability, dimensional stability and flexibility from +60°C. to -20°C. Flooring shall be smooth, free of ribs or patterns. Flooring shall require no maintenance except cleaning with detergent and water. Depending upon room size, floors shall be seamless, or seams shall be welded. Floor covering shall be coved up the walls 4" high, capped with a vinyl trim piece and continuously silicone sealed between vinyl cap and walls. Floor covering color shall be selected by Architect from manufacturer's standard colors.

2.6 EXTERIOR AND INTERIOR METAL SKIN FINISH

A. Stainless Steel (26 gauge) exposed exterior where panel is visually exposed and 26 gauge smooth galvanized exterior where skin is concealed. Interior wall and ceiling finish shall be 26 Gauge Smooth White Galvanized.

2.7 STANDARD HINGED ENTRANCE DOORS

A. Entrance openings shall be provided in 46" sections. The door shall be an in-fitting flush mounted type. Construction of door frame to be as stated in paragraph on wall construction. It shall have a "U" channel type, reinforced stainless steel frame of not less than 12-gauge

thickness around entire perimeter of the door opening to prevent racking and twisting. Sill plates shall include safety walk strips. Door to be capable of reversing swing, left or right, in the field.

B. Opening size: 36" wide x 77" high.

C. All hardware shall be made of satin finish aluminum.

D. Each door shall have three (3) hinges, self-closing and spring-loaded type with stainless steel pin and Delrin cam type bearing and positive action hydraulic type door closer. Door exterior shall have a "break-away" type latch handle and a push plate on the interior.

E. Each door shall be prepped for the campus standard Best Core Lock. It shall include an inside safety release handle to prevent anyone from being locked inside.

F. A thermoplastic gasket with magnetic steel core shall be mounted on top edge and along both sides of the door. The bottom of the door shall contain a wiper gasket.

G. Each door frame shall have (1) heater to prevent condensation and frost formation. Heater shall be concealed and around the entire door perimeter. Heater and element shall be minimum 300 watts.

H. All door panels shall conform to locally recognize electrical and building code.

I. Vision Panel. A nominal 14" wide x 24" high vision panel shall be provided in all doors. It will consist of three panes of glass with sealed air spaces between them. The window shall be supplied with (1) heater and shall be removable for replacement.

J. Light switch with pilot light mounted on the outside of unit.

2.8 DIAL THERMOMETERS TEMPERATURE

A. Provide surface mounted displays. Thermometer probes shall be long enough to extend from display to inlet air of blower coil, armor sheathed. Provide one (1) thermometer and locate on control panel.

2.9 CEILING

A. Environmental rooms require the following construction criteria to accommodate the control requirements:

1. Ceiling Plenum: Provide uniform air circulation and distribution system throughout controlled environmental room utilizing a plenum ceiling. Plenum shall also house lighting fixtures, make-up air fan, refrigeration devices, etc. Clearance below finish ceiling plenum within room work area shall be unobstructed. Include supply and exhaust duct collars above ceiling sized and located as required by HVAC trade.
2. Ceiling Materials: Provide an “egg crate” type white plastic panel ½” thick that has ½” x ½” holes covering 90% of the surface area of the panel.

2.10 LIGHTING

A. For Environmental Rooms: Fluorescent lighting fixtures, gasketed and vapor-proof, with door mounted acrylic lenses, in sufficient quantity to provide 70 fc at 36" AFF. Provide ballast's rated as cold temperature, high efficiency.

2.11 CLOSURES

A. Closure strips/angles/trims of materials matching the exposed exterior of the environmental room shall be furnished and installed wherever a space exists between the walls and roof of the walk-in and other walls, columns, ceilings or ledges.

2.12 ELECTRICAL FITTINGS

A. Furnish for installation by electrical trades, a "seal-off fitting" to prevent condensation in electrical junction boxes; one fitting for each penetration of conduit through environment room walls, partitions and ceilings. Alternatively, provide an "LB" or electrical box at each penetration, sealed with silicone.

B. Outlets: Controlled Temperature Manufacturer to fabricate in wall panels recessed conduit and foamed in place GFI Outlets 115 Volts/1 Phase/60 Hertz. Review drawings for quantity.

C. Tele/Data Outlets: Controlled Temperature Manufacturer to fabricate in wall panels recessed conduit and empty box foamed in place for tele/data outlet. Tele/data outlet will be provided and wired by others.

2.13 AUDIO-VISUAL ALARM

A. The environmental room manufacturer shall furnish and an alarm and safety control for each walk-in compartment. Alarm shall be an illuminated digital readout. The sensor bulb shall be located as far from the evaporator coil as possible to avoid alarm during defrost cycle.

1. Provide the following Alarm System Components:

    a. RTD sensor electronic temperature control with dual bridges and set-points. Divide shall have exposed set-points in the control panel and shall provide independent high and low alarm outputs.
    b. An alarm circuit board including replaceable control relays, solid state circuiting, an alarm buzzer, input/output termination and a "remote alarm" dry contact relay.
    c. Control panel mounted components including the high/low set-points specified above, high-alarm lights, a "reset" switch, which silences the alarm and a control alarm by -pass switch used to restart the system.

2. Alarm System Operation:

    a. Alarm circuitry is an "always alive" circuit. Upon failure of any component of power failure to room, the remote alarm relay will close giving a remote signal.
    b. Alarm circuit cannot be shut off. It can be made inoperative by establishing the set-points too wide and the control portion can be bypassed but it cannot be electrically shut off when room main power switch is on.
    c. When room rises above high temperature set-point, "high" pilot lights, buzzer sound, and all heat-producing devices shut down excluding lights, fans, and door heat. Remote alarm relay shifts giving a normally open or closed signal. System remains in this state until temperature drops, at which time system automatically rests.
    d. Buzzer can be silenced for only a 15-minute period by switching the spring loaded "reset" switch, when alarm condition clears, this portion automatically resets ready for next alarm. Silencing alarm does not shut off remote alarm.
    e. When room drops below set-point, "low" pilot lights, buzzers sounds, and power to all cold-producing components including refrigeration solenoids is interrupted.

Remove alarm relay shifts giving a normally open or closed signal. System operates as specified above for reset, silencing, etc.

B. Provide a spare pair of contacts on alarm for remote monitoring. The environmental room manufacturer will field-wire remote monitoring wires to a single point location on the environmental room. The point location shall be coordinated with the Owner's Representative and General Contractor.

2.14 CONTROL PANEL

A. Provide a complete Control Panel to include and be manufactured under UL 508A at a UL Approved Manufacturing Facility. Control Panel to include white window enclosure with lock and to house a Fuji Controller to display running temperature and set point temperature. Fuji Controller to have smart logic, High/Low temperature Alarms, Defrost Controls, Relays, Pilot Lights, Alarm, Alarm Buzzer, Temperature Platinum RTD, 7-Day, 10: Circular Chart Recorder (Partlow). Personnel Alarm must be included into system. Evaporators, Outlets, Lights, Heaters, Condensate Heaters, Pressure Relief Ports, Window Heaters, Door Heaters, Door Frame Heaters, Light Switch all are to be powered through the control panel. Control Panel to be located in front of cold/freezer room for easy accessibility.

B. The Control Panel also to include:
1. Refrigeration on/off
2. Digital Readout of Temperature
3. High/Low Temperature Alarm readout
4. Defrost On/Off

2.15 ROOM TEMPERATURE UNIFORMITY

A. Control set-point shall be as specified in the Schedule of Rooms. Temperature uniformity shall be +/- 1.0°C as measured on a multi-point recorder using a minimum of six (6) sensors distributed throughout the chamber 40” AFF and 12” from walls.

2.16 PRE-ASSEMBLED REFRIGERATION SYSTEM

A. General.

1. Pre-assembled refrigeration systems consist of two major assemblies. One is the condensing unit assembly with all necessary components, factory installed and wired, including electrical box, time clock, drier sight glass and all necessary interconnecting tubing and wiring. The other is the evaporator coil assembly with expansion valve, fan(s) and heat exchanger completely factory mounted.
2. The refrigeration system shall be integral part of the control and conditioning system. Each system shall be designed and furnished to operate continuously. System shall incorporate an expansion valve and a solenoid valve approach to maintain specified temperature ranges. Refrigerant lines shall be properly sized for distance required between the evaporator and condensing units. The defrost feature shall include a timer with fan delay switch. The room's temperature rise during defrost cycle shall not exceed five degrees C above set point. The defrost period shall be adjustable but not to exceed twenty minutes.
3. System shall be designed to operate with R-134A Hermetic or R-404A Semi-Hermetic refrigerant for all units.
4. Semi-hermetic or Hermetic compressor shall be furnished for water cooled.
5. Compressor-condensing unit shall be specifically designed, engineered, manufactured and of adequate capacities to achieve and maintain the individual room operating

temperature requirements and performance and shall be balanced in operation with conditioning system. Compressor-condensing unit shall be complete in all respects and shall include high/low pressure control, receiver, sight glass, drier, expansion valves and all necessary equipment to achieve the performance specified.

6. Where noted as such, the unit shall be sized mechanically to compensate for ducted ventilation supplied by the building central system.
7. The name of the condenser/refrigerant manufacturer must be submitted at time of bid submittal.
8. All condensing unit equipment shall be above the box.

B. Condensing Units.

1. Shall be provided complete with motor, water cooled condenser, receiver, compressor and all other necessary components mounted in a flexible manner on a common base with vibration isolation equal to Mason Industries SLRS. Compressor shall be semi-hermetic type and shall be designed for continuous operation at the specified evaporating temperature in a 105°F ambient temperature. Motor starters and safety disconnects are required, they shall be furnished for installation in an electrical control panel enclosure.
2. Pre-assembled system controls shall be supplied pre-wired. Fractional through two horsepower systems shall be connected directly to the compressor contactor. On medium temperature systems a solenoid valve shall be supplied so wiring between evaporator and condensing unit is not necessary. The condenser shall be wired to a dedicated circuit and operate on 3/60/208V service.
3. Environmental Room Manufacturer to provide two-way water regulating valves for water cooled condensing unit. Owner/General Contractors plumber to install two-way water regulating valves.

C. Evaporators.

1. Shall be force-convection, unit cooler type, made to be suspended from the ceiling sections. They shall be complete with forced air circulation, arranged so that cooled air is discharged parallel to the ceiling. Air circulating motor, multi-fin and tube type coil and grill (required for safety) shall all be assembled within a protective housing. The coil shall be copper tube, aluminum fin design with aluminum housing; minimum four rows deep. The expansion valve, with strainer, heat exchanger, and inlet/outlet connections shall also be contained within this housing. The coil fan motor shall be a minimum 1/6 H.P. ball-bearing design, rubber mounted; minimum 16" diameter heavy duty aluminum fan blade. Air velocity shall be less than 500 fpm. Air circulation motors must be lifetime sealed and the entire unit cooler assembly must be readily accessible for cleaning.
2. A drip pan, drain connection and drain line shall be provided. Unit evaporators shall be equipped with mounting brackets for installation and all controls necessary for safe and satisfactory operation. When the environmental room is used for freezing, an automatic system for defrosting the unit’s evaporator, including heaters and time control, shall be supplied. All condensate drain lines inside freezer rooms shall be insulated with ½” insulation. Each refrigerant system shall include a dehydrator, liquid line sight glass, shut-off valve, and liquid line solenoid, thermostatic expansion valve at each evaporator, vibration isolator, and other fittings and accessories, as required. Refrigerant lines shall extend vertically from condensing unit to above the hung ceiling, then horizontally to above the evaporators, then in accordance with manufacturer's recommendations.
3. The entire system shall be cleaned; pressure tested, dehydrated, and separately vacuum tested each time for a period of five hours. The pressure test is to be at least 100 PSI above operating conditions and vacuum at 28.5” of mercury or less. The required

operating charge of refrigerant and oil shall then be added, and the system tested for performance.

4. Condensate lines shall be routed out of the box and terminated at condensate drains. Drain piping shall be 7/8" O.D., or greater, Type L copper tubing piped from evaporators to open floor drain, rigidly supported at walls 3' O.C. maximum. Adequately pitch piping toward floor drain, carry through wall of refrigerated areas properly trapped and discharged within 2” of floor drain. Provide chrome-plated escutcheons on both sides of wall penetrations. In the event condensate drain termination cannot be achieved by gravity, provide condensate pump.

D. Piping.

1. General: All refrigerant piping shall be refrigeration grade, either hard or soft-drawn (as required by design) seamless copper tubing, with high-temperature silver solder, Stay-brite or approved equal, joints. All refrigerant suction lines outside of rooms shall be insulated with ½” insulation equal to Armstrong Armaflex, applied during tubing assembly wherever possible and in accordance with the manufacturer's recommendation.
2. Specific Requirements: Manufacturer shall size refrigeration piping integral to equipment.

2.17 VENTILATION

A. General.

1. Where ventilation, supply and exhaust, is indicated, provide a cutout for each in the ceiling of the room. The dimension of the cutout shall be coordinated with the Mechanical Contractor.
2. Once all ducts and pipes are installed, the cutouts shall be silicone sealed both outside and inside the box to avoid leakage and condensation. This shall be executed under Div 23.

2.18 DEHUMIDIFICATION TO DRY CFM INTAKE AIR

A. Dehumidifiers are to be constructed as follows:

1. All air plenums are constructed of hardened aluminum sheet which is welded, gasketed and/or sealed to be air and vapor tight at design static pressures and air flows.
2. Process air inlet plenum is insulated with 1" insulation as required to minimize external condensation.
3. Access panels are to be labeled and furnished with resilient gaskets to preserve the air and vapor integrity.
4. The control enclosure is to be included as standard, mounted within the unit housing is a printed circuit board with a control-indicating package. The feature is to include three push button switches with indicating lights for Auto, Off and Manual Operation, a high process Air Volume Warning Light and a Red Fault Light. The Fault Circuitry is actuated by loss of either Blower Operation or by an Overheat Condition. All power and Control Wiring is in conformance with National Electric Code.
5. A small desiccant dehumidifier is to be placed on top of the environmental room. The desiccant dehumidifier is to be provided by the environmental room manufacturer. Division 23 (HVAC) is to run the CFM intake air duct into the desiccant dehumidifier to dry the air. Division 23 is also to run duct from processed dry airport from the desiccant dehumidifier to the cold/environmental room in order for the dry processed 50 CFM intake air to enter the cold/environmental room. Division 23 is to supply a hard-line duct with insulation on the dry processed CFM intake air duct before entering the

cold/environmental room. The power supply for this desiccant dehumidifier shall be run through the cold/environmental room manufacturers control panel. Division 22(Plumber is to provide a condensate drain line for the desiccant dehumidifier.

6. Division 23 (HVAC) to provide 2" transition piece for ductwork connections to connect the desiccant dehumidifier (2 transitions pieces required per dehumidifier) the power supply for this desiccant dehumidifier shall be run through the cold/environmental room manufacturers control panel.
7. Unit shall be UL approved.

2.19 SCHEDULE OF ROOMS

A. General.

1. All utility requirements noted in the Schedule of Rooms exclude lighting, occupancy, laboratory equipment loads, and the additional power required for intermittent defrost heater when the compressor shuts down. They are included merely as a guide to assist the project engineer in the equipment evaluation of the central plant and to the equipment manufacturer to assist in their bid preparation. Once the contract is awarded, the environmental room manufacturer will determine the specific utility requirements for each unit. They will engineer and provide the properly sized equipment to the job to fulfill their contractual obligations. The room manufacturer shall calculate and compensate for all internal heat loads when sizing the refrigeration system, including, but not limited to, the following:

   a. Lighting.
   b. Laboratory equipment loads (assume 4 watts/SF).
   c. Integral door and window heaters.
   d. Evaporator.
   e. Ventilation where indicated (assume .5 CFM per square foot of room, 50°-80°F, 30-95% RH).
   f. Heat load from desiccant dehumidifiers dry processed air.
   g. Occupancy (assume 1 person for up to 2 hrs/day).

2. Electrical loads for condenser units shall be 3/60/208V. All other electrical loads (evaporator, door heater, window heaters, lights, alarms, chart recorders, etc.) shall be 1/60/115V.

B. Schedule of Rooms:

1. Equipment Designation: CER

Overall Exterior Dimensions:	9'-8"W x 9'-8"D x 9'-4½" High
Interior Dimensions:	9'-0" x 9'-0" x 8'-10½" High
Temperature (°C):	+4.0°C +/-1.0°C
Ventilation:	Yes (50 CFM)
Electrical Load	
Condensing unit:	3/60/208V, 25A circuit
Evaporator:	1/60/115V, Power run through Control Panel Air Defrost System
Refrigerator (HP):	1.5 HP
Condenser Water	9-GPM@55°F
Control Panel:	208 Volts, 1 Phase 60 Amp Circuit (w/ neutral)

Electrical Receptacles:	120 Volts 20 Amps Circuit GFI, Moisture Proof Covers Recessed
Dehumidifier	1/60/115Volt 15 Amp Circuit to run all the time to dry CFM Intake Air before Entering Environmental Room Power run through Control Panel

PART 3 -EXECUTION

3.01 GENERAL

A. All units that are specified with temperature control with a precision of at least +/-1.0°C must be assembled in the factory and tested to demonstrate this capability. The results of the test will be sent to the Owner's Representative for his review and approval. Only after this approval is given may the manufacturer break down the unit and ship it to the job site for installation. The Owner's Representative reserves the right to be present when the test is done. All costs associated with this test, including but not limited to the inspection team's travel expenses (assume one person), are part of this section of the specification. All other units to be field tested.

3.02 EXAMINATION

A. Examine and verify areas and work of other trades for the following:

1. Correct dimensions.
2. Properly located electrical services.

B. Report any unsatisfactory field conditions to the Contractor in writing. Do not proceed with installations until unsatisfactory conditions have been corrected and conform to project requirements.

3.03 PREPARATION

A. Scheduling and Coordination: The room installer shall examine project conditions at the site with regard to access, dimensions, conditions as they exist and the general areas of work and shall perform work in such a manner as required to deliver, install and connect the rooms in close coordination with work of other trades.

3.04 INSTALLATION

A. Install controlled environment rooms in accordance with manufacturer's recommendations and final approved shop drawings.

1. Install components straight, plumb, level and true. Install service lines at right angles to walls and floors, except where required to pitch to drains.
2. Seal or otherwise insure that fastenings to rooms do not compromise vapor barriers or insulation. Seal between all piping and sleeves.

B. Pressurize and leak test entire system at not less than 100 psig, clean and dehydrate by maintaining a vacuum of 50 microns, or lower, for a 5-hour period. Add required charge or refrigerant, and oil if necessary, and test entire system for performance. Mark each system clearly as to refrigerant type used.

C. Provide filler panels to enclose spaces between tops of rooms and ceiling of surrounding area. Extend filler panels to underside of construction above if necessary.

3.05 PERFORMANCE TESTING

A. General: Provide equipment for testing and perform tests. Tests shall confirm that rooms conform to the following requirements:

1. Temperature control of +/-1.0°C shall be temperature at the sensor and shall be the total variation in the temperature control of the room. It should not be confused with temperature uniformity as noted below.
2. Temperature uniformity of 1.0°C refers to the maximum allowable variation in temperature as measured on a horizontal plane 40" AFF and within 12" of walls throughout the entire room. Uniformity shall be measured by a multipoint strip chart recorder utilizing a minimum of 6 thermo-couples during a continuous 12-hour test period. Gradient from floor to ceiling shall not be more than 2.0°C.
3. Room shall recover preset operating temperature within 5 minutes after door has been fully opened to 75°F (24°C) ambient temperature for a period of 1 full minute. Repeat door opening operation, as described, 3 times during the 12-hour period, at least 1 hour apart.
4. After completion of installation each room shall be tested for a minimum of 12 hours at extremes of temperature specified in Schedule of Rooms. Rooms specified to operate over a range of temperatures shall be tested for 12 hours at each of two set points (to be determined) with the second test at the set point designated for operation at acceptance of the unit.

B. Owner's representatives shall be given the option of witnessing and confirming test results. Notify Owner's representative in writing, prior to test.

3.06 CLEANING AND PROTECTION

A. Repair or remove and replace defective work, equipment and accessories as directed upon completion of installation.

B. Clean exposed and semi-exposed surfaces, touch-up finish as required. Remove and refinish damaged or soiled areas.

C. Protection: Adequately protect the work from damage until final acceptance by the Owner.

END OF SECTION 132100

SECTION 20 0000 GENERAL MECHANICAL REQUIREMENTS

PART 1 - GENERAL

1.1 REFERENCE

A. Work under this Section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.

1.2 DESCRIPTION

A. Intent of drawings and Specifications is to obtain complete systems, tested, adjusted, and ready for operation.

B. Except as otherwise defined in greater detail, the terms "provide", "furnish" and "install" as used in Division 20, 21, 22 and 23 Contract Documents shall have the following meanings:
   1. "Provide" or "provided" shall mean "furnish and install".
   2. "Furnish" or "furnished" does not include installation.
   3. "Install" or "installed" does not include furnishing.

C. Include incidental details not usually shown or specified, but necessary for proper installation and operation.

D. Check, verify and coordinate work with drawings and specifications prepared for other trades. Include modifications, relocations or adjustments necessary to complete work or to avoid interference with other trades.

E. Information given herein and on drawings is as exact as could be secured but is not guaranteed. Do not scale drawings for exact dimensions.

F. Where Architectural features govern location of work, refer to architectural drawings.

G. Contractor may install additional piping, fittings and valves, not shown on drawings, for testing purposes or for convenience of installation. Where such materials are installed, they shall comply with specifications and shall be sized to be compatible with system design. Remove such installed materials when they interfere with design conditions or as directed by Architect.

1.3 RELATED WORK

A. Temporary Services:
   1. Division 01 - Temporary Facilities and Controls.

B. Painting:
   1. Painting of mechanical equipment will be done under Division 09 unless specified otherwise or unless equipment is to be furnished with factory applied finish coats.
   2. Equipment
      a. Furnish equipment with factory applied prime finish unless otherwise specified.
      b. If factory finish on equipment furnished by Contractor is damaged in shipment or during construction, refinish equipment to satisfaction of Architect.
   3. Piping:

a. Uninsulated Piping
   1). Paint cast iron, carbon steel, and copper piping located outside building**.**
   2). Galvanized steel and stainless steel piping shall not be painted.
b. Paint Colors
   1). Fire Protection: Red
   2). Natural Gas: Red
   3). Domestic Water: Green
   4). Sanitary Waste and Vent: Black
   5). Storm and Overflow: Galvano
   6). Chilled Water: Blue
   7). Heating Hot Water: Yellow
   8). Steam: Orange

1.4 REQUIREMENTS OF REGULATORY AGENCIES

A. Rules and regulations of Federal, State and Local Authorities and utility companies, in force at time of execution of Contract shall become part of this specification.

1.5 REFERENCE STANDARDS

A. Agencies or publications referenced herein refer to the following:

1.	AGA	American Gas Association
2.	AMCA	Air Movement and Control Association
3.	ANSI	American National Standards Institute
4.	AHRI	Air-Conditioning, Heating and Refrigeration Institute
5.	ASHRAE	American Society of Heating Refrigerating and Air Conditioning Engineers
6.	ASPE	American Society of Plumbing Engineers
7.	ASSE	American Society of Sanitary Engineering
8.	AWS	American Welding Society
9.	AWWA	American Water Works Association
10.	ASME	American Society of Mechanical Engineers
11.	ASTM	American Society for Testing and Materials
12.	CDA	Copper Development Association
13.	CISPI	Cast Iron Soil Pipe Institute
14.	FMG	FM Global
15.	FS	Federal Specifications
16.	IEEE	Institute of Electrical and Electronics Engineers
17.	MCA	Mechanical Contractors Association
18.	MSS	Manufacturers Standardization Society
19.	NEC	National Electrical Code
20.	NEMA	National Electrical Manufacturers Association
21.	NFPA	National Fire Protection Association
22.	NIST	National Institute of Standards & Technology
23.	NSF	National Sanitation Foundation

24. NSPI National Spa and Pool Institute
25. OSHA Occupational Safety and Health Administration
26. PDI Plumbing and Drainage Institute
27. SMACNA Sheet Metal and Air Conditioning Contractors National Association
28. UL Underwriters Laboratories, Inc.
29. WQA Water Quality Association

B. Work shall be in accordance with latest edition of codes, standards or specifications unless noted otherwise.

1.6 SUBMITTALS

A. Shop Drawings (Product Data):
1. Refer to Division 01 - Submittal Procedures.
2. Note that for satisfying submittal requirements for Divisions 20, 21, 22 or 23, "Product Data" is usually more appropriate than true "Shop Drawings" as defined in Division 01. However, the expression "Shop Drawings" is generally used throughout Specification.
3. Submit shop drawings for equipment and systems as requested in the respective specification sections. Submittals that are not requested may not be reviewed.
4. Specifically mark general catalog sheets and drawings to indicate specific items submitted and its correlation to specific designation for product in drawings.
5. Specifically indicate proper identification of equipment by name and/or number, as indicated in specification and shown on drawings.
6. When manufacturer's reference numbers are different from those specified, provide correct cross-reference numbers for each item. Clearly mark and note submittals accordingly.
7. Submit complete record of required components when fixtures, equipment and items specified include accessories, parts and additional items under one designation.
8. Include composite wiring diagrams for electrically powered equipment and devices.
9. Submit equipment room layouts drawn to scale, including equipment, piping, accessories and clearance for maintenance.
10. Where submittals cover products containing non-metallic materials, include "Material Safety Data Sheet" (MSDS) from manufacturer stating physical and chemical properties of components and precautionary considerations required.
11. Submit shop drawings or product data as soon as practicable after signing contracts. Submittals must be approved before installation of materials and equipment.
12. Submittals that are not complete, not permanent or not properly checked by Contractor will be returned without review.

B. Certificates and Inspections:
1. Obtain and pay for inspections required by authorities having jurisdiction and deliver certificates approving installations to Owner unless otherwise directed.

C. Operation and Maintenance Manuals:
1. Refer to Division 01 - Operation and Maintenance Data.

2). By or before the time construction is 75% complete, submit one (1) copy to Architect for approval of operation and maintenance manuals in loose-leaf binders. After securing approval, submit all one (1) hard copy and one (1) electronic copy to Owner.

3). Manuals shall be bound in white, hard cover, three ring (D-ring) binders with clear view, presentation type, vinyl covers. Binders shall also contain front and back pockets. Maximum allowable spine width is two inches. No binder will be accepted that is filled to more than 80% of capacity. When necessary to submit multiple volume sets, each volume will be labeled numerically, using Roman numerals, in ascending order, beginning with number I. The order of the volumes will follow the specification division numbers contained on the tabs inside each volume.

4). Manuals provided must be of sufficient detail as to enable University Employees to install, calibrate, train, operate, maintain, service, and repair every system, subsystem, and piece of equipment installed on or as a part of this project.

5). The Front cover insert shall be printed on high quality white, bonded paper and contain the following: U.K. Logo, U.K. Project Title, U.K. Project Number, Location, date of submittal, volume number, name of Architect, name of Engineer, and the name of the U.K. project management representative. The spinal insert will contain only the U.K. Logo, U.K. Project Title, U.K. Project Number, date of submittal and volume number. No insert will be placed in the back cover. To maintain Uniformity, no other information will be accepted on these inserts.

6). The first page in each volume will be a master Index describing, by division numbers, the information contained in each volume. The page(s) immediately following the master index will be the volume table of contents containing the description and 5 digit division number of all information contained in that volume. All information will be indexed using the 2004 CSI master format 6 digit division numbers. Information will be divided by tabbed inserts with the 6 digit item numbers printed on the tabs. The pages immediately following the table of contents in each volume will contain the following information in this order.

   a). Information Sheet – Project title, project number, location, date of submittal, Architect (name, address, and telephone number), Engineer (name, address, and telephone number), Contractor (name, address, and telephone number), and all Sub-Contractors (name, address, and telephone number).

   b). Emergency Contact List – Names and telephone numbers of contact person on warranty items. Any special instructions should also be included on this page.

   c). Inspections and Guarantees – Copies of all inspection, guarantee, and warranty certificates with the University of Kentucky named as owner of all equipment and property.

   d). Valve Tag List – A record of all valves installed shall be made and shall include the following information: Valve tag number, location of valve, service area, type of service, type of valve, manufacturer, and model number. Refer to Section 20-0553 – Mechanical System Identification.

   e). Finish Schedule – A copy of the interior and exterior finish plan schedule listing all finish materials, manufacturers, colors, paint numbers, and use & care instructions.

   f). Access panel identification charts as specified in Section 20-0553 – Mechanical System Identification.

   g). All equipment required by contract and/or installed by the contractors or sub-contractors must be accompanied by the original copies of its documentation. This documentation must be included in all four sets of manuals and at minimum include: Installation manuals, training manuals, service manuals, parts lists, shop drawings, calibration manuals (if applicable), operation manuals, repair manuals, start up and shut down procedures, and wire lists/diagrams (if applicable). **Under no circumstances will catalog cut sheets be considered acceptable replacements for any of the above items.**

   h). Documentation for each piece of equipment shall be indexed as mentioned above and be placed after the appropriate tab. Each tabbed section must contain, as its first sheet, a

checklist of all documentation included in that section, location(s) of equipment, and vendor name and address. If more than one type of equipment falls under the same number, a checklist for each type must be present. If the binder includes manuals from any one vendor covering model numbers, the model used must be highlighted.

i). Copies of all shop drawings. The maximum drawing size allowed in binders shall be folded 11" x 17". These drawings shall be hole punched, re-enforced, and placed with the appropriate information under the correct tab. Drawings placed in pockets of binder are not acceptable. Top of drawings shall be at the top or spine side of the manual. The complete drawing must be viewable without opening rings. All drawings not meeting these size requirements must be bound together, rolled, banded, and submitted along side manuals.

j). Copies of each system test and balancing record and each system hydronic test and balancing record must accompany manuals submittal. As most such documents are produced using computers, one additional copy of the Test & Balance report should be submitted on a CD.

7). Manuals shall also include the following:

a). CD ROM's of all O&M data. Exploded parts lists shall be included, where available.

b). Internet/WEB page addresses where applicable.

c). Composite electrical diagrams.

d). Flow diagrams.

e). Lubrication instructions.

f). Factory and field test records. (Refer to Test and Balancing in Part 3 of this section.)

g). All drawings in manuals shall have AutoCAD disk file copy transmitted with final record drawings and specifications.

h). Copy of temperature control system record drawings, components, and sequences of operation.

i). Copies of source code for all software and firmware (prom, eprom, rom, other) supplied with any computer, micro controller, or microprocessor.

j). Additional information, diagrams or explanations as designated under respective equipment or systems specification sections.

8. Fire protection system shall be separately bound.
9. Instruct Owner's representative in operation and maintenance of equipment. Instruction shall include complete operating cycle on all apparatus.
10. Furnish O&M Manuals and instructions to Owner prior to request for final payment.

D. Record Documents:

1. Refer to General Conditions of Contract, and Division 01 - Project Record Documents. Prepare complete set of record drawings in accordance with Division 01.
2. Use designated set of prints of Contract Documents as prepared by Architect to mark-up for record drawing purposes.

1.7 JOB CONDITIONS

A. Building Access:

1. Arrange for necessary openings in building to allow for admittance of all apparatus.

B. Electrical Coordination:
   1. Refer to Section 20 0513 - Motors
   2. Contractors for Divisions 20, 21, 22 and 23 shall provide the following items as specified under their respective Division(s) (Division 20, 21, 22 and 23):
      a. Motors
      b. Electrically powered equipment
      c. Electrically controlled equipment
      d. Starters, where specified
      e. Variable frequency drives, where specified
      f. Control devices, where specified
      g. Temperature Control wiring
      h. Wiring diagrams to Electrical Contractor for apparatus indicating external connection and internal controls.
      i. Disconnect devices furnished with units (VFDs, chillers, prepackaged control devices, etc.)
         1). Devices shall have an interrupting rating not less than that of the upstream overcurrent device as shown on electrical drawings.
         2). Equipment electrical connection points shall be labeled with listed electrical short circuit current rating (SCCR). SCCR shall not be less than interrupting rating of upstream overcurrent device as shown on electrical drawings. SCCR shall be marked on equipment control enclosure in accordance with UL508, or other acceptable, accredited third-party testing agency standards.
   3. Electrical Contractor will provide the following devices required for control of motors or electrical equipment, unless noted otherwise.
      a. Starters
      b. Disconnect devices
      c. Control devices:
         1). Pushbuttons
         2). Pilot lights
         3). Contacts
      d. Conduit, boxes and wiring for power wiring.
      e. Conduit, boxes and wiring for control wiring, except temperature control wiring.
   4. Electrical Contractor will make connections, from power source to starter or variable frequency drive and from starter or variable frequency drive, where specified, to motor for ready to operate.
   5. Where starters or other similar control devices are furnished by this contractor, they shall be installed by this contractor and wired by Electrical Contractor.
   6. Should any change in size, hp rating, voltage, or means of control be made to any motor or other electrical equipment after Contracts are awarded, this contractor shall immediately notify Electrical Contractor of change. Additional costs due to these changes shall be responsibility of this contractor.

C. Cutting and Patching:
   1. Refer to General Conditions of the Contract, and Division 01 - Cutting and Patching.

2. Perform cutting and patching required for complete installation of systems, unless otherwise noted. Patch and restore work cut or damaged to original condition. This includes openings remaining from removal or relocation of existing system components.
3. Provide materials required for patching unless otherwise noted.
4. Do not pierce beams or columns without permission of Architect and then only as directed. If openings are required through walls or floors where no sleeve has been provided, hole shall be core drilled to avoid unnecessary damage and structural weakening.
5. Where alterations disturb lawns, paving, walks, etc., replace, repair or refinish surfaces to condition existing prior to commencement of work. This may include areas beyond construction limits.

D. Housekeeping and Cleanup:
1. Refer to Division 01 - Closeout Procedures.
2. As work progresses and/or as directed by Architect, periodically remove waste materials from building and leave area of work broom clean. Upon completion of Work, remove tools, scaffolding, broken and waste materials, etc., from site.

1.8 WARRANTY

A. Refer to Division 01 for general warranty requirements.

B. Refer to technical sections for warranty requirement for each system.
1. Where no warranty requirements are called out, warrant equipment, materials, and workmanship to be free from defect as called out in Division 01

C. Warrant that systems will operate without objectionable noise, vibration and uncontrolled expansion.

D. Repair, replace or alter systems or parts of systems found defective at no extra cost to Owner.

E. In any case, wherein fulfilling requirements of any warranty, if this contractor disturbs any work warranted under another contract, this contractor shall restore such disturbed work to condition satisfactory to Architect and warranty such restored work to same extent as it was warranted under such other contract.

F. Warranty shall include labor, materials, and travel time.

1.9 BUILDING SYSTEMS COMISSIONING

A. “An independent third party Commissioning Agent will document completion of the Mechanical, Fire Suppression, Plumbing, HVAC, Electrical, Communications and Electronic Safety and Security Systems for the project. The Construction Manager and Division Contractors are members of the Commissioning Team and will facilitate completion of the Commissioning process. Refer to section 019113 “Building Systems Commissioning” for the project Commissioning requirements and roles and responsibilities of each member of the Commissioning Team.”

PART 2 - PRODUCTS

2.1 PRODUCT SUBSTITUTIONS

A. Refer to Division 01 - Product Requirements.

PART 3 - EXECUTION

3.1 GENERAL

A. Verify elevations and dimensions prior to installation of materials.

3.2 DELIVERY, STORAGE, HANDLING, AND PROTECTION

A. Deliver products to the site under provisions of Division 01.

B. Store and protect products under provisions of Division 01.

C. Store in clean, dry space.

D. Maintain factory wrapping or provide cover to protect units from dirt, water, construction debris, and traffic.

E. Handle in accordance with manufacturer's written instructions.

F. Handle carefully to avoid damage to components, enclosure, and finish. Lift only with lugs provided for the purpose.

G. Protect openings in equipment until connected to system to prevent entry of foreign materials.

3.3 FLOOR, WALL, ROOF AND CEILING OPENINGS

A. Coordinate location of openings, chases, furred spaces, etc., with appropriate Contractors. Provide sleeves and inserts that are to be built into structure during progress of construction.

B. Remove temporary sleeves, if used to form openings, prior to installation of permanent materials. Utilize minimum 24 ga galvanized sheet metal for permanent sleeves unless otherwise noted.

C. Provide Schedule 40 carbon steel pipe with integral water stop for steel sleeves required in interior floor slabs.

D. Submit to Structural Engineer for review and approval size and location of core-drilled holes prior to execution.

E. Submit product data and installation details for penetrations of building structure. Include schedule indicating penetrating materials (metal pipe, plastic pipe, conduit, etc.), sizes of each, opening sizes and sealant products intended for use.

F. Where penetrations of fire-rated assemblies are involved, seal penetrations with appropriate firestopping systems as specified in Section 20 0573 - Mechanical Systems Firestopping.

G. Submit complete penetration layout drawings showing openings in building structural members including floor slabs, bearing walls, shear walls, etc. Indicate and locate, by dimension, all required openings, including those sleeved, formed or core drilled. Drawings shall be approved prior to preparing openings in structural member.

H. Provide minimum 1" clearance around penetration openings intended for pipe. Where fire resistant penetrations are required, size openings in accordance with written recommendations of firestopping systems manufacturer.

I. Openings for insulated piping shall be sized based on outside diameter of insulation when it is specified or detailed to be continuous through opening.

J. Openings for duct penetrations shall be no more than 1/2” larger on all sides than size of duct or duct including duct insulation, if applicable. Where firestopping systems are required at penetrations, size in accordance with recommendations of firestopping systems manufacturer, but opening shall not exceed 1” average clearance on all sides. Openings for ducts with fire dampers shall be in accordance with fire damper installation requirements.

K. Duct penetrations through concrete floors in mechanical rooms containing liquid heat exchangers and/or pumps shall have 2” high water stopped curbs surrounding openings. This applies to mechanical rooms above the lowest floor level.

L. Seal non fire-rated floor penetrations with non-shrink grout equal to Embeco by Master Builders, or urethane caulk, as appropriate.

M. Seal non fire-rated wall openings with urethane caulk.

N. Where penetrations occur through exterior walls into building spaces, use sleeves with integral water stop. For piping having outer surface temperature less than 150°F, use plastic (HDPE) sleeves, similar to PSI Link-Seal Model CS, rated to 150°F. For piping having outer surface temperature 150°F or higher, or where steel sleeves are shown or walls are fire rated, use steel sleeves with hot dip galvanizing, similar to PSI Link-Seal Model WS. Seal annular space between sleeves and pipe with Thunderline "Link-Seal" modular wall and casing seals, or sealing system by another manufacturer approved as equal by Engineer. Where "Link-Seals" are used with insulated pipe, insulation shall be butted against seals on both sides. Sealing system shall utilize Type 316 stainless steel bolts, washers and nuts.

O. In lieu of openings as specified herein penetration systems as manufactured by Pro Set may be used, including sleeve couplings and plug.

P. If total Pro Set system with Water Guard “CR” is used, opening shall not need additional water proofing or riser clamps.

Q. Finish and trim penetrations as shown on details and as specified.

R. Provide chrome or nickel plated escutcheons where piping passes through walls, floors or ceilings and is exposed in finished areas. Size escutcheons to fit pipe and pipe covering for finished appearance. Finished areas shall not include mechanical/electrical rooms, janitors' closets, storage rooms, etc., unless suspended ceilings are specified.

S. Trim duct penetrations exposed in finished areas with 2” wide galvanized or aluminum trim collars properly sized to fit duct. Collars shall be same gauge as duct, prime finish unless noted otherwise. Finished areas shall not include mechanical rooms, janitors' closets, storage rooms, etc., unless suspended ceilings are specified.

T. In Bio-safety Animal holding Wash down areas,
   1. Exposed conduit penetrations shall be sealed as follows:
      a. Escutcheons shall not be used when conduits are exposed in finished areas and penetrate finished surfaces.
      b. Cut and patch penetration to within 1/4” of conduit.

c. Seal openings around conduit and patch work with sprayable, flexible, liquid polyvinyl chloride coating equal to ANDEK "COCOON® 72634-USDA". Sealant shall be installed per manufacturer's application requirements.

2. Penetrations other than conduits (junction boxes, light fixtures, etc.) including wiring devices shall be sealed as follows:
   a. Seal non-rated opening with silicone sealant.
   b. See Division 26 drawings for details.
   c. Confirm selected sealant is compatible with paint provided by others prior to application.
   d. Product: One-Part Mildew-Resistant Silicone Sealant: Type S; Grade NS; Class 25; Uses NT, G, A, and as applicable to nonporous joint substances indicated, O; formulated with fungicide; intended for sealing interior joints with nonporous substrates and subject to in-service exposure to conditions of high humidity and temperature extremes; subject to compliance with requirements. Provide one of the following:
      1). 786 Mildew Resistant Silicone Sealant; Dow Corning Corp.
      2). Sanitary 1700 Silicone Sealant; General Electric Co.
      3). 898 Silicone Sanitary Sealant; Pecora Corp.
      4). Tremsil 600; Tremco Corp.
      5). OmniPlus; Sonneborn Building Products Div., Rexnord Chemical Products, Inc.

3.4 EQUIPMENT SHUTOFF VALVES

A. Provide shutoff valves at equipment connected to piping system. Refer to valve section or system section for requirements of valve type.

3.5 EQUIPMENT ACCESS

A. Install piping, conduit and accessories to permit access to equipment for maintenance. Relocate piping, equipment or accessories to provide access at no additional cost to Owner.

B. Install equipment with sufficient maintenance space for removal, repair or changes to equipment. Provide ready accessibility to equipment without moving other future or installed equipment or system components.

C. Access doors in walls, chases, or inaccessible ceilings will be provided under Division 08 - Access Doors and Frames, unless otherwise indicated. Access doors for valves, shock stops or other equipment shall provide access for servicing, repairs, and/or maintenance.

D. Provide necessary coordination and information to the Trade Contractor under Division 08 - Access Doors and Frames. This information shall include required locations, sizes, and rough-in dimensions.

E. Provide access doors in walls, chases or above inaccessible ceilings for valves, shock stops, unions or equipment/devices requiring access for servicing, repairs or maintenance, unless otherwise noted. Access frames and doors shall be as manufactured by Milcor, Incorporated, or similar, of style applicable to surface. Provide access doors used in fire rated construction with UL Label. Provide steel, prime coated access doors unless otherwise specified. Provide stainless steel doors in ceramic tile walls, toilet rooms, locker rooms and in areas subject to excessive moisture. Provide access doors of sufficient size to allow complete maintenance. Coordinate location of access doors with General Contractor and rough-in equipment accordingly.

3.6 EQUIPMENT SUPPORTS

A. Provide supporting steel not indicated on drawings as required for installation of equipment and materials including angles, channels, beams, hangers, etc.

3.7 EQUIPMENT GUARDS

A. Provide equipment guards over belt driven assemblies, pump shafts, exposed fans, and elsewhere as indicated in this Specification or required by Code.

B. Paint equipment guards bright yellow.

C. Equipment guards shall comply with OSHA requirements.

3.8 SUPPORT PROTECTION

A. In occupied areas, mechanical rooms and areas requiring normal maintenance access, guard certain equipment to protect personnel from injury.

B. Provide minimum 1/2” thick Armstrong Armaflex insulation or similar product applied with Armstrong 520 adhesive on lower edges of equipment and mechanical supporting devices suspended less than 7 ft above floors, platforms or catwalks in these areas.

C. Protect threaded rod or bolts at supporting elements as described above. Trim threaded rod or bolts such that they do not extend beyond supporting element and devices.

3.9 LEAD SHIELDING

A. Wherever installation of this Contractor's equipment destroys radiologic integrity of wall, floor, or ceiling, this Contractor shall be responsible to provide suitable lead shielding to restore that integrity. Coordinate these requirements with General Contractor.

3.10 MECHANICAL SYSTEMS IDENTIFICATION

A. Refer to Section 20 0553 - Mechanical Systems Identification

3.11 TEST AND BALANCING

A. Tests for equipment, ductwork and piping systems shall be performed as specified in their respective specification sections in accordance with technical requirements noted.

B. Provide equipment required for testing, including fittings for additional openings required for test apparatus.

C. All ductwork and piping inspections and testing shall be successfully completed and approved before application of covering materials.

D. When equipment or systems fail to meet minimum test requirements, replace or repair defective work or material as necessary and repeat inspection and test until equipment or systems meet test requirements. Make repairs with new materials. Caulking of holes or threaded joints is not allowed.

E. Contractor is responsible for certifying in writing equipment and system test results. Certification shall include identification of portion of system tested, date, time, test criteria, test medium and pressure used, duration of test and name and title of person signing test certification document.

F. Maintain copies of certified test results, including those for any failed tests, at project site. At completion of project, include copies of test records and certifications in O&M Manuals.

G. Balancing of various systems shall be in accordance with associated specification sections in addition to requirements noted herein.

H. If exterior domestic water supply also serves as source for fire protection systems, either exterior or interior or both, it shall be tested according to fire protection system requirements as specified in applicable Specification Section.

3.12 START-UP

A. Systems and equipment shall be started, tested, adjusted and turned over to Owner ready for operation. This includes "Owner-Furnished, Contractor-Installed" (OFCI) and "Contractor-Furnished, Contractor-Installed" (CFCI) systems and equipment.

B. Follow manufacturer's pre-start-up check-out, start-up, trouble shooting and adjustment procedures.

C. Contractor shall provide services of technician/mechanic knowledgeable in start-up and check-out of types of systems and equipment on project.

D. Provide start-up services by manufacturer's representative where specified or where Contractor does not have qualified personnel.

E. Coordinate start-up with all trades.

3.13 LUBRICATION

A. Upon completion of work and before turning over to Owner, clean and lubricate bearings except sealed and permanently lubricated bearings. Use only lubricant recommended by manufacturer.

B. Contractor is responsible for maintaining lubrication of mechanical equipment under this Contract until Work is accepted by Owner.

3.14 CLEANING

A. Clean systems after installation is complete.

B. Clean piping and ductwork both internally and externally to remove dirt, plaster dust or other foreign materials. When external surfaces of piping are rusted, clean and restore surface to original condition.

C. Clean pipeline strainers to restore them to original condition or replace with new strainer elements.

D. Clean equipment and plumbing fixtures as recommended by manufacturers.

E. Replace throwaway or replaceable media air filters used during construction period with new filters or new filter media after construction has been completed and before building is turned over to Owner. Filter replacement shall be as hereinafter specified.

F. Blow and clean dirt, plaster dust and other foreign matter from coils, terminal devices, diffusers, registers and grilles.

G. Thoroughly clean equipment of stains, paint spots, dirt and dust. Remove temporary labels not used for instruction or operation.

H. Provide additional cleaning of individual piping systems and apparatus as hereinafter specified.

END OF SECTION

SECTION 20 0529 MECHANICAL SUPPORTING DEVICES

PART 1 - GENERAL

1.1 RELATED WORK

A. Section 20 0700 - Mechanical Systems Insulation

B. Section 23 0550 - Vibration Isolation (Spring Hangers and Mounts)

C. Section 23 3114 - Ductwork (for additional duct supports requirements)

1.2 REFERENCE

A. Work under this Section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.

1.3 DESCRIPTION

A. Provide all supporting devices as specified and as required for proper support of piping, ductwork, equipment, materials and systems.

B. Support for all conditions of operation, including variations in installed and operating weight of equipment, piping and ductwork, to prevent excess stress and allow for proper expansion and contraction.

C. Support of fire protection pipe shall comply with NFPA 13, Installation of Sprinkler Systems, 2007 Edition.

1.4 SUBMITTALS

A. Shop Drawings for each piping system for all pipe sizes and all applicable equipment including, but not limited to, the following:
   1. Manufacturer's name
   2. Model numbers
   3. Materials of construction and load ratings (lbs)
   4. Schedule of hangers and support devices with pipe support spacing
   5. Insulated pipe supports along with application chart or table
   6. Insulation protection saddles and weight bearing insulation table
   7. Details and calculations for sizing supplementary steel utilized for trapeze or specially designed supports
   8. Structural attachments, inserts and concrete anchors. Submit ICC-ES Evaluation Report for each type of anchor.
   9. Calculations and drawings for concrete inserts and anchors for each application
   10. Drawings showing specific locations of any weld attachments to structure, including weight supported by such attachments
   11. Drawings showing specific locations of any suspended loads which exceed 100 lbs within joist chord panel to be attached to open web steel joist structural members. Include weight

supported by such attachments. (Panel is length of chord between two adjacent diagonal web members at point of connection to chord.)

12. Equipment mounting devices
13. Pipe guides and anchors
14. All other appropriate data

1.5 DESIGN CRITERIA

A. Materials and application of pipe hangers and supports shall conform to latest requirements of ANSI/ASME B31 Code for Pressure Piping and MSS Standard Practice SP-58-2009 (Pipe Hangers and Supports Materials, Design, Manufacture, Selection, Application, and Installation), except as supplemented or modified herein.

B. Support materials shall be steel or stainless steel unless specifically indicated.

C. Support devices shall have published load ratings.

D. Unless otherwise indicated, design structural support members and support devices, including couplings, rods, trapeze supports and strut systems, with safety factor in accordance with AISC Manual of Steel Construction, but not less than 2.0.

E. Determine maximum deflection using the following equation.

$$D = \frac{H \text{ or } L}{250}$$

Where D = Max deflection in inches
H = Member height in inches
L = Member length in inches

F. Unless otherwise indicated, hangers, support devices and hardware shall be steel and shall have factory standard galvanized or electroplated finish for indoor application, and hot-dipped galvanized finish for outdoor application and corrosive atmospheres. Coat cut edges, welds or any damaged finish with galvanized paint.
   1. Corrosive atmospheres include the following locations:
      a. Exterior locations
      b. Chemical storage and hazardous waste storage rooms
      c. Food service/kitchen areas
      d. Locker/shower rooms
      e. Utility tunnels
      f. Cage wash room (dirty and clean)
      g. Sterilizer/autoclave room

G. Material in contact with pipe shall be compatible with piping material so that neither shall have deteriorating action on the other. If materials such as copper, stainless steel or other materials are not compatible, provide nonmetallic separation between uninsulated piping and metal supports. Plastic coated steel supports are acceptable.

H. Unless otherwise indicated, steel support devices exposed to ventilation air stream shall be stainless steel or steel with either galvanized finish or paint finish. Paint type shall be approved by Architect/Engineer.

I. This Contractor is responsible for proper placement and sizing of supporting devices to accommodate insulation thickness and pitching of pipe. Coordinate with Contractor performing work specified in Section 20 0700 - Mechanical Systems Insulation.

J. In addition to hangers specified in this Section, piping connected to pumps, compressors, and similar rotating or reciprocating equipment shall have vibration isolation hangers or supports for distance of 100 pipe diameters or 50 ft away from equipment, whichever is greater.

K. Piping connected to coils, which are in assembly mounted on vibration isolators, shall have vibration isolation hangers or supports as indicated above. Piping connected to coils, which are in equipment where fan assembly is separately isolated by vibration isolators and flexible connections, does not require additional vibration isolation hangers or supports. Refer to Section 23 0550 - Vibration Isolation for flexible connections, vibration isolators and additional requirements.

L. Where piping can be conveniently grouped to allow trapeze type supports, supporting steel shall be by means of standard structural shapes.

M. Hangers and rods shall be plumb when pipelines are at their normal operating temperatures.

N. Unless otherwise indicated, continuous insert channels are not allowed.

O. Punching, drilling, or welding of building structural steel is not allowed unless approved by Structural Engineer.

P. Refer to Structural Documents and ICC-ES Evaluation Report for application of concrete inserts and concrete anchors.

Q. Lateral braces shall be designed and detailed to apply loads as directly as possible to structural floor slabs, roof decks, or other building lateral elements. Braces shall not be applied to bottom flanges of steel beams or bottom chords of open web steel joists.

R. Coordinate with General Contractor for any proposed weld attachments to building structure. This may result in use of other welding codes or standards, which may apply to "structural work". Execution of this work may be assigned to General Trades responsible for building structural steel. Cost for this work, however, will remain the responsibility of this Contractor.

S. Top or bottom chords of open web steel joists may be used to support loads, provided total load within panel does not exceed 100 lbs and load is placed concentric to joist. (Panel is length of chord between two adjacent diagonal web members at point of connection to chord).

PART 2 - PRODUCTS

2.1 STRUCTURAL SUPPORTS

A. Design and provide all supporting steel, not indicated on structural drawings, that is required for installation of mechanical equipment and materials, including angles, channels, beams, connections, etc. to suspend or floor support equipment.

2.2 PIPE HANGERS AND SUPPORTS (METALLIC)

A. Manufacturers: Anvil (formerly Grinnell), Erico, Tolco, National Pipe Hanger Corporation, or B-Line, equal to Anvil figures listed. Corresponding MSS Type is indicated where applicable.

B. Hangers/supports for copper pipe where supports directly contact to pipe shall be either plastic, vinyl or epoxy coated.

C. For insulated pipe supports, refer to Insulated Pipe Supports in Part 3 of this Section.

D. Clevis and Roller Type Hangers:

System	Pipe Size	Clevis	Roller
Hot Pipes with Insulation (120°F and above)	2” and smaller	65 (MSS Type-1), 260 (MSS Type-1)	---
	2-1/2” to 6”	---	171 (MSS Type-41), 181 (MSS Type-43)
	8” and larger	---	171 (MSS Type-41)
Ambient Bare Pipes (60°F to 119°F)	2” and smaller	65 (MSS Type-1), 260 (MSS Type-1)	---
	2-1/2” and larger	260 (MSS Type-1), 216 (MSS Type-4)	---
Cold Pipes with Insulation (33°F to 59°F)	2” and smaller	65 (MSS Type-1), 260 (MSS Type-1)	---
	2-1/2” and larger	260 (MSS Type-1), 295 (MSS Type-1)	---

1. For pipe size 2-1/2” and larger, where there is transverse movement at support points due to thermal expansion/contraction, clevis type hangers similar to Anvil Figure 260 (MSS Type-1) may be used if vertical angle of hanger rod is less than 4°.

E. Flat Surfaces (Trapeze, Rack Type):

1. Use structural steel members such as struts, angles, channels and beams to support pipes as required. Select members properly for pipe support types and loading conditions. Refer to Part 1 for design criteria. Submit support details with type of members selected and load calculations. Provide straps, clamps, rollers or slides indicated below at each support point.

System	Pipe Size	Straps or Clamps	Rollers	Slides
Hot Pipes with	2” and smaller	243, 244	---	---

Insulation (120°F and above)	2-1/2” and larger	---	171 or 177(MSS Type-41), 271 (MSS Type-45), 274 (MSS Type-46)	257 or 436 with 212 or 432 clamps, Type 1, 2 or 3 for longitudinal movement only and Type 4, 5 or 6 for both longitudinal and transverse movement of piping.
Ambient Bare Steel Pipes (60°F to 119°F)	6” and smaller	B-Line BVT	---	---
	8” and larger	137 (MSS Type-24)		
Ambient Bare (Copper) pipes (60°F to 119°F)	all sizes	B-Line BVT		
Cold Pipes with Insulation (33°F to 59°F)	10” and smaller	137 (MSS Type-24)	---	---
	12” and larger	432	---	---

2.3 INSULATION PROTECTION SHIELDS

A. Anvil Fig. 167 (MSS Type-40) constructed of galvanized carbon steel. Per the latest edition of Standard MSS SP-58, select shield to accommodate outer diameter of insulation. Shield length and gauge for insulation compression strength not less than 15 psi, shall be as follows:

Pipe Size	Length	Gauge
1/4” thru 3”	12”	18
4”	12”	16
5” and 6”	18”	16
8” thru 14”	24”	14
16” thru 24”	24”	12

2.4 INSULATION PROTECTION SADDLES

A. Anvil Fig. 160 Series (MSS Type-39) constructed of carbon steel or alloy steel plate. Select saddles to accommodate insulation thickness specified in Section 20 0700 - Mechanical Systems Insulation.

2.5 WEIGHT BEARING INSULATION INSERTS

A. Insert thickness shall match pipe insulation thickness. Pipe insulation jackets shall be continuous through sections containing inserts.

B. Minimum length of inserts shall be 12”, or 2” longer than insulation protection shields, whichever is longer. Compressive strength and placement of inserts shall be based on weight of pipe and fluid plus 1.5 safety factor.

C. Hot Pipes (120°F and above):

1. High-density calcium silicate insulation (Type H) similar to Johns Manville Thermo-12 or cellular glass insulation (Type G) similar to Pittsburgh Corning Foamglas. Maximum compression strength for load calculation shall be 90 psi.

D. Cold Pipes (59°F and below):
   1. Cellular glass insulation (Type G) similar to Pittsburgh Corning Foamglas, maximum compressive strength 90 psi, rigid closed cell insulation (Type PP) similar to Trymer Green by ITW, maximum compressive strength for load calculation 31 psi, or expanded polyisocyanurate insulation (Type P) similar to Trymer 2000XP by ITW, maximum compressive strength for load calculation 24 psi.
   2. SNAPP ITZ pre-insulated pipe supports by Mechanical Pipe Shields Mfg or Tru-Balance Insulated Saddles by Buckaroos, Inc. may be used. Pre-insulated pipe supports shall use polyisocyanurate (Trymer 2000 or 4000 or Insul-Phen insulation), with PVC jacket and G90 galvanized steel shield.

2.6 PRE-INSULATED PIPE SUPPORTS

A. Pipe Shields, Inc., Bergen Pre-Insulated Pipe Supports, Rilco, or Tri-State Industries equal to Pipe Shields models listed

B. Insulation shall consist of water-resistant calcium silicate of same thickness as adjoining pipe insulation, thermal conductivity not more than 0.38 Btu·in/(hr·ft^2·°F) at 75°F mean temperature, minimum density of 13 lb/ft^3, and compressive strength not less than 100 psi.

C. Structural inserts shall be water-resistant, high-density calcium silicate with minimum density of 32 lb/ft^3 and minimum compressive strength of 600 psi. Structural inserts shall be used as recommended by manufacturer to meet load ratings.

D. Use vapor barrier steel jacket around insulation. Insulation jackets shall be galvanized steel conforming to ASTM A-527. Hanger bearing surface shall consist of galvanized sheet metal insulation protection shield or casing.

E. When recommended by manufacturer, use double layer insulation protection shield at support bearing surface. Insulation shall extend 1” beyond insulation protection shield to maintain vapor barrier integrity.

F. Pre-insulated pipe supports shall be load rated. Load ratings shall be established by pipe support manufacturer based upon testing and analysis in conformance with the latest edition of the following codes and standards: ASME B31.1, MSS SP-58, MSS SP-69, and MSS SP-89.

G. Load tests shall be made on both supporting materials and configurations. All tests shall be performed by independent testing laboratory. Results of pertinent tests shall be available upon request.

H. Unless otherwise indicated, pre-insulated pipe supports shall be as indicated in the following schedule. Model numbers are based on Shaw Pipe Shields, Inc.
   1. Pipe supported on hangers: Models A2000, A4000, A9000, D3000 and D3200
   2. Pipe supported on flat surfaces: Models A2000, A4000, A6000, A7000, A7200, and A7400
   3. Pipe supported on pipe rolls: Models A4000, A6000, A8000, A8200, and A8400
   4. Pipe supported on slides: Model "B" Series
   5. A1000, A3000 or A5000 may be used for hot pipes (120°F and above)

I. Select proper model to conform to pipe service, support style, and support spacing.

J. Submit chart or table indicating selected model along with pipe sizes, rated loads, support device types and support spacing for each piping system.

K. Pipe support spacing shall be in accordance with manufacturer's recommendations, but in no case shall exceed maximum spacing indicated under Hanger and Support Spacing in Part 3 of this Section.

2.7 HANGER RODS (METALLIC)

A. Rods shall conform to the latest MSS Standards except as modified herein. Furnish rods complete with adjusting and lock nuts.

B. Rods shall have electroplated zinc or hot dip galvanized finish.

C. Unless otherwise indicated, size rods for individual hangers and trapeze support as indicated in the following schedule. Rod size may be reduced one size for double rod hangers. Total weight of equipment, including valves, fittings, pipe, pipe content and insulation, shall not exceed limits indicated.

Max. Pipe Size With Single Rigid Rod	Rod Diameter (inches)	Max Load (lbs) of Hanger Rod (Not exceeding 650°F Service Temp.)
2”	3/8	730
3”	1/2	1350
5”	5/8	2160
8”	3/4	3230
12”	7/8	4480
18”	1	5900
30”	1-1/4	9500

D. Threaded rods are not allowed in clean rooms.

2.8 BOLTS, NUTS, STUDS AND WASHERS

A. ASTM A307, electroplated zinc finish

2.9 ROD ATTACHMENTS

A. Anvil Fig. 290 (MSS Type-17), galvanized finish

2.10 U-BOLTS

A. Anvil Fig. 137 (MSS Type-24), galvanized finish

2.11 BEAM CLAMPS

A. Beam Clamps: Anvil Fig. 133/134 (MSS Type-21), 218 (MSS Type-30), 228 (MSS Type-28 or 29) and 292 (MSS Type-28 or 29)

B. Top Beam Clamps: Anvil Fig. 227 (MSS Type-25)

C. C-Clamps: Anvil Fig. 86, 92 or 93 (MSS Type-19 or 23) with set screw and lock nut

2.12 ADJUSTABLE PIPE SADDLE SUPPORTS

A. Anvil Fig. 264 (MSS Type-38), galvanized finish. Provide Anvil Fig. 63 Type T stanchion with base, galvanized finish, where applicable.

2.13 RISER CLAMPS

A. Anvil Fig. 261 (MSS Type-8), galvanized finish

B. Anvil Fig. CT-121, copper plated carbon steel, plastic coated in area at pipe contact, for bare copper tubing

C. Proset system, proseal plug and fire-fill for sleeved and cored holes.

2.14 CONCRETE INSERTS (WOODEN FORMED CONCRETE)

A. Anvil Fig. 281 or 282, or Hilti HCI-WF (MSS Type-18), suitable for rod diameter and weight supported.

2.15 CONCRETE INSERTS (METAL DECK FORMED CONCRETE)

A. Anvil Fig. 284, Tolco No. 109 A, B-Line Fig. B3019, Powers Fasteners "Bang-It", Hilti HCI-MD, or MSCO No. MX34.

2.16 CONCRETE ANCHORS

A. Manufacturers: Hilti, Powers Fasteners or Red Head

B. Anchors shall be selected, sized, and detailed by Contractor’s structural engineer registered in project’s jurisdiction, based on project conditions and in accordance with project building code. Calculations and drawings shall be submitted.

C. Anchors shall meet ICC Acceptance Criteria, and ICC-ES Evaluation Reports (ESRs) shall specifically list the current applicable codes.

D. Anchors installed in hardened concrete for purpose of transmitting structural loads from one connected element to another, or for safety related elements such as sprinkler pipes, heavy suspended pipes, and barrier rails shall have ICC-ES report demonstrating anchors have met requirements of AC 193 for mechanical anchors in concrete elements.

E. Post-installed expansion anchors and undercut anchors installed in hardened concrete shall be qualified for strength design and tested according to ACI 355.2. Designs shall be per the requirements of ACI 318, Appendix D.

F. Anchors for seismic load application shall be approved by ICC-ES Evaluation Reports to resist seismic loads and selected to meet project seismic design requirements. Refer to Section 20 0549 – Seismic Anchorage and Restraints and Structural drawings.

G. Anchors shall be zinc plated in accordance with ASTM B633.

H. Select anchors with load ratings based on cracked concrete conditions.

2.17 METAL FRAMING SUPPORT SYSTEM (STRUT SYSTEM)

A. Manufacturers: Unistrut, B-Line Strut Systems, Anvil-Strut, Power-Strut, Erico, Superstrut, Kindorf, Hilti, and Hydra-Zorb

B. Channels shall have epoxy paint or electroplated zinc finish.

C. Channels shall not be lighter than 12 ga.

2.18 PIPE MOUNTING PEDESTALS

A. Equal to Roof Products & System Corporation consisting of equipment rail, "U" shaped mounting brackets, galvanized threaded rod and cast iron pipe rollers. Rail shall have built-in raised cant to match roof deck insulation.

2.19 EQUIPMENT RAILS

A. Manufacturers: Roof Products & Systems, ThyCurb, Custom Curb, Inc. or Vent Products equal to Roof Products & Systems Model ER-4 with raised cant style. Mounting rails shall be galvanized steel with integral base plate, continuous welded corner seams, factory installed 2x4 wood nailer and 18 ga galvanized steel counter flashing.

B. Mounting rail gauge shall be selected to support equipment adequately but shall be not less than 18 ga.

C. Height shall be as detailed, but not less than 8” above finished roof.

D. Equipment rails shall span minimum of 2 joists and not cantilever more than 6” where joists are used. Rails shall be level at top with pitch built in when deck slopes 1/4" per foot or greater.

2.20 PIPE ROOF PENETRATION PROTECTIONS

A. Manufacturers: Roof Products & Systems, ThyCurb or Vent Products equal to Roof Products & Systems "RPS-Pipe Portals" consisting of 12” OD prefabricated roof curb, laminated acrylic coated ABS plastic curb cover with EPDM protective rubber cap and stainless steel clamp.

2.21 PIPE GUIDES

A. Unless otherwise indicated, guides shall be Pipe Shields, Bergen Pre-Insulated Pipe Supports, or Rilco equal to Pipe Shields "B" Series B3000, B4000, B7000, B8000, selected by load and movement.

2.22 PIPE ANCHORS

A. Unless otherwise indicated, anchors shall be no-moment type, Shaw Pipe Shields or Rilco equal to Shaw Pipe Shields Insulated Positive Pipe Anchor Model C3000 or C4000 Series, sized to meet anchor forces shown with minimum safety factor of 3.0.

B. Contractor may fabricate anchors of steel sections suitable for location of installation and for withstanding anchor forces shown with minimum safety factor of 3.0.

2.23 CASEWORK PIPE SUPPORTS

A. Hinged pipe clamp and Strutcatcher, nylon 12 Grilamid, Clic by Litchfield International.

B. Vibration isolation pipe clamp, yellow zinc chromate finish, B-Line BVT Series Vibraclamp or Kwik-Clip by B-Line.

2.24 FIXTURE SUPPLY SUPPORT

A. Galvanized steel stud support bracket, pre-drilled tube support mounting holes, adjustable stud width, Erico TSGB or equal.

B. UV resistant nylon tube support, rated for 0°F through 130°F, resealable locking mechanism, Erico TPC or equal.

C. Support bracket and tube support to be from same manufacturer.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install supports to allow for free expansion of piping. Support piping from building structural members using concrete inserts, beam clamps, ceiling plates, wall brackets, or floor stands. At no time shall hangers and supports overload building structural members. Fasten ceiling plates and wall brackets securely to structure and test to demonstrate adequacy of fastening.

B. Select and size building attachments properly in accordance with MSS Standards and manufacturer's published load rating information.

C. Coordinate hanger and support installation to properly group piping of all trades.

D. Suspend piping hangers by means of hanger rods. Perforated band iron and flat wire (strap iron) are not allowed.

E. Piping and ductwork shall be supported independently from other piping or ductwork.

F. Pipe hangers and supports shall not penetrate vapor barrier of pipe insulation.

G. Do not support equipment, piping or ductwork from metal roof decking or ceiling grid.

H. Install adequate supports so as not to over stress either piping or equipment to which piping is connected.

I. Refer to Section 20 0000 - General Mechanical Requirements for requirements of personnel injury protection guards for supporting devices.

3.2 HANGER AND SUPPORT SPACING

A. Space pipe hangers and supports for horizontal pipe accordance with the following schedule, with exceptions as indicated herein:

B. Steel Pipe (Standard Weight and Extra Strong):

Pipe Size	Max Spacing
1-1/4” and smaller	7’-0”
1-1/2” and larger	8’-0”

C. Copper Tube (Unless Otherwise Noted):

Pipe Size	Max Spacing
3/4” and smaller	5’-0”
1” to 1-1/4”	6’-0”
1-1/2” and larger	8’-0”

D. Copper Tube (Domestic Water, Laboratory Water, Non-potable Water):

Pipe Size	Max Spacing
1-1/4” and smaller	6’-0”
1-1/2” and larger	8’-0”

E. Copper Tube (Domestic Water, Laboratory Water, Non Potable Water):

Pipe Size	Max Spacing
1-1/2” and smaller	6’-0”
2” and larger	8’-0”

F. Cast Iron Pipe:
   1. Maximum hanger and support spacing shall be 10 ft for all pipe sizes. Provide minimum of one hanger per pipe section close to joint on barrel, at each pipe fitting, at change of direction and branch connections.
   2. Support Cast Iron No-Hub pipe as recommended in CISPI Publication "Cast Iron Soil Pipe and Fittings Handbook, Chapter IV - Installation of Cast Iron Soil Pipe and Fittings."

G. Maximum spacing shown above may be restricted by strength of attachment to building structure. Submit data with calculations with published load ratings showing attachment to be utilized and maximum spacing allowable for that type of attachment and pipe size.

H. Spacing less than indicated above may be required to conform to building structure design or loading limitations.

I. If pipe size changes between support points, maximum spacing shall be based on the smaller pipe size.

J. If trapeze hangers are used to support multiple services, spacing shall be based on the most restrictive pipe size and material on trapeze hanger.

K. For non-metallic pipe, follow manufacturer's installation recommendations in addition to requirements noted herein.

L. Install supports for vertical piping and anchors as recommended by pipe manufacturer.

M. Place hangers and supports to meet requirements of Section 23 2116 - Pipe and Pipe Fittings or specific pipe system sections, with regard to pitch for drainage and venting and clearance between services.

N. Hangers and supports shall bear on outside of insulation when pipes are to be insulated.

O. Place hangers and supports within 1 ft of each fitting, such as elbows and tees, and at each valve, strainer, and other piping specialty for piping 4" and larger.

P. Place hanger or support at first elbow upstream of pump inlet and first elbow downstream of pump outlet.

3.3 RISER SUPPORTS

A. Insulated Piping:
   1. Unless otherwise indicated, support vertical piping as indicated below:
   2. Support vertical piping at approximately midpoint of riser, secured and anchored to building structure. Provide guides on vertical piping. Use spring hangers at top and bottom of riser and at take offs from riser at each floor. Use spring hangers for minimum 3 hangers away from top and bottom elbows and from each take off at riser.
   3. Guide vertical piping 2" and smaller at every floor. Guide 2-1/2" and larger at every other floor. Spring hangers (Type 6) and guides (Type VSG) are specified in Section 23 0550 - Vibration Isolation.

B. Non-insulated Piping:
   1. Unless otherwise indicated, maximum vertical support spacing for ambient bare steel and cast iron pipes shall be 15 ft.
   2. Maximum vertical support spacing for other piping including copper tubing and plastic piping shall be 10 ft.
   3. Install riser clamps and intermediate supports as required.
   4. Rest riser clamps on floor or on pipe sleeve.
   5. Non-insulated piping above 120°F such as steam vents shall be supported per insulated piping requirements.

3.4 INSULATION PROTECTION SHIELDS

A. Install insulation protection shields at support points as specified under Insulated Pipe Supports.
   1. Use one shield (bottom) for clevis hanger.
   2. Use 2 shields (top and bottom) for roller hanger/support or strap/clamp support. Apply 2 metal straps to hold top and bottom shields onto insulation jacket.

3.5 INSULATION PROTECTION SADDLES

A. Install saddles at support points as specified under Insulated Pipe Supports. Tack weld saddle to pipe by tacking center of each point of contact. Pack saddle cavity with insulation of same type as specified for piping system.

B. Where depth of single saddle is less than specified insulation thickness, provide additional saddle tack welded to first saddle to equal insulation thickness.

3.6 INSULATED PIPE SUPPORTS

A. Install insulated pipe support at each support point of insulated pipe. Provide insulation protection shields except where saddles are used.

B. Pipe Size 1-1/2" and Smaller:

1. Use insulation protection shields. Pipe insulation specified in Section 20 0700 - Mechanical Systems Insulation shall be continuous through support points.

C. Pipe Size 2" and Larger:
1. Use pre-insulated pipe supports. Refer to Part 2 for acceptable products.
2. In lieu of pre-insulated pipe supports, field-assembled insulated pipe supports may be used. If used, submit application details including materials, thickness, compression strength, load bearing surfaces, load calculations of support assembly and total pipe weight based on support spacing.
3. Field-assembled insulated pipe supports shall consist of weight bearing insulation inserts and insulation protection shields.
4. Insulation protection saddles may be used in lieu of assembled insulated pipe supports on roller hangers/supports for hot water pipes, low pressure steam and steam condensate pipes.

3.7 PIPE FLOOR SUPPORTS

A. Unless specifically shown otherwise, use adjustable pipe saddle supports with associated stanchion similar to Anvil Fig. 264/63. Select supports properly for weight and height of pipe stand.

3.8 CONCRETE INSERTS

A. Concrete insert application, size, loading, and placement shall be this Contractor's responsibility.

B. Coordinate with General Contractor for placement of inserts before concrete pour. Minimize use of inserts and anchors after concrete pour.

3.9 BEAM CLAMPS

A. Provide locknut for hanging rod at clamp.

B. C-clamps are allowed for rod size 3/8" or smaller and only for static loading such as air piping, cold water piping, fire protection piping and, other similar piping and ductwork. C-clamps are not allowed for hot water piping and steam and steam condensate piping, except hot water runouts to terminal heating devices.

C. C-clamps are not allowed for open web steel joist application.

D. C-clamps are not allowed for seismic application.

3.10 TRAPEZE SUPPORTS

A. Construct trapeze supports with struts, angles, or channels and hang them by inserts or welded beam attachments and rods.

B. Determine trapeze supports spacing by the smallest pipe on trapeze.

3.11 PIPE MOUNTING PEDESTALS

A. Use for all piping on roof. Install bottom of pedestal flat on roof deck, insulate exterior of pedestal, flash and counter flash.

3.12 EQUIPMENT RAILS

A. Use for all roof-mounted equipment, which is not curb mounted. Install bottom of equipment rail flat on roof deck. Insulate exterior of equipment rail.

B. Flashing will be by General Contractor. Provide counter flashing as specified and secure to wood nailer with stainless steel truss head screws.

3.13 CONCRETE ANCHORS

A. Anchor application, size, and placement shall be this Contractor's responsibility.

3.14 PIPE ROOF PENETRATION PROTECTIONS

A. Install at points where pipes are penetrating roof. Install as shown and according to manufacturer's installation instructions.

3.15 PIPE GUIDES

A. Install where shown on drawings.

B. For manufactured expansion devices, install minimum of 2 pipe guides at each side of manufactured pipe expansion device. Locate first guide no more than 4 pipe diameters from expansion device and second guide at 14 pipe diameters from first guide. Install intermediate guides in accordance with guide spacing data recommended by manufacturer or the following table, whichever is more stringent.

MAXIMUM DISTANCE BETWEEN INTERMEDIATE GUIDES (FT)

	Pipe Operating Pressure			
Pipe Size (inches)	0-50 psig	51-100 psig	101-150 psig	151-200 psig
3	21	19	17	16
4	35	29	25	22
6	57	44	37	32
8	66	52	45	40
10	91	69	58	51
12	107	79	66	58
14	115	85	71	62
16	127	94	78	68

C. If anchor is located within 4 pipe diameters from expansion joints, guides need not be installed on anchor side.

3.16 PIPE ANCHORS

A. Install anchors where shown on drawings or in conjunction with expansion joints, loops and swing joints as required to allow proper expansion and contraction of piping without damage to structure, equipment or piping.

B. Do not anchor piping to concrete block walls, wood, or partition walls.

END OF SECTION

SECTION 20 0553 MECHANICAL SYSTEMS IDENTIFICATION

PART 1 - GENERAL

1.1 REFERENCE

A. Work under this Section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.

1.2 SUBMITTALS

A. Product Data: For identification materials and devices

B. Valve Schedules: For each piping system

C. Samples: Of color, lettering style, and graphic representation required for each identification material and device.

PART 2 - PRODUCTS

2.1 IDENTIFYING DEVICES

A. Marker System:
   1. Manufacturers: Brady USA, Marking Services Inc. (MSI), Kolbi, or Seton
   2. Manufacturer's standard, preprinted with color coding, lettering size and length of color field according to ASME A13.1.
   3. Use pressure-sensitive type or "snap-on" type.
   4. "Strap-on" type may be used for piping over 6” size including insulation.

B. Valve Tags:
   1. Minimum 1-1/2” diameter, 0.032” thick, polished brass or 316 stainless steel.

C. Laminated Plastic Nameplates:
   1. *Equipment* nameplates shall be *a minimum of 2*-1/2" x *3/4"*, *1/8*” thick, and have 1/2” high lettering. Face of plastic nameplates shall be black with white letters.
   2. Fasteners shall be self-tapping, stainless steel screws or contact type with permanent adhesive.

D. Underground Warning Tape:
   1. Manufacturers: Brady USA, Marking Services Inc. (MSI), Kolbi, or Seton
   2. Underground warning tape, 5.0 mil overall thickness, 2” width minimum, aluminum foil core where required to be detectable, bonded polyethylene jacket. Brady “Identoline” or equal.
   3. Following services shall be provided with warning tape with colors and trace wire as indicated:
      a. Natural Gas: Yellow with black letters, detectable
      b. Water Lines: Blue with black letters, detectable
      c. Sanitary Sewer: Green with black letters, detectable

d. Storm Sewer: Green with black letters, detectable

PART 3 - EXECUTION

3.1 GENERAL

A. After painting and/or covering is completed, identify equipment and piping as indicated. Locate identification as conspicuously as possible except where such would distract from finished area.

B. Where markers are used in high heat applications or exposed to harsh chemical or acid environments, specifically select marker materials for those applications.

3.2 PIPING SYSTEM IDENTIFICATION

A. Install pipe identification on each system. Place flow directional arrows at each pipe identification location.

B. Identify all piping not less than once every 25 ft, not less than once in each room, at each branch, adjacent to each access door or panel, at each valve and where exposed piping passes through walls and floors. Space every 10 ft in mechanical rooms.

a. All plumbing and mechanical piping, except medical gas piping, shall be labeled, including sprinkler lines according to the following system:

University of Kentucky Standard Abbreviations for Mechanical Piping

Type of Service	Markings
High pressure steam & return (over 76 psig)	H.P.S. & H.P.R.
Medium pressure steam & return (21 psig to 75 psig)	M.P.S. & M.P.R.
Low pressure steam & return (0 psig to 20 psig)	L.P.S.& L.P.R.
Safety Valve Vents	S.V.V.
Domestic cold Water	D.C.W.
Domestic hot Water	D.H.W.
Reheat supply & return	R.S. & R.R.
Chilled water supply & return	C.W.S. & C.W.R.
Medium temperature chilled water supply & return	MTCHS & MTCHR
Cast iron soil & waste vents	W. & V.
Air (steel pipe)	AIR
Air (copper pipe)	AIR

Type of Service	Markings
Vacuum (copper pipe)	VAC
Vacuum (steel pipe)	VAC
Nitrogen	NITROGEN
Nitrous Oxide	N. OXIDE
Roof leaders	R.L.
Soft water	S.W.
Condensate pump discharge	COND. P.D.
Sump Pump Discharge	S. PUMP DIS.
Fire suppression/sprinkler system	FIRE
Glycol solutions	GLYCOL

C. Identify piping with marker system.
   1. For "strap-on" type, ensure marker is fitted snugly to pipe or pipe insulation surface with sufficient straps.

3.3 DUCT SYSTEM IDENTIFICATION

A. Install duct identification on each system. Place flow directional arrows at each duct identification location.

B. Identify all ductwork not less than once every 25 ft, not less than once in each room, adjacent to each access door or panel, and where exposed ductwork passes through walls and floors.

3.4 VALVE AND DAMPER IDENTIFICATION

A. Identify valves with brass tags bearing system identification and valve sequence number in 1/2" black characters. Attach tag to valve body with brass jack chain and "S" hook for brass tag and SS jack chain or SS braided wires with swag sleeves and "S" hook for stainless steel tag. Non-metallic fasteners are not allowed. Valves and dampers located above the ceiling shall also be identified with a tag, similar to Seton-Ply Discs, attached to the ceiling grid under the equipment or to access doors in non-accessible ceilings.

B. Valve numbers shall be prefixed with corresponding piping system identification in 1/4" black letters.

a. Identify valves and dampers with the following abbreviations and tag colors:

Equipment	Abbreviation	Color

Equipment	Abbreviation	Color
Valve	V.	Yellow
Terminal Unit	T.	Red
Variable Volume Unit	V.V.	Red
Chilled Beam	C.B.	Red
Heating Coil	H.C.	Blue
Cabinet Unit Heater	C.H.	Red
Fire Damper	F.D.	Black
Smoke Damper	SM.D.	Black
Combination Fire/Smoke Damper	FS.D.	Black
Volume Damper	VD	Black

C. Furnish typewritten valve schedule indicating valve number, fixtures, equipment or areas served by each numbered valve and incorporate in O&M Manuals.

D. Furnish typewritten framed chart under glass or clear plastic indicating fixtures, equipment or areas served by each numbered valve and mount same as directed by Architect.

3.5 STEAM TRAP IDENTIFICATION

A. Identify steam traps as specified for valve identification.

3.6 EQUIPMENT IDENTIFICATION

A. Identify major equipment, including air handling units, fans, boilers, chillers, heat exchangers, air terminal devices, pumps, water heaters, tanks, compressors, etc.

B. Identify equipment with laminated plastic nameplates.

C. Identify control equipment and panels with laminated plastic nameplates.

D. Nameplate Markings:
   1. Identify model number, size, capacity, electrical characteristics, serial number, along with other items scheduled for equipment on drawings.
   2. Indicate motor horsepower, voltage, phase, cycles, RPM, full load amps, locked motor amps, frame size, manufacturer's name and model number, Service Factor, Power Factor, efficiency, minimum circuit amps, minimum feeder conductor size, disconnect or fuse size, refrigerant, and other pertinent information.

E. Locate motor nameplates for easy reading. Relocate or provide new nameplates on motors if original nameplates are not located for easy reading.

3.7 ACCESS PANEL IDENTIFICATION

A. Identify each service opening or access opening *as indicated above in valve and damper identification.*

B. Furnish typewritten charts with identification and location of all access panels serving equipment and valves and incorporate in O&M Manuals.

3.8 SPRINKLER ZONE CONTROL VALVE IDENTIFICATION

A. Identify sprinkler zone control valves with laminated plastic nameplates. Nameplate shall include name of sprinkler zone served and description of area served.

B. Identify inspector's test valve with laminated plastic nameplate if valve is located remote from sprinkler control valve. Nameplate shall include name of sprinkler zone served.

3.9 UNDERGROUND WARNING TAPE

A. Install detectable warning tape 4" to 6" below grade to allow for accurate above surface detection.

B. Install non-detectable warning tape 6" to 12" below grade.

C. Repair and replace existing underground warning tape where disturbed by excavation.

END OF SECTION

SECTION 20 0573 - MECHANICAL SYSTEMS FIRESTOPPING

PART 1 - GENERAL

1.1 REFERENCE

A. Work under this Section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 - General Requirements.

1.2 SCOPE

A. Work under this Section includes but is not limited to the following:
   1. Penetrations through fire-resistance-rated floor, roof, walls, partitions, and smoke barriers including openings containing pipes, ducts and other penetrating items.
   2. Penetrations through non-fire-resistance-rated floors where vertical service riser penetrates 3 or more floors.

1.3 SYSTEM PERFORMANCE REQUIREMENTS

A. Firestopping systems shall be UL Classified for the application and correspond to those indicated by reference to designations listed by UL Fire Resistance Directory.

B. Firestop materials and methods shall conform to requirements of Local Code Authority Having Jurisdiction.

1.4 SUBMITTALS

A. Manufacturer's specifications and product data for each type of product including composition and limitations, documentation of UL Certification for firestopping systems to be used and manufacturer's installation instructions.

B. Material safety data sheets provided with product delivered to job-site.

C. LEED Submittals:
   1. Product Data for Credit IEQ 4.1: For penetration firestopping sealants and sealant primers, documentation including printed statement of VOC content.
   2. Laboratory Test Reports for Credit IEQ 4: For penetration firestopping sealants and sealant primers, documentation indicating that products comply with testing and product requirements of California Department of Health Services' "Standard practice for Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Champers."

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Firm experienced in installing penetration firestopping similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful performance. Qualifications include having necessary experience, staff, and training to install manufacturer's products per specified requirements.

1.6 DELIVERY, STORAGE AND HANDLING

A. Deliver products to project site in original, unopened containers or packages with intact and legible manufacturers' labels identifying product, type and UL Label where applicable.

B. Store materials to prevent deterioration or damage due to moisture, temperature changes, contaminants or other causes.

C. Handle in accordance with recommended procedures, precautions or remedies described in material safety data sheets as applicable.

1.7 PROJECT CONDITIONS

A. Do not install firestopping when ambient or substrate temperatures are outside limits permitted by firestopping manufacturers or when substrates are wet because of rain, frost, condensation or other causes.

B. Install and cure firestopping per manufacturers' written instructions using natural ventilation or, where this is inadequate, forced-air circulation.

1.8 COORDINATION

A. Coordinate construction of openings and penetrating items to ensure that penetration firestopping is installed according to specified requirements.

B. Coordinate sizing of sleeves, openings, core-drilled holes, or cut openings to accommodate penetration firestopping.

C. Notify Owner's testing agency at least seven (7) days in advance of penetration firestopping installations; confirm dates and times on day preceding each series of installations.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. 3M, Hilti, Tremco, Nelson Firestop Products, Specified Technologies, Inc., or RectorSeal Corp.

B. Pro-set firestop products may be used for specific applications, provided products meet requirements in this Section.

C. HydroFlame water/firestop sleeves may be used for specific applications provided products meet requirements in this Section.

2.2 MATERIALS

A. Use only firestop products that have been UL 1479, ASTM E814 Tested for specific fire-rated construction conditions conforming to construction assembly type, penetrating item type, annular space requirements and fire-rating involved for each separate instance.

B. VOC Content: Penetration firestopping sealants and sealant primers shall comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):
   1. Sealants: 250 g/L
   2. Sealant Primers for Nonporous Substrates: 250 g/L
   3. Sealant Primers for Porous Substrates: 775 g/L

C. Where UL classified systems are indicated, they refer to system numbers in UL's "Fire Resistance Directory" under product Category XHEZ.

D. Materials shall be red in color.

2.3 MIXING

A. For those products requiring mixing before application, comply with through-penetration firestop system manufacturer's written instructions for accurate proportioning of materials, water (if required), type of mixing equipment, selection of mixer speeds, mixing containers, mixing time, and other items or procedures needed to produce products of uniform quality with optimum performance characteristics for application indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements for opening configurations, penetrating items, substrates, and other conditions affecting performance of firestopping.

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

3.2 PREPARATION

A. Clean out openings immediately before installing firestopping to comply with manufacturer's written instructions.

B. Prime substrates where recommended in writing by manufacturer using that manufacturer's recommended products and methods. Confine primers to areas of bond; do not allow spillage and migration onto exposed surfaces.

C. Provide masking and temporary covering to prevent soiling of adjacent surfaces by firestopping materials.

3.3 INSTALLATION

A. Install penetration firestopping to comply with manufacturer's written installation instructions and published drawings for products and applications.

B. Install forming materials and other accessories of types required to support fill materials during application. After installing fill materials and allowing materials to fully cure, remove forming materials and other accessories not indicated as permanent components of firestop systems.

C. Avoid multiple penetrations of common fire barrier opening. Seal each penetration in accordance with manufacturer's UL installation details. When multiple penetrations are unavoidable, seal openings with appropriate UL Classified firestopping systems.

3.4 FIELD QUALITY CONTROL

A. Inspecting Agency: Owner will engage a qualified independent inspecting agency to inspect Through-Penetration Firestop Systems and to prepare test reports.

1. Inspecting agency will state in each report whether inspected Through-Penetration Firestop Systems comply with or deviate from requirements.

B. Provide certification by Installer that all Through-Penetration Firestop Systems have been firestopped in accordance with applicable Building Codes of this State.

C. Proceed with enclosing Through-Penetration Firestop Systems with other construction only after inspection reports are issued.

D. Where deficiencies are found, repair or replace Through-Penetration Firestop Systems so they comply with requirements.

3.5 IDENTIFICATION

A. Identify Through-Penetration Firestop Systems with pressure-sensitive, self-adhesive, preprinted vinyl labels. Attach labels permanently to surfaces adjacent to and within 150mm(6") of firestopping edge so labels will be visible to anyone seeking to remove penetrating items or firestop systems. Use mechanical fasteners or self-adhering type labels with adhesives capable of permanently bonding labels to surfaces on which labels are placed. Include the following information on labels:
   1. The words: "Warning--Through-Penetration Firestop System—Do Not Disturb. Notify Building Management of Any Damage."
   2. Contractor's name, address, and phone number.
   3. Through-Penetration Firestop System designation of applicable testing and inspecting agency and UL Class and rating.
   4. Date of installation.
   5. Manufacturer's name.
   6. Installer's name.

3.6 CLEANING AND PROTECTION

A. Clean surfaces adjacent to sealed holes and joints to be free of excess firestop materials and soiling as Work progresses.

B. Provide final protection and maintain conditions during and after installation that ensure that penetration firestopping is without damage or deterioration at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, immediately cut out and remove damaged or deteriorated penetration firestopping and install new materials to produce systems complying with specified requirements.

END OF SECTION

SECTION 20 0700 MECHANICAL SYSTEMS INSULATION

PART 1 - GENERAL

1.1 RELATED WORK

A. Section 20 0529 - Mechanical Supporting Devices

1.2 REFERENCE

A. Work under this Section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.

1.3 DESCRIPTION

A. Provide insulating materials and accessories as required for mechanical systems as specified below.

B. Insulating products delivered to construction site shall be labeled with manufacturer's name and description of materials.

1.4 DEFINITIONS

A. Concealed areas, where indicated in this Section, shall apply to shafts, furred spaces and space above finished ceilings, inaccessible tunnels and crawl spaces. All other areas, including walk-through tunnels, shall be considered as exposed.

B. Unless otherwise indicated, unit of thermal conductivity is Btu·in/(h·ft^{2}·°F).

C. Interstitial spaces are considered as concealed areas.

1.5 SUBMITTALS

A. Shop Drawings for each piping system for all pipe sizes, each ductwork system, and all equipment including, but not limited to, the following:
   1. Manufacturer's name
   2. Schedule of insulating materials
   3. Insulation material and thickness
   4. Jacket
   5. Adhesives
   6. Fastening methods
   7. Fitting materials
   8. Intended use of each material
   9. Manufacturer's data sheets indicating density, thermal characteristics, temperature ratings
   10. Insulation installation details (manufacturer's installation instruction/details, Contractor's installation details, MICA plates where applicable)
   11. Literature data sheet from sealants and adhesive manufacturers stating VOC compliance with USGBC LEED IEQ 4.1.

12. Literature data sheet from coatings and mastics (including lagging adhesives) manufacturers stating VOC compliance with USGBC LEED IEQ 4.2.
13. All other appropriate data

1.6 DELIVERY, STORAGE AND HANDLING

A. Insulation material shall be delivered to project site in original, unbroken factory packaging labeled with product designation and thickness. Shipment of materials from manufacturer to installation location shall be in weather-tight transportation. Protect insulation materials from moisture and weather during storage and installation. Protect insulation material against long exposure to UV light from sun.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Insulation:
   1. Owens Corning, Johns Manville, Manson, Knauf or CertainTeed similar to product indicated except where product of manufacturers not listed above is specifically identified for special type of insulation.

B. Coatings, Mastics, Sealants and Adhesives:
   1. Foster, Childers, Vimasco, Miracle or Pittsburgh Corning

2.2 MATERIALS

A. Products used for or related to air conditioning and ventilating systems shall conform to NFPA 90A possessing flame spread index of not over 25 and smoke developed index no higher than 50.

B. Unless otherwise indicated, all products, material itself or on composite basis, shall have flame spread index not more than 25 and smoke developed index not more than 50, when tested in accordance with ASTM E-84 or UL723.

C. Pipe insulation which is not located in air plenum may have flame spread rating not over 25 and smoke developed rating no higher than 450 when tested in accordance with UL 723 and ASTM E84.

D. Insulation applied on stainless steel shall meet requirements of ASTM C795 and NRC 1.36.

2.3 INSULATION

A. Insulation materials shall be fire retardant, moisture and mildew resistant, vermin proof, and suitable to receive jackets, adhesives and coatings as indicated.

B. Glass fiber insulation shall be of inert inorganic material, non-corrosive to mechanical surfaces.

C. Insulating cement shall be Quick-Cote by PK Insulation MFG Co. or Ryder GP, with dry density of no more than 38 lb/ft^3 thermal conductivity of 0.96 at 400°F mean temperature, and service temperature to 1200°F.

D. Type F Insulation (Flexible Glass Fiber):

1. Minimum density of 1.50 lb/ft^3 with thermal conductivity of not more than 0.25 at 75°F mean temperature, and suitable for temperatures to 250°F. Owens Corning "All Service Duct Wrap", Johns Manville Microlite EQ Type 150.

E. Type R Insulation (Rigid Glass Fiber):
1. Minimum nominal density of 3 lb/ft^3 with thermal conductivity of not more than 0.23 at 75°F mean temperature.
2. Pipe insulation shall be premolded type in accordance with ASTM C547 Type I, suitable for temperatures to 850°F, Johns Manville Micro-Lok, Owens Corning Fiberglas ASJ/SSL-II or Knauf Earthwool 1000° pipe insulation.
3. Duct and equipment insulation shall be in accordance with ASTM C612, Type IA and IB, suitable for temperatures to 450°F, Johns Manville Spin-Glas Type 814, Owens Corning Type 703.
4. Pipe and tank wrap faced with specified jacket may be used for equipment and round ducts insulation, provided that it meets all insulation characteristics requirements stated above and maintains same R-value as specified.

2.4 JACKETS

A. Jacket puncture resistances shall be based on ASTM D-781 test methods. Vapor barrier permeance ratings shall be based on ASTM E-96 Procedure A.

B. Type D-1 Jacket:
1. Heavy-duty, fire retardant material with glass fiber reinforcing. Jackets shall have neat, white Kraft finish suitable for painting, with beach puncture resistance of 50 units minimum. Vapor barrier shall be adhered to inner surface of jacket. Permeance shall not exceed 0.02 perm. Owens Corning "ASJ", Johns Manville "AP".

C. Type D-2 Jacket:
1. Glass fiber reinforced foil Kraft laminate with permeance not exceeding 0.02 perm and beach puncture resistance 25 units minimum. Owens Corning "FRK", Johns Manville "FSK".

D. Type P-1 Jackets:
1. Heavy-duty, fire retardant material with glass fiber reinforcing and self-sealing lap. Jacket shall have neat, white Kraft finish suitable for painting, with burst strength of 1.5 Joules(50 beach units) minimum and tensile strength 45 lbs/in minimum. Vapor barrier shall be adhered to inner surface of jacket. Permeance shall not exceed 0.02 perm. Owens Corning "ASJ-SSL", Johns Manville "ASJ" and Knauf ASJ+.

2.5 ADHESIVES, MASTIC, COATINGS, SEALANTS, AND REINFORCING MATERIALS

A. Adhesives and sealants shall comply with the South Coast Air Quality Management District (SCAQMD) Rule #1168; VOC limits shall comply with Indoor Environmental Quality Section, Credit IEQ-4.1.

B. Coatings and mastics shall comply with VOC limits set forth by Green Seal BS-11 and comply with the South Coast Air Quality Management District (SCAQMD) Rule #113; VOC limits shall comply with Indoor Environmental Quality Section, Credit IEQ-4.2.

C. Products shall be compatible with surfaces and materials on which they are applied, and shall be suitable for use at operating temperatures of systems to which they are applied.

D. Products shall be fire retardant, moisture resistant and mildew resistant and vermin proof.

E. Vapor Barrier Mastic: Below ambient insulation. Water vapor permeance shall be less than 0.08 perms at 45 mils dry film thickness per ASTM F1249.
   1. Foster 30-33
   2. Childers CP-33
   3. Vimasco 749

F. Weather Barrier Breather Mastic: Above ambient insulation. Permeance shall be greater than 1.0 perms at 1/16” dry film thickness per ASTM E96.
   1. Foster 46-50 Weatherite
   2. Childers CP-10/CP-11 Vi Cryl
   3. Vimasco WC-5

G. Lagging Adhesive/Coatings: Indoors applications used in conjunction with canvas/glass cloth.
   1. Foster 30-36
   2. Childers CP-50 AMV1
   3. Vimasco 713

H. Metal jacketing sealant for aluminum jacketing:
   1. Foster 95-44 Elastolar
   2. Childers CP-76 Chil Byl
   3. Pittsburgh Corning 727

I. Insulation joint sealant for Type P, Type PP, and Type G insulation:
   1. Foster 95-50 Flextra
   2. Childers CP-76 Chil Byl
   3. Pittsburgh Corning CW Sealant

J. Glass fiber fabric reinforcing shall be 10 x 10 mesh similar to Childers Chil Glas #10 or Foster Mast A Fab.

K. Wire mesh reinforcing shall be 22 ga, 1” galvanized.

L. Insulation cement shall be ANSI/ASTM C195, hydraulic setting mineral wool.

M. Finishing cement shall be ASTM C449.

N. Butt joint and longitudinal joint adhesive for Type A insulation shall be Armstrong 520, Rubatex 373, Childers CP-82 or Foster 85-75.

O. Weather-resistant protective finish for Type A insulation shall be equal to Armstrong WB Armaflex finish or Foster 30-64 elastomeric coating.

2.6 METAL BANDS AND WIRES

A. Aluminum bands shall be 0.5" x 0.020” up to 48” diameter and 0.75" x 0.020” over 48” diameter.

B. Stainless steel bands shall be 0.5" x 0.015” or 0.75" x 0.015”.

C. Stainless steel wires shall be 16 ga.

2.7 INSULATION FASTENERS

A. Insulation fasteners shall be cup head weld pins, galvanized low carbon steel, minimum 12 ga (0.105") pins.

B. Washer edge shall be beveled.

C. Fasteners shall be stainless steel for stainless steel ductwork application.

D. Insulation fasteners using adhesive are not allowed.

2.8 ACOUSTICAL BARRIER MATERIALS

A. Acoustical barrier material shall be similar to Kinetics Model KNM-100ALQ. Barrier material shall have acoustic ratings of STC-28, 1.0 lb/ft^2 nominal density, flame spread index less than 25, smoke developed index less than 50, and minimum continuous operating range from 40°F to 220°F.

B. Minimum sound transmission loss at each octave band shall be as follows:

Sound Transmission Loss (dB)					
Octave Band Center Frequency (Hz)					
125	250	500	1000	2000	4000
13	16	24	33	43	49

PART 3 - EXECUTION

3.1 APPLICATION

A. Provide insulation and jackets as indicated in the following schedule. The schedule applies to both exposed and concealed applications unless noted otherwise:

Piping System							
			Insulation Thickness According to Pipe Size				
Service	Jacket Type	Insulation Type	3/4" and less	1" - 1-1/4"	1-1/2" - 3"	4" - 6"	8" and Larger
Heating Hot Water (105-140°F)	P-1	R	1"	1"	1-1/2"	~~1-1/2"~~ 2"	~~1-1/2"~~ 2"
Medium Temperature Chilled Water	P-1	R	1"	1"	1"	1"	1-1/2"
Cooling Coil Condensate Drain	P-1	R	1"	1"	1"	1"	1"

Type A 3/4" thick insulation may be used.

Low Pressure Steam and Condensate (201-250°F)	P-1	R	2-1/2"	2-1/2"	2-1/2"	3"	3"
Medium Pressure Steam and Condensate (251-350°F)	P-1	R	3"	4"	4-1/2"	4-1/2"	4-1/2"

	Ductwork/Equipment System		
Service	Jacket Type	Insulation Type	Insulation Thickness
Supply Ducts Exposed	D-1	R	1-1/2"
Supply Ducts Concealed	D-2	F	2"
Exhaust or Relief Ducts from Control or BD Damper to Outside Wall or Roof	D-1	R	1-1/2"
Return and Relief Ducts in Equipment Rooms	D-1	R	1-1/2"

B. Exposed piping in any room and all piping in boiler or mechanical rooms shall have an 8 ounce canvas jacket applied over the fiberglass factory ASJ/SSL jacketing to further protect the insulation from abuse. This jacketing must be properly applied with lagging adhesive, such that the outer surface is smooth and free of wrinkles. The canvas jacketing in all mechanical areas is to be prepared for painting, and then painted according to the University of Kentucky standard piping color coding. All chilled water piping insulation shall be completely sealed so that a perfect vapor barrier is achieved.

3.2 INSTALLATION - GENERAL

A. All insulation installation methods shall be performed in accordance with the latest edition of National Commercial and Industrial Insulation Standards published by MICA (Midwest Insulation Contractors Association) and manufacturer's installation instructions, except as modified in this Section of specifications.

B. Install products with good workmanship, with smooth and even surfaces. Use full-length factory-furnished material where possible. Do not use scrap pieces.

C. Apply insulation only on clean, dry surfaces, after all rust and scale have been removed and testing of systems has been completed. Do not insulate any section of system that must be pressure tested until after it has been successfully tested. Any removal and reinstallation to correct system defects prior to end of guarantee period shall be accomplished at no expense to Owner.

D. Install insulating materials with necessary joints and terminations, to permit easy access and removal of equipment sections where inspection, service or repair is required, and to allow for expansion.

E. Where possible longitudinal joints in jackets shall face toward wall or ceiling.

F. Apply insulation to each pipe or duct individually. Common insulation applied to adjacent pipes or ducts will not be accepted.

G. Unless otherwise indicated, pipe and duct insulation shall be continuous through walls and floors.

H. Where multiple layers of insulation are used, stagger and secure each layer with metal bands.

I. Where penetrations occur through fire-rated walls, partitions, or floors, provide fire seal as specified in Section 20 0000 - General Mechanical Requirements and Section 20 0573 - Mechanical Systems Firestopping.

J. Insulate water piping within casework up to penetration of casework pipe chase at fixture stop. Insulate water piping within walls up to pipe penetration through the wall at fixture stop when serving wall-mounted fixtures. Termination of insulation shall be in neat and workman like manner with insulation jacket cap.

K. Insulate the following systems for complete vapor barrier protection:
   1. Chilled Water
   2. Refrigerant
   3. Cooling coil condensate drain
   4. Storm
   5. Clearwater Waste
   6. Cold Water
   7. All insulated ductwork
   8. All equipment with surface temperature below 65°F

L. Apply Type A insulation for insulation and jackets requiring vapor barrier protection where specified insulations are cut for mounting sensors, control devices, parts of valves, devices or components which extend out from specified insulation to prevent condensation.

3.3 GLASS FIBER FABRIC COVERING (TYPE E-1 JACKET)

A. Glass fiber fabric shall be fitted without wrinkles.

B. Glass fiber fabric shall be sized immediately upon application with lagging adhesive and shall be capable of drying within 6 h.

C. Apply adhesive and coating in accordance with manufacturer's recommendations.

D. All seams shall overlap not less than 2".

3.4 PIPING, VALVE AND FITTING INSULATION

A. Apply insulation to pipe, unions, flanges, fittings, valves and piping specialties with butt joints and longitudinal seams closed tightly. Valve insulation shall cover entire valve body including bonnets and packing nuts.

B. Laps on factory-applied jackets shall be 2" minimum width firmly cemented with lap adhesive, or shall be pressure sealing type lap.

C. Cover joints with factory furnished tape (3" minimum width) to match jacket. Cement firmly with lap adhesive. On systems requiring a vapor barrier (ASJ), vaporseal all longitudinal and butt joints ASJ/Saran seams with 4" wide coat of vapor barrier mastic.

D. Where staples are used, they shall be on 6" maximum centers. When used for systems requiring vapor barrier, cover lap and staples with finish coat of vapor barrier mastic.

E. For finishing of insulated pipe fittings and valves where surface temperature of insulation is not higher than 125°F, one piece PVC fitting covers, minimum thickness of 20 mil, may be used. Fitting covers located in mechanical rooms within 8 ft above floor shall be 30 mil thickness. Johns Manville Zeston 2000 PVC, PROTO Fitting Covers, or similar by other manufacturers listed. Where fitting and valve insulation requires vapor barrier, seal joints of PVC covers with vapor barrier adhesives. Insulation type, R-value and density of insulation used at fittings shall match those of adjacent piping. Install insulation at pipe fittings and valves completely prior to applying PVC covers.

F. Stove pipe style insulation on elbows (Detail A on Plate 2-200 of MICA 7th Edition) is not allowed. It may be used for closed cell elastomeric insulation.

G. Where terminations of pipe insulation are required, insulation shall have tapered ends, built up and finished as specified for fittings.

H. For pipes 1-1/2" and smaller, install specified pipe insulation and jacket continuous through hanger or support locations. Install insulation protection shields to protect insulation from compressing.

I. For pipes 2" and larger, where manufactured pre-insulated pipe supports are used at hanger or support locations, extend insulation to insulated pipe supports. Where vapor barrier is required, this Contractor shall be responsible for continuity of vapor barrier at insulated pipe supports. Use 3" wide vapor barrier tape on hot and cold systems at pipe supports.

J. For pre-insulated pipe supports and insulation protection shields, refer to Section 20 0529 - Mechanical Supporting Devices.

K. For Contractor-fabricated anchors, secure insulation directly to pipe surface and extend insulation up anchor for distance of 4 times insulation thickness. For pre-insulated anchors, cover entire surface of anchors with Type A insulation. Where applicable, take special care to assure vapor seal at anchor.

L. Where mechanical grooved pipe connections are used in piping system, insulate couplings as specified for pipe.

M. Piping, fittings and valves not to be insulated:
   1. Heating hot water piping inside fin tube radiation enclosures
   2. Control valves and balancing valves for heating terminal devices
   3. Valves furnished with removable insulation/jacket
   4. Steam system traps

3.5 EQUIPMENT INSULATION

A. For equipment requiring Type H, Type M or Type C insulation such as breechings, stacks, exhaust pipes and mufflers, apply insulation to equipment and secure with stainless steel bands with tightly butted joints as recommended by manufacturer. Where multiple layers of insulation are required, stagger and secure each layer with stainless steel bands.

B. Install removable insulation where access is required for cleaning, repair and inspection, including pump heads and strainers. Construct removable insulation with Type A insulation for cold equipment and Type R insulation with V-1 jacket for hot equipment. Do not apply bonding adhesive to equipment surface.

C. Provide removable insulating blankets on expansion joints.

D. Do not insulate over equipment nameplates or ASME stamps. Bevel and seal insulation at these locations.

E. Water chiller insulation shall include insulation of evaporator shell, water boxes and other miscellaneous piping and/or equipment as directed by equipment supplier. Provide removable insulation with Type A insulation at chiller water boxes. Verify that chillers are fully charged with refrigerant before insulating.

F. Equipment not to be insulated:
   1. Equipment furnished with factory insulation.

3.6 DUCTWORK AND COMPONENTS

A. Apply duct insulation evenly over duct surface. Unless otherwise indicated, insulation and jacket shall run continuously between duct and duct supports. Maintain insulation thickness specified over duct reinforcing members.

B. For support points of rectangular or oval ducts supported by trapeze hangers, place weight-supporting insulation at bottom of duct over trapeze. Weight supporting insulation inserts shall be minimum 6" long with same thickness as insulation specified and shall be Type G, H or P insulation. Size inserts based on compression strength and weight being supported.

C. For support points of round ducts smaller than 16" diameter, weight-supporting insulation is not required for either rigid or flexible glass fiber insulation.

D. For support points of round ducts 16" diameter and larger, place weight-supporting insulation between duct and strap or trapeze. Weight-supporting insulation shall be minimum 6" long with same thickness as insulation specified and shall be Type G, H or P insulation. Size inserts based on compression strength and weight being supported.

E. Secure flexible glass fiber insulation (Type F) to underside of horizontal rectangular or oval ductwork 24" in width or greater and on vertical sides of horizontal and vertical ductwork with weld pin not over 18" on center and within 3" of butt joint or edge.

F. Secure rigid glass fiber insulation (Type R or Type RR) to all sides of horizontal and vertical rectangular or oval ductwork with weld pin. Install pins as required to secure, but not less than 12" on center for underside and sides of ducts and 24" on center for top of ducts, and within 3" of butt joint or edge.

G. Fastening insulation anchors to ductwork with adhesives is not allowed. Where weld pin fasteners are used, install them without damage to interior galvanized surface. Where weld pin fasteners cannot be used, use other type of fasteners such as metal bands.

H. Where insulation is required for ductwork, provide insulation over entire ductwork system, including system components such as filters, mixing air chambers, sound attenuators, air measuring stations, reheat coils, etc. For fire dampers, smoke dampers and combination F/S dampers in ductwork requiring insulation, install insulation and jacket to wall and apply vapor barrier sealant to prevent condensation.

I. Provide insulation over supply air diffusers, grilles and unlined boots after termination point of flexible ducts or rigid duct insulation to prevent from sweating.

J. Where vapor barrier jackets are specified, pins and staples if used shall be jacketed over with matching material using 4" tape. Where staples are used for systems requiring vapor barrier, cover lap and staples with finish coat of vapor barrier mastic. Vaporseal insulation seams, punctures, and tears with two 4” wide coats of vapor barrier mastic.

K. Insulation without factory jacket shall be cut and mitered to suit surface. Build up voids, seams and joints with insulating cement, cover with glass fabric as specified herein and finish to smooth surface.

L. For other than factory-applied vapor barrier jackets, apply 2 coats of vapor barrier mastic with glass fiber reinforcing fabric, after application of insulating cement. For surfaces not requiring vapor barrier jackets, apply 2 coats of weatherproof breather mastic with glass fiber reinforcing fabric after application of insulation cement. Apply coating in accordance with manufacturer's recommended procedure.

M. D-1 jackets:
   1. Butt together joints and seams firmly, cover with glass fiber fabric 4" minimum width.

N. D-2 jackets:
   1. Butt together joints and seams firmly and cover with 4" wide FSK tape.

O. D-3 jackets:
   1. Install jacket in strict accordance with manufacturer's installation requirements.
   2. For rectangular ducts, overlap bottom half jacket and top half jacket at each side of duct at least 4" (bottom inside top outside at overlap).
   3. For round ducts, wrap duct insulation continuously with spiral shaped overlapping. Overlap at least 4".
   4. Use welded stickpins for Type D-3 jacketing wider than 24" in width alongside and bottom surfaces of ducts. Retainers of stick pins shall be covered with Type D-3 patch, minimum 4" square, once retainer cup is in place on stick pin.

P. Acoustical Barrier Materials:
   1. Provide 2" thick Type R insulation with Type D-1 jacket as inner layer. Over insulation install acoustical barrier materials as outer layer in accordance with manufacturer’s installation instruction.
   2. For ductwork specified with Type F insulation, replace it with insulation specified above.
   3. Refer to plans for ductwork requiring acoustical barrier materials.

Q. Ductwork not to be insulated:
   1. Internally lined ductwork
   2. Ductwork components with factory installed insulation

3.7 PROTECTIVE INSULATION SHIELD (A-1 JACKET) FOR PIPE JACKETS EXTERIOR TO BUILDING

A. Unless otherwise indicated, install shields (A-1 jacket) around insulated pipe and fittings exterior to building. Seal water and vapor tight at terminations.

B. Longitudinal overlap shall be at least 2" wide with vapor barrier sealant.

C. Secure jacketing with 3/4" wide 0.015" stainless steel or 3/4" wide 0.020" aluminum bands and wing seals on maximum 18" centers.

3.8 TYPE G INSULATION (CELLULAR GLASS)

A. Install cellular glass insulation system in strict accordance with manufacturer's installation instructions.

B. Chilled Water Piping (Interior):
   1. Butter joints of insulation with Pittseal 727 or 444N Sealant. Apply insulation to pipe and fittings with joints tightly fitted and sealed full depth with joint sealant. Secure each length of insulation with 1" wide filament tape and stainless steel wire over tape. Apply insulation with joints fitted to eliminate voids. Eliminate voids by refitting or replacing insulation. Do not fill voids with joint sealer.
   2. Finish with specified jacket, joints and laps sealed with fire rated adhesive. Finish elbows and fittings with white PC-79 polyester fabric coated with Pittcote 404.

3.9 TYPE P INSULATION (POLYISOCYANURATE)

A. Install Type P insulation with specified insulation jacket in accordance with manufacturer’s installation recommendations. Insulation shall be tightly butted and free of voids and gaps at joints. Use 3" wide tape at butt joints with minimum 1.25 times circumference wrapping. Apply insulation joint sealant in longitudinal and butt joints.

B. Install pre-fabricated tight fitting insulation pieces on fittings, elbows, tees and valves.

C. Insulation at fittings and valves shall be the same thickness as on pipe section.

D. Replace Type P insulation and jacket with Type R insulation of same thickness with Type P-1 jacket at penetration of fire rated walls and floor slabs where fire stopping system is required.

3.10 TYPE S INSULATION (POLYSTYRENE)

A. Pipe:
   1. Use sectional insulation (semi-circular form) for pipe sizes 10" and smaller. Use segmental or sectional insulation for pipe sizes above 10".
   2. Plain sectional insulation shall be applied so that end joints are broken by making one-half of first section 18" long and leaving other half 36" in length. Longitudinal joints shall be on top and bottom of pipe. Apply insulation with sealer such as Foster 30-45 Foam-seal or Childers CP-70 Chil Joint on joints of single layer and outer layer insulation with band placed

approximately 3" or 4-1/2" (see band schedule) back from end joints. Do not cement insulation to pipe. Omit joint sealer from inner layer of double layer insulation.

3. Plain insulation lagging (blocks) for segmental insulation may be factory fabricated or beveled lagging assembled on job. Lags shall fit pipe snugly and maximum width of each lag shall be such as to leave not more than 1/8" void between pipe and joints of segments. Joints shall be broken by, starting with alternating 18" and 36" lags. Apply sealer and bands same as specified for plain sectional insulation.
4. Apply pipe insulation in double layer construction with joints staggered (2 layers at 1" thick each).

B. Fittings, Valves and Flanges:
   1. Insulation at fittings shall not be of less thickness than insulation on adjacent piping. Fitting insulation (covers) shall be held together and applied with sealer. Insulation on welded fittings shall fit snugly to fitting contour and shall be applied in same manner and with same materials as specified for pipe.
   2. Apply fitting insulation with sealer on joints and band insulation in place using not fewer than 2 bands on threaded fittings and 4 bands on flanged fitting.
   3. Insulate threaded fittings before straight pipe is covered. Insulate flanged fittings after straight pipe is covered.

C. Band Material:
   1. Secure single layer or outer layer insulation with stainless steel bands, 6" spacing for insulated outside diameter under 12" and 9" spacing for 12" and over.
   2. Secure inner layer insulation with stainless steel bands 9" spacing.
   3. Tighten bands with mechanical tightening tool and secure with 304 stainless steel wing type seals.

D. Vapor Barrier and Jacket:
   1. Finish plain pipe insulation, fittings, valves and flanges with vapor barrier mastic.
   2. After thoroughly dry, apply service jacket (Type P-1) and insulation shield jacket (Type A-1).

END OF SECTION

SECTION 210100 - FIRE PROTECTION SYSTEM

1. GENERAL

A. The General Conditions, Instructions to Bidders, Section 200100, 1. A, and other Contract Documents are a part of this specification and shall be binding on the Contractor. It shall be the Contractor's responsibility to apprise himself of all information pertinent to his work prior to submitting his proposal. No adjustments will be made in this Contract which is a result of failure to comply with this requirement.

B. No Contractor, other than those regularly engaged in the installation of approved and franchised automatic sprinkler systems, will be considered or approved for the work under this section of the specifications. Bidders must have had not less than five (5) years experience in the fabrication and erection of such systems: wet, dry and rack storage types, and shall have completed installations similar and equivalent in scope to this system under approval by one or more of the recognized Underwriting Associations in the Insurance Field.

C. Before submitting bid, examine all Mechanical, Architectural, and Structural Drawings, visit the site and become acquainted with all conditions that may, in any way whatsoever, affect the execution of this work. Also, the Contractor shall coordinate with the rating bureau and insuring agency to verify adequacy of water supply for the proposed sprinkler system extension.

D. The Contractor shall take his own measurements and be responsible for exact size and location of all openings required for installation of this work. Figured dimensions where indicated are reasonably accurate and should govern in setting out work. Detailed method of installation is not indicated. Where variations exist between described work and approved practice, the Engineer shall be consulted for directive.

E. It is the intent of the Plans and Specifications to provide a general layout only and locate major equipment, piping, etc. Variations in head locations, pipe routing, etc., may be anticipated by the Contractor and shall be coordinated with all other trades and indicated on the drawings and descriptive literature called for hereinafter. It shall be the express responsibility of the Contractor to provide all required materials and equipment and perform all work required to install a complete and approved installation.

F. All materials and methods shall be in accordance with applicable codes, regulations and/or ordinances and meet approval of local inspection authority and the State Fire Marshal. Also, all work shall comply with the latest editions of the National Board of Fire Underwriters, National Fire Protection Association, OSHA Regulations, the National Building Code, the Life Safety Code, IMC Code and the Southern Building Code (Where applicable). The local insuring agency shall review plans prepared and submitted by the Contractor but shall have no authority to make changes once work has begun.

G. All work performed under this section shall be accomplished in close harmony with all other trades. All work not so coordinated shall be removed and reinstalled at the expense of the Contractor.

H. The Contractor shall submit a proposed layout to the Engineer prior to submittal to the Fire Marshal's Office.

I. An independent third party Commissioning Agent will document completion of the Mechanical, Fire Suppression, HVAC, Electrical, Communications and Electronic Safety and Security Systems for the project. The Construction Manager and Division Contractors are members of the Commissioning Team and will facilitate completion of the Commissioning Process. Refer to section 019113 “Building Systems Commissioning” for the project Commissioning requirements and roles and responsibilities of each member of the Commissioning Team.

2. SCOPE OF WORK

A. Furnish all material, labor, tools, equipment and supervision required for installation of a complete fire protection system as indicated on the project drawings. Include all necessary piping, sprinkler heads, valves, drains, etc.

B. Provide dry pipe systems or freeze proof heads as required to provide continuous coverage without freezing.

3. WATER SUPPLIES AND SYSTEM LAYOUT CRITERIA

A. Where flow and pressure data are available, they are indicated on the project drawings. **The Contractor shall independently verify all such information and notify the engineer of any discrepancies discovered prior to beginning the work.** Where no flow information is indicted on the project drawings, the Contractor shall obtain it and indicate it on the shop drawing submittal. Piping systems shall be hydraulically sized based on the most conservative flow information obtained. No adjustments in the contract amount will be allowed for failure of the Contractor to obtain adequate flow information.

4. DRAWINGS AND DESCRIPTIVE LITERATURE

A. The Contractor shall prepare and submit to the Engineers, digital copies of detailed drawings indicating his proposed Automatic Sprinkler System. These drawings shall indicate minimally the following components when they are used in the system.

(1) Name and address of Owner, Architect and Engineers.
(2) Make and type of sprinkler heads (Catalog cuts).
(3) Make and type of flanged check valve (Catalog cuts).
(4) Make and type of flanged gate valve (Catalog cuts).
(5) Make and type of automatic drains (Catalog cuts).
(6) Make and type of pipe hangers (1 catalog cut of each make and/or type).
(7) Make, type and electrical characteristics of:
    a. The main gate valve supervisory switch*.
    b. The flow switch*.
(8) Make and type of indicating butterfly valve.

Note: All layouts and drawings are to be closely coordinated with the work of all other trades. The Engineers will, upon request, provide a complete set of Architectural, Structural, Mechanical and Electrical Plans and Specifications to aid the Contractor in this work.

*SPECIAL NOTE: 1) The items (indicated by asterisk) must be clearly coordinated with the Fire Alarm System supplier.

(9) On a set of drawings to the same scale as the drawings accompanying these specifications, indicate:

a. Each head location coordinated with lights, diffusers and other ceiling mounted device.
b. Location of all risers, mains, runout lines, etc.
c. Size of all risers, mains, runout lines, etc.
d. Location and type of pipe hangers.
e. All other information required by the Kentucky Department of Housing, Buildings and Construction.

The Contractor shall submit these drawings to the Engineer through the General Contractor/Construction Manager and Architect where applicable. The Contractor shall submit reviewed drawings to the Kentucky Department of Housing, Buildings and Construction for their review and approval. No work shall be done until drawings are approved by the Kentucky Department of HBC.

5. SYSTEM DRAINAGE

A. The entire Sprinkler System shall be installed so as to allow 100% drainage.

B. All sprinkler branch piping shall be installed so as to drain back to the main riser.

C. Where sprinkler piping is trapped, an approved auxiliary draw-off shall be provided and neatly installed.

D. All draw-offs shall have a metal tag labeled "Sprinkler Drain."

6. INSPECTIONS AND TESTS

A. Furnish all labor, equipment and conduct all required tests in the presence of the Owner and Engineer or designated representative.

B. All piping and devices comprising the fire protection system shall be tested under hydrostatic pressure of not less than 200 PSI and maintained for not less than two (2) hours.

C. Upon completion of his work, the Contractor shall submit a written and signed certificate to the Engineers indicating that he performed the above prescribed tests and rectified all malfunctions arising there from.

7. PERMITS

A. The Contractor shall obtain and pay for all necessary state, municipal, county, city and other permits and fees and pay all State taxes which are applicable.

8. GUARANTEE

A. All workmanship, equipment and material shall be guaranteed in writing against defects from any cause, other than misuse, for a period of one year after date of final acceptance.

9. ACCEPTANCE CERTIFICATE

A. Upon completion, the Contractor shall submit to the Engineers, a properly filled out "Sprinkler Contractor's Certificate Covering Materials and Tests." (4 copies).

10. CLEANING

A. Upon completion of this work all debris, material, and equipment shall be removed from the building and premises; all piping shall be cleaned ready for finish painting. Note: Do not remove rust inhibitive primer specified hereinafter.

11. PAINTING

A. All concealed piping and piping in storage rooms, mechanical rooms and utility rooms shall be painted red enamel. All other exposed piping (outside the stairwells) shall be painted to match the ceiling, and red enamel bands 102mm (4” in.) wide shall be painted at 3,000 mm (10ft.) intervals. In aesthetically sensitive areas, exposed sprinkler piping may be painted to match ceiling without red enamel bands if approved DFM.

12. EQUIPMENT AND MATERIALS

A. Signs

Appropriate code approved and required signs shall be installed on all control valves, drains, inspector's test, etc., indicating the function, installation, etc. Signs shall be neatly affixed with rust inhibitive screws, rivets or where hung from piping; with stainless steel No. 14 AWG wire.

B. Finish

All exposed materials such as valves, sprinkler heads, etc., shall be brass or chrome-plated brass.

C. Pipe & Fittings

(1) Nipples and fittings shall be of same material, composition, and weight classification as pipe in which installed.

(2) Up to 2" (Interior) Schedule 40 ASTM A-53 black steel; 125# cast iron screwed fittings or Schedule 10, ASTM A-135 black steel with victaulic or similar type approved fittings.

(3) 2-1/2" and larger (Interior) Schedule 40 black steel with flanged, welded or victaulic (or similar) type approved fittings or Schedule 10, ASTM A-135 black steel with victaulic or similar type approved fittings.

(4) Dry Pipe System Piping: Same as standard system except Schedule 10 piping is not acceptable.

(5) Piping shall be sized such that no pipe velocity exceeds 32 ft/sec at any point.

D. Clamps and Anchors

(1) Furnish and install approved clamps, as required, at all (45 degree) 1/8 bends, (90 degree) 1/4 bends and flange and spigot pieces to the straight pipe to insure permanent anchorage of all fire lines. Clamps, clamp rods, nuts, washers, and glands shall be coated with a quick drying coal tar bituminous paint after installation.

E. Hangers

(1) All piping shall be adequately and permanently supported in an approved manner on approved hangers (Submit with drawings).

F. Sleeves and Escutcheon Plates

(1) Furnish and install sleeves for pipes where piping penetrates masonry walls; exterior wall sleeves to be watertight. Fire and smoke stop all penetrations through fire and smoke walls and coordinate with General Contractor for locations.

(2) Furnish and install cast brass chrome plated split ring type escutcheons where piping penetrates walls, ceilings and floors, whether in finished areas or not.

G. Electric Wiring

(1) All electric wiring for the system which may be required shall be installed in accordance with the National Board of Fire Underwriters, and National Electric Code. The cost of this electric wiring shall be included under this Contract. All electrical wiring and conduit installed in fire protection pits shall be sealed watertight.

H. Sprinkler Heads

Gem, Grinnell, Star, Viking, Reliable, Central or approved equivalent as follows:

(1) Where piping is exposed: "Standard up right."

(2) Where piping is concealed above finished ceilings, provide two pieces, semi recessed, white plated sprinkler heads with removable escutcheon.

(3) In areas where ceilings are constructed of wood slats, the heads shall be semi-recessed. Custom color to be selected by the architect. The installation elevation and fit in the wood slat ceilings shall be demonstrated on a sample piece of ceiling prior to actual installation for coordination and approval.

(4) Where ceilings are open to above such as the Lecture Halls or atrium monumental stairwell, sprinkler heads shall be provided in the ceiling and upright heads located above the ceiling.

(5) Install sprinkler head guards where heads are subject to physical abuse. Heads located below seven (7) feet above floor, etc.

(6) Sprinkler head degree ratings shall be determined by the area serviced in accord with current Codes and Standard Practices. Indicate degree ratings on submitted Shop Drawings.

(7) The Contractor shall submit to the Engineer for inspection, one (1) sample of each type of sprinkler head, proposed to be used on the project.

(8) Where heads are installed in a tile ceiling, they shall be installed in the middle of the tiles, at half or quarter points along the length of the tiles. Install sprinkler heads at quarter points of center scoured 2' X 4' ceiling tiles.

(9) Provide high temperature heads in sterilizer rooms due to high pressure steam.

(10) Flexible hose sprinkler heads are not allowed.

I. Flow Indicator Switches

(1) Furnish and install flow indicator switches as required by NFPA 13. All flow indicator switches shall be UL approved. Coordinate with Fire Alarm System supplier/installer. Provide a set of dry contacts on each flow switch for interface to the Control System if this control point is specified in the Controls Section.

J. Tamper Switches for Water Shut-Off Valves

(1) Furnish and install tamper switches where required by NFPA 13. All tamper switches shall be UL approved. Coordinate with fire alarm system supplier/installer. All tamper switches located in fire protection pits shall be waterproof, capable of operating beneath water similar to Potter PTS Series and be NFPA approved.

END OF SECTION

SECTION 220010 - GENERAL PROVISIONS - PLUMBING

PART 1 - GENERAL

1.1. The Advertisement for Bids, Instructions to Bidders, Bidding Requirements, General, Special and Supplementary Conditions, and all other contract documents shall apply to the Contractor's work as well as to each of his Sub-Contractor's work. All manufacturers, suppliers, fabricators, contractors, etc. submitting proposals to any part if for work, services, materials or equipment to be used on or applied to this project are hereby directed to familiarize themselves with all documents pertinent to this Contract. In case of conflict between these General Provisions and the General and/or Special Conditions, the affected Contractor shall contact the Engineer for clarification and final determination.

1.2. Each Proposer shall also be governed by any unit prices and Addenda insofar as they may affect his part of the work or services.

1.3. The work included in this division consists of the furnishing of all labor, equipment, transportation, supplies, material, appurtenances and services necessary for the satisfactory installation of the complete and operating Plumbing System(s) indicated or specified in the Contract Documents.

1.4. Any materials, labor, equipment or services not mentioned specifically herein which may be necessary to complete or perfect any part of the Mechanical Systems in a substantial manner, in compliance with the requirements stated, implied or intended in the drawings and/or specifications, shall be included as part of this Contract.

1.5. It is not the intent of this section of the specifications to make any Contractor, other than the General Contractor, responsible to the Owner, Architect and Engineer. All transactions such as submittal of shop drawings, claims for extra costs, requests for equipment or materials substitution, shall be routed through the General Contractor to the Architect (if applicable), then to the Engineer. Also, this section of the specifications shall not be construed as an attempt to arbitrarily assign responsibility of work, material, equipment or services to a particular trade or Contractor. Unless stated otherwise, the subdivision and assignment of work under the various sections shall be optional.

1.6. It is the intent of this Contract to deliver to the Owners a "like new" project once work is complete. Although plans and specifications are complete to the extent possible, it shall be the responsibility of the Contractors involved to remove and/or relocate or re-attach any existing or new systems which interfere with new equipment or materials required for the complete installation without additional cost to the Owner.

1.7. In general, and to the extent possible, all work shall be accomplished without interruption of existing facilities operations. The Contractor shall advise the Owners at least two weeks prior to the interruption of any services or utilities. The Owners shall be advised of the exact time that interruption will occur and the length of time the interruption will last. Failure to comply with this requirement may result in complete work stoppage by the Contractors involved until a complete schedule of interruptions can be developed.

1.8. Definitions and Abbreviations

A. Contractor - Any Contractor whether proposing or working independently or under the supervision of a General Contractor and/or Construction Manager and who installs any type of

mechanical work (Controls, Plumbing, Sprinkler, Gas Systems, etc.) or, the General Contractor.

B. Engineer - The Consulting Mechanical-Electrical Engineers either consulting to the Owners, Architect, other Engineers, etc. In this case: CMTA, Inc., Consulting Engineers.

C. Architect - The Architect of Record for the project.

D. Furnish - Deliver to the site in good condition and turn over to the Contractor who is to install.

E. Provide - Furnish and install complete, tested and ready for operation.

F. Install - Receive and place in satisfactory operation.

G. Indicated - Listed in the Specifications, shown on the Drawings or Addenda thereto.

H. Typical - Where indicated repeat this work, method or means each time the same or similar condition occurs whether indicated or not.

I. Contract Documents - All documents pertinent to the quality and quantity of work to be performed on this project. Includes, but not limited to: Plans, Specifications, Instructions to Bidders, General and Special Conditions, Addenda, Alternates, Lists of Materials, Lists of Sub-Contractors, Unit Prices, Shop Drawings, Field Orders, Change Orders, Cost Breakdowns, Schedules of Value, Periodical Payment Requests, Construction Contract with Owners, etc.

J. Proposer - Any person, agency or entity submitting a proposal to any person, agency or entity for any part of the work required under this contract.

K. OSHA - Office of Safety and Health Administration.

L. KBC - Kentucky Building Code.

M. The Project - All of the work required under this Contract.

N. NEC - National Electrical Code.

O. NFPA - National Fire Protection Association.

P. ASME - American Society of Mechanical Engineers.

Q. AGA - American Gas Association.

R. ANSI - American National Standards Institute.

S. NEMA - National Electrical Manufacturers Association.

T. UL - Underwriters Laboratories.

U. ADA - Americans with Disabilities Act.

V. IMC - International Mechanical Code.

W. IFGC - International Fuel Gas Code.

X. NIH – National Institutes of Health

1.9. Required Notices:

A. Ten days prior to the submission of a proposal, each proposer shall give written notice to the Engineer of any materials or apparatus believed inadequate or unsuitable; in violation of laws, ordinances, rules or regulations of authorities having jurisdiction; and any necessary items of work omitted. In the absence of such written notice, Proposers signify that they have included the cost of all required items in the proposal and that the Proposer will be responsible for the safe and satisfactory operation of the entire system.

1.10. An independent third party Commissioning Agent will document completion of the Mechanical, Fire Suppression, HVAC, Electrical, Communications and Electronic Safety and Security Systems for the project. The Construction Manager and Division Contractors are members of the Commissioning Team and will facilitate completion of the Commissioning Process. Refer to section 019113 “Building Systems Commissioning” for the project Commissioning requirements and roles and responsibilities of each member of the Commissioning Team.

PART 2 - INTENT

2.1. It is the intention of the Contract Documents to call for finished work, tested and ready for operation.

2.2. Details not usually shown or specified, but necessary for the proper installation and operation of systems, equipment, materials, etc., shall be included in the work, the same as if herein specified or indicated.

PART 3 - DRAWINGS AND SPECIFICATIONS

3.1. The drawings are diagrammatic only and indicate the general arrangement of the systems and are to be followed. If deviations from the layouts are necessitated by field conditions, detailed layouts of the proposed departures shall be submitted to the Engineer for approval before proceeding with the work. The drawings are not intended to show every item which may be necessary to complete the systems. All proposers shall anticipate that additional items may be required and submit their bid accordingly.

3.2. The drawings and specifications are intended to supplement each other. No Proposer shall take advantage of conflict between them, or between parts of either. Should this condition exist, the Proposer shall request a clarification not less than twelve days prior to the submission of the proposal so that the condition may be clarified by Addendum. In the event that such a condition arises after work is started, the interpretation of the Engineer shall be final.

3.3. The drawings and specifications shall be considered to be cooperative and anything appearing in the specifications which may not be indicated on the drawings or conversely, shall be considered as part of the Contract and must be executed the same as though indicated by both.

3.4. Contractor shall make all his own measurements in the field and shall be responsible for correct fitting. He shall coordinate this work with all other branches of work in such a manner as to cause a minimum of conflict or delay.

3.5. The Engineer shall reserve the right to make adjustments in location of piping, ductwork, equipment, etc. where such adjustments are in the interest of improving the project.

3.6. Should conflict or overlap (duplication) of work between the various trades become evident, this shall be called to the attention of the Engineer. In such event neither trade shall assume that he is to be relieved of the work which is specified under his branch until instructions in writing are received from the Engineer.

3.7. Unless dimensioned, the mechanical drawings only indicate approximate locations of equipment, piping, etc. Dimensions given in figures on the drawings shall take precedence over scaled dimensions and all dimensions, whether given in figures or scaled, shall be verified in the field to ensure no conflict with other work.

3.8. Each Proposer shall review all drawings including Architectural, Mechanical, Electrical, Fire Protection, Structural, Laboratory Consultant, etc., to ensure that the work he intends to provide does not encroach a conflict with or affect the work of others in any way. Where such effect does occur it shall be the Proposer's responsibility to satisfactorily eliminate any such encroachment conflict or effect prior to the submission of his proposal. Each Proposer shall in particular ensure that there is adequate space to install his equipment and materials. Failure to do so shall result in the correction of such encroachment conflict or effect of any work awarded the proposer and shall be accomplished fully without expense to others and that they are reasonably accessible for maintenance. Check closely all mechanical and electrical closets, chases, ceiling voids, wall voids, crawl spaces, etc., to ensure adequate spaces.

3.9. Where on the drawings a portion of the work is drawn out and the remainder is indicated in outline, or not indicated at all, the parts drawn out shall apply to all other like portions of the work. Where ornamentation or other detail is indicated by starting only, such detail shall be continued throughout the courses or parts in which it occurs and shall also apply to all other similar parts of the work, unless otherwise indicated.

3.10. Details not usually shown or specified, but necessary for the proper installation and operation of systems, equipment, materials, etc., shall be included in the work, the same as if herein specified or indicated.

3.11. Where on the Drawings or Addenda the word typical is used, it shall mean that the work method or means indicated as typical shall be repeated in and each time it occurs whether indicated or not.

3.12. Special Note: Always check ceiling heights indicated on Architectural Drawings and Schedules and ensure that they may be maintained after all mechanical and electrical equipment is installed. Do not install equipment in the affected area until the conflict is resolved.

PART 4 - EXAMINATION OF SITE AND CONDITIONS

4.1. Each Proposer shall inform himself of all of the conditions under which the work is to be performed, the site of the work, the structure of the ground, above and below grade, the obstacles that may be encountered, the availability and location of necessary facilities and all relevant matters concerning the work. Each Proposer shall also fully acquaint himself with all existing conditions as to ingress and egress, distance of haul from supply points, routes for transportation of materials, facilities and services, availability of utilities, etc. His proposal shall

cover all expenses or disbursements in connection with such matters and conditions. No allowance will be made for lack of knowledge concerning such conditions after bids are accepted.

PART 5 - EQUIPMENT AND MATERIALS SUBSTITUTIONS OR DEVIATIONS

5.1. When any Contractor requests approval of materials and/or equipment of different physical size, capacity, function, color, access, it shall be understood that such substitution, if approved, will be made without additional cost to anyone other than the Contractor requesting the change regardless of changes in connections, space requirements, electrical characteristics, electrical services, etc., from that indicated. In all cases where substitutions affect other trades, the Contractor requesting such substitutions shall advise all such Contractors of the change and shall remunerate them for all necessary changes in their work. Any drawings, Specifications, Diagrams, etc., required to describe and coordinate such substitutions or deviations shall be professionally prepared at the responsible Contractor's expense. Review of Shop Drawings by the Engineers does not in any way absolve the Contractor of this responsibility.

5.2. Notwithstanding any reference in the specifications to any article, device, product, material, fixture, form, or type of construction by name, make or catalog number, such reference shall be interpreted as establishing a standard of quality and shall not be construed as limiting competition; any devices, products, materials, fixtures, forms, or types of construction which, in the judgment of the Engineer, are equivalent to those specified are acceptable, provided the provisions of Paragraph (A) immediately preceding are met. Requested substitutions shall be submitted to the Engineer a minimum of twelve days prior to bids.

5.3. Wherever any equipment and material is specified exclusively only such items shall be used unless substitution is accepted in writing by the Engineers.

5.4. Each Proposer shall furnish along with his proposal a list of specified equipment and materials which he is to provide. Where several makes are mentioned in the specifications and the Contractor fails to state which he proposes to furnish, the Engineer shall choose any of the makes mentioned without change in price. Inclusion in this list shall not ensure that the Engineers will approve shop drawings unless the equipment, materials, etc., submitted in shop drawings is satisfactorily comparable to the items specified and/or indicated.

PART 6 - SUPERVISION OF WORK

6.1. The Contractor shall personally supervise the work for which he is responsible or have a competent superintendent, approved by the Engineers, on the work at all times during progress with full authority to act for him.

PART 7 - CODES, RULES, PERMITS, FEES, INSPECTIONS, REGULATIONS, ETC.

7.1. The Contractor shall give all necessary notices, obtain and pay for all permits, government sales taxes, fees, inspections and other costs, including all utility connections, meters, meter settings, taps, tap fees, extensions, water and/or sewer system development charge, etc. in connection with his work. He shall also file all necessary plans, prepare all documents and obtain all necessary approvals of all governmental departments and/or the appropriate municipality or utility company having jurisdiction, whether indicated or specified or not. He shall hire an independent Registered Engineer to witness installations and provide necessary certifications where required by utility companies, municipal agencies or others that have review authority. He shall also obtain all required certificates of inspection for his work and deliver same to the Engineers before request for acceptance and final payment for the work. Ignorance of Codes, Rules, Regulations,

Laws, etc. shall not render the Contractor irresponsible for compliance. The Contractor shall also be versed in all Codes, Rules and Regulations pertinent to his part of the work prior to submission of a proposal.

7.2. The Contractor shall include in his work, without extra cost, any labor, materials, services, apparatus and drawings in order to comply with all applicable laws, ordinances, rules and regulations, whether or not indicated or specified.

7.3. All materials furnished and all work installed shall comply with the National Fire Codes of the National Fire Protection Association, with the requirements of local utility companies, or municipalities and with the requirements of all governmental agencies having jurisdiction.

7.4. All materials and equipment so indicated and all equipment and materials for the electrical portion of the mechanical systems shall bear the approval label of, or shall be listed by the Underwriters' Laboratories (UL), Incorporated. Each packaged assembly shall be approved as a package. Approval of components of a package shall not be acceptable. Where required by the Code and/or the Authority Having Jurisdiction, provide the services of a field labeling agency to provide a UL label for the entire system in the field under evaluation.

7.5. All plumbing work is to be constructed and installed in accordance with plans and specifications which have been approved in their entirety and/or reflect any changes requested by the State Department of Health. Plumbing work shall not commence until such plans are in the hands of the Contractor.

7.6. The Contractor shall furnish three (3) copies of all Final Inspection Certificates obtained to the Engineer when work is complete. Final payment for work will be contingent upon compliance with this requirement.

7.7. Where minimum code requirements are exceeded in the Design, the Design shall govern.

7.8. The Contractor shall ensure that his work is accomplished in accord with the OSHA Standards and that he conducts his work and the work of his personnel in accord with same.

7.9. Work in elevators, elevator shafts and elevator equipment rooms shall comply with the Elevator Code enforced by the Commonwealth of Kentucky.

7.10. All work relating to the handicapped shall be in accord with regulations currently enforced by the Department of Housing, Buildings and Construction, Commonwealth of Kentucky and the American Disabilities Act.

7.11. All work in conjunction with a natural gas installation shall, in addition to all other Codes, Rules, Regulations, Standards, etc., comply with the requirements of the local gas supplier and/or standards and recommendations of the American Gas Association.

7.12. All work in relation to domestic water systems shall, in addition to all other Codes, Rules, Regulations and Standards, be in compliance with the requirements of the local water utility company and the adopted edition of the 10 States Standards.

7.13. All work in relation to the installation of sanitary or storm sewers shall, in addition to all other Codes, Rules, Regulations and Standards, be in compliance with the local agency governing such installations and the adopted edition of the 10 States Standards.

7.14. All work relating to the handicapped shall be in accord with regulations currently enforced by the Department of Housing, Buildings, and Construction, Commonwealth of Kentucky and the American Disabilities Act.

PART 8 - EQUIPMENT AND PIPING SUPPORT

8.1. Each piece of equipment, apparatus, piping, or conduit suspended from the structure or mounted above the floor level shall be provided with suitable structural support, pipe stand, platform or carrier in accordance with the best recognized practice. Such supporting or mounting means shall be provided by the Contractor for all equipment and piping. Exercise extreme care that structural members of building are not overloaded by such equipment. Provide any required additional bracing, cross members, angles, support, etc., as indicated or required by the Structural Engineer. This, in some instances, will require the Contractor to add an angle to a joist to transfer the load to a panel point. If in doubt, contact the Structural Engineer.

PART 9 - PIPE MOUNTING HEIGHTS

9.1. All exposed or concealed piping, etc., shall be held as high as possible unless otherwise noted and coordinated with all other trades. Exposed piping and ductwork shall, insofar as possible, run perpendicular or parallel to the building structure.

PART 10 - COST BREAKDOWNS (SCHEDULE OF VALUES)

10.1. Within thirty days after acceptance of the Contract, the Contractor shall furnish to the Engineer, one copy of a detailed cost breakdown on each respective area of work. These cost breakdowns shall be made in a format approved by the Engineer. Payments will not be made until satisfactory cost breakdowns are submitted.

PART 11 - CORRECTION PERIOD

11.1. All equipment, apparatus, materials, and workmanship shall be the best of its respective kind. The Contractor shall replace all parts at his own expense, which are proven defective as described in the General Conditions. The effective date of completion of the work shall be the date of the Architect's or Engineer's Statement of Substantial Completion. Items of equipment which have longer guarantees, as called for in these specifications, shall have warranties and guarantees completed in order, and shall be in effect at the time of final acceptance of the work by the Engineer. The Contractor shall present the Engineer with such warranties and guarantees at the time of final acceptance of the work. The Owner reserves the right to use equipment installed by the Contractor prior to date of final acceptance. Such use of equipment shall not invalidate the guarantee except that the Owner shall be liable for any damage to equipment during this period, due to negligence of his operator or other employees. Refer to other sections for any special or extra warranty requirements.

11.2. It is further clarified that all required and specified warranties shall begin on the date of Substantial Completion, not at the time of equipment start-up.

PART 12 - COMPUTER-BASED SYSTEM SOFTWARE

12.1. For all equipment, controls, hardware, computer-based systems, programmable logic controllers, and other materials provided as a part of the work, software that is installed shall be certified in

writing to the Engineer and Owner by the manufacturer and/or writer to be free of programming errors that might affect the functionality of the intended use.

PART 13 - CHANGES IN MECHANICAL WORK

REFER TO GENERAL AND SPECIAL CONDITIONS.

PART 14 - CLAIMS FOR EXTRA COST

REFER TO GENERAL AND SPECIAL CONDITIONS.

PART 15 - SURVEY, MEASUREMENTS AND GRADE

15.1. The Contractor shall lay out his work and be responsible for all necessary lines, levels, elevations and measurements. He must verify the figures shown on the drawings before laying out the work and will be held responsible for any error resulting from his failure to do so.

15.2. The Contractor shall base all measurements, both horizontal and vertical from established bench marks. All work shall agree with these established lines and levels. Verify all measurements at the site and check the correctness of same as related to the work.

15.3. Should the Contractor discover any discrepancy between actual measurements and those indicated, which prevents following good practice or the intent of the contract documents, he shall promptly notify the Engineer and shall not proceed with this work until he has received instructions from the Engineer on the disposition of the work.

PART 16 - TEMPORARY SERVICES

16.1. The Contractor shall arrange any temporary water, electrical and other services which he may require to accomplish his work. Refer also to General and Special Conditions.

PART 17 - RECORD DRAWINGS

17.1. The Contractor shall ensure that any deviations from the Design are as they occur recorded in red, erasable pencil on record drawings kept at the jobsite. The Engineer shall review the record documents from time to time to ensure compliance with this specification. Compliance shall be a contingency of final payment. Pay particular attention to the location of under floor sanitary and water lines, shut-off valves, cleanouts and other appurtenances important to the maintenance and operation of Mechanical Systems. Also, pay particular attention to Deviations in the Control Systems and all exterior utilities. Keep information in a set of drawings set aside at the job site especially for this purpose. Deliver these record drawings electronically in hand marked field set to the Engineer. Electronic bid drawings will be furnished to the Contractor for his use.

PART 18 - SURVEY, MATERIALS AND WORKMANSHIP

18.1. All equipment, materials and articles incorporated in the work shall be new and of comparable quality to that specified. Each Proposer shall determine that the materials and/or equipment he proposes to furnish can be brought into the building(s) and installed within the space available. In certain cases, it may be necessary to remove and replace walls, floors and/or ceilings and this work shall be the responsibility of the Contractor. All equipment shall be installed so that all parts are readily accessible for inspection, maintenance, replacement of filters, etc. Extra compensation will not be allowed for relocation of equipment for accessibility or for dismantling

equipment to obtain entrance into the building(s). Ensure, through coordination, that no other Contractor seals off access to space required for equipment, materials, etc.

18.2. Materials and equipment, where applicable, shall bear Underwriters' Laboratories label where such a standard has been established.

18.3. Use extreme care in the selection of equipment and its installation to ensure that noise and vibration are kept at a minimum. The Engineer's determination shall be final and corrections to such discrepancies shall be made at the cost of the Contractor.

18.4. Each length of pipe, fitting, trap, fixture and device used in the plumbing or drainage systems shall be stamped or indelibly marked with the weight or quality thereof and with the manufacturer's mark or name.

18.5. All equipment shall bear the manufacturer's name and address. All electrically operated equipment shall bear a data plate indicating required horsepower, voltage, phase and ampacity.

PART 19 - COOPERATION AND COORDINATION WITH OTHER TRADES

19.1. The Contractor shall give full cooperation to all other trades and shall furnish in writing with copies to the Engineer, any information necessary to permit the work of other trades to be installed satisfactorily and with the least possible interference or delay.

19.2. Where any work is to be installed in close proximity to, or will interfere with work of other trades, each shall cooperate in working out space conditions to make a satisfactory adjustment. If so directed by the Engineer, the Contractor shall prepare composite working drawings and sections at a suitable scale not less than 1/4” = 1'-0”, clearly indicating how his work is to be installed in relation to the work of other trades, or so as not to cause any interference with work of other trades. He shall make the necessary changes in his work to correct the condition without extra charge.

19.3. The Contractor shall furnish to other trades, as required, all necessary templates, patterns, setting plans, and shop details for the proper installation of work and for the purpose of coordinating adjacent work.

PART 20 - QUALIFICATIONS OF WORKMEN

20.1. All mechanical work shall be accomplished by qualified workmen competent in the area of work for which they are responsible. Untrained and incompetent workmen, as evidenced by their workmanship, shall be summarily relieved of their responsibilities in areas of incompetency. The Engineer shall reserve the right to determine the quality of workmanship of any workman and unqualified or incompetent workman shall refrain from work in areas not satisfactory to him. Requests for relief of a workman shall be made through the normal channels of Architect, Contractor, etc.

20.2. All plumbing work shall be accomplished by Journeymen Plumbers under the direct supervision of a Master Plumber as defined and clarified under Kentucky State Plumbing Law Regulations and Code. Proof and Certification may be requested by the Engineer.

20.3. All pipe fitting work shall be installed by workmen normally engaged or employed in these respective trades, except where only small amounts of such work are required and are within the competency of workmen directly employed by the Contractor involved.

20.4. All special systems (Pneumatic Tube, Oxygen, Vacuum, Medical Air, Automatic Sprinkler Equipment, etc.) shall be installed only by workmen normally engaged in such services. Exception to this specification may only be made in writing by the Engineer.

20.5. All electrical work shall be installed only by competent workmen under direct supervision of a fully qualified Electrician.

PART 21 - CONDUCT OF WORKMEN

21.1. The Contractor shall be responsible for the conduct of all workmen under his supervision. Misconduct on the part of any workman to the extent of creating a safety hazard, or endangering the lives and property of others, shall result in the prompt relief of that workman. The consumption of alcoholic beverages or other intoxicants, narcotics, barbiturates, hallucinogens or debilitating drugs on the job site is strictly forbidden.

PART 22 - PROTECTION OF MATERIALS AND EQUIPMENT

22.1. The Contractor shall be entirely responsible for all material and equipment furnished by him in connection with his work and special care shall be taken to properly protect all parts thereof from physical, sun, and weather damage during the construction period. Such protection shall be by a means acceptable to the manufacturer and Engineer. All rough-in soil, waste, vent and storm piping, ductwork, etc., shall be properly plugged or capped during construction in a manner approved by the Engineer. Equipment damaged, stolen or vandalized while stored on site, either before or after installation, shall be repaired or replaced by the Contractor at his own expense.

PART 23 - SCAFFOLDING, RIGGING AND HOISTING

23.1. The Contractor shall furnish all scaffolding, rigging, hoisting and services necessary for erection and delivery onto the premises of any equipment and apparatus furnished. All such temporary appurtenances shall be set up in strict accord with OSHA Standards and Requirements. Remove same from premises when no longer required.

PART 24 - BROKEN LINES AND PROTECTION AGAINST FREEZING

24.1. No conduits, piping, troughs, etc. carrying water or any other fluid subject to freezing shall be installed in any part of the building where danger of freezing may exist without adequate protection being given by the Contractor whether or not insulation is specified or indicated on the particular piping. All damages resulting from broken and/or leaking lines shall be replaced or repaired at the Contractor's own expense. If in doubt, contact the Engineer. Do not install piping across or near openings to the outside whether they are carrying static or moving fluids or not. Special Note: Insulation on piping does not necessarily ensure that freezing will not occur.

PART 25 - CLEANING

25.1. The Contractor shall, at all times, keep the area of his work presentable to the public and clean of rubbish and debris caused by his operations; and at the completion of the work, shall remove all rubbish, debris, all of his tools, equipment, temporary work and surplus materials from and about the premises, and shall leave the area clean and ready for use. If the Contractor does not attend to such cleaning upon request, the Engineer may cause cleaning to be done by others and charge the cost of same to the Contractor. The Contractor shall be responsible for all damage from fire which originates in, or is propagated by, accumulations of his rubbish or debris.

25.2. After completion of all work and before final acceptance of the work, the Contractor shall thoroughly clean all equipment and materials and shall remove all foreign matter such as grease, dirt, plaster, labels, stickers, etc., from the exterior of piping, equipment, fixtures and all other associated or adjacent fabrication.

PART 26 - ACCESSIBILITY

26.1. The Contractor shall provide access panels for each concealed valve, control damper or other device requiring service as shown on engineer's plans or as required. Locations of these panels shall be identified in sufficient time to be installed in the normal course of work.

PART 27 - SMOKE AND FIRE PROOFING

27.1. The Contractor shall fire and smoke stop all openings made in fire or smoke rated walls, chases, ceilings and floors in accord with the KBC. Patch all openings around ductwork and piping with appropriate type material to stop smoke at smoke walls and provide commensurate fire rating at fire walls, floors, ceilings, roofs, etc. Back boxes in rated walls shall be a minimum distance apart as allowed by code to maintain the rating. If closer provide rated box or fireproofing in code approved manner.

PART 28 - CUTTING AND PATCHING

28.1. The Contractor shall provide his own cutting and patching necessary to install his work. Patching shall match adjacent surfaces and shall be to the satisfaction of the Architect and Engineer.

28.2. No structural members shall be cut without the approval of the Engineer and all such cutting shall be done in a manner directed by him.

PART 28 - CURBS, PLATES, ESCUTCHEONS & AIR TIGHT PENETRATIONS

28.3. Escutcheon plates shall be provided for all pipes and conduit passing thru walls, floors and ceilings. Plates shall be nickel plated, of the split ring type, of size to match the pipe or conduit. Where plates are provided for pipes passing thru sleeves which extend above the floor surface, provide deep recessed plates to conceal the pipe sleeves.

28.4. Seal all pipe, conduit, etc., penetrations through walls and floors air tight. If wall or floor assembly is rated then use similarly rated sealing method.

PART 29 - WEATHERPROOFING

29.1. Where any work pierces waterproofing including waterproof concrete, the method of installation shall be as approved by the Engineer before work is done. The Contractor shall furnish all necessary sleeves, caulking and flashing required to make openings permanently watertight.

PART 30 - OPERATING INSTRUCTIONS, MAINTENANCE MANUALS AND PARTS LISTS

30.1. Upon completion of all work tests, the Contractor shall instruct the Owner or his representative(s) fully in the operations, adjustment and maintenance of all equipment furnished. The time and a list

of representatives required to be present will be as directed by the Engineer. Turn over all special wrenches, keys, etc., to the owner at this time.

30.2. The Contractor shall furnish three (3) complete bound sets for delivery to the Engineer of typewritten and/or blueprinted instructions for operating and maintaining all systems and equipment included in this contract. All instructions shall be submitted in draft, for approval, prior to final issue. Manufacturer's advertising literature or catalogs alone will not be acceptable for operating and maintenance instructions.

30.3. The Contractor, in the instructions, shall include a preventive maintenance schedule for the principal items of equipment furnished under this contract and a detailed, parts list and the name and address of the nearest source of supply.

PART 31 - REQUIRED CLEARANCE FOR ELECTRICAL EQUIPMENT

31.1. The NEC has specific required clearances above, in front, and around electrical gear, panels etc. The Contractor shall not install any piping, ductwork, etc., in the required clearance. If any appurtenance is located in the NEC required clearance, it shall be relocated at no additional cost.

PART 32 - INDEMNIFICATION

32.1. The Contractor shall hold harmless and indemnify the Engineer, employees, officers, agents and consultants from all claims, loss, damage, actions, causes of actions, expense and/or liability resulting from, brought for, or on account of any personal injury or property damage received or sustained by any person, persons, (including third parties), or any property growing out of, occurring, or attributable to any work performed under or related to this contract, resulting in whole or in part from the negligence of the Contractor, any subcontractor, any employee, agent or representative.

PART 33 - HAZARDOUS MATERIALS

33.1. CMTA, Inc., Consulting Engineers, have no expertise in the determination of the presence of hazardous materials. Therefore, no attempt has been made by them to identify the existence or location of any such material. Furthermore, CMTA nor any affiliate thereof will neither offer nor make any recommendations relative to the removal, handling or disposal of such material.

33.2. If the work interfaces, connects or relates in any way with or to existing components which contain or bear any hazardous material, asbestos being one, then, it shall be the Contractor's sole responsibility to contact the Owner and so advise him immediately.

33.3. The Contractor by execution of the contract for any work and/or by the accomplishment of any work thereby agrees to bring no claim relative to hazardous materials for negligence, breach of contract, indemnity, or any other such item against CMTA, its principals, employees, agents or consultants. Also, the Contractor further agrees to defend, indemnify and hold CMTA, its principals, employees, agents and consultants, harmless from any such related claims which may be brought by any subcontractors, suppliers or any other third parties.

PART 34 - ABOVE CEILING AND FINAL PUNCH LISTS

34.1. The Contractor shall review each area and prepare a punch list for each of the subcontractors, as applicable, for at least two stages of the project:

A. For review of above ceiling or enclosed shafts, shaft walls, or ceilings work that will be concealed by concrete and backfill or other materials well before substantial completion.
B. For review of all other work as the project nears substantial completion.

34.2. When all work from the Contractor's punch list is complete at each of these stages and prior to completing ceiling installations (or at the final punch list stage), the Contractor shall request that the Engineer develop a punch list. This request is to be made in writing seven days prior to the proposed date. After all corrections have been made from the Engineer's punch list, the Contractor shall review and initial off on each item. This signed-off punch list shall be submitted to the Engineer. The Engineer shall return to the site once to review each punch list and all work prior to the slab being installed and at the final punch list review.

END OF SECTION

SECTION 220020- SCOPE OF THE PLUMBING WORK

PART 1 - GENERAL

1.1. The plumbing work for this Contract shall include all labor, materials, equipment, fixtures, excavation, backfill and related items required to completely install, test, place in service and deliver to the Owner the complete mechanical systems in accordance with the accompanying plans and all provisions of these specifications. This work shall primarily include, but is not necessarily limited to the following:

A. Complete Fire Suppression System Distribution and Select area sprinkler heads and branch piping.

B. Lab Gas and Vacuum Systems.

C. Domestic Water System.

D. Lab Grade Water System and Piping.

E. Interior soil, waste and vent systems.

F. All applicable services and work specified in Section 200100; General Provisions – Plumbing.

G. One year guarantee of all mechanical equipment, materials and workmanship.

H. Thorough instruction of the owner's maintenance personnel in the operation and maintenance of all mechanical equipment.

I. Thorough coordination of the installation of all piping, equipment and any other material with other trades to ensure that no conflict in installation.

J. Approved supervision of the mechanical work.

K. Cutting, patching, sleeving, concrete work, etc., required to construct the mechanical systems.

L. Prior to submitting a bid, the Contractor shall contact all serving utility companies to determine exactly what each utility company will provide and exactly what is required of the Contractor and shall include such requirements in his base bid.

M. Procurement of all required permits and inspections, including fees for all permits and inspection services and submission of final certificates of inspection to the Engineers (Plumbing, Fire Protection, etc.).

END OF SECTION

SECTION 220030 - SHOP DRAWINGS, DESCRIPTIVE LITERATURE, MAINTENANCE MANUALS, PARTS LISTS, SPECIAL KEYS & TOOLS

PART 1 - GENERAL

1.1. The Contractor's attention is directed also to the General Provisions Section 220010, as well as to all other Contract Documents as they may apply to his work.

1.2. The Contractor shall prepare and submit to the Engineer, through the General Contractor and the Architect (where applicable) within thirty (30) days after the date of the Contract, all shop drawings, certified equipment drawings, installation, operating and maintenance instructions, samples, wiring diagrams, etc. on all items of equipment specified hereinafter through Ecomm. In addition to the electronic submittal, hard copies of the Fire Protection drawings shall be submitted.

1.3. Submittal data shall include specification data including metal gauges, finishes, accessories, etc. Also, the submittal data shall include certified performance data, wiring diagrams, dimensional data, and a spare parts list. Submittal data shall be reviewed by the Engineer before any equipment or materials is ordered or any work is begun in the area requiring the equipment.

1.4. All submittal data shall have the stamp of approval of the Contractor submitting the data as well as the General Contractor and the Architect (if applicable) to show that the drawings have been reviewed by the Contractor. Any drawings submitted without these stamps of approval may not be considered and will be returned for proper resubmission.

1.5. It shall be noted that review of shop drawings by the Engineer applies only to conformance with the design concept of the project and general compliance with the information given in the contract documents. In all cases, the Contractor alone shall be responsible for furnishing the proper quantity of equipment and/or materials required, for seeing that all equipment fits the available space in a satisfactory manner and that piping, electrical and all other connections are suitably located.

1.6. The Engineers review of shop drawings, schedules or other required submittal data shall not relieve the Contractor from responsibility for: adaptability of the item to the project; compliance with applicable codes, rules, regulations and information that pertains to fabrication and installation; dimensions and quantities; electrical characteristics; and coordination of the work with all other trades involved in this project. Any items that differ from the Drawings or Specifications shall be flagged by the Contractor so the Engineer will be sure to see the item. Do not rely on the Engineer to “catch” items that do not comply with the Drawings or Specifications. The Contractor is responsible for meeting the Drawings and Specification requirements, regardless of whether or not something does not get caught by the Contractor or Engineer during shop drawing reviews.

1.7. Equipment shall not be ordered and no final rough-in connections, etc., shall be accomplished until reviewed equipment shop drawings are in the hands of the Contractor. It shall be the Contractor's responsibility to obtain reviewed shop drawings and to make all connections, etc. in the neatest and most workmanlike manner possible. The Contractor shall coordinate with all the other trades having any connections, roughing-in, etc. to the equipment.

1.8. If the Contractor fails to comply with the requirements set forth above, the Engineer shall have the option of selecting any or all items listed in the Specifications or on the drawings; and the Contractor shall be required to furnish all materials in accordance with this list.

1.9. Colors for equipment in other than mechanical spaces shall be selected from the Manufacturer's standard and factory optional colors. Color samples shall be furnished with the shop drawing submission for such equipment.

1.10. Shop Drawing Submittals

A. All items listed in the schedules shall be submitted for review in a tabular form similar to the equipment schedule.

B. All items submitted shall be designated with the same identifying tag as specified on each sheet.

C. Any submittals received in an unorganized manner without options listed and with incomplete data will be returned for resubmittal.

PART 2 - SHOP DRAWINGS

2.1. Shop Drawings, descriptive literature, technical data and required schedules shall be submitted on the following:

Pipe
Hangers
Valves
Lab Gas Accessories
Fire Suppression Accessories
Plumbing Fixtures

SPECIAL NOTES:

A. Upon substantial completion of the project, the Contractor shall deliver to the Engineers (in addition to the required Shop Drawings) three (3) complete copies of operation and maintenance instructions and parts lists for each item marked (1) above. These documents shall include at least:

1. Detailed operating instructions
2. Detailed maintenance instructions including preventive maintenance schedules.
3. Addresses and phone numbers indicating where parts may be purchased.

PART 3 - SPECIAL WRENCHES, TOOLS, ETC.

3.1. The Contractor shall furnish, along with equipment provided, any special wrenches or tools necessary to dismantle or service equipment or appliances installed under the Contract. Wrenches shall include necessary keys, handles and operators for valves, cocks, hydrants, etc. A reasonable number of each shall be furnished.

END OF SECTION

SECTION 220040 - SLEEVING, CUTTING, PATCHING AND REPAIRING

PART 1 - GENERAL

1.1. The Contractor's attention is directed to the General Provisions – Plumbing and to all other Contract Documents as they apply to this branch of the work. Attention is also directed to all other sections of the Contract Documents which affect the work of this section and which are hereby made a part of the work specified in this section.

1.2. The Contractor shall be responsible for all openings, sleeves, etc., that he may require in floors, ceilings, walls, etc., and shall coordinate all such work with the General Contractor and all other trades. Coordinate with the General Contractor, any openings which he is to provide before submitting a bid proposal in order to avoid conflict and disagreement during construction. Improperly located openings shall be reworked at the expense of the Contractor.

1.3. The Contractor shall plan his work ahead and shall place sleeves, frames or forms through all walls, floors and ceilings during the initial construction, where it is necessary for piping, conduit, etc., to go through; however, when this is not done, the Contractor shall do all cutting and patching required for the installation of his work, or he shall pay other trades for doing this work when so directed by the Engineer. Any damage caused to the buildings by the workmen of the responsible Contractor must be corrected or rectified by him at is own expense.

1.4. The Contractor shall notify other trades in due time where he will require openings or chases in new concrete or masonry. He shall set all concrete inserts and sleeves for his work. Failing to do this, he shall cut openings for his work and patch same as required at his own expense.

1.5. The Contractor shall be responsible for properly shoring, bracing, supporting, etc., any existing and/or new construction to guard against cracking, settling, collapsing, displacing or weakening while openings are being made. Any damage occurring to the existing and/or new structures, due to failure to exercise proper precautions or due to action of the elements shall be promptly and properly made good to the satisfaction of the Engineer.

1.6. All work improperly done or not done at all as required by the Plumbing Trades in this section, will be performed by the Contractor at the direction of the trade whose work is affected.

PART 2 - SLEEVES, PLATES AND ESCUTCHEONS

2.1. The Contractor shall provide and locate all sleeves and inserts required for his work before the floors and surface being penetrated are built, otherwise the Contractor shall core drill for pipes where sleeves and inserts were not installed, or where incorrectly located. Core drilling is the only acceptable alternative to sleeves. Do not chisel openings. Where sleeves are placed in exterior walls or in slabs on grade, the space between the pipe or conduit and the sleeves shall be made completely and permanently water tight.

2.2. Pipe that penetrates fire and/or smoke rated assemblies shall have sleeves installed as required by the manufacturer of the rating seal used.

2.3. At all other locations either pipe sleeves or core drilled openings are acceptable.

2.4. Sleeves in wall shall be constructed of 24 gauge galvanized sheet steel with lock seam joints or Schedule 40 pipe. Sleeves in floors shall extend 1" above finished floor level.

2.5. In floor slab sleeves shall be cast-in place firestop, Hilti cp 680-P, or approved equivalent. Sleeves shall extend 1" above finished floor level. Any sleeves damaged in construction shall be repaired or replaced per the manufacturers' requirements to maintain a 1 inch waterproof assembly extending beyond the slab elevation.

2.6. Fasten sleeves securely in floors, walls, so that they will not become displaced when concrete is poured or when other construction is built around them. Take precautions to prevent concrete, plaster or other materials being forced into the space between pipe and sleeve during construction.

PART 3 - CUTTING

3.1. No cutting is to be done at points or in a manner that will weaken the structure and unnecessary cutting must be avoided. If in doubt, contact the Engineer.

3.2. Pipe openings in slabs and walls shall be cut with core drill. Hammer devices will not be permitted. Edges of trenches and large openings shall be scribe cut with a masonry saw.

PART 4 - PATCHING AND REPAIRING

4.1. Patching and repairing made necessary by work performed under this division shall be included as a part of the work and shall be done by skilled mechanics of the trade or trades for work cut or damaged, in strict accordance with the provisions herein before specified for work of like type to match adjacent surfaces and in a manner acceptable to the Engineer.

4.2. Where the installation of piping, etc. requires the penetration of fire or smoke rated walls, ceilings or floors, the space around such conduit, duct, pipe, etc., shall be tightly filled with an approved non-combustible fire insulating material satisfactory to maintain the rating integrity of the wall, floor or ceilings affected.

4.3. Piping passing through floors, ceilings and walls in finished areas, unless otherwise specified, shall be fitted with chrome plated brass escutcheons of sufficient outside diameter to amply cover the sleeved openings and an inside diameter to closely fit the pipe around which it is installed.

4.4. Where pipes, and conduits pass through interior or exterior walls, the wall openings shall be sealed air tight. This shall include sealing on both sides of the wall to insure air does not enter or exit the wall cavity. This is especially critical on exterior walls where the wall cavity may be vented to the exterior.

END OF SECTION

SECTION 220060 – PLUMBING PIPE, PIPE FITTINGS AND PIPE SUPPORT

1. GENERAL

1.1. The Contractor's attention is directed to the General Provisions and to all other Contract Documents as they apply to this branch of the work. Attention is also directed to all other sections of the Contract Documents which affect the work of this section and which are hereby made a part of the work specified in this section. **All piping and fittings shall be in compliance with the University of Kentucky's Design and Construction Standards available online at: http://www.uky.edu/EVPFA/Facilities/CPMD/standards/div15/15060s02.pdf**

1.2. When a pipe size is not indicated, the Contractor shall request the pipe size from the Engineers. All piping shall be installed straight and true, parallel or perpendicular to the building construction. Piping shall be installed so as to allow for expansion without damage to the building finishes, structure, pipe, equipment, etc., use offsets, U-bends or expansion joints as required. Where a section of piping is not indicated but is obviously required for completion of the system, the Contractor shall provide same at no additional cost to the project. No mitered joints or field fabricated pipe bends shall be accepted. Pipe shall clear all windows, doors, louvers and other building openings.

1.3. All pipe shall be supported in a neat and workmanlike manner and wherever possible, parallel runs of horizontal piping shall be grouped together on trapeze type hangers. Vertical risers shall be supported at each floor line with approved steel pipe riser clamps. The use of wire or perforated metal to support pipes will not be permitted. Hanging pipes from other pipes shall not be permitted. Spacing of pipe supports shall not exceed eight feet for pipes up to 1-1/4 inches and ten feet on all other piping. Small vertical pipes (1 inch and less) shall be bracketed to walls, structural members, etc. at four (4) foot intervals so as to prevent vibration or damage by occupants. Insulated piping shall be supported on a rigid insulation block at each hanger so as to prevent crushing of insulation by hangers. Hangers shall pass completely around the insulation jacket and a steel protective saddle shall be applied to prevent compression of the insulation. (Refer to Specifications Section entitled INSULATION-PLUMBING).

1.4. Where piping rests directly on a hanger, clip, bracket or other means of support, the support element shall be of the same material as the pipe, (e.g., copper to copper, ferrous to ferrous, etc.) or shall be electrically isolated one from the other so as to prevent pipe damage by electrolysis. Pay particular attention and do not allow copper pipe to rest on ferrous structural members, equipment, etc. without electrolytic isolation.

1.5. In general, piping shall be installed concealed except in Mechanical, Janitor Rooms, etc. unless otherwise indicated, and shall be installed underground or beneath concrete slabs only where indicated. All lines at ceilings shall be held as high as possible and shall run so as to avoid conflicts with other trades, and to facilitate the Owner's use and maintenance. Location of pipe in interior partitions shall be carefully coordinated with whoever will construct the partitions after the piping is in place. Where exposed risers occur they shall be kept as close to walls as possible.

1.6. Installation of pipe shall be in such a manner as to provide complete drainage of the system toward the source. Drain valves shall be provided at all drainage points on pipes. Drain valves shall be 1/2" size gate type with 3/4" hose thread end and vacuum breaker. Label each drain valve.

1.7. All hot and cold water piping shall be kept a sufficient distance apart so as to prevent heat transfer between them. Cold water piping shall also be kept apart from refrigerant hot gas lines.

1.8. Piping carrying water or other fluids subject to freezing shall not be installed in locations subject to freezing; if in doubt, consult Engineer.

1.9. Piping for all drainage systems shall be installed to permit flow, trapping, and venting in accord with current codes and sound practice.

1.10. All cast iron soil pipe and fittings shall be coated inside and out with coal tar varnish.

1.11. Non-metallic piping shall be installed in strict accordance with the manufacturer's instructions. If no such instructions are available, consult Engineers.

1.12. Nipples shall be of the same material, composition and weight classification as pipe with which installed.

1.13. Where piping is not indicated on the plans, but is obviously or apparently required, contact the Engineers prior to submission of a bid proposal.

1.14. Pay particular attention to conflict of piping with other work. Do not install until conflict is resolved. If necessary, contact Engineers.

1.15. Piping materials in each system shall, to the extent practicable, be of the same material. Frequent changes of material (for example, from copper to steel) shall be avoided and in no case shall be accomplished without use of insulating unions and permission of the Engineers.

1.16. Apply approved pipe dope (for service intended) to all male threaded joints. Pay particular attention to dope for fuel gas lines. The dope shall be listed for such use.

1.17. All piping shall be capped or plugged during erection as required to keep clean and debris and moisture free.

1.18. The entire domestic hot, cold and recirculating hot water piping system shall be sterilized in strict accord with requirements of the Department of Health Codes, Rules and Regulations for the State which the work is being accomplished in.

1.19. Provide expansion joints where shown on the plans and where required by good practice. Expansion joints shall be guided and anchored in accordance with the recommendations of the Expansion Joint Manufacturer's Association.

1.20. Where plastic pipe penetrates a fire rated assembly, it shall be replaced with a metal threaded adapter and a metal pipe per code.

1.21. Where piping penetrates interior or exterior walls, the wall shall be sealed air tight. Refer to the sleeving, cutting, patching and repairing section of the specifications for additional requirements.

1.22. Provide check valves on individual hot and cold water supplies to each mixing valve (including each sensor style faucet, safety shower, mop sink, etc.) and each showerhead with a diverter valve (including all ADA showers). This requirement shall not be satisfied by mixing valves or fixtures with internal check valves. Independent external check valves are required.

2. UNIONS AND FLANGES AND WELDED TEES

2.1. Screwed unions, soldered unions or bolted flanges shall be provided as required to permit removal of equipment, valves and piping accessories from the piping system. Keep adequate clearances for coil removal, rodding, tube replacement, motor lubrication, filter replacement, etc. Flanged joints shall be assembled with appropriate flanges, gaskets and bolting. Gaskets for steam piping systems shall be flexitalic spiral wound type. The clearance between flange faces shall be such that the connections can be gasketed and bolted tight without imposing undue strain on the piping system.

2.2. Dielectric insulating unions or couplings shall be used wherever the adjoining materials being connected are of dissimilar metals such as connections between copper and steel pipe.

2.3. Tee connections for welded pipe shall be made up with welding fittings. Where the size of the side outlet is such that a different connection technique than on the run is required, a weldolet, sockolet, or threadolet type fitting may be used for the branch in place of reducing tees only where the branch is 2/3 the run size or smaller.

3. SPECIFICATIONS STANDARDS

All piping and material shall be new, made in the United States and shall conform to the following minimum applicable standards:

3.1. Steel pipe; ASTM A-120, A-53 Grade A, A-53 Grade B.

3.2. Copper tube; Type K, L, M; ASTM B88-62; Type DWV ASTM B306-62.

3.3. Cast iron soil pipe; ASA A-40.l and CS 188-59.

3.4. Cast iron drainage fittings; ASA B16.12.

3.5. Cast iron screwed fittings; ASA B16.4.

3.6. Welding fittings; ASA B16.9.

3.7. Cast brass and wrought copper fittings; ASA B16.18.

3.8. Cast brass drainage fittings; ASA B16.23.

3.9. Reinforced concrete pipe; ASTM-C-76-64T.

3.10. Solder; Handy and Harmon, United Wire and Supply; Air Reduction Co. or equivalent.

4. PITCH OF PIPING

All piping systems shall be installed so as to drain to a low point. Certain minimum pitches shall be required for this drainage. For proper flow and/or for proper operation, the following pitches shall be required:

4.1. Interior Soil, Waste and Vent Piping:

2% slope in direction of flow where possible but in no case less than 1/8" per foot.

4.2. Roof Leaders:

1/8 inch per foot where possible.

4.3. All Other Lines:

Provide ample pitch to a low point to allow 100 percent drainage of the system.

5. APPLICATIONS

5.1. General Notes

5.1.1. Where plastic piping penetrates a fire rated assembly, it shall be replaced with a threaded metal adapter and metal pipe or whatever means necessary to maintain the separation rating in accordance with local plumbing and fire codes.

5.1.2. Plastic piping or any materials with a flame and smoke spread rating not approved for plenum use shall not be permitted in supply, return, relief or exhaust plenums.

5.2. Fire Protection

Refer to the Fire Protection System section of these specifications.

1. Soil, Waste and Vent Piping (Below Slab)

   A. Cast Iron service weight, hub and spigot soil pipe and fittings ASTM A74. Pipe shall have heavy coating of coal tar varnish or ashpaltum on both inside and outside surfaces. Hubs to have neoprene compression gaskets; ASTM C564.

2. Soil, Waste and Vent Piping (Above Slab)

   A. Less than 4”- DWV copper, lead free solder, iron with manufacturer’s approved bands.

   B. 4” and Over-Service weight hubless cast iron with manufacturer’s approved bands.

3. Roof Leaders/Interior Storm Sewer Piping

   A. Service weight hubless cast iron pipe with manufacturers approved bands.

4. Domestic Cold, Hot and Recirculating Hot Water Piping (Above Slab)

   A. Type "L" hard copper tubing with wrought copper fittings with lead free solder equivalent in performance to 95/5. (Maximum lead content of solder and flux is 2%).

5.3. Acid Waste and Vent Piping - (Above Slab)

5.3.1. Above slab, pipe in non-plenum area: Schedule 40 flame retardant polypropylene pipe conforming to ASTM D4101 with joints made in accordance with the Kentucky Plumbing Code. Piping shall be installed with fusion joints within concealed spaces and with

mechanical joints in accessible areas. All mechanical couplings below casework or exposed shall have the clamp edges smoothed or covered to keep sharp edges from cutting people

5.3.2. Piping shall be protected from sunlight in accordance with the manufacturer's recommendations.

5.3.3. Acceptable manufacturers of acid waste and vent piping materials above slab: Enfield (Ipex), Orion, or G.F. Sloane.

5.4. Laboratory Deionized Water Piping

5.4.1. Polypropylene with solvent cement fittings. Piping shall be cleaned and flushed with a chlorine solution prior to building occupancy. Provide additional temporary connection pieces with valve shutoffs to allow for flushing where complete piping system has not been installed.

5.5. Lab Gas Piping (Compressed Air, Vacuum, Oxygen, Carbon Dioxide, Nitrogen, Etc.)

5.5.1. Refer to Section 220600 – Laboratory Gas and Vacuum Piping Systems.

END OF SECTION

SECTION 220070 - HANGERS, CLAMPS, ATTACHMENTS, ETC.

PART 1 - GENERAL

1.1. The Contractor's attention is directed to the General Provisions – Plumbing and to all other Contract Documents as they apply to this branch of the work. Attention is also directed to other sections of the Contract Documents which affect the work of this section and which are hereby made a part of the work specified in this section.

1.2. Each Contractor's attention is also directed to Section 220060, Plumbing Pipe, Pipe Fittings and Pipe Support.

1.3. This section includes, but is not limited to, furnishing and installing dampers, supports, anchors, and accessories for piping, ductwork, equipment, etc. Furnishing and installing shall be by each trade for the completion of their work.

1.4. Power driven anchors and expansion anchors shall be permitted only when permission is granted in writing by the Architect and Engineer.

PART 2 - MATERIALS AND EQUIPMENT

2.1. Hangers, Clamps, Attachments, Etc.:

	SIZE	SPECIFICATION
1. Pipe Rings	2" pipe and smaller	Adjustable swivel split ring or split pipe ring, Grinnell Figures 104 and 108, Elcen, Fee & Mason, or approved equivalent.
2. Pipe Clevis	2-1/2" pipe and larger	Adjustable wrought Clevis type, Grinnell Figure 260, Elcen, Fee & Mason, or approved equivalent.
3. Pipe Clevis	All	Steel Clevis for insulated pipe, Elcen Figure 12A, Grinnell, Fee & Mason or approved equivalent.
4. Rise Clamps	All	Extension pipe or riser clamp, Grinnell Figure 261, Elcen, Fee & Mason or approved equivalent.
5. Beam Clamps and Attachments	All	Grinnell Figure numbers listed or, Elcen, Fee & Mason, or approved equivalent. Malleable beam clamp with extension piece figure 229; I-beam clamp figure 131; C-clamp figures 83, 84, 85, 86, 87, and 88.
6. Brackets	All	Welded steel brackets medium weight, Grinnell Figure 195, Elcen, Fee & Mason or approved equivalent.

7. Concrete Inserts	All	Grinnell Figure numbers listed or, Elcen, Fee & Mason or approved equivalent. Wrought steel insert Figure 280 and wedge type insert Figure 281.
8. Concrete Fasteners	All	Self-drilling concrete inserts, Phillips, Grinnell, Elcen or approved equivalent.
9. Ceiling	All	Grinnel Figure numbers listed or Elcen, Fee & Mason, or approved equivalent. Pipe hanger flange Figure 153, adjustable swinging hanger flange Figure 155, ceiling flanges Figures 128 and 128R, and adjustable ceiling flange Figure 116.
10. Rod Attachments	All	Grinnel Figure numbers listed or Elcen, Fee & Mason, or approved equivalent. Extension piece Figure 157, rod coupling Figure 136, and forged steel turnbuckle Figure 230.
11. U-Bolts	All	Standard, U-bolt, Grinnell Figure 137, Elcen, Fee & Mason, or approved equivalent.
12. Welded Pipe Saddles	All	Pipe covering protection saddle sized for thickness of insulation, Grinnell Figure 186, Elcen, Fee & Mason or approved equivalent.
13. Pipe Roll	All	Adjustable swivel pipe roll, Grinnell Figure 174, Elcen, Fee & Mason, or approved equivalent.
14. Protection Saddle	All	18 gauge sheet metal pipe protection saddle, Elcen Figure 219, Fee & Mason, Power Strut, or approved equivalent.
15. Hanger Rods	All	Steel, diameter of the hanger threading, ASTM A-107.
16. Miscellaneous Steel	All	Steel angles, rods, bars, channels, etc., used in framing for supports and fabricated brackets, anchors, etc., shall conform to ASTM-A-7.
17. Concrete Channel Inserts	All	Continuous slot inserts, Unistrut, or approved equivalent. Heavy duty Series P-3200 or Light Duty Series P-3300 as required.
18. Adjustable Spot Insert	All	Adjustable spot insert Unistrut, or approved

		equivalent, P-3245. Design load 1000 lbs.

PART 3 - INSTALLATION

3.1. Unless otherwise specifically indicated or hereinafter specified in the specifications, all supporting, hanging and anchoring of piping, ductwork, equipment, etc., shall be done by each trade as is necessary for completion of the work and shall be as directed in the following paragraphs:

A. Supporting and hanging shall be done so that excessive load will not be placed on any one hangers so as to allow for proper pitch and expansion of piping. Hangers and supports shall be placed as near as possible to joints, turns and branches.

B. For concrete construction, utilize adjustable concrete inserts for fasteners. Expansion anchors and power driven devices may be used when approved in writing by the Architect/Engineer. Utilize beam clamps for fastening to steel joists and beams and expansion anchors in masonry construction. When piping is run in joists, piping shall be top mounted on trapeze type hangers with each pipe individually clamped to trapeze hanger.

C. Trapeze hangers shall be supported by steel rods of sufficient diameter to support piping from joists or concrete construction. Where desired or required, piping may be double mounted on trapeze hangers. Where conditions permit, trapeze hangers may be surface mounted on exposed joists by means of approved beam clamps, or to concrete construction by means of approved adjustable inserts or expansion anchors.

D. Install all miscellaneous steel other than designed building structural members as required to provide means of securing hangers, supports, etc., where piping does not pass directly below or cross steel joists.

E. Piping shall not be supported by the equipment to which it is connected. Support all piping so as to remove any load or stress from the equipment.

F. Where piping, etc., is run vertically, approved riser clamps, brackets or other means shall be utilized at approximately 10'-0" center to center minimum and an approved adjustable base stand or fitting on concrete support base shall be utilized at the base of the vertical run.

G. Where piping is run along walls, knee braced angle frames or pipe brackets with saddles, clamps, and rollers (where required) mounted on structural brackets fastened to walls or columns shall be used.

H. Support all ceiling hung equipment, with approved vibration isolators.

I. Where copper tubing is specified, hangers shall be of copper clad type when piping is uninsulated.

J. Uninsulated piping hung from above shall be supported with ring and clevis type pipe hangers. Uninsulated piping mounted on trapeze and wall bracket type support shall be held in place with U-bolts. U-bolts shall allow for axial movement in the piping.

K. All insulated piping shall be supported with clevis type and/or pipe roll hangers. Hangers shall be sized to allow the pipe insulation to pass through the hangers. Install insulation protection saddles at all hanger locations. Welded pipe saddles shall be installed at all hangers on

piping 5" and larger. The pipe saddles shall be sized for the thickness of insulation used. Hangers shall fit snugly around outside of insulation saddles.

L. Under no conditions will perforated band iron or steel wire driven hangers be permitted.

M. In general, support piping at the following spacing:

1. Steel and copper piping - 5 feet intervals for piping 3/4" and smaller. 6 feet intervals for 1 ¼" and 1" pipe. 8 foot intervals for piping 1 ½" and larger.

2. Polyethylene piping – 4 foot intervals for piping 2" and smaller. 5 foot intervals for 3" pipe. 6 foot intervals for 4", 6", and 8" pipe. 7 foot intervals for 10" and larger pipe.

3. Where the manufacturer of the pipe has more strict guidelines, the manufacturer's recommendations shall be followed.

END OF SECTION

SECTION 220100 - PLUMBING SPECIALTIES

1. GENERAL

1.1. The Contractor's attention is directed to the General Provisions – Plumbing and to all other Contract Documents as they apply to this branch of the work. Attention is also directed to all other sections of the Contract Documents which affect the work specified in this section.

1.2. The Contractor shall provide all equipment and specialties complete with trim required and connect in a manner conforming to the Kentucky Building Code.

1.3. The Contractor shall obtain exact centerline rough-in dimensions between partitions, walls, etc. as required for lay-out of his rough-in work. All work shall be roughed-in so that all exposed piping will be straight and true without bends or offsets.

1.4. Prior to final inspection, test by operation at least twice, all equipment.

1.5. Prior to final inspection, remove all stick-on labels, dirt, grease, other removable stampings, lettering, etc. from equipment and specialties and thoroughly clean same.

1.6. All equipment and specialties shall be installed as recommended by the manufacturer in a neat and workmanlike manner. Unacceptable workmanship shall be removed and replaced at the installing Contractor's cost.

1.7. All pipes, valves, fittings, fixtures, etc. for use in potable water systems 2” and below shall comply with federal lead free requirements that the lead content of wetted surfaces cannot exceed 0.25% by weight.

2. DRAINAGE SPECIALTIES

2.1. GENERAL

A. Provide all drainage specialties indicated, specified and/or required to provide complete and acceptable removal of all storm, sanitary, waste, laboratory waste, etc. from the building and into approved receptors.

B. Drainage specialties shall be on non-electrolytic conduction to the material to which they are connected.

C. Drainage specialties shall be installed in a manner so as to insure no leakage of toxic or odorous gases or liquids and shall have traps and/or backflow preventers where required. Nor shall they allow backflow into other or existing systems.

2.2. CLEANOUTS - INTERIOR (CO)

A. In addition to cleanouts indicated, provide cleanouts in soil and waste piping and storm drainage at the following minimum locations:

1. At base of each stack.
2. At fifty (50) foot maximum intervals in horizontal lines.
3. At each change of direction of a horizontal line.

4. As required by current KBC.
5. As required to permit rodding of entire system. (If in doubt, contact Engineers.)

B. Water closets, slop sinks and other fixtures with fixed traps shall not be accepted as cleanouts.

C. Cleanouts and/or test tees concealed in inaccessible pipe spaces, walls and other locations shall have an eight (8) inch by eight (8) inch (minimum) access panel or cover plates shall be set flush with finished floors and walls and shall be key or screw driver operable.

D. Access panels for cleanouts shall be of the Zurn, 1460 series or equivalent by Josam or Watts. Where they are not to receive paint, they shall be polished bronze unless otherwise indicated where they are to receive paint or other finishes. They may, at the Contractor's option, be Perma-Coated steel, prepared to receive finish.

E. Cleanouts and access panels shall be sized so as to permit the entry of a full sized rodding head capable of one hundred percent circumferential coverage of the line served.

F. Provide a non-hardening mixture of graphite and grease on threads of all screwed cleanouts during installation.

G. Do not install cleanouts against walls, partitions, etc. where rodding will be difficult or impossible. Extend past the obstruction.

H. In finished walls, floors, etc., insure that cleanouts are installed flush with finished surfaces and, where required, grout or otherwise finish in a neat and workmanlike manner.

I. Cleanouts shall be as manufactured by Zurn, Josam, Jay R. Smith, Watts, MIFAB, Ancon or equivalent, similar to the following:

1. Zurn, Z-1440 cleanouts or Z-1445 cleanout tee at base of exposed stack and at change in direction of exposed lines.

2. Zurn, Z-1440 cleanout or Z-1445-1 cleanout tee where stacks are concealed in finished walls

3. Zurn, ZN-1400-T cleanout with square scoriated top in finished concrete and masonry tile floors.

4. Zurn, ZN-1400-Tx cleanout with square recessed top for tile in vinyl and linoleum finished floors.

5. Zurn, ZN-1400-Z cleanout with round recessed top for terrazzo floors.

6. Mueller, No. D-731 or D-714, Nibco, Flage or equivalent for cleanouts in copper waste with cover plates and/or access panels listed for other cleanouts.

7. Threaded hex head type cleanouts of same materials as pipe for piping 2" and smaller.

8. Zurn, cleanout with round top with adjustable retainer for carpet area. Install flush with carpet.

3. WATER SUPPLY SPECIALTIES

3.1. GENERAL

A. Provide all water supply specialties indicated, specified and/or required for the complete installation. Install in a neat and workmanlike manner in accordance with the manufacturer's recommendations and the KBC.

B. Where required by the KBC, install code approved vacuum breakers in each water supply specialty.

C. **Independent check valves shall be installed at any location where a mixing valve is provided. Internal check valves to the mixing valves is not acceptable.**

3.2. HOSE BIBBS (HB)

A. Provide code approved hose bibbs with vacuum breakers and male threaded spouts at each location indicated and as follows:

B. Do not install hose bibbs spaces which do not have existing planned or installed floor drains even if sill cocks are indicated for these areas.

C. Hose bibbs shall be mounted at eighteen (18) inches above finished floor served.

D. The hose bibb shall be Zurn or equivalent similar to the following:

1. Zurn Z1350-VB Model. Encased moderate climate wall hydrant for narrow wall installation. Complete with bronze body, all bronze interior parts, replaceable seat washer, screwdriver operated stop valve in supply, key operated control valve, and ¾ [19] IP female inlet and ¾[19] male hose connection standard. Adjustable stainless steel box furnished with hinged cover, cylinder lock and “WATER” stamped on cover. Provide with 3/4 adapter vacuum breaker.

3.3. WATER HAMMER ARRESTORS (WHA): Provide water hammer arrestors at each location indicated and/or as required to eliminate hydrostatic on the domestic water system. Provide at least one water hammer arrestor at all quick acting valve locations including:

Automatic Clothes Washers – Type “A”
Commercial Dishwashers – Type “B”
Sterilizers – Type “D”
Mop Basins (downstream of check valve) – Type “A”
Flush valve fixtures - Type “B” (Each toilet room with 1-3 flush valve fixtures shall have its own Type “B” water hammer arrestor.)

A. Multiple Fixtures – Branch Line Less Than 20’ Long: The preferred location for a Zurn Shoktrol is at the end of the branch line between the last two fixtures when the branch lines do not exceed 20’ in length, from the start of the horizontal branch line to the last fixture supply on this line.

B. Multiple Fixtures – Branch Line More Than 20’ Long: On branch lines over 20’ in length, use two Shoktrols whose capacities total the requirement of the branch. Locate one unit between the last and next to last fixture and the other unit approximately midway between the fixtures.

C. Water hammer arrestors shall be Zurn, Z-1700, Shoktrol, Smith, Josam, Wade, or equivalent. Water hammer arrestors shall be stainless steel, bellows type. Field fabricated capped cylinders shall not be acceptable.

D. Note: Provide insulation unions where arrestors are of dissimilar material from the piping served (unless piping is non-conducting, such as ABS or PVC).

MARK	MANUFACTURER & MODEL	SIZE	P.D.I. SIZE
TYPE "A"	ZURN, Z-1700 # 100	1-11	A
TYPE "B"	ZURN, Z-1700 # 200	12-32	B
TYPE "C"	ZURN, Z-1700 # 300	33-60	C
TYPE "D"	ZURN, Z-1700 # 400	61-113	D

3.4. REDUCED PRESSURE BACKFLOW PREVENTERS (RPBP)

Watts #909 or equivalent reduced pressure backflow preventer. Provide with gate valves for isolation, FDA food grade strainer and air gap fitting. RPBP shall be UL listed.

3.5. DOUBLE CHECK VALVE ASSEMBLY

Watts #709 or equivalent double check valve assembly. Provide with FDA approved food grade strainer and gate valves for isolation. Assembly shall be UL listed.

4. GENERAL SPECIALTIES

4.1. VACUUM BREAKERS AND BACK FLOW PREVENTERS

Where required by the KBC, whether indicated or not, provide approved vacuum breakers or backflow preventers at the following locations.

A. Where domestic water system connects to fire protection system.

B. Where domestic water system connects to hydronic system.

C. At any hose (threaded) tap on the domestic water system.

END OF SECTION

SECTION 220200 – LABORATORY GAS AND VACUUM PIPING SYSTEMS

1. GENERAL

A. The Contractor's attention is directed to the General Provisions and to all other Contract Documents as they apply to this branch of the work. Attention is also directed to all other sections of the Contract Documents which affect the work of this section and which are hereby made a part of the work specified in this section.

B. The Contractor shall provide all equipment and specialties complete with trim required and connect in a manner conforming to the NFPA and all other applicable codes.

C. The Contractor shall obtain exact centerline rough-in dimensions between partitions, walls, etc., as required for lay-out of his rough-in work. All work shall be roughed-in so that all exposed piping will be straight and true without bends or offsets.

D. All equipment and specialties shall be new unless otherwise indicated or specified. They shall also be of equivalent quality, dimensions, materials, etc., as those specified.

E. All equipment and specialties shall be installed as recommended by the manufacturer.

F. All equipment and specialties shall be installed in a neat and workmanlike manner. Unacceptable workmanship shall be removed and replaced at the installing Contractor's cost.

G. Refer to applicable Division 26 sections for wiring and power.

H. Commissioning: This section specifies a system or a component of a system being commissioned as defined in Commissioning section. Testing of these systems is required, in cooperation with the Owner and the Commissioning Authority. Refer to Commissioning section for detailed commissioning requirements.

2. DESCRIPTION OF WORK

A. Extent of laboratory gas and vacuum piping system work is indicated on the drawings and by requirements of this section.

B. NFPA Compliance: Comply with requirements of NFPA Standard 99 Gas and Vacuum Systems. All portions of each system shall be listed by and bear the seal of UL, Inc., where a standard has been established for such.

C. Comply with ANSI/AWS A5.8 - Specifications for Brazing Filled Metal regarding pipe joint make-up.

D. Central Laboratory Gas and Vacuum Systems: Consisting of Specialty Gases, Laboratory Air (25 PSI and 100 PSI) and Vacuum Services; complete, ready for operation, including all necessary piping, fittings, valves, gauges and all necessary parts, accessories, connections and equipment.

E. Related Work

(1) Sealing around pipe penetrations to maintain the integrity of time rated construction.

(2) Sealing around pipe penetrations through the floor and roof to prevent moisture migration.

(3) Piping systems identification.

(4) Exposed piping and sleeves, and water piping, controls and accessories.

F. Quality Assurance

(1) Materials and Installation: In accordance with NFPA 99, and as specified.

(2) Equipment Installer: Show technical qualification and previous experience in installing laboratory gas equipment on three similar projects.

(3) Equipment Supplier: Show evidence of equivalent product installed at three installations similar to this project that has been in satisfactory and efficient operation for three years.

(4) Independent Laboratory Gas System Testing Organization:

a. Testing agency that is financially independent of laboratory gas equipment manufacturer and supplier.

b. Provide names of three projects where testing of laboratory gases and systems has been performed by the testing agency. Include the name of the project, names of such persons at that project who supervised the work for the project owner, and a written statement that the projects listed required work of similar scope to that set forth in this specification.

c. Submit the testing agency's detailed procedure which will be followed in the testing of this project. Include details of the testing sequences, procedures for cross connection, tests, outlet function tests, ceiling column function tests, alarm tests, purity tests, etc., as required by this specification. For purity test procedures, include data on test methods, types of equipment to be used, calibration sources and method references.

(5) Certification: Provide documentation upon completion of the testing to include all test results, the names of individuals performing work for the testing agency on this project, detailed procedures followed for all tests, and a certification that all results of tests were within limits allowed by this section.

3. DRAWINGS AND DESCRIPTIVE LITERATURE

The Contractor shall prepare and submit to the Architect and/or Engineer, seven (7) copies of shop drawings including, but not limited to, the following list:

A. Manufacturer's Literature and Data

(1) Piping.

(2) Valves.

B. Applicable Publications

(1) The publications listed below form a part of this specification to the extend referenced. The publications are referenced in the test by the basic designation only.

(2) Federal Specifications (Fed. Spec.):

WW-V-35C .....Valve, Ball

(3) American National Standards Institute (ANSI):

B16.22-89 .....Wrought Copper and Bronze Solder-Joint Pressure Fittings

B-40.1-85 .....Gauges-Pressure Indicating Dial Type-Elastic Element

(4) American Society for Testing and Materials (ASTM):

B88-88 .....Seamless Copper Water Tube

B280-88 .....Seamless Copper Tube for Air Conditioning and Refrigeration Field Service

(5) American Society of Mechanical Engineers (ASME):

Boiler and Pressure Vessel Code

Section VIII .....Pressure Vessels, Division I

(6) American Welding Society (CGA):

G-10.1-85 .....Nitrogen, Commodity

P-9-80 .....Inert Gases Argon, Nitrogen and Helium

V-5-78 .....Diameter Index Safety System (Non-Interchangeable Low Pressure Connections for Medical Gas Applications)

(7) National Electrical Manufacturers Associations (NEMA):

ICS-6-83 .....Enclosures for Industrial Control Systems

(8) National Fire Protection Association (NFPA):

99.....Gas and Vacuum Systems

(9) United States Pharmacopeia XXI/National Formulary XVI (USP/NF)

(10) National Association of Architectural Metal Manufacturers (NAAMM):

Metal Finishes Manual

4. LABORATORY GAS PIPING MATERIALS AND PRODUCTS

A. General

Provide piping materials and factory-fabricated piping products of sizes, types, pressure ratings, and capacities as indicated on drawings. Provide materials and products complying with the latest NFPA 99. Provide fittings of materials which match pipe materials used in medical gas piping systems including equipment connection.

(1) Piping shall be hard-drawn seamless medical gas tube, Type K or L (ASTM B819), and bear one of the following markings: OXY, MED, OXY/MED, ACR/OXY, or ACR/MED. Mains and branches in piping systems shall be not less than 1/2 in. nominal size.

(2) Brazing Alloy: Provide brazing that complies with the latest NFPA 99 Gas and Vacuum Systems.

(3) Threaded Joints: Provide threaded joints that complies with the latest NFPA 99 Gas and Vacuum Systems.

(4) Identification: The gas content of gas and vacuum piping systems shall be readily identifiable by appropriate labeling with the name of the gas contained. Such labeling shall be by the means of metal tags, stenciling, stamping or with adhesive markers in a manner that is not readily removable. Labeling shall appear on the piping at intervals of not more than 20 ft (6 m) and at least once in each room and each story traversed by the piping system. Where supplementary color identification of piping is used, it shall be in accordance with the gases and colors indicated in CGA Pamphlet C-9, Standard Color-Marking of Compressed Gas Cylinders Intended for Medical Use.

(5) General Requirements for Central Supply Systems:

a. Piping for laboratory air shall be capable of delivering flows and pressures consistent with their intended use, as noted on drawings.

b. A nitrogen system shall be capable of delivering at least 60 psig to all outlets at maximum flow.

B. Basic Piping Specialties

(1) General

Provide piping specialties complying with the latest NFPA 99 in accordance with the following listing:

a. Pipe Escutcheons.

b. Pipe Sleeves.

c. Sleeve Seals.

C. Basic Supports, Anchors and Seals

(1) General

Provide supports, anchors and seals complying with Division 48 in accordance with the following listing:

a. Adjustable swivel pipe rings for horizontal piping hangers and supports.

b. Two-bolt riser clamps for vertical piping supports.

c. Concrete inserts, C-clamps, and steel brackets for building attachments.

5. LABORATORY GAS SYSTEM COMPONENTS

A. General

Furnish and install per latest NFPA 99 requirements a complete vacuum, laboratory air, nitrogen, vacuum system, carbon dioxide systems, etc., including, but not limited to, the following list:

(1) Gauges

a. Pressure Gauges: Includes gauges temporarily supplied for testing purposes.

1) For Line Pressure Use Adjacent to Source Equipment: ANSI B40.1, pressure gauge, single, size 4-1/2, for compressed air and nitrogen accurate to within two percent, with metal case. Range shall be two times operating pressure. Dial graduations and figures shall be black on white background, or white on a black background. Gauge shall be cleaned for oxygen use, labeled for appropriate service, and marked "USE NO OIL." Install with gaugecock.

2) For All Services Downstream of Main Shutoff Valve: Manufactured expressly for oxygen use but labeled for appropriate service and marked "USE NO OIL," 1-1/2 inch diameter gauge with dial range 1-100 psig for air and 1-300 psig for nitrogen service.

b. Vacuum Gauges:

1) For vacuum line use adjacent to source equipment: ANSI B40.1, vacuum gauge, size 4-1/2" gauge for air, accurate to within two percent, with metal case. Range shall be 0-30 inches Hg. Dial graduations and figures shall be black on a white background, or white on a black background. Label for vacuum service. Install with gaugecock.

2) For vacuum service upstream of main shutoff valve: Provide 1-1/2 inch diameter gauge with steel case, Bourdon tube and brass movement, dial range 0-30 inches Hg.

c. All gauges shall be manufactured by Beacon Medaes, Amico, Puritan Bennett or equivalent.

(2) Pressure and Vacuum Switches and Relief Valves

a. General purpose, contact or mercury type, allowing both high and low pressure set points, with contact type provided with a protective dust cover; adjustable range set by

inside or outside adjustment; switches activate when indicated by alarm requirements.

b. Each central supply system shall have a pressure relief valve set at 50% above normal line pressure, installed downstream of the pressure regulator and upstream of any shutoff valve. This pressure relief valve may be set at a higher pressure provided another pressure relief valve set at 50% above normal line pressure is installed in the main supply line. All pressure relief valves shall close automatically when excess pressure has been released. Pressure relief valves set at 50% above normal line pressure shall be vented to the outside if the total capacity of the supply system is in excess of 2000 cu ft (57 m3) of gas. Pressure relief valves shall be of brass or bronze and especially designed for the gas service involved.

c. All pressure and vacuum switches shall be manufactured by Beacon Medaes, Amicoor equivalent.

(3) VALVES

a. General

1) All valves shall comply with the latest NFPA 99 Gas and Vacuum Systems.

b. Ball

1) Three Inches and Smaller: Fed. Spec. WW-V-35, Type II, Class A, Style 1, with brazed connections. Three-piece, Buna-N or teflon seat seals, full flow, 300 psig minimum working pressure, with locking type handle.

c. Check

1) Three Inches and Smaller: Brass body, self-aligning, spring loaded ball type check mating with teflon cone seat.

6. PURGING

A. After all laboratory gas piping systems have been tested, the source of the test gas shall be disconnected and the proper gas source of supply connected to each respective system. Following this connection and pressurization, all outlets shall be opened in a progressive order, starting nearest the source and completing the process of purge flushing at the outlet farthest from the source.

B. Purge gas shall be allowed to impinge upon a white cloth material at a minimum flow rate of 100 liters per minute until no evidence of discoloration is evident and the test gas used during the previous tests has been removed from the piping systems.

7. ANALYSIS

A. After completing the purge flushing of the piping in accordance with the latest NFPA 99, the flow of gas from each station outlet for oxygen, mixed gases containing oxygen and medical compressed air shall be tested with an oxygen analyzer to confirm the presence of the desired percentage of oxygen.

NOTE: Testing of outlets for other gases to confirm the presence of the designated gas is also required.

(1) Where mixtures are piped that involve a low concentration of one component, such as 95% oxygen and 5% carbon dioxide, an analyzer must be used having sufficient accuracy to properly indicate the mixture. This, in some cases, may require an analyzer specific to each component.

(2) The test specified in the latest NFPA 99, shall be conducted on the downstream portions of the medical gas piping system whenever a system is breached and whenever modifications are made or maintenance performed in anesthetizing locations or vital life support or critical area.

The only test required when the oxygen (pure or mixed) or medical compressed air portion of an existing piped medical gas system is repaired is an analysis test to assure that no cross-connection of gases has been created. This may seem unnecessary when replacing a broken outlet or zone valve, but it is very important to document that the correct gas is flowing out of a labeled outlet. There can be no compromises in patient safety with respect to gases that will be inhaled by patients.

Once verification and analysis have been conducted on a new or modified of a system, it does not have to be repeated until the system is again breached or modified.

B. Prior to the connection of any work to the systems, all tests shall be successfully performed. After connection to the systems and before use for patient care, the tests in the above sections shall be successfully completed.

C. The final connection shall be leak tested with the source gas at the normal operating pressures. This pressure shall be maintained until each joint has been examined for leakage by means of soapy water or other equally effective means of leak detection safe for use with oxygen.

8. INSTALLATION AND TESTING OF LABORATORY GAS SYSTEM

A. In accordance with the latest NFPA 99.

Before installation, all piping, valves, fittings and other components for all nonflammable laboratory gas systems shall be thoroughly cleaned of oil, grease and other readily oxidizable materials as is for oxygen service. After cleaning, particular care shall be exercised in the storage and handling of such material. Such material shall be temporarily capped or plugged to prevent recontamination before final assembly. Just prior to final assembly, such material shall be examined internally for contamination and shall be recleaned if necessary.

(1) Piping, valves, fittings and other components may be especially prepared in a facility equipped to clean, rinse and purge the material in accordance with the requirements of the latest NFPA 99 or may be prepared on the job site in accordance with NFPA 99. Trichloroethylene shall not be used in any cleaning operation at the job site. Carbon tetrachloride shall not be employed in any cleaning operation.

a. Piping, valves, fittings and other components that have been especially prepared shall have been cleaned in accordance with the provisions of CGA Pamphlet G-4.1, Cleaning Equipment for Oxygen Service. Such material shall be delivered capped or plugged and

shall be inspected prior to final assembly as required in the latest NFPA 99. If necessary, recleaning shall be done in accordance with NFPA 99.

b. Piping, valves, fittings and other components prepared at the job site shall be cleaned by washing in a hot alkaline cleaner-water solution, such as sodium carbonate or trisodium phosphate (proportion of one pound to three gallons of water). Scrubbing shall be employed where necessary to ensure complete cleaning. After washing, the materials shall be thoroughly rinsed in clean, hot water.

B. Comply with other specification section for exposed piping and sleeves.

C. Keep open ends of tube capped or plugged at all times. Wash and rinse unplugged, partially completed piping system in accordance with Article, Cleaning of Piping, Valves and Fittings.

D. Cut piping square and accurately with a tube cutter (sawing not permitted) to measurements determined at place of installation. Ream tube to remove burrs, being careful not to expand tube and so no chips of copper remain in the tube. Work into place without springing or forcing. Bottom tube in socket so there are no gaps between tube and fitting. Exercise care in handling equipment and tools used in cutting or remaining of tube to prevent oil or grease being introduced into tubing. Where contamination has occurred, rewash affected items in accordance with Article, Cleaning of Piping, Valves and Fittings.

E. Spacing of Hangers: Shall comply with the latest NFPA 99 but shall in no case be greater than 10 feet.

F. Rigidly support valves and other equipment to prevent strain on tube or joints.

G. Take care not to anneal copper tube while brazing. Braze only while purging the interior tube with nitrogen, minimum U.S.P. or Grade B as specified in CGA G-10.1.

All brazed joints in the piping shall be made up using brazing filler allows that bond with the base metals being brazed and that comply with Specification for Brazing Filler Metal, ANSI/AWS A5.8 and the latest NFPA 99.

H. Do not bend tubing. Use fittings.

I. Install pressure and vacuum switches to be easily accessed and provide access panel where installed above plaster ceiling.

J. Apply pipe labeling during installation process and not after.

K. Pipe compressor intake to a source of clean ambient air as indicated in the latest NFPA 99.

L. After initial leakage testing is completed, allow piping to remain pressurized with testing gas until testing agency perform final tests complying with the latest NFPA 99.

M. Penetrations

(1) Fire Stopping: Where pipes pass through fire partitions, fire walls, smoke partitions, or floor, install a fire stop that provides an effective barrier against the spread of fire, smoke and gases as specified in other sections. Completely will and seal clearances between raceways and openings with the fire stopping materials.

(2) Waterproofing: At floor penetrations, completely seal clearances around the pipe and make watertight with sealant as specified in other sections.

9. CERTIFICATION AND TESTS

A. Cross connection certification shall be the responsibility of the Contractor and shall be as follows:

(1) Cross-connection testing and certification of the medical-gas system shall be performed by medical gas testing agency.

(2) Laboratory gas system shall be tested in accordance with the latest NFPA 99.

(3) In addition to cross-connection testing, this specification shall require the laboratory gas testing agency to test each individual pipeline system component for performance to design specifications and the Contractor make any necessary adjustments to ensure a complete and working system.

(4) In the event the cross-connection test indicates contaminated or cross connected laboratory gas systems, it shall be the responsibility of the Contractor to correct the problems at no additional cost to the Owner. This procedure shall be repeated until the cross-connection test proves positive and is hence certified.

B. Tests

(1) Initial Tests: Blowdown, and high and low pressure leakage tests as required by the latest NFPA 99, with documentation.

(2) Laboratory Gas Testing Agency Shall Perform the Following:

a. Perform and document all cross connection tests, labeling verification, supply system operation and valve and alarm operation tests as required by and in accordance with NFPA 99 and the procedures set for in prequalification documentation.

b. Verify that the systems, as installed, meet or exceed the requirements of NFPA 99 and this specification and that the systems operate as required.

c. All Vacuum piing shall be pressure tested to 150 PSIG with Nitrogen with less than 5 psig pressure change over 24 hours.

d. Inlet Flow Test:

1) Vacuum inlets must draw no less than 3.0 scfm with adjacent inlet flowing, at a dynamic inlet pressure of 12-inches Hg and a static vacuum of 15-inches Hg.

10. QUALITY CONTROL/STARTUP

A. Major equipment and system startup and operational tests shall be scheduled and documented in accordance with Commissioning section.

B. Functional Performance Tests: System functional performance testing is part of the Commissioning Process as specified in Commissioning section. Functional performance

testing shall be performed by the contractor and witnessed and documented by the Commissioning Authority.

END OF SECTION

SECTION 220210 – DEIONIZED LABORATORY WATER SYSTEM (RO WATER)

1. GENERAL

A. Related Documents

(1) Drawings and general provisions of Contract, including General and Supplementary Conditions, General Mechanical Provisions, and Division 01 Specification sections, apply to work of this section.

B. Description of Work

(1) Provide a complete reverse osmosis piping system connected to existing RO piping loop.

(2) Install pipe accessories (such as escutcheons, sleeves, strainers, valves, hangers, gauges, etc.) furnished under other sections of the specifications, in piping systems.

C. Quality Assurance

(1) Codes and Standards:

a) Plumbing Code Compliance: Comply with applicable portions of Kentucky State Plumbing Code pertaining to selection and installation of plumbing materials and products.

b) UL and NEMA Compliance: Provide electric motors and products which have been listed and labeled by Underwriters; Laboratories (UL) and comply with National Electrical Manufacturers Association (NEMA) standards.

D. Product Delivery, Storage and Handling

(1) Protect pipe/tube with plastic end-cap protectors to prevent pipe-end damage and to eliminate dirt and moisture from pipe/tube interiors.

(2) Store reverse osmosis water piping and equipment indoors and protect from weather and construction traffic.

E. This section specifies a system or a component of a system being commissioned as defined in Commissioning section. Testing of these systems is required, in cooperation with the Owner and the Commissioning Authority. Refer to Commissioning section for detailed commissioning requirements.

2. PRODUCTS

A. General

(1) Piping for the system shall be of polypropylene materials. Support (horizontal sections) with full-length half-round galvanized steel troughs (formed sheet with 20-gauge minimum thickness).

B. Pipe, Fittings, and Valves

(1) Refer to Plumbing Piping Specification 220060.

C. Valves

(1) Polypropylene: Polypropylene body material with seats, seals, and other components suitable for potable water service. Comply with the following:

a) Ball Valves: Union type with socket or threaded ends.

b) Butterfly Valves: Lug type with locking, lever handle.

c) Check Valves, 2-inch NPS and Smaller: Diaphragm or ball type with threaded or socket ends.

d) Check Valves, 3-Inch NPS and Larger: Swing or ball type with flanged ends.

e) Zero-Dead Leg Valve: ASAHI #T343 Zero Dead Leg Diaphragm valve; Natural Polypropylene Body with IPS end connections & EPDM diaphragms.

3. EXECUTION

A. Installation of Deionized Water Distribution Piping

1) Install piping level with now pitch:

2) Locate groups of pipes parallel to each other, spaced to permit applying full insulation and servicing valves.

B. Hanger and Support Installation

(1) Refer to Division 22 Section Hangers and Supports for Plumbing Piping and Equipment" for pipe hanger and support devices. Install the following:

a) Riser clamps, MSS Type 8 or Type 42, for vertical runs.

b) Adjustable steel clevis hangers, MSS Type 1, for individual, straight, horizontal runs.

(2) Install supports according to Division 22 Section Hangers and Supports for Plumbing

(3) Support vertical piping and tubing at base and at each floor.

(4) Rod diameter may be reduced one size for double-rod hangers, with 3/8" (10-mm) minimum rods.

C. Installation of Valves

(1) Sectional Valves: Install on each branch and riser, close to main, where branch of riser serves 2 or more equipment connections, and elsewhere as indicated.
(2) Provide service valve at each faucet connections. Install valve between piping loop and faucet and allow for zero dead leg of piping.

D. Equipment Connections

(1) Piping Runouts to Equipment: Provide water piping runouts to equipment of sizes indicated, but in no case smaller than required by Kentucky State Plumbing Code.

E. Connections to Equipment by Others

(1) The laboratory outlets or dispensing assemblies will be furnished as part of the laboratory casework. (See Division II of these Specifications for casework). The Contractor under this Division shall install and connect to the outlets in accordance with casework shop drawings.

F. Field Quality Control

(1) Manufacturer's Field Service: Provide services of a factory-authorized service representative to supervise the field assembly of components and installation of reverse osmosis system, including piping and electrical connections, to start up system and to report results in writing.

(2) Conductivity Testing: Conduct conductivity tests of water at outlets to determine cleanliness of the system. If the resistance of outlet water is less than 10 megohms, the Contractor shall disassemble, clean and retest the system until system delivers 10 megohm water.

(3) Pressure test reverse osmosis water distribution piping as follows:

a) Test for leaks and defects in new piping. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.

b) Leave uncovered and unconcealed new, altered, extended, or replaced water piping until it has been tested and approved. Expose work that has been covered or concealed before it has been tested and approved.

c) Cap and subject piping to static water pressure of 150 psig without exceeding pressure rating of piping system materials. Isolate test source and allow to stand for 4 hours. Leaks and loss in test pressure constitute defects that must be repaired.

d) Repair leaks and defects with new materials and retest piping or portion thereof until satisfactory results are obtained.

e) Prepare reports for tests and required corrective action.

G. Startup

(1) Fill water piping. Check components to determine that they are not air bound and that piping is full of water.

(2) Perform the following steps before putting into operation:

a) Close drain valves, and hose bibbs.

b) Open shutoff valves to fully open position.

c) Open throttling valves to proper setting.

d) Remove plugs used during testing of piping and plugs used for temporary sealing of piping during installation.

END OF SECTION

SECTION 220220 - PLUMBING FIXTURES, FITTINGS AND TRIM

1. GENERAL

A. The Contractor's attention is directed to the General Provisions and to all other Contract Documents as they apply to this branch of the work. Attention is also directed to all other sections of the Contract Documents which affect the work of this section and which are hereby made a part of the work specified in this section.

B. The Contractor shall provide all fixtures complete with trim required and connect in a manner conforming to the State Plumbing Code.

C. The Contractor shall obtain exact centerline rough-in dimensions between partitions, walls, etc. as required for lay-out of his rough-in work. All work shall be roughed-in so that all exposed piping will be straight and true without bends or offsets.

D. All exposed piping or in casework below sinks, stops, traps, tailpieces, etc., shall be code approved chrome plated brass unless otherwise indicated or specified. Water supplies shall connect through walls with stops and chrome plated escutcheons with set screws.

E. All fittings, fixtures and trim shall be new unless otherwise indicated or specified. They shall also be of equivalent quality, dimensions, material, etc. as those specified. All faucets, drains, levers, trim, etc. shall be constructed of metal and not plastic.

F. Handicapped fixtures shall be mounted as recommended by the KBC and ADA.

G. All fixtures shall be mounted as recommended by the manufacturer. Fixtures shall be rigidly mounted to walls and floors. Pay particular attention to flush valves and bracket concealed portion to building structure during rough-in. Loose, shaky faucets, lavatories, etc. shall not be acceptable.

H. Prior to final inspection open all faucets and allow to run for fifteen (15) minutes, then remove all faucet aerators and thoroughly clean until smooth flow is obtained.

I. Prior to final inspection, test by operation at least twice:

(1) (Where applicable) adequate flow of hot and/or cold water at;

a. All Faucets
b. Hose Bibbs
c. All Other Valved Hot and/or Cold Water Openings In the Plumbing System

J. Prior to final inspection, remove all stick-on labels, dirt, grease, other removable stampings, lettering, etc. from plumbing fixtures and thoroughly clean same.

K. All sink and lavatory traps shall have screw in plugs in the bottom for ease of cleaning and have mechanical fittings for ease of removal.

L. All fixtures shall be set level and true and shall be grouted into finished walls, floors, etc. in a neat and workmanlike manner with an approved waterproof non-yellowing grout for such service.

M. Special Note for Handicap Grab Rails: Coordinate top of shower valves, flush valves, flush tank, etc., with location of grab rails as shown on the architectural plans. The Contractor shall install all items to allow for installation, removal and service without removal of the grab bar.

N. All exposed drain pipes and domestic water piping under handicap accessible sinks and lavatories shall be insulated in accordance with ADA requirements and shall have a vinyl plastic covering over all insulation.

O. The Contractor shall obtain a copy of the casework shop drawings and confirm sinks, faucets, gas turrets, etc., will fit in the space provided. Additionally, in ADA applications with handicap sink base cabinets, the Contractor shall limit the total distance from the bottom of the sink to the bottom of the P-trap and coordinate waste pipe rough-in height to ensure the proper installation of the handicap sink base cabinet front closure panel. The Contractor shall not order sinks until he confirms no conflicts occur and shall adjust sink sizes if required. If the Contractor orders sinks, faucets, etc., that do not fit in the casework supplied, he shall replace them at no additional cost.

P. All lavatories, sinks, etc. shall be supplied with center rear drain outlets where necessary to avoid conflict with casework, handicapped kneeboards, etc. If the Contractor orders sinks that do not fit in the casework supplied, he shall replace them at no additional cost.

Q. All gooseneck faucets shall have rigid spouts, unless swing spouts are specified. If swing spouts are specified, the spout shall have a maximum swing of 140 degrees from side to side.

R. All plumbing fixtures shall comply with federal lead free requirements that the lead content of wetted surfaces cannot exceed 0.25% by weight.

2. FIXTURES AND TRIM

Available Manufacturers: Subject to compliance with requirements of manufacturers offering plumbing fixtures and trim. Plumbing fixtures and trim, which may be incorporated in the work include, but are not limited to, the following:

A. Plumbing Fixtures - Lavatory

American Standard, U.S. Plumbing Products
Kohler Co.
Zurn Co.

B. Plumbing Faucet and Trim

American Standard, U.S. Plumbing Products
Chicago Faucet Co.
Kohler Co.
Delta Co.
T&S Brass & Bronze Work Co. (Commercial)
Zurn Co.
Just Co.

C. Service Sinks and Mop Basins

American Standard, U.S. Plumbing Products
Fiat Products
Kohler Co.

Stern-Williams Co., Inc.
Florestone

D. Stainless Steel Sink

Elkay Mfg. Co.
Just Mfg. Co.
Moen, Div. of Stanadyne/Western

E. Water Connection Box

Guy Gray Co.
Wolverine Brass, Inc.

F. P-Trap Insulation Kit (Trap Wrap)

Truebro
Brocar
Plumberex

Note: Lab Equipment, Special Equipment, Etc.

Contractor to provide final plumbing connections to all of the equipment furnished by Owner including, but not limited to: chrome supplies, stops, continuous drains, drain tailpiece, Kentucky Code "P" traps and escutcheons.

3. FIXTURE SELECTION

A. Refer to drawings for fixture schedule.

END OF SECTION

SECTION 222100 - VALVES AND COCKS-PLUMBING

1. GENERAL

A. The Contractor's attention is directed to the General Provisions and to all other Contract Documents as they apply to this branch of the work. Attention is also directed to all other sections of the Contract Documents which affect the work of this section and which are hereby made a part of the work specified herein.

B. The Contractor shall provide all valves required to control, maintain and direct flow of all fluid systems indicated or specified. This shall include for all Plumbing Systems.

C. All valves shall be designed and rated for the service to which they are applied.

D. The following type valves shall not be acceptable: Zinc, plastic, fiber or non-metallic.

E. Ball valves with temperature and pressure ports are not an acceptable alternative to the balancing valves specified herein. Valves that do not comply with these specifications shall be removed and replaced by the Contractor with no increase in contract price.

F. Each type of valve shall be of one manufacturer, i.e., gate valves, one manufacturer, globe valves, one manufacturer, silent check valves, one manufacturer, etc. The following valve manufacturers shall be acceptable: Lunkenheimer, Tour & Anderssen, Powell, Nibco, Crane, Jenkins, T & S Brass, Walworth, Milwaukee, DeZurik, Consolidated Valve Industries, Inc., Victaulic, Bell & Gossett, Flow Design, Watts, Victaulic.

G. All valves shall comply with current Federal, State and Local Codes.

H. All valves shall be new and of first quality.

I. All valves shall be full line size. Valves and hydronic specialties shall not be reduced to coil or equipment connection size. Size reductions shall be made at the connection to the equipment.

J. Angle stops for plumbing fixtures shall be quarter turn ball type.

K. All valves for use in potable water systems shall comply with federal lead-free requirements that the lead content of wetted surfaces cannot exceed 0.25% by weight.

2. LOCATION OF MAINTENANCE VALVES

Maintenance valves and unions, installed so as to isolate equipment from the system shall be installed at the following locations:

A. At each plumbing fixture.

B. At all other locations indicated on the drawings.

3. WORKMANSHIP AND DESIGN

A. Handwheels for valves shall be of a suitable diameter to allow tight closure by hand with the application of reasonable force without additional leverage and without damage to stem, seat and disc. Seating surfaces shall be machined and finished to ensure tightness against leakage for

service specified and shall seat freely. All screwed valves shall be so designed that when the screwed connection is properly made, no interference with, nor damage to the working parts of the valve shall occur. The same shall be true for sweat valves when solder or brazing is applied.

4. TYPES AND APPLICATION

A. CHECK VALVES

Check Valves shall be horizontal swing type with two-piece hinges, disc construction seats to be bronze and bronze discs or with composition face depending on service and provide silent operation. Valves 1-1/2 inches and smaller shall be bronze with ends to suit piping, have full area "Y" pattern body and integral seats. Valves 2 inches and larger shall be iron body brass mounted and with flanged ends. Working pressure for bronze valves shall be 150 psi and iron valves 125 psi when installed in piping with system pressures up to 100 psi and 250 psi for 100 psi and over. 3" and under NIBCO T433Y, greater than 3" NIBCO F918B (for less than 100 psi systems) greater than 3” NIBCO F968B (for 100 psi or greater systems). Victaulic 716/779 check valves allowed with grooved piping system.

B. BALL VALVES (POTABLE WATER)

All valves for use in potable water systems 2” and smaller contain less than 0.25% lead by weight and comply with federal lead free potable water requirements. Ball valves shall have a removable lever handle with vinyl grip, adjustable stem gland screw, reinforced Teflon stuffing box ring, blowout proof stem, stainless steel or bronze body, reinforced Teflon seats, stainless steel or chrome plate steel ball as manufactured by Apollo, Aslo, Nibco, Milwaukee, or equivalent. Provide a stem extension so that the base of the handle is ¼” above the insulation similar to Nibseal. NIBCO S-585-66-LF. Ball valves shall be provided with threaded connections per UK Standards.

C. BUTTERFLY VALVES

Butterfly valves shall be line sized cast iron body, lug style, 200 PSI rating (bubble tight) EPT or Viton seat, cartridge type; high strength stem. Disc to have ground and polished seating surface. Operator shall be locking lever style. Quality equivalent to Crane Monarch series. 3" and under NIBCO LD3222-3, greater than 3" NIBCO LD322-5. Valves 6” and over shall have gear driven operators. 3” and under Victaulic 608N, greater than 3” Vic-300 butterfly valves allowed with grooved piping system.

D. BALANCING VALVES

Bell & Gossett, Model CB circuit setter balancing valve or approved equivalent. Calibrated balancing valve shall have flanged connections suitable for 125# working pressure at 250°F. 4” and up shall be rated at 175# at 250°F working pressure. Provide with brass readout valves fitted with an integral EPT insert and check valve. Each balance valve shall have a calibrated nameplate to assure specific valve settings and be constructed with internal seals to prevent leakage. Valves shall be lead free for potable water systems.

E. GAUGE COCKS

Straight, Lunkenheimer, Fig. 1178; 125#; bronze; tee handle. FIP.

F. LUBRICATED PLUG COCKS

2" and under; Homestead Fig. 601; 150#; semi-steel; screwed; 2-1/2" and over; Homestead Fig. 602; ±50#; semi-steel; flanged.

END OF SECTION

SECTION 222200 - INSULATION - PLUMBING

1. GENERAL

A. The Contractor's attention is directed to the General provisions and to all other Contract Documents as they apply to this branch of the work. Attention is also directed to all other sections of the Contract Documents which affect the work of this section and which are hereby made a part of the work specified herein.

B. Work under this section shall include all labor, equipment, accessories, materials and services required to furnish and install all insulation, fittings and finishes for all mechanical systems specified herein and/or as indicated.

C. Application of insulation materials shall be done in accordance with manufacturer's written recommendations. Where thickness of insulation is not specified, use applicable thickness recommended by manufacturer for specific use. Insulation shall be applied by a company regularly engaged in the application of insulation and any work deemed unacceptable by the Engineers shall be removed and properly installed at the expense of the Contractor.

2. MANUFACTURERS

A. Insulation shall be as manufactured by Manville, Knauf, CertainTeed, Owens-Corning, Armacell or other approved equivalent. Insulation sundries, adhesives, and jackets/covers shall be as made by Benjamin Foster, Zeston, Speedline, Proto, Childers, Vimasco or approved equivalent.

3. FIRE RATINGS AND STANDARDS

A. Insulations, jackets and facings shall have composite fire and smoke hazard ratings as tested by ASTM E-84, NFPA 255 and UL 723 procedures not exceeding Flame Spread 25, Smoke Developed 50.

B. Adhesives, mastics, tapes and fitting materials shall have component ratings as listed above.

C. All products and their packaging shall bear a label indicating above requirements are not exceeded.

4. GENERAL APPLICATION REQUIREMENTS

A. Insulation shall be applied on clean, dry surfaces in a neat and workmanlike manner reflecting the best current practices in the trade. Insulation shall not be applied to piping or equipment until tested, inspected and released for insulation.

B. All insulation shall be continuous through walls, ceiling openings and sleeves. However, insulation shall be broken through fire walls. All covered pipe is to be located a sufficient distance from walls, other pipe and other obstacles to permit the application of the full thickness of insulation specified. If necessary, extra fittings and pipe are to be used. No noticeable deformation of insulation or discontinuity of vaporseal, where required, will be accepted.

C. "Concealed", where used herein, shall mean hidden from sight as in trenches, chases, furred spaces, pipe shafts, or above hung finished ceilings. "Exposed" shall mean that piping or equipment is not "concealed" as defined above. Piping and equipment in service tunnels, mechanical equipment rooms, storage areas, or unfinished rooms is to be considered as "exposed".

D. Existing and/or new insulation removed and/or damaged during course of construction shall be repaired or replaced as directed by the Engineer.

E. Vapor barrier jackets shall be applied with a continuous unbroken vapor seal. Do not use staples thru the jacket. NO EXCEPTIONS!

F. All insulation shall be installed with joints butted firmly together.

G. The Contractor shall insure that all insulation (piping, equipment, etc.) is completely continuous along all conduits, equipment, connection routes, etc. carrying cold fluids (air, water, other) and that condensation can, in no way, collect in or on the insulation, equipment, conduits, etc. Any such occurrence of condensation collection and/or damage therefrom shall be repaired solely at the expense of the Contractor.

5. PIPING SYSTEMS

A. GENERAL

(1) Bevel insulation and jacket at all points where insulation terminates at unions, flanges, valves and equipment. Note: Applies to hot water lines only; cold water lines require continuous insulation.

(2) Pipe insulation shall extend around valve bodies to above drain pans in hydronic equipment over pumps, etc. to ensure no condensation drip or collection.

(3) Factory molded fittings may be installed in lieu of built-up fittings. Jackets to be the same as adjoining insulation. Insulated fittings must have same or better K factors than adjoining straight run insulation.

(4) Valves, flanges and unions shall only be insulated when installed on piping whose surface temperature will be at or below the dew point temperature of the ambient air.

(5) Insulation shall not extend through fire and smoke walls. A UL-listed penetration system shall be used for each fire or smoke wall penetration in accordance with KBC. Materials used such as caulk, sleeves, etc. shall be manufactured by 3M, Hilti, or equal.

B. INSULATION SHIELDS

(1) Metal insulation shields are required at all pipe hangers where the piping is insulated. Metal shields shall be constructed of galvanized steel, formed to a 180 degree arc. Insulation shields shall be the following size:

PIPE SIZE	SHIELD GAUGE	SHIELD LENGTH
2" AND LESS	20	12"
2 1/2" TO 4"	18	12"
5" TO 10"	16	18"
12" AND GREATER	14	24"

C. INSULATION MATERIAL (FOR THE FOLLOWING SYSTEMS)

Insulation shall be Owens-Corning Model 25ASJ/SSL, or approved equivalent fiberglass pipe insulation with an all service jacket. The insulation shall be a heavy density, pipe insulation with a K factor .23 at 75°F mean temperature. The insulation shall be wrapped with a vapor barrier jacket approved manufacturers are listed in section 2. Manufacturers. The jacket shall have an inside foil surface with self sealing lap and a water vapor permeability of .02 perm/inch. All circumferential joints shall be vapor sealed with butt strips. All insulation shall be installed in strict accordance with the manufacturers' recommendations. The following pipes shall be insulated with the thickness of insulation as noted.

(1) Domestic Cold Water, Domestic Soft Cold Water and Animal Water Supply.

a. Piping 3'' or less – use 1" thick insulation.

b. Piping 4'' or greater – use 1'' thick insulation.

(2) Domestic Hot Water and Recirculating Hot Water.

a. Piping 1 ½'' or less – use 1 ½'' thick insulation.

b. Piping 2'' or greater – use 2'' thick insulation.

(3) Horizontal Roof Leaders.

a. Piping 3'' or less – use 1/2" thick insulation

b. Piping 4'' or greater – use 1'' thick insulation

(4) RO Water piping shall not require insulation.

(5) Tepid Water piping shall not require insulation.

END OF SECTION

SECTION 23 0000 GENERAL HVAC REQUIREMENTS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Specification requirements defined in Division 20 of this Specification apply to, and are in addition to the work associated with equipment, systems, materials, and installation requirements specified in Division 23. Contractor shall provide the requirements specified in Division 20 to obtain complete systems, tested, adjusted, and ready for operation.

1.2 RELATED WORK

A. Section 20 0000 - General Mechanical Requirements

B. Section 20 0513 - Motors

C. Section 20 0529 - Mechanical Supporting Devices

D. Section 20 0553 - Mechanical Systems Identification

E. Section 20 0573 - Mechanical Systems Firestopping

F. Section 20 0700 - Mechanical Systems Insulation

1.3 BUILDING SYSTEMS COMISSIONING

A. “An independent third party Commissioning Agent will document completion of the Mechanical, Fire Suppression, Plumbing, HVAC, Electrical, Communications and Electronic Safety and Security Systems for the project. The Construction Manager and Division Contractors are members of the Commissioning Team and will facilitate completion of the Commissioning process. Refer to section 019113 “Building Systems Commissioning” for the project Commissioning requirements and roles and responsibilities of each member of the Commissioning Team.”

PART 2 - *PRODUCTS*

2.1 NOT APPLICABLE TO THIS SECTION.

PART 3 - EXECUTION

3.1 NOT APPLICABLE TO THIS SECTION.

END OF SECTION

SECTION 23 0550 VIBRATION ISOLATION

PART 1 - GENERAL

1.1 RELATED WORK

A. Section 20 0529 - Mechanical Supporting Devices

B. Section 23 3314 - Ductwork Specialties (Duct Flexible Connections)

1.2 REFERENCE

A. Work under this Section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.

1.3 DESIGN CRITERIA

A. Isolate all motor driven mechanical equipment, unless otherwise noted, from building structure, and from systems that they serve, to prevent equipment vibrations from being transmitted to structure. Unless specifically indicated, follow the latest edition of ASHRAE Application Handbook - Sound and Vibration Control, or manufacturer's recommendations for isolator selection whichever is more stringent.

B. Select and locate isolators to produce uniform loading and deflection. Use minimum of 4 isolators to support each piece of equipment.

C. Select vibration isolation devices based on the lowest operating speed of equipment.

D. Vibration Criteria:

1. All rotating equipment shall operate at speeds less than 80% of their true critical speed. Unless otherwise required, equipment shall be balanced according to recommendations given in the following schedules.
2. Vertical vibration of rotating equipment shall not be greater than levels indicated. Vibration shall be measured on equipment. If equipment has inertia base, allowable vibration level is reduced by ratio of equipment weight alone to equipment weight plus inertia base weight.

Equipment Speed rpm	Maximum Allowable Vibration Displacement Peak-to-Peak (mil)
100 to 200	10
200 to 300	6
300 to 600	4
600 to 1000	3
1000 or 2000	2
over 2000	1

1.4 SUBMITTALS

A. Submit Shop Drawings including, but not limited to, the following:

1. Manufacturer's name

2. Isolator type and model number
3. Materials of construction and finish
4. Dimensional data
5. Load ratings (lbs)
6. Isolator free and operating heights
7. Static deflections
8. Isolation efficiency based on lowest operating speed
9. All other appropriate data

1.5 SUPERVISION, INSPECTION AND CERTIFICATION

A. Vibration isolation manufacturer or qualified representative shall provide supervision to assure correct installation and adjustment of isolators. Upon completion of installation and after system is put into operation, manufacturer or manufacturer's representative, shall make final inspection, adjustment, and submit report to Engineer in writing, certifying correctness of installation and compliance with Specifications.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Materials used shall retain their isolation characteristics for life of equipment served. Elastomeric materials shall comply with ASTM D2240 and shall be oil-resistant industrial grade neoprene.

B. Isolators shall be treated to resist corrosion.

C. Isolation devices subject to weather shall have either hot-dip or cold-dip galvanized, cadmium plated, or neoprene coated finish after fabrication and be furnished with limit stops to resist wind.

D. Vibration isolator springs shall have minimum additional travel to solid equal to 50% of rated deflection.

E. Ratio of lateral to vertical stiffness of vibration isolators shall not be less than 0.8 or greater than 2.0.

F. Coordinate selection of devices with isolator and equipment manufacturer.

2.2 MANUFACTURERS

A. Mason Industries, Amber/Booth Co., Aeroflex-VMC-Korfund. Vibration Eliminator, Vibro-Acoustics, or Kinetics equal to manufacturer's model listed, except flexible pipe connections.

B. Mason, Metraflex, Proco, Twin City Hose, Engineered Flexible Products (EFP) or Flex-Weld/Keflex for flexible pipe connections.

2.3 TYPE 5 HANGERS (SPRING HANGER WITH NEOPRENE)

A. Mason Type 30N, vibration hangers with steel spring and neoprene element in series. Neoprene element shall be molded with rod isolation bushing that passes through hanger box. Spring diameters and hanger box lower hole sizes shall be large enough to permit hanger rod to swing through 30° arc before contacting hole and short circuiting spring.

B. Mason Type DNHS may be used where load rating and specified deflection cannot be accommodated by Type 30N.

2.4 TYPE 8 HANGERS (SPRING HANGER WITH NEOPRENE)

A. Mason Type 30, W30, or PC30 steel spring located in neoprene cup manufactured with grommet to prevent short-circuiting of hanger rod. Neoprene cup to contain steel washer designed to properly distribute load on neoprene and prevent its extrusion. Spring diameters and hanger box lower hole size to be large enough to permit hanger rod to swing through 30° arc before contacting hole and short-circuiting spring. Provide hangers with rod attachments or eyebolts on spring end.

2.5 FLEXIBLE PIPING CONNECTORS

A. Flexible connectors shall be suitable for pressure, temperature and fluid involved, but not less than 215 psig working pressure at 250°F for 14” and smaller and 150 psi working pressure at 250°F for 16” and larger.

B. Flexible connectors shall be straight pipe configuration and shall not be used to replace pipe fittings such as elbows.

C. Unless otherwise specified, minimum live length of flexible connector shall be as follows.

Nominal Pipe Diameter (in)	Minimum Live Length (in)
2-1/2” and smaller	12”
3” and 4”	18”
5” and larger	24”

D. Water System:
   1. Connection to Non-rotating Equipment Mounted on Vibration Isolators:
      a. Seamless corrugated bronze or stainless steel flexible connector with braided cover for 2" and smaller with threaded or flanged connections; seamless corrugated stainless steel flexible connector with braided cover for 2-1/2" and larger with flanged connections.

E. Steam and Condensate Including Pumped Condensate System:
   1. Seamless corrugated stainless steel flexible connector with braided cover for 2" and smaller with threaded or flanged connections; seamless corrugated stainless steel flexible connector with braided cover for 2-1/2" and larger with flanged connections.

2.6 PERFORMANCE

A. Select vibration isolation devices to achieve either minimum 95% isolation efficiency or minimum static deflection and mounting requirements listed below, whichever is greater. Minimum static deflections listed below are not nominal but certifiable minimums with actual installed load. Unless otherwise indicated, apply requirements listed for floor mount for roof-mounted equipment.

B. Suspended Piping 2.5” and larger: Use Type 5 hangers with 0.75” minimum deflection.

C. Suspended Ductwork: For ductwork with air velocities greater than 2000 fpm and duct cross sectional area greater than or equal to 2.0 sq ft. use Type 8 hangers with 0.75” minimum static deflection.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install and adjust vibration isolation devices as specified, as shown on drawings and according to manufacturer's recommendations.
   1. Adjust isolators after piping system is at operating weight.
   2. Adjust limit stops on restrained spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.
   3. Adjust active height of spring isolators.
   4. Adjust restraints to permit free movement of equipment within normal mode of operation.
   5. Adjust air-spring leveling mechanism.

B. In no case shall installation short circuit isolation devices.

3.2 FLEXIBLE PIPING CONNECTIONS

A. Install flexible connections on equipment side of shut off valves and horizontal and parallel to equipment shafts where applicable.

B. For non-metallic flexible piping connections, 2-1/2" and larger, use flange type recommended by manufacturer. Flanges for mechanical grooved connections are not allowed.

END OF SECTION

SECTION 23 0594 WATER SYSTEMS TEST ADJUST BALANCE

PART 1 - GENERAL

1.1 RELATED WORK

A. Section 23 0901 - Control Systems Integration

B. Section 23 0993 - Control Sequences

C. Section 23 2118 - Valves (balancing valves)

D. Section 23 2120 - Piping Specialties (flow measure devices)

1.2 REFERENCE

A. Work under this Section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.

1.3 DESCRIPTION

A. This Contractor shall be responsible for providing complete testing, adjusting and balancing (TAB) work for HVAC hydronic systems, such as chillers, pumps, convertors and other processes included in this project.

B. Work required shall consist of setting volume flow rates and adjusting speed controls, recording data, making tests, and preparing reports, as specified herein.

C. Scope of work includes TAB of new work specified herein and includes all equipment, distribution systems, and terminal units connected.

D. Scope of work also includes TAB of HVAC hydronic systems associated with the core and shell scope of work as defined by drawings, schedules, or specified in this Section.

E. TAB work shall be performed by persons trained in TAB work and certified by Associated Air Balance Council (AABC) or National Environmental Balancing Bureau (NEBB). Procedures shall be in accordance with the latest edition of AABC, NEBB or TABB Standards, ASHRAE - 2011 HVAC Applications Chapter 38, and as detailed herein.

F. Mechanical Contractors who are members of AABC, NEBB or TABB and who have qualified personnel available to perform work may submit Quality Assurance Submittal for approval. Mechanical Contractors who cannot meet these requirements shall subcontract with independent TAB Contractor who meets these requirements. TAB subcontractor shall prepare Quality Assurance Submittal for Contractor who will submit it for approval.

G. Upon direction of Architect/Engineer or TAB subcontractor, Mechanical Contractor shall provide at no additional cost to Owner, any additional work and/or devices necessary to properly balance system, including calibrated balancing valves, gauge tappings, flow sensors, and thermometer wells. Mechanical Contractor shall be responsible for trimming and balancing pump impellers as necessary to obtain design pump flow rates at the minimum pressure differential.

H. TAB work shall not proceed until all assigned personnel have been approved by Architect/Engineer via Quality Assurance Submittal. Coordinate each phase of TAB work with overall project

schedule. Each phase of TAB work shall be done in timely manner as detailed herein. Fieldwork must be completed before occupancy. Certificate of Substantial Completion shall not be issued until after Final Report is accepted by Architect/Engineer.

1.4 SUBMITTALS

A. General:
   1. Make submittals in accordance with project submittal procedure. Submit minimum of 5 copies of submittals unless otherwise directed (3 for O&M Manuals, 1 for A/E, 1 for Contractor).
   2. Reports shall be assembled using 3-ring hard cover binder with project name and location on cover and side panel. Information sheets shall be 8-1/2" x 11" white bond paper. Use pre-printed forms of NEBB, AABC or TABB wherever possible. Provide sortable electronic version as well as hard copy. Provide numbered tabs for each system. Assemble report in the following order:
      a. Transmittal letter
      b. Cover sheet with project title, location, submittal date, and name and addresses of Owner, Mechanical Contractor, TAB subcontractor, Architect, and Engineer
      c. Index of numbered tabs listing major systems
      d. Data organized by system in the following order:
         1). Equipment data and measurement summary
         2). Equipment measurement data
         3). Branch main measurement data
         4). Terminal device measurement data arranged by room or zone

B. Quality Assurance Submittal:
   1. Within 30 days of signing contract, Contractor shall submit the following information:
      a. Firm resume
         1). AABC, NEBB or TABB active membership certificate
         2). Names of 3 recent relevant completed projects along with project address, Owner's contact person, supervising design professional
      b. Supervisor resume
      c. Balance technicians resumes
   2. Architect/Engineer and/or Owner reserves the right to contact previous project representatives and to reject persons whom Architect/Engineer and/or Owner feel are not qualified for this project due to lack of relevant experience or problems on previous projects.

C. Planning Report:
   1. Submit Planning Report as detailed in Part 3 of this Section to demonstrate to Architect/Engineer and Owner that proper procedures are being followed. Submit Planning Report after Quality Assurance submittal and 30 days before any fieldwork starts.

D. Initial Test Report:
   1. Prior to starting Final Balance Phase, submit Initial Test Report as detailed in Part 3 of this Section to indicate to Architect/Engineer and Contractor incomplete work or problem areas to be resolved before final balance is completed.

E. Final Report:

1. Within 30 days after fieldwork is completed, submit Final Report as detailed in Part 3 of this Section to assure design objectives are met and to assist Owner in future maintenance.

1.5 REFERENCE STANDARDS

A. Refer to the latest publications of NEBB, AABC, TABB and ASHRAE publications for establishing required procedures.

PART 2 - PRODUCTS

2.1 INSTRUMENTATION

A. Provide required instrumentation to obtain proper measurements. Application of instruments and accuracy of instruments and measurements shall be in accordance with requirements of NEBB or AABC or TABB Standards and instrument manufacturer's specifications.

B. Instruments used for measurements shall be accurate, and calibration histories for each instrument shall be available for examination by Architect/Engineer upon request. Calibration and maintenance of all instruments to be in accordance with requirements of NEBB, AABC or TABB Standards.

PART 3 - EXECUTION

3.1 GENERAL

A. TAB work shall be done in separate phases as outlined herein. TAB schedule shall allow ample time to complete TAB work before occupancy. Follow procedures outlined herein and as described in Planning Phase narratives.

B. Unless otherwise specified, maximum acceptable offset tolerance shall be ± 10% of design flow rates indicated on drawings and schedules.

3.2 PLANNING PHASE

A. Procedure:
   1. Obtain the latest Contract Documents including addenda, construction bulletins and change orders. Obtain shop drawings and performance curves from Mechanical Contractor for pumps, flow measuring devices, and terminal devices. Prepare Planning Report as detailed herein. Make adjustments in Planning Report and/or measuring instrument calibration.

B. Planning Report:
   1. Planning Report shall contain the following minimum requirements.
   2. Narratives: Furnish written narratives of procedures to be used. Include separate narratives for each pump and liquid fluid handling system. Identify flow-measuring devices to be used at each pump and terminal device. Include different narratives for constant and variable flow systems. For non-standard water systems, include narratives on how to measure and adjust for different viscosities. Narratives shall include references to published standards of NEBB or AABC. Narratives shall include measuring instruments to be used and ranges required for each procedure. Narratives shall include specified adjustment tolerances.
   3. Prebalance Checklist shall include, but not be limited to:
      a. Check for completeness of work

b. System cleaning
c. System fill and air venting
d. Place system into operation
e. Check expansion tanks and fill pressures
f. Pump bearings, alignment, starters, vibration isolators, rotation
g. Setting valves to proper position including shut-off and bypass valves
h. Set up of controls and control devices

4. Measuring Instrument List: List of measuring instruments will be used for each procedure. Indicate ranges required for each procedure. Provide data on each measuring instrument to be used. This data shall include:
   a. Manufacturer name and model number
   b. Measurement range
   c. Pressure/temperature limits
   d. Date put into service
   e. Date of last calibration
   f. Certificate from calibration firm
5. Architect/Engineer reserves the right to request adjustments in any procedure and/or ask for recalibration of any measuring instrument that has not been recalibrated within past year.
6. Samples: Submit copies of TAB forms to be used.
7. Branch circuit and terminal measurements and adjustments: Indicate on pre-printed forms all measurements to be taken and adjustments to be made in field. Include branch circuit or terminal identification, system, space served, location, design flow rates (including zone and system summaries), and flow measuring device size, type, Cv, and manufacturer. Indicate the initial set points on forms.

3.3 SET-UP PHASE

A. Procedure:
   1. Perform prebalance checkout as per Planning Phase narrative.

B. Initial Test:
   1. Measure pump data and flow rates in "as found" condition after initial valve settings are made.

C. Initial Test Report:
   1. Submit report to Architect/Engineer and Mechanical Contractor indicating measurements made and including notes of items that are not complete or are not within design tolerance.

3.4 FINAL BALANCE PHASE

A. Procedure:
   1. Perform procedures as per Planning Phase narrative. Correct deficiencies and redo procedures as required prior to submitting Final Report.

B. Final Report:
   1. Submit report to Architect/Engineer and to Mechanical Contractor indicating all data, measurements and adjustments as per requirements herein and per Planning Phase narrative. Do not submit partial or incomplete reports.

C. Final Report Adjustments:

1. Architect/Engineer reserves the right to check any measurement or adjustment made and to reject any portion of work not within specified tolerance. Contractor shall resubmit all or portions of Final Report as directed by Architect/Engineer.

END OF SECTION

SECTION 23 0595 AIR SYSTEMS TEST ADJUST BALANCE

PART 1 - GENERAL

1.1 RELATED WORK

A. Section 23 0901 - Control Systems Integration

B. Section 23 0993 - Control Sequences

C. Section 23 3314 - Ductwork Specialties

1.2 REFERENCE

A. Work under this Section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.

1.3 DESCRIPTION

A. This Contractor shall be responsible for providing complete testing, adjusting and balancing (TAB) work for air systems, such as air handling units, return fans, exhaust fans, air terminal devices, diffusers, grilles and other air moving processes included in this project.

B. Work required shall consist of setting volume flow rates and adjusting speed controls, recording data, making tests, and preparing reports, as specified herein.

C. Scope of work includes TAB of new work specified herein and includes all equipment, distribution systems, and terminal units connected.

D. Scope of work also includes TAB of air systems associated with the core and shell scope of work as defined by drawings, schedules, or specified in this Section.

E. TAB work shall be performed by persons trained in TAB work and certified by Associated Air Balance Council (AABC), National Environmental Balancing Bureau (NEBB), or Testing, Adjusting and Balancing Bureau (TABB). Procedures shall be in accordance with the latest edition of AABC, NEBB or TABB Standards, ASHRAE - 2011 HVAC Application Chapter 38, and as detailed herein.

F. Mechanical Contractors who are members of AABC or NEBB and who have qualified personnel available to perform work may submit Quality Assurance Submittal for approval. Mechanical Contractors who cannot meet these requirements shall subcontract with independent TAB Contractor who meets these requirements. TAB subcontractor shall prepare Quality Assurance Submittal for Contractor to submit for approval.

G. TAB Contractor shall perform ductwork leakage tests. Refer to Section 23 3114 - Ductwork. Test equipment will be provided by Mechanical Contractor.

H. Upon direction of Architect/Engineer or TAB subcontractor, Mechanical Contractor shall provide at no additional cost to Owner, any additional work and/or devices necessary to properly balance system, including fan sheaves, motor sheaves and/or drive belts.

I. TAB work shall not proceed until assigned personnel have been approved by Architect/Engineer via Quality Assurance Submittal. Coordinate each phase of TAB work with overall project schedule. Each phase of TAB work shall be done in timely manner as detailed herein. Fieldwork

must be completed before occupancy. Certificate of Substantial Completion shall not be issued until after Final Report is accepted by Architect/Engineer.

1.4 SUBMITTALS

A. General:
   1. Make submittals in accordance with project submittal procedure. Submit minimum of 5 copies of submittals unless more directed (3 for O&M Manuals, 1 for A/E, 1 for Contractor).
   2. Reports shall be assembled using 3-ring hard cover binder with Project Name and location on cover and side panel. All information sheets shall be 8-1/2" x 11" white bond paper. Use preprinted forms of NEBB, AABC or TABB wherever possible. Provide sortable electronic version as well as hard copy. Provide numbered tabs for each system. Assemble report in the following order:
      a. Transmittal letter
      b. Cover sheet with Project title, location, submittal date, and name and addresses of Owner, Mechanical Contractor, TAB subcontractor, Architect, and Engineer
      c. Index of numbered tabs listing major systems
      d. Data organized by system in the following order:
         1). Equipment data and measurement summary
         2). Equipment measurement data
         3). Branch main measurement data
         4). Terminal device measurement data arranged by room or zone

B. Quality Assurance Submittal:
   1. Within 30 days of signing contract, Contractor shall submit the following information:
      a. Firm resume
         1). AABC or NEBB active membership certificate
         2). Names of 3 recent relevant completed projects along with project address, Owner's contact person, supervising design professional
      b. Supervisor resume
      c. Balance technician(s) resume
   2. Architect/Engineer and/or Owner reserves the right to contact previous project representatives and to reject persons whom Architect/Engineer and/or Owner feel are not qualified for this project due to lack of relevant experience or problems on previous projects.

C. Planning Report:
   1. Submit Planning Report as detailed in Part 3 of this Section to demonstrate to Architect/Engineer and Owner that proper procedures are being followed. Planning Report shall be submitted after Quality Assurance submittal and 30 days before any fieldwork starts.

D. Initial Test Report:
   1. Prior to starting Final Balance Phase, submit Initial Test Report as detailed in Part 3 of this Section to indicate to Architect/Engineer and Contractor incomplete work or problem areas to be resolved before final balance is completed.

E. Final Report:
   1. Within 30 days after fieldwork is completed, submit Final Report as detailed in Part 3 of this Section to assure design objectives are met and to assist Owner in future maintenance.

F. LEED Submittal:
   1. Air Balance Report for LEED IEQ Prerequisite 1: Documentation of work performed for ASHRAE 62.1-2007, Section 7.2.2, “Air Balancing”.

1.5 REFERENCE STANDARDS

A. Refer to the latest publications of NEBB, AABC, TABB, ASHRAE, and Sheet Metal and Air Conditioning Contractors' National Association (SMACNA) publications for establishing required procedures.

PART 2 - PRODUCTS

2.1 INSTRUMENTATION

A. Provide all required instrumentation to obtain proper measurements. Application of instruments and accuracy of instruments and measurements shall be in accordance with requirements of NEBB, AABC or TABB Standards and instrument manufacturer's specifications.

B. Instruments used for measurements shall be accurate, and calibration histories for each instrument to be available for examination by A/E upon request. Calibration and maintenance of instruments to be in accordance with requirements of NEBB, AABC or TABB Standards.

2.2 INSTRUMENT TEST HOLE PLUGS

A. Center-pull plugs similar to Alliance Plastics CP Series. Plug material shall be Grade 1 virgin polyethylene.

PART 3 - EXECUTION

3.1 GENERAL

A. TAB work shall be done in separate phases as outlined herein. TAB schedule shall allow ample time to complete TAB work before occupancy. Follow procedures outlined herein and as described in Planning Phase narratives.

B. Unless otherwise specified, maximum acceptable offset tolerance is plus or minus 10% of the design flow rates as indicated on drawings and/or as scheduled.

C. For spaces where supply airflow rates and exhaust airflow rates are used to maintain pressure relationships, such as lab spaces, operating rooms, cath labs, ICU rooms, isolation rooms, clean rooms, dirty rooms and animal rooms, maximum acceptable supply air offset shall be 0 to +10% of design flow rate. Associated exhaust air (or return air) flow rate shall be balanced to provide indicated airflow differential between supply air and exhaust air (or return air) after supply air system has been balanced.

3.2 PLANNING PHASE

A. Procedure:
   1. Obtain the latest Contract Documents including addenda, applicable construction bulletins and change orders. Obtain shop drawings and performance curves from Mechanical Contractor for fans, flow measuring devices, and all terminal devices. Prepare Planning Report as detailed herein. Make adjustments in Planning Report and/or measuring instrument calibration.

B. Planning Report:
   1. Planning Report shall contain the following minimum requirements.
      a. Samples: Provide copies of all forms to be used.
      b. General narratives: Furnish written narratives of all procedures used. Include separate narratives for each fan and air handling system. Identify flow-measuring devices to be used at each fan, air terminal device, and air outlet. Narrative shall include statement that every air outlet shall be measured and adjusted. Provide different narratives for constant and variable flow systems. Narratives shall include references to published standards of NEBB or AABC. Narratives shall include measuring instruments to be used and ranges required for each procedure. Narratives shall include specified adjustment tolerances.
      c. Air system narratives: Provide narratives for each air system which shall include procedures for measuring static pressures at each component of air handling system to generate a static pressure profile. Measurements shall be made to measure performance of system in all operating modes including economizer mode using 100% outside air where applicable. Differentiate between constant and variable flow systems.
      d. Non-standard air system narratives: Include narratives on how to measure and adjust for different air densities for systems with static pressures greater than 8" WG or temperatures greater than 140°F.
      e. Air terminal narratives: Narratives shall describe procedures for measuring flows and adjusting controls to meet specified minimum and maximum flow rates based on actual field installed conditions.
      f. Branch duct and air outlet measurements: Indicate on preprinted forms all measurements to be taken in field. Include branch duct or air outlet identification, system, space served, location, and design flow rates (include zone and system summaries). Indicate duct or air outlet neck size, make, model number, and design velocities.
      g. Pressure relationship test narrative: Narratives shall describe how to obtain and measure pressure relationships between spaces as per schedule or as listed below.
         1). Laboratories
         2). Operating Rooms
         3). Isolation Rooms
         4). ICU Rooms
         5). Animal Holding Rooms
         6). Procedure Rooms
      h. Clean Room Certification: this work is not included under this Section and is part of clean room package.
      i. Fume Hood Certification: Narrative shall include procedures as described in Scientific Equipment and Furniture Association (SEFA) Standard SEFA 1-2006. Each hood shall be labeled with:
         1). Test date
         2). Name of tester
         3). Sash position at 100 fpm and 125 fpm
         4). Hood Classification
      j. Refer to fume hood specification for sash type of each hood, design exhaust rate and sash design opening size. Design airflows are based on design operating sash opening and 100 fpm face velocity at the sash opening. Hoods handling isotopes, perchloric acids, and/or carcinogens shall have minimum face velocity of 125 fpm.

2. Prebalance Checklist - to include, but not limited to:
   a. Check for completeness of work
   b. System cleaning if required
   c. Check fire, smoke and balancing damper positions
   d. Place system into normal operation without economizers.
   e. Install test openings where required.
   f. Indicate type of test holes to be used and installation procedure.
   g. Note condition of filters.
   h. Provide temporary blankoffs to simulate design pressure drops of filters.
   i. Chisel holes and duct tape are not allowed.
   j. Wet cooling coils
   k. Fan wheels, blades, bearings, alignment, starters, vibration isolators, and rotation
   l. Drive belt tension and alignment
   m. Setting of automatic dampers to proper position including shutoff and bypass dampers
   n. For hoods and ovens indicate temperature and humidity. Correct for density changes.
   o. Set up of controls and control devices
3. Measuring Instrument List - list what measuring instruments will be used for each procedure. Indicate ranges required for each procedure. Provide data on each measuring instrument to be used. This data shall include:
   a. Manufacturer name and model number
   b. Measurement range
   c. Pressure/temperature limits
   d. Date put into service
   e. Date of last calibration
   f. Include certificate from calibration firm
4. Architect/Engineer reserves the right to request adjustments in any procedure and/or ask for recalibration of any measuring instrument, which has not been recalibrated within past year.

3.3 SET-UP PHASE

A. Procedure:
   1. Perform prebalance checkout as per Planning Phase narrative.

B. Initial Test:
   1. Measure fan data and flows in "as found" condition after initial damper settings are made.

C. Initial Test Report:
   1. Submit report to Architect/Engineer and Mechanical Contractor indicating all measurements made and make notes of all items, which are not complete or are not within design tolerance.

3.4 FINAL BALANCE PHASE

A. Procedure:
   1. Perform all procedures as per Planning Phase narrative. Correct all deficiencies and redo procedures as required before submitting Final Report.

B. Final Report:
   1. Submit report to Architect/Engineer and Mechanical Contractor indicating all data and measurements as per requirements herein and per Planning Phase narrative. Do not submit partial or incomplete reports.

C. Final Report Adjustments:
   1. Architect/Engineer reserves the right to check any measurement made and to reject any portion of work not within required tolerance of design flow. TAB Contractor shall resubmit all or portions of Final Report as directed by Architect/Engineer.

END OF SECTION

SECTION 23 0901 CONTROL SYSTEMS INTEGRATION

PART 1 - GENERAL

1.1 RELATED WORK

A. Section 01-9913 – Building Systems Commissioning

B. Section 20-0000 – General Mechanical Requirements

C. Section 20 0513 – Motors

D. Section 23 0550 - Vibration Isolation

E. Section 20-0553 – Mechanical System Identification

F. Section 23 0902 - Control Valves and Dampers

G. Section 23 0903 - Control Instrumentation

H. Section 23 0923 - Direct Digital Controllers and Networks

I. Section 23 0924 - Graphical User Interface Integration

J. Section 23 0993 - Control Sequences

K. Section 23 2118 - Valves

L. Section 23 3600 - Air Terminal Devices

M. Section 23 3614 - Laboratory Temperature and Airflow Control System

N. Section 26 0000 - General Electrical Requirements

O. Section 26 0533 - Raceway and Fittings

P. Section 26 0519 - Conductors and Cables

Q. Section 23-3614 – Pressure Relationship, Temperature and Airflow Control System

R. Section 26-0519 – Low-Voltage Electrical Power Conductors and Cables

S. Section 26-0533 – Raceway and Boxes for Electrical Systems

T. Section 26-0926 – Lighting Control Systems

U. Section 26-2300 – Low Voltage Switchgear

V. Section 26-2713 – Electrical Metering

W. Section 28-3116 – Multiplexed Fire Detection and Alarm Systems

1.2 REFERENCE

A. Work under this Section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.

B. ASHRAE FUN IP - (2013) Fundamentals Handbook, I-P Edition

C. ASHRAE 135 - (2012) BACnet - A Data Communication Protocol for Building Automation and Control Networks (ANSI Approved) .13

D. BUILDING SYSTEMS COMMISSIONING

1. "An independent third party Commissioning Agent will document completion of the Mechanical, Fire Suppression, Plumbing, HVAC, Electrical, Communications and Electronic Safety and Security Systems for the project. The Construction Manager, Division Contractors, and Control Contractor are members of the Commissioning Team and will facilitate completion of the Commissioning process. Refer to section 019113 "Building Systems Commissioning" for the project Commissioning requirements and roles and responsibilities of each member of the Commissioning Team."

1.3 DEFINITIONS

A. The following abbreviations, acronyms, and definitions may be used in addition to those found elsewhere in Contract Documents.

1.	Actuator:	Control device to provide motion of valve or damper in response to control signal.
2.	AI:	Analog Input
3.	AO:	Analog Output
4.	Analog:	Continuously variable state over stated range of values
5.	Auto-Tune:	Software routine used to adjust tuning parameters based on historical data.
6.	BAS:	Building Automation System
7.	BMS	Building Management System
8.	DDC:	Direct Digital Control
9.	DDCP:	Direct Digital Control Panel
10.	Discrete:	Binary or digital state
11.	DI:	Discrete Input (Sometimes referred to as Binary Input BI)
12.	DO:	Discrete Output (Sometimes referred to as Binary Output BO)
13.	EMCS:	Energy Management and Control System (Typically interchangeable with BAS or BMS)
14.	E/P:	Voltage to pneumatic transducer (Often solenoid valve is referred to as an E/P transducer)
15.	FA	Field Adjustable
16.	FC:	Fail Closed position of control device or actuator. Device moves to closed position on loss of control signal or energy source.
17.	FMS:	Facility Management System linking two or more BAS
18.	FO:	Fail Open position of control device or actuator. Device moves to open position on loss of control signal or energy source.
19.	I/P:	Current to pneumatic transducer
20.	Instrument:	Device used for sensing input parameters or used for actuation.

21. Modulating: Movement of control device through an entire range of values proportional to an infinitely variable input value.
22. Motorized: Control device with actuator
23. NC: Normally Closed position of switch after control signal is removed or normally closed position of manually operated valves or dampers.
24. NO: Normally Open position of switch after control signal is removed or normally open position of manually operated valves or dampers.
25. Node: DDCP, operator workstation, or other control device connected to communications network.
26. Operator: Same as actuator for motorized devices. Also refers to an individual who physically "operates" facility.
27. PC: Personal Computer
28. Peer-to-Peer: Mode of communication between controllers in which each device connected to network has equal status and each share its database values with other devices connected to network.
29. P: Proportional control, control mode with continuous linear relationship between observed input signal and final controlled output element.
30. PI: Proportional - Integral control, control mode with continuous proportional output plus additional change in output based on both amount and duration of change in controlled variable (reset control).
31. PID: Proportional - Integral - Derivative control, control mode with continuous correction of final controlled output element versus input signal based on proportional error, its time history (reset), and rate at which its changing (derivative).
32. Point: Analog or discrete instrument with addressable database value.
33. Self-Tune: Same as Auto-Tune
34. Solenoid: Electric two-position actuator. (See E/P.)
35. TCC: Temperature Control Contractor (Same as Control Contractor)
36. TCP: Temperature Control Panel

1.4 ACCEPTABLE CONTROL CONTRACTORS

A. Control Contractor shall have full service office within 100 miles of project site. Full service office is defined as being home office of applications engineers, supervisors, and field technicians, having complete parts inventory, and having required test and diagnostic equipment. Control Contractors shall be factory authorized agent or dealer of controllers and control hardware as manufactured by:
   1. Johnson Controls, Inc.
   2. Honeywell, Inc.
   3. Alerton Technology
   4. Distech

B. The systems integration contractor must have on staff the following number of key personnel as a minimum each with a minimum of 5 years of related controls installation experience:
   1. Project Manager – 2 years
   2. Controls applications Engineer – 2 years
   3. Programmer – 2 years
   4. Installation Supervisor – 2 years

5. Controls Technician – 5 years

C. Prefer contractor staff to include Niagara Tridium AX or N4 certified technicians, and one advanced certified.

D. Have experience with successful integrations of controls with Niagara Tridium systems.

E. Contractor to have a minimum of 3 years of installation history with the brand of controls being bid.

F. Must have help desk operation or staff available for phone contact 24/7 for providing technical support to university staff. Call forward and emergency service numbers are not acceptable during normal business hours.

G. Bids will be accepted only from prequalified Control Contractor per "Instruction to Bidders".

1.5 SYSTEMS DESCRIPTION

A. System shall be electric and/or electronic.

B. Control system shall be Direct Digital Control (DDC).

C. Damper and valve actuators shall be electronic type, unless otherwise noted.

D. Control system shall be 100% DDC unless otherwise indicated.

E. Provide supplementary BAS architecture, that is based on and consistent with the UK standard architecture, consisting of communication network, modular designed DDCPs with all points addressable and modifiable from existing BAS user workstations or from master DDCP using laptop computer. BAS shall communicate via BACnet/MSTP or BACnet/IP communications protocol between the room level controllers and the building level controllers and BACnet/IP communications protocol between the building level controllers and the existing BAS server. All system components shall be fully BACnet compliant without the use of integration gateways. BAS shall be fully expandable with addition of BACnet based hardware and/or software. Expansion shall not require removal of existing DDCPs, sensors, actuators, or communication networks.

F. System must be able to communicate with Tridium Niagara Framework at the University Medical Center via Protocol Address assigned by the University at the building location. Provide PICS for Windows-based control software and every controller in system, including unitary controllers. PICS and BIBBS shall comply with Tridium PICS and BIBBS.

G. Ethernet network cabling shall be installed by Division 27 contractor with cable runs from central EIDF/IDF communication closet to multiple central locations on each floor. Ethernet cabling shall be utilized for BAS BACnet/IP communication from each zone to the existing BAS operator workstation. Controls contractor shall provide BACnet/IP to BACnet/MSTP small capacity Building Level Controller in each zone. BACnet/MSTP communication network shall be provided and installed by controls contractor between each room level controller in zones to BACnet/IP to BACnet/MSTP Building Level Controller. BACnet/MSTP communication network node capacity for each small capacity Building Level Controller zone shall be limited to a maximum of 80% manufacturer’s recommended DDC controller capacity or 25 devices per trunk total, whichever total number of nodes is smaller

H. System intelligence shall be such that existing operator workstation(s) can be used for programming controls, performing analysis on filed data, perform trending of user defined inputs,

generating maintenance and operation reports and providing permanent storage for programs and data, and the ability to connect to the Internet.

I. System shall be web-based, telnet or HyperTerminal capable. No graphics shall be provided. All graphics will be owner provided to existing Tridium system.

J. All building automation products utilizing BACnet shall communicate using the protocols and network standards as defined by ANSI/ASHRAE Standard 135-2001, BACnet and be tested by BACnet Testing Laboratories (BTL) and have passed the necessary requirements for BACnet compliance and interoperability.

K. New BAS shall seamlessly integrate with existing site **Tridium** web server. Existing web server shall be able to access and read all input, output and calculated points and issue commands to all output points in new BAS by means of a standard web browser. Contractor shall provide necessary hardware and software components to accomplish this interface.

L. Provide modular designed stand-alone controllers capable of future BAS architecture with peer-to-peer and/or low/medium speed communication networks. Upgrade to full BAS architecture shall not require removal of existing controllers, sensors, actuators, etc.

M. BAS network architecture shall be based on an Open implementation of BACnet using ASHRAE 135-2012 exclusively as the communications protocol for communication between DDC Hardware devices, including BAS Web Server, to allow multi-vendor interoperability.

N. Building Automation System (BAS) shall control building's HVAC components and provide interface with Lighting Control System.

O. Division 27 Contractor shall provide Ethernet work connections for BAS equipment requiring network connects.

P. Provide BAS architecture consisting of communication network, operator workstations, web servers and modular designed controllers with all points addressable and modifiable from operator workstations or from master controller using laptop computer. BAS shall be fully expandable with addition of hardware and/or software. Expansion shall not require removal of existing controllers, sensors, actuators, or communication networks.

Q. System shall support operator workstations as specified and shall be capable of additional workstations, limited only by systems maximum node capacity.

R. Operator workstations connected to building Ethernet network shall be able to access BAS information as determined by Graphical User Interface (GUI) software through standard web browsing software (Internet Explorer, Mozilla Firefox, Opera, or Google Chrome). GUI software shall allow transparent access to each building component/system for control and/or monitoring.

S. System intelligence shall be such that operator workstation(s) can be used for programming controls, performing analysis on filed data, generating maintenance and operation reports and providing permanent storage for programs and data.

T. Workstation PCs and printers will be furnished by Owner. Provide hardware interface card to communicate with BAS Network and required software for each workstation, as defined in this Section, to make each PC full function workstation.

1.

1.6 SCOPE OF WORK

A. Provide all labor and materials for complete fully functioning control systems in accordance with Contract Documents including this Section plus:
   1. Section 23 0902 - Control Valves and Dampers
   2. Section 23 0903 - Control Instrumentation
   3. Section 23 0923 - Direct Digital Controllers and Networks
   4. Section 23 0993 - Control Sequences
   5. Section 23-3600 – Air Terminal Devices
   6. Section 23-3614 – Pressure Relationship, Temperature and Airflow Control System

B. Engineering services shall be performed by factory trained engineers that are employed by the control manufacturer. System shall be installed either by trained mechanics directly employed by Control Contractor or by subcontractors who are under direct supervision of Control Contractor's representative. Owner reserves the right to exclude any project managers, engineers, field supervisors, or technicians whose past experience are not sufficient to meet needs of project. The manufacturer shall be responsible for the engineering, installation, startup, checkout, commissioning and warranty of control systems.

C. Engineering services shall be performed by Factory Trained Engineers. System shall be installed either by trained mechanics directly employed by Control Contractor or by subcontractors who are under direct supervision of Control Contractor's representative. Engineer reserves right to exclude Project Managers, Engineers, Field Supervisors, or Technicians whose past experience is not sufficient to meet needs of Project.

D. Control Contractor’s Project Managers, Engineers and Digital System Programmers shall have previously performed in capacity that qualifies them to successfully engineer system of scope and magnitude similar to this Project.

E. Submit qualification of Project Managers, Engineers, Programmers, Field Supervisors, and Technicians to be assigned to this Project within 30 days after contract award. Use Qualification Form attached at end of this Section.

F. Labor shall include, but not be limited to:
   1. Engineering services to size unscheduled valves and dampers based on design criteria specified in Section 23 0902 - Control Valves and Dampers, and confirm sizing of scheduled valves and dampers.
   2. Engineering services to produce requested submittals and working construction drawings and record drawings as specified here within.
   3. Engineering services for required software programming including integration of all BAS functionality into existing Tridium BAS.
   4. Engineering services for mapping control points from Laboratory Temperature and Airflow Control System (Section 23 3614), if provided for the project.
   5. Engineering services for BAS Ethernet network design.
   6. Project management services as single point contact to coordinate construction related activities.
   7. Field mechanics for installation of control wiring and related control devices.
   8. Field technicians to startup, calibrate, adjust, and tune control loops.
   9. Field technicians to perform system checkout and testing, and to complete required reports.

10. Field supervisor during controls installation and startup.
11. Field technicians to assist Mechanical Contractor and Testing and Balancing (TAB) Contractor in adjusting controls and determining setpoints related to TAB work.
12. Field representatives and/or classroom instructors to provide Owner training as specified.

G. Control Contractor shall be responsible for complete installation of control devices (except as noted), wiring terminations at controller locations to accomplish control sequences specified in project manual or on drawings. Control Contractor is required to provide power for air terminal controllers and other field mounted devices that require 24 VAC, 60 Hertz and shall be powered from 120 to 24 VAC transformer panels provided by Control Contractor. Control Contractor shall also be responsible for additional instrumentation described in point schedules found in Contract Documents, which may not be directly related to specified control sequences.
   1. Control contractor shall provide unique tag numbers for all devices under this specification and reference those tag numbers in control sequences and control diagrams.
   2. If Owner has tagging convention, Control contractor shall utilize it. If no tagging convention exists, Control contractor shall provide one for all devices under this specification.

H. Control Contractor shall furnish all actuators, linkages if required, differential pressure transmitters, controllers and any other devices required for unit control that are not provided by air terminal unit manufacturer for air terminal unit manufacturer's factory mounting. Control Contractor shall coordinate with Air Terminal Unit manufacturer for timely delivery and for proper factory installation.

I. Mechanical Contractor shall provide wells, taps, and other mechanical interfaces required for control equipment mounting into piping systems. Mechanical Contractor shall install in-line mounted devices, such as valves, dampers, flow meters, static pressure probes, etc., furnished by Control Contractor. Control Contractor shall be responsible for installation of other control devices, such as actuators, linkages, sensors, air terminal controllers, flow transducers, remote mounted control devices, control panels, control transformers, etc.

J. Electrical work required as integral part of control work is responsibility of Control Contractor. Control Contractor is responsible for providing final power connections, including conduit, wire, and/or disconnect switches, to control devices from appropriate electrical distribution panels.
   1. Electrical Contractor will provide circuit breakers required to provide electrical power to controllers.
   2. 120 to 24 VAC transformer panels shall be provided by Control Contractor and mounted adjacent to controller panels or in Equipment Intermediate Distribution Frame (EIDF) rooms and powered from dedicated electrical circuit.
   3. Should any change in number of controllers or addition of other electrical equipment after Contracts are awarded, Control Contractor shall immediately notify Electrical Contractor of change. Additional costs due to these changes shall be responsibility of Control Contractor.
   4. Coordinate with Electrical Contractor for additional power requirements.

K. Fully functioning BAS Ethernet network, including all hardware (horizontal network cabling, routers, switches, firewalls, patch panels, patch cords, cabinets, etc.), is provided by the University and division 27 contractor.

L. Materials shall be as specified unless approved through procedures for product substitution specified in Division 01. Control Contractor shall provide components not specifically indicated or specified, but necessary to make system function within the intent of specification.

M. If during the installation period any of the factory equipment or material provided in the system is found to be defective in material or workmanship, it shall be replaced or repaired by the Control Contractor within a two day working period from the time the problem was reported at no additional cost to the Owner.

N. Any part/device or equipment installed as part of this contract found to be malfunctioning or defective during the warranty period shall be replaced by the Contractor within a two day working period from the time the problem was reported.

O. Electrical products shall be listed and labeled by UL and comply with NEMA Standards.

P. Control Contractor is responsible for integration of the following independent systems into the Control System.
   1. Low Voltage Switchgear.
      a. Low Voltage Switchgear provider will supply a data port for communication with BAS. BAS contractor shall coordinate and provide communication connection via BACnet/IP or BACnet/MSTP from data port to the BAS. BAS contractor shall supply cabling, conduit, and gateway/integrator necessary to make an interface connection from the gateway/integrator to the Low Voltage Switchgear data port. BAS contractor responsible for a BAS solution to communicate data directly or through a gateway/integrator to all suppliers listed in Division 26 for Low Voltage Switchgear bidders. BAS contractor and Low Voltage Switchgear provider shall be responsible for coordination of gateway requirements if needed, translation of network protocols, testing of communications between systems, and joint commissioning of systems. BAS contractor to refer to Section 26 2300 – Low Voltage Switchgear and Section 23 0992 – DDC Point List for programming and monitoring requirements.
   2. Lighting Control System (LCS):
      a. LCS provider will provide appropriate network termination points for connection to BAS. Contractor shall supply cabling, conduit, and gateway (if necessary) to make an interface connection from BAS to LCS point of connection. Contractor is responsible for a BAS solution to communicate data directly or through a gateway to all suppliers listed in Division 26 for LCS bidders. Contractor and LCS provider are responsible for coordination of gateway requirements if needed, translation of network protocols, testing of communications between systems, and joint commissioning of systems. Contractor to refer to P&ID's, DDC Point Schedules, and Division 26 for programming and monitoring requirements.

Q. Provide weather protection cover or weatherproof control devices where required for control devices located outdoors.

R. Provide tamper resistant screws and fasteners for equipment located in accessible and/or public areas.

S. Contractor is responsible for integration of the following independent systems into BAS:
   1. Electrical Metering:
      a. Electrical Metering provider will provide BACnet/IP connection(s) for interfacing to BAS. Control contractor responsible for a BAS solution to communicate data directly or through a gateway to all suppliers listed in Division 26 for Electrical Metering. Control contractor and Electrical Metering provider responsible for coordination of gateway requirements if needed, translation of network protocols, testing of communications between systems, and joint commissioning of systems. Control contractor to refer to P&ID's, Section 26

2413 Switchboards and Section 26 2713 Electrical Metering for programming and monitoring requirements.

1.7 SUBMITTALS

A. Extended Service Agreement:

1. Control manufacturer shall, upon completion of warranty period, make available to Owner annual service agreement covering all labor and material required to effectively maintain control system after warranty period. Owner reserves the right to accept or reject any such offers and to cancel on-going agreements with 30-day written notice.
2. During extended service period, Contractor shall maintain Operation and Maintenance manuals to reflect all changes made to BAS.
3. Each submittal shall have a cover sheet with the following information provided: submittal ID number; date; project name, address, and title; BAS Contractor name, address and phone number; BAS Contractor project manager, quality control manager, and project engineer names and phone numbers.

B. Shop Drawings:

1. Submit manufacturer's printed product data sheets for control devices and materials listed in bill of material in Control Contractor's control drawings. An index listing of all control devices and equipment applicable to project to be listed in the following format:
    a. Room #
    b. Device Part #
    c. Device Description
    d. Sheet # where cut sheet is located
2. Datasheets shall be submitted electronically in pdf format with bookmarks provided for each individual device and table of contents listing each device manufacturer and full model number with links to device pages. Organize sheets in order of model number, alphabetically, then numerically. If more than 20 product data sheets are submitted, provide front index and tabs for logical groups of devices. When a manufacturer’s data sheet refers to a series of devices rather than a specific model, the data specifically applicable to the project shall be highlighted or clearly indicated by other means. Data sheets shall include sufficient technical data to describe instrument parameters required as specified. Refer to Specification section 20-0000 General Mechanical Requirements for additional submittal requirements and formatting. Data sheets shall include sufficient technical data to describe instrument parameters required as specified in Section 23 0903 - Control Instrumentation.
3. BAS manuals to be in two parts: 1) Operation and maintenance, and 2) System application manuals.
4. One (6) hard copy and (1) electronic copy of BAS manuals shall be provided to Physical Plant by BAS contractor at date of submittal completion.
5. Submit data concerning type of signal wiring and installation methods including raceway types and grounding methods.
6. Submit control drawings including, but not limited to, the following:
    a. Front sheet index for projects with more than 10 control drawing sheets.
    b. Overall system/network architecture drawings: Provide block diagram showing relationship of each controller, control panel, or other network devices relative to each other. Label room location of each device. Number and indicate model number of each device. Indicate network types.

c. Control Drawings: Including graphic representation of systems with major in-line components to properly locate all control devices. Identify controlled devices with their software designation on drawings, including unique valve and damper tag numbers.

d. Detailed wiring and piping diagrams showing point-to-point hookup details of transducers, relays, outputs, inputs and subsystem components.

e. Bill of material identifying actual product model number used for each control device for each schematic control drawing.

f. Drawings showing proposed locations of sensors and flow meters in ductwork and piping systems.

g. Vendor's own written description for each sequence of operations, to include the following:

   1). Sequences shall reference input/output and software parameters by name and description.

   2). The sequences of operations provided in the submittal by the BAS Contractor shall represent the detailed analysis needed to create actual programming code from the design documents.

   3). Points shall be referenced by name, including all software points such as programmable setpoints, range limits, time delays, and so forth.

   4). The sequence of operations shall cover normal operation and operation under the various alarm conditions applicable to that system.

h. BACnet Compliance Documentation: The Protocol Implementation Conformance Statement for each component.

i. Points list for each DDC controller, including: Tag, Point Type, System Name, Object Name, Expanded ID, Display Units, Controller Type, Address, Cable Destination, Module Type, Terminal ID, Panel, Slot Number, Reference Drawing, and Cable Number. The initial shop drawing submittal for review needs to include all point names meeting the naming convention outlined in this specification for UEM approval at the shop drawing phase prior to the contractor beginning any programming.

j. Control Damper Schedules. This spreadsheet type schedule shall include a separate line for each damper and a column for each of the damper attributes, including:

   1). Code Number,

   2). Fail Position,

   3). Damper Type

   4). Damper Operator

   5). Blade Type

   6). Bearing Type

   7). Seals

   8). Duct Size

   9). Damper Size

   10). Mounting

   11). Actuator Type.

k. Control Valve Schedules. This spreadsheet type schedule shall include a separate line for each valve and a column for each of the valve attributes, including:

   1). Code Number

   2). Configuration

3). Fail Position
4). Pipe Size
5). Valve Size
6). Body Configuration
7). Close off Pressure
8). Capacity
9). Valve CV
10). Calc CV
11). Design Pressure
12). Actual Pressure
13). Actuator Type.

l. Cataloged cut sheets of all equipment used. All models used shall be highlighted. This includes, but is not limited to, the following: DDC panels, peripherals, sensors, actuators, dampers, and so forth.

m. Range and scale information for all transmitters and sensors. This sheet shall clearly indicate one device and any applicable options. Where more than one device to be used is on a single sheet, submit two sheets, individually marked.

n. Hardware data sheets for all local access panels.

o. Software manuals for all applications programs to be provided as a part of the programming devices, and so forth for evaluation for compliance with the performance requirements of this Specification.

p. The controls contractor shall include their BACnet PICS and BIBB statements (as described in ASHRAE 135-2001) for each device.

q. BAS Contractor shall not order material or begin fabrication or field installation until receiving authorization to proceed in the form of an approved submittal. BAS Contractor shall be solely responsible for the removal and replacement of any item not approved by submittal at no cost to the Owner.

r. Submittal shall have approved point names.

C. Operation and Maintenance Manuals

1. Maintenance Data:

a. Submit maintenance instructions and spare parts lists for each type of control device. Include that type data, product and shop drawings in maintenance manual.

b. This contractor shall prepare an electronic Operations Manual entitled "Automatic Temperature Control and Monitoring Systems Operation and Maintenance Data." Manual shall be PDF files with separate PDFs for each of the items noted below.

c. Each manual shall contain the following information:

1). Name and address of Consulting Engineer, Contractor, and index of equipment, including vendor (name and address).

2). Complete brochures, descriptive data and parts list, etc., on each piece of equipment, including all approved shop drawings.

3). Complete maintenance and operating instructions, prepared by the manufacturer, on each major piece of equipment, including preventative maintenance instructions.

4). Complete shop drawing submittal on temperature and monitoring controls including control diagrams updated to reflect "as built" conditions.

5). All wiring and component schematics necessary for Owner (UEM) to troubleshoot, repair and expand the system.

6). All manuals shall be submitted to the Engineer prior to final inspection of the building.

7). Provide a laminated copy mounted in a sleeve on the outside of the panels for the controls sequences pertinent to equipment supplied by that specific controls panel.

2. Layout Design Drawing for each control panel:
   a. The layout drawing shall be to scale with all devices shown in their proposed positions.
   b. All control devices shall be identified by name.
   c. All terminal strips and wire channels shall be shown.
   d. All control transformers shall be shown.
   e. All 120 VAC receptacles shall be shown.
   f. All IP connection points shall be shown.
3. Wiring/Pneumatic Design Diagram for each control panel.
   a. The control voltage wiring diagram shall clearly designate devices powered by each control transformer. If the control devices use half wave power, the diagram shall clearly show the consistent grounding of the appropriate power connection. All wire identification numbers shall be annotated on the diagram.
   b. The Field Bus wiring diagram shall clearly show the use of the daisy chain wiring concept, the order in which the devices are connected to the Field Bus, and the location of end of segment termination devices. All wire identification numbers shall be annotated on the diagram.
   c. If shielded communication wiring is used, the grounding of the shield shall be shown.
   d. The terminal strip wiring diagram shall identify all connections on both sides of the terminal strip. Wiring label numbers for all wiring leaving the control panel shall be annotated on the diagram.
   e. Detailed piping diagrams showing point-to-point hookup details of transducers, relays, outputs, inputs and subsystem components. Label pneumatic lines with field ID numbers/colors.
4. Wiring Design Diagram for individual components (controllers, protocol translators, etc.): The wiring diagram for each component shall identify all I/O, power, and communication wiring and the locations on the terminal blocks to which the wires are landed. Example: Fan Status sensor is wired from terminals 5/6 on the controller to terminals 17 and 18 on the terminal strip.
5. Installation Design Detail for each I/O device.
   a. A drawing of the wiring details for each sensor and/or end device.
   b. For devices with multiple quantities, a standard detail may be submitted.
6. A System Flow Design Diagram for each controlled system.
   a. A two dimensional cross sectional diagram showing key components such as fans, coils, dampers, valves, pump, etc.
   b. Identify the locations and names of all sensors and end devices that are associated with the control system. Label the panel name and terminal numbers where the connections are landed.
   c. A legend shall be provided for all symbols used.
7. BACnet Compliance Documentation:
   a. The Protocol Implementation Conformance Statement (PICS) for each component.
8. Direct Digital Control System Hardware Technical Data.

a. A complete bill of materials of equipment to be used indicating quantity, manufacturer, and model number.
b. Manufacturer's description and technical data for each unique device to include performance curves, product specification sheets, and installation instructions. When a manufacturer's data sheet refers to a series of devices rather than a specific model, the data specifically applicable to the project shall be highlighted or clearly indicated by other means.
c. This requirement applies to:
    1). Controllers
    2). Transducers/Transmitters
    3). Sensors
    4). Actuators
    5). Valves
    6). Relays and Switches
    7). Control Panels
    8). Power Supplies
    9). Batteries

9. An Instrumentation List for each controlled system.
    a. The list shall be in a table format.
    b. Include name, type of device, manufacturer, model number, and product data sheet number.
10. Sequence of Control: A sequence of control for each system being controlled. Include the following as a minimum.
    a. Process control sequence for each end device.
    b. Supervisory logic sequence of control for each system.
    c. The impact of each global application program on the sequence of control (Example: Demand Control).
    d. A list of all physical inputs and outputs associated with each sequence.
    e. Within the sequence of control, all application parameters that are to be user adjustable from an Operator Workstation shall be annotated with (FA) after the name of the parameter. This shall include set points, reset schedule parameters, calibration offsets, timer settings, control loop parameters such as gain, integral time constant, sample rates, differentials, etc.
    f. Within the sequence of control, all calculated values that are to be viewable at the Operator Workstation shall be annotated with (rpt) after the name.
    g. All points that shall be subject to manual control from an operator workstation.
    h. A list of all alarm points, a description of the alarm and a description of the alarm criteria.
    i. A list of all variables for which historical trending will be applied, the sample rates and any criteria used to start and stop the historical trending.
11. Binding Map
    a. A list of the device to device data flow. This shall not include the flow of data from devices to the presentation system.
    b. Include:
        1). Description of the variable.
        2). Sending device.

3). Receiving device.

D. Completion Checklist:
   1. Submit with shop drawings, detailed completion checklist including written procedures for adjusting and calibrating each type of instrument and sensor. Engineer reserves the right to request modifications to any procedure, which is incomplete or not adequate to prove system performance.
   2. Checklist shall include references to the following additional requirements:
      a. Instruments and sensors shall be calibrated by comparison to known device, which is traceable to National Institute of Standards and Testing.
      b. Each point shall be checked for calibration, connection to correct control loop, and proper setting of limit and alarm values.
      c. Transducers and other output devices shall be properly zeroed and calibrated at both minimum and maximum output. Document settings for discrete instruments and set points for analog instruments shall include minimum and maximum positions for safe operating conditions where applicable (max. pump speed or max. frequency of fan drive, etc.).
      d. Control loops shall be tuned to maintain controlled process variable at set point through seasonal conditions without operator intervention. Provide multiple sets of tuning parameters if necessary. Controller shall automatically use tuning parameters appropriate to existing ambient conditions. Maintain record on completion checklist, of control loops that require tuning at alternate times of year. Instruct technicians to supply default parameters that can approximate stable control until actual load conditions allow proper tuning of control loops.
      e. Performance tests of analog control loops shall be performed by changing set points and verifying that sequences can come into stable control within reasonable time period appropriate for each sequence. Simulate load changes for pressure and flow control loops.
      f. Performance tests of discrete control loops shall be performed by adjusting set point and verifying sequence action.
      g. Alarms, including network failures, shall be tested for each controller and device connected to network. Ensure that alarms are properly acknowledged at operator's workstation.
      h. Schedules for each system/device shall be verified.
      i. Testing of BAS to ensure cyber security. Coordinate testing requirements with Owner.

E. Control Contractor and Mechanical Contractor shall walk proposed static pressure sensor and flow meter locations and mark up drawings for review and approval by Owner and Engineer prior to installation.

1.8 WARRANTY

A. Warranty period shall begin as authorized by the UEM representative in writing. A Certificate of Occupancy does not initiate the control system warranty. Any defects in materials and workmanship arising during this warranty period shall be corrected without cost to the owner.

B. All applicable software as detailed in this specification shall be updated by the BAS Contractor free of charge during the warranty period. This will ensure that all system software will be the most up-to-date software available from the BAS Contractor.

C. Authorization will not be given before the following conditions are met:
   1. All verified completion checklists provided to Owner.
   2. Completion of all punch list items.
   3. Conduction of a preliminary training session for personnel. The training shall consist of an orientation session at the job site to familiarize the personnel with the location and type of controlled equipment and controls on the project, a discussion of the control sequences, and a review of the control drawings.
   4. Completion and distribution of the as-built control drawings, including correction of all items noted by Owner and Engineer after review of the documents.

D. Warranty shall cover all costs for parts, labor, associated travel, and expenses for a period of one year from completion of system acceptance.

E. Hardware and software personnel supporting this warranty agreement shall provide on-site or off-site service in a timely manner after failure notification to the vendor. A telephone number where the service supervisor can be reached at all times shall be provided. The maximum acceptable response time to provide this service at the site shall be 24 hours Monday through Friday, 48 hours on Saturday and Sunday.

F. This warranty shall apply equally to both hardware and software. All applicable software as detailed in this specification shall be updated by the EMS Contractor free of charge during the warranty period. This will ensure that all system software will be the most up-to-date software available from the EMS Contractor.

G. Service personnel shall be qualified to accomplish work promptly and satisfactorily. Owner shall be advised in writing of the name of the designated service representative, and of any changes in personnel.

H. Scheduled Inspections:
   1. Two inspections shall be performed prior to warranty expiration and all work required shall be performed. Inspections shall be scheduled 6 months after Owner acceptance and one month prior to end of warranty period.
   2. These inspections shall include:
      a. Visual checks and operational tests of equipment.
      b. Clean control system equipment including interior and exterior surfaces.
      c. Check and calibrate each field device. Check and calibrate 50 percent of the total analog inputs and outputs during the first inspection. Check and calibrate the remaining 50 percent of the analog inputs and outputs during the second major inspection. Certify analog test instrumentation accuracy to be twice the specified accuracy of the device being calibrated. Randomly check at least 25 percent of all digital inputs and outputs for proper operation during the first inspection. Randomly check at least 25 percent of the remaining digital inputs and outputs during the second inspection.
      d. Run system software diagnostics and correct diagnosed problems.
      e. Resolve any previous outstanding problems.
      f. Install software upgrades, patches and fixes. Contractor to provide verification to facility personnel that all upgrades, patches and fixes to be installed have been tested in accordance with site testing and deployment procedures.

I. Scheduled work shall be performed during regular working hours, Monday through Friday, excluding holidays.

J. Dated records and logs shall be kept of each task, with cumulative records for each major component, and for the complete system chronologically. A continuous log shall be maintained for all devices. The log shall contain initial analog span and zero calibration values and digital points. Complete logs shall be kept and shall be available for inspection onsite, demonstrating that planned and systematic adjustments and repairs have been accomplished for the control system.

K. Each service call request shall be recorded as received and shall include its location, date and time the call was received, nature of trouble, names of the service personnel assigned to the task, instructions describing what has to be done, the amount and nature of the materials to be used, the time and date work started, and the time and date of completion. A record of the work performed shall be submitted within 5 days after work is accomplished.

L. Recommendations for system modification shall be submitted in writing. No system modifications, including operating parameters and control settings, shall be made without prior approval of the Owner. Any modifications made to the system shall be incorporated into the Operations and Maintenance Instructions, and other documentation affected.

M. During the warranty period, the Contractor shall maintain a backup of all software installed in the system. The backup shall be updated monthly or whenever the Contractor makes a change to the software. A reload of backup software into the system shall be performed by the Contractor immediately upon notification by the Owner. The reload shall be free of charge.

N. At the end of the warranty period, the Contractor shall provide updated copies of the latest versions of all project record documentation as described in Paragraph 1.10, Record Documents. This includes final updated drawings, software documentation, and electronic media backups that include all changes that have been made to the system during the warranty period.

1.9 COORDINATION WITH TAB CONTRACTOR

A. Control Contractor shall allow sufficient time to provide assistance and instruction to TAB Contractor in proper use and setting of control components such as, Operator Workstation computers, static pressure controllers, "K" Factors for VAV boxes, or any other devices that may need set points changes so that TAB work can be performed.

B. Provide required hardware and software related to control system to TAB Contractor to allow testing of systems and continued operation.

1.10 OPERATION AND MAINTENANCE MANUALS

A. Refer to Division 01 - General Requirements.
   1. One (1) physical and one (1) electronic copy of FMS Manuals shall be provided to University of Kentucky by the BAS Contractor at date of completion.

B. Operation and Maintenance manuals shall provide descriptions of maintenance on all system components, including sensors and controlled devices. Descriptions shall include:

C. Facility Management System (FMS) Manuals
   1. FMS manuals are to be split into two parts:
      a. Operation and Maintenance
         1). Index of all control devices
         2). Detailed Data sheets
         3). Detailed Sequence of operations

4). Detailed Diagrams
   a). System architecture diagram for components within the building annotated with specific location information.
5). List of recommended maintenance tasks associated with the system, controllers, instruments, operator workstations, data servers, web servers, and web clients.
   a). Define the task.
   b). Recommend a frequency for the task.
   c). Reference the product manual that includes instructions on executing the task.
6). Licenses, guarantees, and warranty documents for equipment and systems.
7). System architecture diagram for components within the building annotated with specific location information.
8). As-built drawing for each control panel
9). As-built wiring design diagram for each control panel
10). As-built system flow diagram for each system
11). Binding map for the building
   a). A list of the device to device data flow. This shall not include the flow of data from devices to the presentation system.
   b). Include:
   c). Description of the variable
   d). Sending device
   e). Receiving device
12). Product data sheet for each component
13). Troubleshooting guide
14). Repair parts list
15). Calibration instructions
16). Control Contractor's completion checklist
17). Manufacturer representative's name, address, and phone number

b. System Application manuals
1). Detailed Sequence of operations
2). Definitions of all DDCP software programs
3). Flow chart of all DDCP software programs
4). Points list of all hardwired devices
5). A programming section that includes a description of programming language used
6). Full documentation and program description of all separately written programs
   a). Operating the system
   b). Administering the system
   c). Engineering the Operator workstation
   d). Application programming
   e). Engineering the network
   f). Setting up the web server
   g). Report creation
   h). Graphics creation

i). Data backup & Archiving

1.11 RECORD DRAWINGS

A. Refer to Division 01 - General Requirements.

B. Submit revised shop drawings indicating changes made during Project.

C. Record drawing submittals shall be inclusive of BAS as installed and commissioned.

D. Update control diagrams to include tuning parameters and set points applicable to systems depicted as of date of system completion. This information shall be incorporated with sequence of operation for each system.

E. Include floor plans showing location of control panels and routing of BAS network cabling.

F. List of all IP addresses assigned on IFMS complete with description of device and associated vendor.

G. BACnet systems and devices:
   1. Submit finished device addressing documentation.
   2. Submit finished hardcopy of device binding database.

H. Provide passwords, if used, for back-up and restore functions for each controller.

I. Software (as installed and commissioned)
   1. All software submittals shall be provided in a format suitable for restoration of the programming and configuration of respective digital controllers, servers, workstations and peripheral devices, etc. provided as part of the BAS.
   2. Submit a copy of all software installed on the servers and workstations. These copies shall be delivered to UEM for archiving purposes.
   3. Submit all licensing information for all software installed on the servers and workstations.
   4. Submit a copy of all software used to execute the project even if the software was not installed on the servers and workstations.
   5. Submit all licensing information for all of the software used to execute the project.
   6. All software revisions shall be as installed at the time of the system acceptance.

J. Firmware Files (as installed and commissioned)
   1. All firmware files shall be provided in a format suitable for restoration of the programming and configuration of respective digital controllers, servers, workstations and peripheral devices, etc. provided in the BAS.
   2. Submit a copy of all firmware files that were downloaded to or pre-installed on any devices installed as part of this project. This does not apply to firmware that is permanently burned on a chip at the factory and can only be replaced by replacing the chip.
   3. Submit control listing of firmware version for all firmware that is permanently burned on a chip at the factory.
   4. Submit a copy of all application files that were created during the execution of the project.

1.12 OWNERSHIP OF PROPRIETARY MATERIAL

A. Owner shall retain all rights to software for this project.

B. Owner shall sign a copy of the manufacturer's standard software and firmware licensing agreement as a condition of this contract. Such license shall grant use of all programs and application software to the Owner as defined by the manufacturer's license agreement, but shall protect the manufacturer's rights to disclosure of Trade Secrets contained within such software.

C. Licensing agreement shall not preclude the use of the software by individuals under contract to the Owner for commissioning, servicing, or altering the system in the future. Use of the software by individuals under contract to the Owner shall be restricted to use on the Owner's computers and only for the purpose of commissioning, servicing, or altering the installed system.

D. All project developed software, files and documentation shall become the property of Owner. These include but are not limited to:
   1. Server and Workstation software
   2. Application Programming Tools
   3. Configuration Tools
   4. Addressing Tools
   5. Application Files
   6. Configuration Files
   7. Graphic Files
   8. Report Files
   9. Graphic Symbol Libraries
   10. All Documentation.

PART 2 - PRODUCTS

2.1 CONTROL WIRING

A. Control wiring shall be in accordance with National Electrical Code and Local Electrical Codes. Final connection points at controllers and panels shall be made either at terminal blocks integral to device or at separate terminal blocks mounted inside of control panel enclosures. Use of wire nuts and crimped connections are not allowed for terminating control wiring unless approved by Engineer.

B. Refer to Division 26 for specification requirements for conduits and conductors, except as noted.

C. Terminal Blocks:
   1. Terminal blocks which are not integral to other equipment shall be insulated, modular, feed-through, clamp style with recessed captive screw-type clamping mechanism, shall be suitable for rail mounting, and shall have end plates and partition plates for separation or shall have enclosed sides.

D. Signal and Power Conductors (24 V and Under):
   1. Wires smaller than #18 AWG shall not be used, except for manufacturer supplied instrument specific wire, or where otherwise specified. Use 2-wire stranded twisted/shielded pair 24 VDC for analog and discrete input and 24 VAC/VDC output devices. For 3-lead RTD signal wiring, use #18 AWG stranded, tinned copper twisted/shielded 3-conductor. Provide isolated instrument grounding system as per manufacturer's recommendations.
   2. Conductors not concealed in raceway shall have UL Listed plenum rated Teflon insulation.

3. Provide 250 ohm, 5 watt, 0.1% tolerance dropping resistors in 4 - 20 mA circuits as required to generate 1 to 5 volt signals in 24 VDC powered instrument loops.
4. 24 VAC Power Conductors shall be #18 AWG 2 wire twisted pair or larger. Provide Metal Oxide Varistors (MOVs) on 24 VAC/VDC discrete outputs connected to inductive loads to reduce noise levels (i.e., solenoid valves, motor contactors, relays, damper/valve electric actuators, etc.).

E. Communication Cable:
1. Cable not concealed in raceway shall have UL Listed plenum rated insulation.
2. Floor Level Network Communication Cable (Twisted Pair): Use control system manufacturer's standard communications cable or #22 AWG to #24 AWG twisted, shielded pairs, coaxial cable, or fiber optics for communications between remote controllers/devices
3. Interior LAN Horizontal Communication Cable:
   a. Refer to specification 27 1500 - Communications Horizontal Cabling.
   b. Horizontal copper LAN cable shall meet or exceed all requirements of Category 6 cable as specified in TIA/EIA-568-B.2.
   c. BAS Ethernet network Horizontal copper LAN cable shall be yellow.
   d. Horizontal copper LAN cable shall be terminated in an eight-position modular Jack with color to match system cable.
   e. Horizontal copper LAN cable shall be terminated in a telecommunication room that is on the same floor as the area being served in a 4-pair 100Ω twisted pair modular patch panel with color to match system cable.
   f. Horizontal copper LAN cabling shall not exceed 295 ft.
   g. Provide minimum of 10’ of slack at telecommunication room and 12” of slack at outlet

F. All wiring, conductors and transmission medium shall be in conduit.
1. Minimum conduit size shall be ¾”
2. Size conduit for 75% fill.
   a. Example: for each three conductors in the conduit, room for one additional conductor must be provided.
3. All EMT fittings used on conduit sizes 2 ½” and smaller shall be compression type. No set-screw type fittings are allowed.

G. Transient Voltage Surge Suppression Devices:
1. Devices shall be designed for 120 V power conditioning devices for electronic equipment. Devices shall be designed, manufactured, tested, and installed in compliance with ANSI/IEEE C62.41 and C62.45, Federal Information Processing Standards Publication 94 (FIPS PUB 94), NEMA, NFPA 70, 75, and 78, and UL 1449 and 1283. Devices shall be labeled for UL 1449.
2. Clamping voltage for 120 V power systems shall be 400 V.
3. Provide visual indicator of when surge device has been used.

H. Uninterruptible Power Supply
1. Manufacturers: MGE UPS Systems, Eaton Powerware, Liebert PowerSure or approved equal
2. Provide UPS for backup power for Operator Workstations, Building Level Controllers, Floor Level Controllers and field panels required for control of emergency/standby powered equipment, UPS shall maintain control upon loss of normal power and until emergency/standby power supply is brought on line.

3. Select UPS for minimum of 5 minutes backup time for load connected. This will allow emergency/standby power sources to come on line and provide backup power to emergency/standby powered equipment.
4. Upon sensing loss of normal power, transfer time shall be 8 milliseconds maximum.
5. Operating Parameters:
   a. Operating Temperature: 32°F to 104°F
   b. Relative Humidity: 0 to 95% rh, non-condensing
   c. Recharge Time: 8 hours, typical
6. UPS shall have self-diagnostic capability with DO to BAS to allow remote monitoring/alarming of UPS trouble or alarm conditions.

2.2 INPUT/OUTPUT SUMMARY

A. The system as specified shall monitor, control and calculate all of the points and functions as listed in the Input/Output Summary.

2.3 LOCAL CONTROL PANELS

A. Control panels shall meet the following minimum requirements:
   1. Outdoors: Control panels located outdoors shall comply with NEMA 3R or 4X requirements.
   2. Mechanical Rooms: Control panels located in mechanical or electrical rooms shall comply with NEMA 12 requirements.
   3. Other Locations: Control panels in other locations, including but not limited to occupied spaces, above ceilings, and plenum returns shall comply with NEMA 1 requirement.

B. Local control panels shall be constructed of steel or extruded aluminum with hinged door and keyed lock, with baked enamel finish of manufacturer's standard color. Construction shall comply with NEMA **1** Standards for interior panels, NEMA **3R** for exterior panels.

C. Provide panels of adequate size to accommodate instruments for future expansion of approximately 25% beyond space required for this scope of work.

2.4 NETWORK HARDWARE

A. Ethernet Switches, Routers, and Bridges:
   1. Network hardware shall be provided and configured to form a campus-wide Fast Ethernet (a combination of 100BASE-TX and 100BASE-BX, -FX, and –SX or higher).
   2. Ethernet devices shall be IEEE Std 802.3 which shall function as the center of a distributed-star architecture and shall be "learning" type with spanning tree algorithms per IEEE Std 802.1D. All devices shall have a non-blocking architecture.
   3. The switch shall support the connected media types and shall have a minimum of 150% the required ports and no fewer than 4 ports. One port shall be switch selectable as an uplink port.
   4. Network hardware shall be compatible with the copper and fiber optic cabling installed by the Division 27 contractor. Refer to specifications 27 1300 and 27 1500 for media types.
   5. Switch located in BAS server rack shall be managed type and shall have a minimum of two fiber optic ports.
   6. Switch shall include N.O./N.C. alarm contact for monitoring by BAS.

B. Network Components:

1. Network components (Racks, enclosures, patch panels, etc.) shall comply with respective sections of specification 27 1100 – Communications Equipment Room Fittings.

PART 3 - EXECUTION

3.1 GENERAL

A. Install control equipment, **[and wiring]** in neat and workmanlike manner.

B. Coordinate timely delivery of materials and supervise activities of other trade contractors to install devices such as immersion wells, pressure tappings, any associated shut-off valves, flow switches, level switches, flow meters, air flow stations, valves, dampers, and other such items furnished by Control Contractor, which are to be installed by Mechanical Contractor.

C. Install control devices in accessible location.

D. All BAS associated 120 VAC power wiring (including all input and output power supplies) shall originate from clearly-marked, BAS-dedicated circuit breakers. All input/output transducers shall be powered from the same circuit that supplies power to the associated BAS controller. All BAS equipment shall be fused in accordance with manufacturer's recommendations.

E. BAS controllers shall be labeled with the source of electrical power including panel number, circuit breaker number, and room number where electric panel is located.

F. Devices containing mercury are not allowed.

G. Coordinate mounting height and location of control devices so that NEC workspace clearances are maintained.

H. All anchors used for mounting equipment, devices, or panels shall be metal. Plastic anchors are not allowed.

3.2 DELIVERY, STORAGE AND HANDLING

A. Provide factory shipping cartons for each piece of equipment and control device. Maintain cartons while shipping, storage and handling as required to prevent equipment damage and to eliminate dirt and moisture from equipment. Store equipment and materials inside and protect from weather.

3.3 CONTROL WIRING

A. Provide electrical wiring required for complete functional control systems, including power circuit to control panels, both line and low voltage, in accordance with applicable local codes, and latest version of National Electrical Code and NFPA. Refer to Paragraph 1.6.H. for definition of scope of Work.

1. Voltage drops for all low voltage circuits shall be calculated prior to installing low voltage circuits. Voltage drop calculations shall be made available to Engineer on demand.

B. Control panels serving equipment fed by emergency/standby power shall also be served by emergency/standby power. Equipment fed by emergency/standby power is so indicated on mechanical equipment schedules and electrical panelboard schedules. Control panels shall be powered by local UPS (Uninterruptible Power Supply) to ensure continued control of equipment powered by site standby power sources when primary power source is lost. Devices such as

Operator Workstations, Floor Level and Building Level Controllers, Application Specific Controllers and fume hood controls shall be provided with local UPS power.

C. Where multiple controllers reside in a single control panel, provide a separate disconnect (or fuse) for each controller.

D. Power wiring to control compressors and dryers will be provided by Electrical Contractor. Furnish field-mounted starters to Electrical Contractor for installation and supervise installation.

E. Install control wiring in raceway system per Division 26 – Electrical, except as noted.
   1. All 24 VAC or any cabling carrying AC voltage will not be allowed in cable tray. 24 VAC and any other AC voltage cabling will require conduit or raceway separate from data cable raceway.

F. Install control wiring in raceway system per Division 26 – Electrical, except as noted.
   1. All 24 VAC or any cabling carrying AC voltage will not be allowed in cable tray. 24 VAC and any other AC voltage cabling will require conduit or raceway separate from data cable raceway.

G. Control wiring shall be installed in raceway or rigid conduit. Cabling connections between control devices and raceway/conduit shall be installed in flexible conduit not more than 6’ in length.

H. Color-code each junction box cover plate as to signal type using 1/2" self-adhesive color dot or enamel spray paint. Use green for low voltage signal wiring, blue for pneumatic tubing, and yellow for line voltage wiring used for signal wiring or dedicated power wiring.

I. Tag each wire termination at control panels, junction boxes, and remote control devices with unique wire ID number.

J. All wiring, conductors and transmission medium shall be in conduit.
   1. Minimum conduit size shall be ¾”
   2. Size conduit for 75% fill.
      a. Example: for each three conductors in the conduit, room for one additional conductor must be provided.
   3. All EMT fittings used on conduit sizes 2 ½” and smaller shall be compression type. No set-screw type fittings are allowed.

K. Terminate low voltage DC instrument signal cable with black terminated on positive terminal and white terminated on negative unless otherwise noted.

L. Run direct current instrument conductors separately from alternating current conductors. Where allowed by NEC wiring classification, AC-DC route crossings shall be at 90 degrees. Install special sensor to transmitter cables in accordance with manufacturer's installation drawings or in compliance with manufacturer's instructions. Extra precautions shall be taken when pulling and shortening these "vendor furnished" cables. Any extra length on these cables shall be neatly coiled into minimum 3" diameter coils and installed into junction box.

M. All wiring terminating in a control panel/enclosure shall be landed on terminal strips, with one wire per terminal. All I/O points on a DDC/BAS controller shall be wired to panel-side of terminal strip, including all spare I/O points.

N. Route intrinsic safe wiring separately from other conductors. These conductors shall not be run with, nor cross, conductors of other NEC classifications and shall require intrinsic barrier if run in the same path with wiring of other classifications.

O. Follow Control Contractor's Company standard cabling color codes.

P. Suggested instrument and control conductor cables and color codes are as follows:

Type	Configuration	Colors	Manufacturer Part No.
120 VAC, 14 AWG	2 Cond., Unshielded, Non-Plenum Rated	Cond. 1 - BLK Cond. 2 - RED Jacket - Gray PVC	Belden 9411
120 VAC, 14 AWG	3 Cond., Unshielded, Non-Plenum Rated	Cond. 1 - BLK Cond. 2 - WHT Cond. 3 - RED Jacket - Gray PVC	Belden 9495
24 VAC, 18 AWG	2 Cond., Unshielded, Plenum Rated	Cond. 1 - BLK Cond. 2 - RED Jacket - Red FEP	Belden 89740
24 VAC, 18 AWG	2 Cond., Unshielded, Non-Plenum Rated	Cond. 1 - BLK Cond. 2 - RED Jacket - Gray PVC	Belden 9409
Analog Input, 18 AWG	2 Cond., Shielded, Plenum Rated	Cond. 1 - BLK Cond. 2 - RED Jacket - Red FEP	Belden 88760
Analog Input, 18 AWG	2 Cond., Shielded, Non-Plenum Rated	Cond. 1 - BLK Cond. 2 - WHT Jacket - Black PVC	Belden 1032A
Analog Input, 18 AWG	3 Cond., Shielded, Plenum Rated	Cond. 1 - BLK Cond. 2 - WHT Cond. 3 - RED Jacket - Red FEP	Belden 88770
Analog Input, 18 AWG	3 Cond., Shielded, Non-Plenum Rated	Cond. 1 - BLK Cond. 2 - WHT Cond. 3 - RED Jacket - Black PVC	Belden 1036A
Analog Output, 18 AWG	2 Cond., Shielded, Plenum Rated	Cond. 1 - BLK Cond. 2 - RED Jacket - Red FEP	Belden 88760
Analog Output, 18 AWG	2 Cond., Shielded, Non-Plenum Rated	Cond. 1 - BLK Cond. 2 - WHT Jacket - Black PVC	Belden 1032A
Analog Output, 18	3 Cond., Shielded,	Cond. 1 - BLK	Belden

Type	Configuration	Colors	Manufacturer Part No.
AWG	Plenum Rated	Cond. 2 - WHT Cond. 3 - RED Jacket - Red FEP	88770
Analog Output, 18 AWG	3 Cond., Shielded, Non-Plenum Rated	Cond. 1 - BLK Cond. 2 - WHT Cond. 3 - RED Jacket - Black PVC	Belden 1036A
Discrete Input, 18 AWG	2 Cond., Unshielded, Plenum Rated	Cond. 1 - BLK Cond. 2 - RED Jacket - Red FEP	Belden 89740
Discrete Input, 18 AWG	2 Cond., Unshielded, Non-Plenum Rated	Cond. 1 - BLK Cond. 2 - RED Jacket - Gray PVC	Belden 9409
Discrete Output, 18 AWG	2 Cond., Unshielded, Plenum Rated	Cond. 1 - BLK Cond. 2 - RED Jacket - Red FEP	Belden 89740
Discrete Output, 18 AWG	2 Cond., Unshielded, Non-Plenum Rated	Cond. 1 - BLK Cond. 2 - RED Jacket - Gray PVC	Belden 9409
Discrete Output, 18 AWG	3 Cond., Shielded, Plenum Rated	Cond. 1 - BLK Cond. 2 - WHT Cond. 3 - RED Jacket - Red FEP	Belden 88770
Discrete Output, 18 AWG	3 Cond., Shielded, Non-Plenum Rated	Cond. 1 - BLK Cond. 2 - WHT Cond. 3 - RED Jacket - Black PVC	Belden 1036A
General Purpose, 18 AWG	2 Cond., Unshielded, Plenum Rated	Cond. 1 - BLK Cond. 2 - RED Jacket - Red FEP	Belden 88760
General Purpose, 18 AWG	2 Cond., Unshielded, Non-Plenum Rated	Cond. 1 - BLK Cond. 2 - RED Jacket - Gray PVC	Belden 9409
General Purpose, 18 AWG	3 Cond., Shielded, Plenum Rated	Cond. 1 - BLK Cond. 2 - WHT Cond. 3 - RED Jacket - Red FEP	Belden 88770

Type	Configuration	Colors	Manufacturer Part No.
General Purpose, 18 AWG	3 Cond., Shielded, Non-Plenum Rated	Cond. 1 - BLK Cond. 2 - WHT Cond. 3 - RED Jacket - Black PVC	Belden 1036A
Intrinsically Safe Control Cable, 17 AWG	2 Cond., Shielded, Non-Plenum Rated	Cond. 1 - BLK Cond. 2 - RED Jacket - Light Blue PVC	Anixter BL0012650
Intrinsically Safe Control Cable, 17 AWG	3 Cond., Shielded, Non-Plenum Rated	Cond. 1 - BLK Cond. 2 - WHT Cond. 3 - RED Jacket - Light Blue PVC	Anixter BL0012651

Q. Electric Signal Cables:
   1. Analog electric signal cables from electronic transmitters to controllers/receivers and from controllers to other analog devices shall be continuously shielded to reduce effects of EMI on control signals residing on those cables. Electric signal cables to discrete devices typically do not require shielding, but for better noise immunity use twisted/shielded pairs.
   2. Shields shall be grounded at power source end only and floated at other end. Pay particular attention to floating shields through termination points, maintaining only one single grounding point, and insulating from ground at other points.
   3. Provide 250 ohm, 5 watt, 0.1% tolerance, dropping resistors as required to generate 1 - 5 VDC signals or 500 ohm, 5 watt, 0.1% tolerance, dropping resistors as required to generate 2 - 10 VDC signals from 4 - 20 mA control loop powered by 24 VDC power supply.

R. BAS Network Communication Cable:
   1. Install special cable connectors in accordance with BAS manufacturer's recommendations.
   2. Typically, #22 AWG, but no smaller than #24 AWG, twisted pairs, twisted shielded pairs, coaxial cable, fiber optics or manufacturer's standard cabling for communications between remote control devices and BAS controllers.
   3. BAS Network communication cable shall not be spliced.
   4. Provide isolated instrument grounding system as necessary per manufacturer's recommendations.

3.4 LOCAL CONTROL PANELS

A. Provide local control panel for each system where more than one control device requires field mounting, (air handling units, exhaust fans, miscellaneous control systems including pump controls, heat exchanger controls, etc.). Single devices may be mounted on piping, wall or ductwork. Install local control panel where indicated on drawings or suitable location adjacent to system served.

B. Mount panels on wall with suitable brackets or on self-supporting stand. Mount top of panels no higher than 6 ft above floor. Install panels so front cover door can swing fully open without interference.

C. Label local control panels with respective unique ID numbers in accordance with Section 20 0553 - Mechanical Identification.

D. All control panels located in accessible areas be provided with keyed locks. Locks shall utilize a single master key. Provide 2 spare key sets to Owner.

E. Panel Layout:
   1. Locate controllers in lower half of panel first and upper half second.
   2. Locate terminal strips either horizontally in upper half of back panel or vertically. Do not locate terminal strips below 2'-0" or above 6' above finished floor.
   3. Separate 24 VDC and 120 VAC, wire, cable, and devices by 6" minimum space.
   4. Enclose wire and cable in wireways or bundle w/ wire ties and secure to back-panel. This does not apply to wire exiting wireways to terminal strips or panel mounted devices.
   5. Space controllers according to manufacturer's requirements with 3" minimum between controllers and other devices on panel and 6" between controller front and door mounted devices. Ensure adequate space is allowed for device heat dissipation.
   6. Do not place controller or control devices on enclosure sides.
   7. Do not use any control panel as wire or cable pass-through to adjacent panel.

3.5 BAS ETHERNET NETWORK TESTING AND BENCHMARKING

A. Test and document connectivity, latency, and integrity of network from each switch to each BAS controller and BAS server switch and from switch-to-switch.
   1. Latency between any ports shall be equal to or less than 1 millisecond.
   2. Packet loss shall be less than 0.5% between any ports when tested with frame sizes between 64 and 1518 frames for duration of 60 seconds.

B. Test and document all telecommunication protection/security techniques employed on system including access control into BAS Ethernet network from other building networks and access control to other building networks from BAS Ethernet network. Coordinate testing procedures with Owner.

3.6 ADJUSTMENT AND COMPLETION CHECKLIST

A. After completion of installation, follow checklist procedure defined in checklist submittal to adjust and calibrate thermostats, control valves, control actuators, controllers, sensors, and other equipment provided in this Contract. Include signed and dated, completed checklist in Operation and Maintenance Manuals.

B. Upon completion of Work but before final acceptance of systems, Engineer or Owner's representative will verify performance of control loops. Control Contractor shall immediately remedy any deficiencies found. Corrective measures may include modification or addition of equipment and devices, control strategies and/or software program. Corrective modifications made by Control Contractor during warranty period shall be incorporated and updated in Operation and Maintenance Manuals.

C. After final acceptance of system, Contractor shall work with Owner to remove all existing user names and passwords for all software and hardware used on project and create new user names and passwords as required.

D. Upon completion of the installation, the BAS Contractor shall start up the system and perform all necessary testing and debugging operations. An acceptance test in the presence of the Owner's representative shall be performed. The vendor shall check all sensors that exhibit any problems or faulty reading. When the system performance is deemed satisfactory in whole by UEM, the system parts will be accepted for beneficial use and placed under warranty. The BAS Contractor is to be available for system commissioning at the end of the installation when requested by the Engineer and/or Owner. The contractor is to also be available for seasonal commissioning for the other seasons beyond the initial commissioning.

E. This Contractor shall work with the Owner (UEM), who is developing the graphics, to ensure that all points report, function and alarm as required on the BACnet head-end system. The Contractor will also work with the Project Manager or CNS/MCIS to obtain all necessary IP's and Ethernet drops needed for BACnet panel. The Owner (UEM) will assign all BACnet/IP instance numbers and all BACnet/MSTP network numbers for use by the Contractor. All BACnet/IP devices will report directly to the head-end system.

F. UEM will be performing their own complete point by point evaluation as part of this project, independently of the commissioning activity. This will occur during the warranty period of the project.

3.7 OWNER TRAINING

A. Provide full time BAS operator to run system after systems have been started and are regularly used until Owner has completed on-site training specified.

B. Provide minimum of **24** hours of on-site training to Owner's representatives. Conduct training sessions during normal business hours after system start-up and acceptance by Owner. Scheduling of training session(s) will be established by Owner. Portions of training may be performed before system is completely operational, but no sooner than one month before system is planned to be fully operational. Final training session shall be held after systems are complete including all graphics programming.

C. *The BAS Contractor shall provide two copies of an electronic version of the operator's manual describing all operating and routine procedures to be used with the system. This user's manual should contain subjects such as: standard operation, error message explanations, software usage, commands, system troubleshooting, etc. The Contractor shall also provide wiring schematics for all system components.*

D. *The BAS Contractor shall instruct the Owner's designated representatives in these procedures during the start up and test period. The duration of the instruction period shall be no less than four (4) hours during two 2 hour sessions. (Number of hours may be adjusted to a max of 40 dependent upon the size and scope of project. For larger projects, training vouchers for instructional training at the manufacturer's facilities may be requested in lieu of on-site training.) These instructions are to be conducted during normal working hours at the Owner's convenience and are to be prearranged with the Owner. The owner can request this training any time within the one year warranty period and may request any number of classes adding up to the total number of hours. The contractor shall provide an hourly unit price for additional on-site training.*

E. *The instructions shall consist of both hands on at the job site and classroom training at a classroom location on the University of Kentucky campus coordinated with the Project Manager and UEM.*

F. Course content shall include, but not be limited to, the following topics:

1. Upon completion, the attendees shall be able to operate the system and implement system changes including start up, boot load, add point to the data base, enter messages, and down line load field units.
2. Prior to the scheduling of the sessions, an agenda outlining the training topics must be submitted for approval. Agenda items shall include, but not be limited to, the following topics:
   a. Explanation of control sequences. Include which sensors are used and how output device operates.
   b. Explanation of control drawings and manuals, including symbols, abbreviations, and overall organization.
      1). Walk-through of project to identify controller locations and general routing of network cabling.
   c. Review of operation and maintenance of hardware devices including air compressor, air dryers, controllers, instruments, and sensors. Include schedule for routine maintenance.
   d. Programming Application Specific Controllers
      1). Backing up and Restoring Application Specific Programming
      2). Adding/Deleting/Editing points on Application Specific controllers
      3). Troubleshooting Application Specific controllers (inputs/outputs/logic/master – slave relationships/bus issues)
   e. Programming Building Specific Controllers
      1). Backing up and Restoring Building Specific Controllers Programming
      2). Adding/Deleting/Editing points on Building Specific Controllers controllers
      3). Troubleshooting Building Specific Controllers controllers (inputs/outputs/logic/network issues)
   f. How to use tools and cables

G. Course content shall include, but not be limited to, the following topics:
   1. Review of operation of operator's workstation; include hardware (PC's, printers, etc.).
   2. Review of operator's workstation software using specific examples of operating hardware.
   3. Review of portable operator's workstation software using specific examples of operating hardware.
   4. Any additional item(s) specifically requested by Owner.

H. Provide listing of regularly scheduled factory classroom training sessions concerning advanced topics covering proper operation and maintenance of control systems, sensing, monitoring and control equipment. Additional classes travel and lodging will be arranged and paid by Owner.

I. Provide minimum of **8** hours of additional on-site training to Owner's Representatives, 6 months after initial training is completed.

J. Scheduling of training session(s) will be established by Owner.

END OF SECTION

Qualification Form	
Brief resume of **key** persons, specialists, and individual consultants anticipated for this project:	
a. Name & Title:	b. Project Assignment:
c. Name of Firm with which Associated:	d. Years of Experience: With this Firm_____ Other firms_____
e. Education: Degree(s)/Year/Specialization	f. Responsibility Level Proposed for this Project:
g. Other experience and qualifications relevant to the proposed project (include training courses/certifications):	

Recent Relevant Experience (see example below) ▪ Company, Location - Name of Specific Project, Facility - Description of Work and Responsibilities	**Qualifications**

SECTION 23 0902 CONTROL VALVES AND DAMPERS

PART 1 - GENERAL

1.1 RELATED WORK

A. Section 23 0901 - Control Systems Integration

B. Section 23 0993 - Control Sequences

C. Section 23 2118 - Valves

D. Section 23 3314 - Ductwork Specialties

E. Section 23 3600 - Air Terminal Devices

F. Section 23-3614 – Pressure Relationship, Temperature and Airflow Control System

G. Section 23-8413 – Humidification Equipment

1.2 REFERENCE

A. Work under this Section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.

1.3 GENERAL

A. Devices containing mercury are not allowed.

1.4 SUBMITTALS

A. Product data sheets shall include construction materials and assembly methods, maximum design parameters (temperature, pressure, velocity, etc.), and performance data for full range of actuator stroke. Product data sheets shall include charts, graphics or similar items used in making selections, including damper to duct area ratio and free area ratio. Damper product data sheets shall indicate certified leakage rates for given pressure differentials.

B. Submit valve schedules with shop drawings, indicating unique tag numbers for each device, equipment item or system served, device model numbers, sizes, shut-off head required, actuator air pressure or force required to meet shut-off head, torque requirements for rotary valves, flow coefficients (Cv) for 10% and 100% valve stem travel, actual flow requirements based on equipment shop drawings, calculation of actual pressure drops, actuator model number, actuator torque capacities and pilot positioner locations.

C. Valve and damper Shop Drawing submittals will not be processed unless supporting data and sizing calculations are included.

D. Submit damper schedules with Shop Drawings, indicating unique tag numbers for each device, equipment or system served, device model numbers, duct sizes, damper sizes, flow rates, pressure differentials, calculation of actual damper pressure drops, approach velocities, leakage rates, torque requirements, actuator model number, actuator torque capacities and pilot positioner locations.

E. Select dampers to meet their intended service with respect to maximum approach velocities and maximum pressure differential. Damper materials shall match duct construction materials of systems in which they are installed (galvanized steel, aluminum, 304 or 316 stainless steel, etc.).

F. Aluminum dampers may be used in galvanized steel ductwork.

1.5 VALVE SELECTION AND SIZING

A. General:
1. Select control valves to meet their intended service without cavitation. Provide cavitation calculations for modulating globe control valves over 250°Fand all modulating butterfly valves over 60°F.
2. Select control valves and actuators for 100% shut-off against system maximum differential pressure.
3. Valve body ratings indicated in Part 2 are minimum required. Valve body, trim and packing selected shall be designed to withstand maximum pressure and temperature encountered in system.
4. Submit engineering calculations for sizing modulating control valves unless valves are scheduled. Control valves serving terminal devices may be sized based on flow ranges for each pump system.
5. Shut-off and 2-position valves shall be full pipe size.
6. Calculations for sizing modulating valves shall be based on actual characteristics of equipment and system in which valves are installed. Valve calculations shall include information such as pump head or available pressure.
7. Control Contractor is responsible for obtaining adequate system information necessary for sizing.

B. Instrumentation Valves:
1. Unless otherwise noted, instrumentation shut-off valves for isolation of gauges, switches, transmitters, etc., shall be as follows:
a. Compressed air/instrumentation air systems: ball or plug-type valves
b. Water systems: globe-type valves
c. Steam and condensate systems: gate-type valves
d. Ductwork, air handling unit or air terminal device penetrations: ball or plug-type valves
e. Liquid line sampling valves: multiple turn, metering-type valves.

C. Water Valves:
1. Select modulating control valves to provide 3-5 psi pressure drop at design flow rate with differential pressure less than 20 psi, and pressure drop equal to 25% of total pressure drop with differential pressure equal to or greater than 20 psi.
2. Design criteria for sizing modulating valves shall be based on 2 port, normally open, equal percentage valves unless otherwise specified. Select heating and cooling coil control valves of major equipment including air handling units for minimum of 30-50% of equipment sub-circuit pressure drop, but not more than maximum available pump head allowing minimum 2 psi drop for balancing valve.
3. Select control valves based upon pressure drop calculations and Cv values at 100% stroke.
4. Size 3-way mixing or diverting valves not directly associated with pump subcircuit for 3-5 psi pressure drop.

5. Subcircuit is defined as branch supply and return piping to terminal device, including valve, coil, control valve, and balancing valve.

D. Steam Valves
1. Modulating straight-through globe type valves with linear characteristics for 90% of closing stroke and equal-percentage for final 10%.
2. For steam inlet pressure less than 15 psig, size valves for pressure drop equal to 80% of gauge inlet steam pressure. (ΔP = 0.8 x Inlet Gauge Pressure).
3. For steam inlet pressure of 15 psig or greater, size valves for pressure drop equal to 42% of absolute inlet steam pressure. (ΔP = 0.42 x Inlet Absolute Pressure).

1.6 DAMPER SELECTION AND SIZING

A. Submit engineering calculations for sizing modulating control dampers including outside, return, and relief air dampers of air handling units unless dampers are scheduled.

B. Calculations for sizing dampers shall be based on actual characteristics of ductwork system being installed. Opposed blade dampers shall be sized for minimum of 10% of duct system pressure drop. Parallel blade dampers shall be sized for minimum of 30% of duct system pressure drop. Duct section is defined as ductwork containing flow control damper starting with inlet or branch tee and ending with outlet or branch tee. Calculate actual duct pressure drops for each duct section containing modulating damper using latest version of ASHRAE Handbook of Fundamentals. If control systems fixes pressure drop, use those pressure setpoints. Use balance damper to provide additional pressure drop as required for obtaining linear damper response.

C. Control Contractor is responsible for obtaining adequate system information necessary for sizing.

D. Two position dampers to be sized as close as possible to duct size, but in no case is damper size to be less than duct area.

E. Submit leakage and flow characteristic data for control dampers along with shop drawings. Leakage ratings shall be based on AMCA Standard 500 and dampers shall bear AMCA Air Leakage Seals.

PART 2 - PRODUCTS

2.1 CONTROL VALVES

A. General:
1. If control valves are not scheduled, refer to Part 1 of this Section for sizing criteria.
2. Use 2 or 3 port normally open globe type control valves with equal percentage contoured throttling plugs for steam and water applications, except as otherwise noted.
3. Butterfly valves may be used for water system control valves 5" and larger provided that valves meet pressure and temperature requirements. High performance butterfly valves shall be used for modulating applications. General purpose butterfly valves may be used for 2 position control.

B. Globe Valves (Commercial Grade):
1. Manufacturers: Honeywell, Johnson Controls, Siemens Building Technologies, or TAC

2. Valves shall be bronze or brass body, threaded ends for steel piping, solder ends for copper piping, 150 psi rating for 2" and smaller; iron body, bronze mounted, flanged, 125 psi rating for 2-1/2" and larger.
3. Valves shall have stainless steel stems, spring-loaded Teflon packing, with replaceable stem/plug and packing kits.

C. Characterized Ball Valves:
1. Belimo, Valve Solutions Inc., Bray Controls, Neles Controls or approved equal
2. Provide two-way or three-way modulating control valves as required.
3. Valves shall be ball-type valves with V-notch, segmented ball or characterizing disks for equal percentage flow response. Characterizing disks shall be securely fastened by a keyed ring or other securing device to prevent the disk from movement during operation.
4. Valves shall be forged brass body, NPT threaded ends, 150 psi rating for 2" and smaller. Valve bodies 2-1/2" and larger shall be carbon steel or cast iron.
5. Valves shall be furnished with stainless steel ball and stem with fiberglass reinforced Teflon (RTFE) seats and Viton, EPDM or RTFE O-rings and seals.
6. Actuators shall be spring return type for valves requiring fail position; floating control, or fail last position type for areas such as animal rooms, offices or conference rooms.
7. Actuators for major equipment such as air handling units, heating hot water or chilled water shall be fail-in-place, fail open, or fail closed depending upon service requirements. Size actuators to achieve system shutoff pressures.
8. Terminal control valves near the end of the reheat supply lines on each floor shall be 3-way diverting type valves to provide minimum flow through the supply mains.

D. General Purpose Butterfly Valves:
1. Refer to Section 23 2118 - Valves. Refer to Damper and Valve Actuators in this Section for valve actuators.

E. High Performance Butterfly Valves:
1. Manufacturers: DeZurik, Xomox, Jamesbury, Posi-Seal, Bray/McCannalok or Fisher
2. Carbon steel body, lugged style, ANSI Class 150, adjustable PTFE packing, PTFE seat with suitable metal back-up ring, upper and lower shaft thrust bearings, 316 stainless steel one piece shaft and 316 stainless steel disc with offset shaft/disc design.
3. Normal and dead end (without downstream flanging) pressure rating shall be 275 psi.
4. Provide pneumatic actuator and positioner. Provide limit switches as required.
5. Valves and actuators shall be manufactured by valve manufacturer. Valve assembly including actuator, positioner and limit switches if used shall be assembled by valve manufacturer.

F. Terminal Control Valves With Characterizing Disks (Reheat or Chilled Water):
1. Belimo, Johnson Controls, Siemens Building Technologies, Honeywell, TAC or approved equal
2. Provide two-way or three-way modulating control valves as required.
3. Valves shall be ball-type valves with characterizing disks for equal percentage flow response. Characterizing disks shall be securely fastened by a keyed ring to prevent the disk from movement.
4. Valves shall be forged bass body with nickel plating, NPT threaded ends, 150 psig rating for 2" and smaller.

5. Valves shall be furnished with stainless steel ball and stem, and fiberglass reinforced Teflon seats and seals.
6. Terminal control valves near the end of the reheat supply lines on each floor shall be 3-way diverting type valves to provide minimum flow through the supply mains.
7. Actuators shall be spring return type for valves requiring fail position, floating control with fail last position type for areas such as animal rooms, offices or conference rooms.
8. Manufacturer shall warranty components for period of 5 yrs from date of production, with first 2 yrs unconditional.

G. Terminal Control Valves – Globe Type:
1. Manufacturers: Siemens Building Technologies, Johnson Controls, Honeywell, Invensys Building Systems or approved equal.
2. Valves shall be globe type forged brass or bronze with threaded body connections. Valves shall be provided with stainless steel stems and trim. Packing shall be Ethylene Propylene Rubber or Teflon.
3. Provide 3-way mixing control valves at the last 2 reheat coils at the end of each supply main on each floor to provide minimum flow path.
4. Unless otherwise noted, provide fail open pneumatic or electric actuators as identified in control sequences and shown on project drawings.

2.2 CONTROL DAMPERS

A. General:
1. If control damper sizes are not shown or scheduled, refer to Part 1 of this Section for sizing criteria.
2. Unless otherwise indicated, modulating control dampers shall be opposed blade or parallel blade type and 2-position (open/close) dampers shall be parallel blade type.
3. Blade linkage hardware shall have corrosion-resistant finish and be readily accessible for maintenance.
4. Actuators are to be electric type unless otherwise noted. Provide damper position switches when damper position is required by control sequences.
5. AMCA Leakage Classification of Control Dampers

Class	**Static Pressure kPa (Inches Water Column)**			
	1	4	8	12
	Leakage Rate L/s/m^2(cfm/ft^2)			
IA	3	N/A	N/A	N/A
I	4	8	11	14
II	10	20	28	35
III	40	80	112	140

B. Standard Modulating and Two-Position Dampers:
1. Manufacturers and acceptable model numbers:
a. Johnson Controls D-1200/D-1300 (Double Piece)
b. Honeywell D642/D643
c. Ruskin CD50/CD60

2. Damper frames shall be minimum of 14 ga extruded aluminum. Blades shall be minimum of 14 ga aluminum. Blades shall have maximum blade width of 8" with steel trunnions mounted in bronze sleeve, nylon or ball bearings.
3. Furnish dampers with blade seals and stainless steel side seals. Dampers and seals shall be suitable for maximum system temperature, pressure differential and approach velocity, but not less than temperature range of -40° to 200°F, pressure differential of 6" WC, and approach velocity of 4000 fpm based on 4 ft damper section width.
4. Leakage rate shall meet AMCA Leakage Class IA or I.
5. Testing and ratings shall be per AMCA Standard 500-D.

C. Exhaust System Outside Air Bypass Dampers:
1. Manufacturers: Ruskin Model CD80AF2 or American Warming and Ventilating Model VC-423
2. Galvanized steel construction, suitable for maximum temperature 250°F, approach velocity 6000 fpm and differential pressure of 13.5" WC.
3. Air foil blade design, 16 ga minimum and 12" maximum width.
4. Furnish with flexible jamb seals, EPDM, silicone or neoprene blade seals and pneumatic damper actuators with pilot positioners.
5. Damper actuators shall be fail-open pneumatic type with pilot positioners.
6. Damper actuators shall be fail-open, electric 120 V AC, heavy duty industrial quality similar to Valvcon, Rotork, Limitorque or Automax.

D. SMOKE DAMPERS
1. Manufacturers: Air Balance, Johnson Controls, Ruskin or Vent Products.
2. Dampers shall be leakage rated at no higher than Leakage Class I (4 cfm/ft2 at 1" WG and 8 cfm/ft2 at 4" WG) under UL 555S at temperature category 250°F. Furnish dampers with factory-mounted, caulked sleeve and actuator assemblies. Damper shall have 16 gauge or heavier frame with air foil-shaped blades, rated to minimum 4" WG in closed position and to 2000 fpm in open position.
3. Actuator assemblies shall be installed outside airstream, linked to damper for fail (normally) closed operation. Actuator shall be capable of closing damper at pressures encountered in system.
4. Size smoke dampers as close as possible to duct size, but in no case is damper size to be less than duct size.
5. Dampers shall fully open in 15 seconds or less and fully close in not more than 15 seconds and not less than 7 seconds when activated.
6. Electric actuators shall be non-stall type.

2.3 DAMPER AND VALVE ACTUATORS

A. Analog Electronic:
1. Manufacturers: Belimo, Honeywell, Johnson Controls, Siemens Building Technologies or TAC
2. Actuators shall be electric motor/gear drives that respond proportionally to analog voltage or current input, or digital floating control signals.
   a. Floating control actuators shall only be used for terminal hot water or chilled water control.
   b. Analog control actuators shall be used for all other modulating applications.
3. Stroke time for major equipment shall be 90 seconds or less for 90° rotation. Stroke time for terminal equipment shall be compatible with associated local controller, but no more than 6 minutes.

4. Provide spring return feature for fail open or closed positions, as required by control sequence, for critical applications such as outside, return, or exhaust dampers, heating and cooling coils on major air handling units, humidifiers, heat exchangers, flow control for major equipment items such as chillers, cooling towers, boilers, etc. Fail-last-position actuators do not have spring return feature.
5. Provide position feedback potentiometers connected to controller for closed loop control on major equipment analog control loops.
6. Actuators for terminal heating/cooling equipment do not require spring return feature.

B. Discrete Two-Position Electric:
1. Manufacturers: Belimo, Honeywell, Johnson Controls, Siemens Building Technologies or TAC
2. Actuators shall be electric motor/gear drives for two-position control. Stroke time shall be 90 seconds or less for 90° rotation.
3. Provide spring return feature for fail open or closed positions as required by control sequence. Fail-last-position actuators do not have spring return feature.

PART 3 - EXECUTION

3.1 CONTROL VALVES

A. Furnish control valves as shown on drawings and/or as required to perform control sequences specified.

B. Control valves furnished by Control Contractor shall be installed by Mechanical Contractor under coordinating control and supervision of Control Contractor.

C. Increaser and decreaser fittings required to facilitate valve installations shall be provided by Mechanical Contractor.

3.2 CONTROL DAMPERS

A. Furnish control dampers actuators as shown on drawings and/or as required to perform control sequences specified, except those furnished with other equipment.

B. Control dampers furnished by Control Contractor shall be installed by Mechanical Contractor under coordinating control and supervision of Control Contractor.

C. Blank-off plates or transitions required to facilitate dampers shall be provided by Mechanical Contractor.

3.3 SMOKE DAMPERS

A. Refer to Section 23 3314 - Ductwork Specialties

B. Furnish smoke dampers as shown on drawings.

3.4 ACTUATORS

A. Provide actuator for each automatic damper or valve with sufficient capacity to operate damper or valve under all conditions. Select actuators to provide tight shut-off against maximum system temperatures and pressure encountered. Each actuator shall be full-modulating or two-position type as required or specified, and shall be provided with spring-return for fail open or fail closed

position for fire, freeze, moisture, occupant safety, equipment protection, heating or cooling system protection on power interruption as indicated and/or as required. Smoke dampers and steam valves serving pressure rated heat exchangers or convertors shall fail-closed.

B. Where sequencing of valves or dampers is required for pneumatic systems, such sequencing shall be accomplished by spring ranges adequate for applications to avoid both overlap of operation and simultaneous use of heating and cooling.

C. Provide pilot positioners for all sequenced devices, and devices which require adjustable operating speeds.

D. Provide pilot positioners for pneumatic modulating outside and return air dampers and fan volume control devices such as fan inlet dampers where used.

E. Provide pilot positioners for pneumatic modulating valve and damper actuators where torque required by controlled devices exceeds 50% of torque capacity of operator.

F. Valve and damper operating speeds shall be selected or adjusted so that actuators will remain in step with controllers without hunting, regardless of load variations. Actuators acting in sequence with other actuators shall have adjustment of control sequence as required by operating characteristics of system.

G. Provide speed control valves for On/Off actuators for adjustment of actuator speed to prevent water hammer or excessive stress on large valves and dampers.

H. Provide proper linkage and brackets for mounting and attaching actuators to devices. Design mounting and/or support to provide no more than 5% hysteresis in either direction (actual movement of valve stem or damper shaft versus ideal movement) due to deflection of actuator mounting.

I. Provide single actuator on damper section not exceeding torque capacity of actuator.

J. Multiple damper sections where used shall be connected together via jackshaft or other coupling device, not by internal pinned connections at blade shafts of individual damper sections. Where multiple damper sections are connected together via jackshaft or other coupling device, damper actuator shall be mounted directly to jackshaft or other coupling device for operating damper sections. For instances where damper actuator cannot be mounted to jackshaft or other coupling device, damper actuator shall be provided for each damper section.
    1. Mounting multiple actuators to common damper jackshaft or valve stem to meet torque requirements is not allowed.

K. Position feedback potentiometers shall be provided where floating control actuators are sequenced with other floating control actuators in terminal hot water control (i.e., reheat valve, fin tube radiator valve, radiant ceiling panel valve, etc.).

L. Calibrate position feedback potentiometers, where specified, with range and gain factors as required for proper operation per manufacturer's recommendations.

M. Integral actuator end switches or feedback potentiometers shall not be used. Provide separate end switches/feedback potentiometers that provide actual damper/valve position.
    1. Integral actuator end switches or feedback potentiometers can be used if damper or valve shaft is keyed or directly affixed to the actuator such that the shaft cannot slip and provide false

position. U-clamp type actuator mounting always requires separate end switches/feedback potentiometers.

END OF SECTION

SECTION 23 0903 CONTROL INSTRUMENTATION

PART 1 - GENERAL

1.1 RELATED WORK

A. Section 23 0901 - Control Systems Integration

B. Section 23 0905 - Instrument Point List

C. Section 23 0993 - Control Sequences

D. Section 23 2120 - Piping Specialties

1.2 REFERENCE

A. Work under this Section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.

1.3 GENERAL

A. Devices containing mercury are not allowed.

1.4 SUBMITTALS

A. Devices shall be indexed by bill of material for each system as detailed in Section 23 0901 - Control Systems Integration.

B. Thermostat/Room Temperature Sensor Schedules:
   1. Submit thermostat/room temperature sensor schedule with shop drawings. Thermostat/room temperature sensor schedule shall have detailed listing of which type is used for each room, including data concerning service and model numbers, sizes, cover types, and engineering data sheets for each control device.

C. Warranty
   1. Provide 1 year warranty on all materials and labor.
   2. Warranty requirements shall include furnishing and installing software upgrades issued by the manufacturer during the 1 year warranty period.

1.5 FCC COMPLIANCE

A. Digital equipment furnished under this Contract shall be tested and made to comply with limits for Class A computing devices pursuant to Subpart J of Part 15 of FCC Rules, which are designed to provide reasonable protection against interference when operated in commercial environments. Literature shall so note and equipment shall be so labeled.

PART 2 - PRODUCTS

2.1 GENERAL

A. Pressure and temperature ratings of devices indicated in Part 2 - of this Section are minimum required. Devices shall be designed to withstand maximum pressures and temperatures encountered in respective systems.

B. No devices containing mercury will be allowed under this Specification.

2.2 GENERAL INSTRUMENTATION

A. Pressure Gauges:
   1. Refer to Section 23 2120 - Piping Specialties

B. Thermometers (Dial-Type):
   1. Refer to Section 23 2120 - Piping Specialties

C. Analog Electronic Instrument Indicators:
   1. Electronic indicators, used for displaying sensor and/or output values as measured by current or voltage, shall be panel mount type and at least 2" square. Output may be either analog needle type or digital with 1/2" high LED or backlit LCD displays.
   2. Electronic indicators shall be marked in appropriate units (degrees, psi, % rh, gpm, cfm, etc.) and with appropriate range of values. Panel mounted indicators shall have minimum accuracy of 1% of scale range. Digital units shall be scaled to show 3 digits plus 1 decimal point.

D. Control Panels
   1. Panelboard shall contain all instruments and accessories. Provide each item of equipment with an engraved nameplate. Panelboard shall be wall mounted or stand mounted and shall be completely enclosed.
   2. As far as is practical, the control components for each system shall be grouped. Provide each group of components with identification.
   3. The entire panelboard shall be pre wired and brought to a main terminal strip. All relays, switches, etc., shall be installed, furnished and wired on panelboard. Clearly mark each terminal strip as to which wire from which component is to be connected.
   4. Fabricate panels of 0.06-inch- (1.5-mm-) thick, furniture-quality steel or extruded-aluminum alloy, totally enclosed, with hinged doors and keyed lock, with manufacturer's standard shop-painted finish and color.
   5. Panel-Mounted Equipment: Temperature and humidity controllers, relays, and automatic switches; except safety devices. Mount devices with adjustments accessible through front of panel.
   6. Door-Mounted Equipment: Flush-mount (on hinged door) manual switches, including damper-positioning switches, changeover switches, thermometers, and gages.
   7. Graphics: Color-coded graphic, laminated-plastic displays on doors, schematically showing system being controlled, with protective, clear plastic sheet bonded to entire door.

2.3 DISCRETE ELECTRIC INSTRUMENTATION

A. General:

1. Electrical devices, switches, and relays shall be UL listed and of type meeting current and voltage characteristics of project. Terminal connections shall be made at terminal blocks inside of NEMA 1 enclosures unless otherwise specified. Outdoor units shall be NEMA 4 with concealed adjustment.
2. Ratings of normally open and normally closed contacts shall be adequate for applied load (minimum 5 amps at 240 Volts).
3. Accuracy of devices shall be ± 1% of scale with adjustable offset unless otherwise specified.

B. Temperature Switches (Electric Thermostats):
1. Line voltage or low voltage type suitable for application with adjustable setpoint and setpoint indication.
2. Low voltage type to have heat anticipation.
3. Thermostats with remote sensing bulb shall have liquid filled sensing element and exposed setpoint adjustment.
4. Wall mounted space thermostat enclosure shall have concealed sensing element and exposed setpoint adjustment.
5. Unless otherwise stated, space thermostat covers shall be custom color “bright white”.

C. Temperature Switches (Aquastats):
1. Electric 2-position type with strap-on or immersion temperature sensing element. Switch contacts close on increasing temperature to provide start signal for unit heaters, cabinet unit heaters and open on high limit control for heating hot water heat exchangers.
2. Sensing element shall be set for 100°F (FA) for unit heater control. For setpoints to aquastats for hot water heat exchangers, refer to control sequences for each hot water system. Provide screw-type terminals in NEMA 12 switch enclosure for field mounting at unit heaters.

D. Relays:
1. Manufacturers: IDEC, Potter Brumfield, Square D, or Allen Bradley
2. Equal to IDEC Type RH2B-U, miniature 8 blade pilot relay with DPDT silver cadmium oxide contacts rated at 10A, 30 VDC, or 120 VAC. Coil shall match control circuit characteristics. DDC outputs shall be 24 VDC with maximum current burden of 50 milliamps. Rectangular base socket mount with blade type plug-in terminals and polycarbonate dust cover.
3. Provide DIN rail mountable (Snap type) mounting sockets equal to IDEC SH2B-05.

E. Enclosed Relay (Relay-in-a-Box):
1. Manufacturers: Veris Industries, Kele & Associates, Functional devices, Inc. or approved equal
2. 1 or 2 SPDT relays in NEMA 1 or better enclosure. Coil shall be selected for control circuit characteristics.
3. Contacts rated at 10A, 28 VDC or 120 VAC. Conduit nipple is 1/2" NPT. Maximum coil current burden 50 milliamps.

F. Pressure Differential Switches (Air Systems):
1. Manufacturers: Cleveland Controls, Dwyer, Honeywell, Johnson Controls/Penn, Siemens Building Technologies, or TAC
2. Adjustable set point, differential pressure type. Select switches for accuracy, ranges (20 to 80% of operating range) and dead-band to match process conditions, electrical requirements and to implement intended functions.

3. Pressure differential switches for air systems shall have pressure rating of at least 10" WC.
4. Pressure indicating differential switches for air systems shall be equal to Dwyer Series 3000 photohelic gauge.
   a. Maximum Temperature Rating: 180°F
   b. Repeatability: ± 1%

G. Level Switches:
1. Manufacturers: Drexelbrook, Magnetrol, Endress and Hauser or Dwyer
2. Radio Frequency (RF) type continuous level probe with multiple adjustable setpoints and SPDT snap action contacts to meet intended use. Probe shall have probe shielding to reject build up of conductive, sticky or viscous material. Probe length shall match vessel dimensions to measure within 6" of bottom.
3. Provide probe brace every 4 ft if probe length exceeds 6 ft, and not installed in stilling well.
   a. Supply Voltage: 120 VAC/60 Hz
   b. Fail Safe: Low Level output on instrument failure
   c. Ambient Temperature Limits: -40 to 160°F
   d. Minimum Enclosure Rating: NEMA 4
   e. Transmitter Mounting: Remote
   f. Performance:
      1). Accuracy: ± 2% nominal
      2). Linearity: ± 1% nominal
      3). Repeatability: ± 1% nominal
      4). Response Time: 20 milliseconds
      5). Ambient Temperature Effect: 2% per 100°F max.
      6). Voltage Variation Effect: ± 0.2% maximum per 10 V change

H. Time Switches (Time Clocks):
1. Manufacturers: Invensys Paragon, Intermatic, Kessler-Ellis Products, Automatic Timing and Controls or Tork.
2. Programmable electronic clock type consisting of electronic clock, LED or LCD display, user interface keypad, and multiple normally open/fail close contacts. Time clocks shall be programmable for up to 8 start/stops per day for each 7 day period.
3. Provide each time clock with battery that will maintain programming schedule for up to 8 hours upon electric power failure and shall return to its programmed position after re-start.

I. E-P Switches (Solenoid Valves):
1. Manufacturers: Asco, Johnson Controls, Siemens Building Technologies, TAC, Kele & Associates or MAC Valves
2. E-P switches shall provide control air for operation of fan isolation dampers, smoke or smoke/fire dampers, or other On/Off dampers. Line voltage actuators shall be Class "H" (high temperature) and listed by UL or CSA.
   a. Valve Body: Brass or bronze
   b. Valve Type: 2-way or 3-way
   c. Operating Voltage: 24 VDC, 24 VAC, 120 VAC or as specified
   d. Operating Temperature: 32 to 104°F

e. Operating Pressure: Greater than maximum supply pressure
f. Pipe Size: 1/4" NPT
g. Enclosure Rating: NEMA 4 (locally mounted), NEMA 1 (Panel Mounted)
h. Conduit Connection: 1/2"

J. Current Switches - Constant Load, Constant Speed:
1. Manufacturers: Veris Industries, N-K Technologies, Absolute Process Instruments, Kele & Associates, R-K Electronics or approved equal
2. These shall be Induction type sensors clamped over single phase conductor of AC electrical power and shall be solid-state sensors with adjustable threshold and normally open contacts. Each current switch shall be selected for proper operating range of current.
a. Output: Solid state relay or relay contacts
b. Trip Setpoint: Adjustable by multi-turn potentiometer
c. Operating Temperature: 32 to 131°F
d. Response Time: < 0.5 seconds

K. Current Switches - Variable Load, Variable Speed
1. Manufacturers: Veris Industries, N-K Technologies or approved equal
2. These shall be induction type sensors clamped over single-phase conductor of AC electrical power and shall consist of solid-state sensors with self-calibrating threshold and normally open contacts. Each current switch shall be selected for proper operating range of current.
a. Output: Solid state relay or relay contacts
b. Trip Setpoint: Self-calibrating through microprocessor
c. Operating Temperature: 32 to 131°F
d. Response Time: < 0.5 seconds

L. Indicator Lights:
1. Manufacturers: Allen Bradley, GE, Square-D, or Idec
2. 1/4" minimum size or 1-1/4" maximum size, push-to-test type. Use green for normal, yellow for warning (low/high values), and red for alarm or fail (low-low or high-high conditions). AC or DC type with voltage matched to control circuit without transformers.

M. Moisture Detector:
1. Manufacturers: Raychem Corp. or approved alternate.
a. Moisture detector shall alarm in the event of water or other conductive liquid present on floors or areas damage may occur to. Moisture detectors shall be used in but not limited to mechanical equipment rooms, computer rooms or other spaces where liquid leakage may cause damage to equipment in the space.
2. Alarm Module: Raychem Model TTA-1 or equal.
a. Supply Voltage: 120/240 VAC, 60 Hz
b. Power Consumption: 14 VA
c. Temperature Rating: 32°F to 105°F (0°C to 40°C)
d. Sensing Cable: Raychem Trace Tek® Series
e. Max. Sensing Cable Length: 50 ft. (15 m)
f. Relays Contacts:
1). Type: 4PDT

2). Rating: 3A at 120 VAC/28 VDC
3). Audible Alarm: 95 decibels
4). Enclosure Rating: NEMA 12 (Optional NEMA 4X)

3. Sensing Cable: Raychem Model TT1000 or equal.
   a. Sensing Fluid: Water
   b. Cable Characteristics:
      1). Cable Diameter: 0.24 in. (6.0 mm) nominal
      2). Continuity/signal wires: 2 x 26 AWG with fluoropolymer insulation
      3). Sensing Wires 2 x 30 AWG with conductive fluoropolymer jacket
      4). Max. Cable Length: 50 ft.
      5). Max. Cable weight 2.3 lbs.
      6). Max. Operating Temp. 174°F (75°C)
   c. Sensitivity length: 2 inches maximum at any point along sensing cable.
   d. Drying time: Cable dries and resets within 15 seconds of removal from standing water.
4. Accessories:
   a. Modular Leader Cable: Non-conductive cable for connecting Sensing Cable to the Alarm Module.
   b. Modular End Termination: Required for Sensing Cable operation.
   c. Hold Down Clips: For anchoring the Sensing Cable to floor, bottom of trough or wall.
5. Mount Alarm Module near area to be monitored at approximately 5 feet above finished floor. Run Modular Leader Cable through conduit to location where it connects to the Sensing Cable. In mechanical equipment rooms or electrical equipment rooms, specify NEMA 4X enclosures for the Alarm Module. In computer rooms or other environmentally controlled area a NEMA 12 enclosure may be used for the Alarm Module.

N. Drain Pipe Moisture Detector:
1. Manufacturers: Honeywell 470-12 or approved alternate.
   a. Moisture detector shall alarm in the event of water flowing through drain pipe. Moisture detectors shall be provided with two sensitivity settings.
   b. Supply Voltage: 12 VDC
   c. Power Consumption: 1 mA
   d. Relay Rating: 5 A
   e. Alarm Output: SPDT Form C Contact

2.4 ANALOG ELECTRONIC INSTRUMENTATION

A. Space Temperature Sensors:
1. Sensors shall be platinum RTD type, with the following minimum performance:
   a. Temperature Coefficient of Resistivity (TCR): 0.00385 ohm/ohm/°C
   b. Accuracy: ± .54°F + (0.005 X T) (Class B)
   c. Accuracy: ± .27°F + (0.005 X T) (Class A)
      T = Temperature of interest
   d. Conformance: DIN-IEC 751

e. Operating Range: 32 to 122°F, 0 to 99% rh

2. Thermistors will be acceptable in lieu of RTD provided thermistor carries 5 year guarantee that device will maintain its accuracy within tolerance of ± 0.36°F between 32°F and 65.5150°F, and 0.5°F between -20°F and 212°F.

1. Unless otherwise stated, space sensor cover shall be brushed aluminum or brushed nickel.
2. Provide visible setpoint, set point adjustment, and space temperature indication.
3. Unless otherwise stated, space thermostat covers shall be custom color “bright white”.
4. As indicated on mechanical plans, provide button type temperature sensor (for hallways).

B. Duct Mounted or Insertion Temperature Sensors:

1. Platinum RTD type, with the following minimum performance:
   a. Temperature Coefficient: 0.00385 ohm/ohm/°C
   b. Accuracy: ± .54°F + (0.005 X T) (Class B)
   c. Accuracy: ± .27°F + (0.005 X T) (Class A)
      T = Temperature of interest
   d. Conformance: DIN-IEC 751
   e. Operating Range: -50 to 170°F, 0 to 99% RH
2. Install insertions sensors in stainless steel probes or wells.
3. Standard lengths to be 5.5”, 11.5” and 17.5”. Other lengths will be at owner’s written approval.
4. Outside air sensors shall be weatherproof of noncorrosive construction and protected with solar shield. Mount outside air sensors on north side of building or in area intake wells for air handling systems to avoid thermal effects from direct sunlight. Glass encapsulated element unless otherwise approved.
5. Sensors mounted in air streams, such as air handling units, supply ducts, exhaust ducts or return ducts, shall be averaging type. Averaging type sensor to be installed in ducts larger than 24" x 24" or greater than 576in^2. Mount averaging sensor across duct area in a “Z” pattern using mounting clips specific for averaging temperature sensor probes.
6. Thermistors will be acceptable in lieu of RTD provided thermistor carries 5 year guarantee that the device will maintain its accuracy within a tolerance of ± 0.36°F between 32°F and 150°F, and 0.5°F between -20°F and 212°F.

C. Direct Insertion Temperature Sensors:

1. Sensor assembly shall be direct insertion, suitable for use with water systems, 150 lb class, minimum rating.
2. Sensor shall be platinum wound RTD, minimum accuracy of ± 0.06% at 32°F.
3. Sheath diameter shall not exceed 5/16". Length shall be such that sheath, containing sensor, projects into process fluid from 2" to 2.5" beyond pipe wall when installed. Material to be 304 or 316 stainless steel. Process coupling to be 3/8" or 1/2" NPT.
4. Connection head to be NEMA 4, cast iron, with screw on cap. Provide internal termination for RTD and wire connection. Conduit connection shall be 1/2" NPT.
5. Provide hot tap assembly and extension. Material to be 304 or 316 stainless steel. Support hot tap at minimum of 2 points to eliminate vibration. Extension shall exceed insulation thickness by 1".
6. Refer to Section 25 3003 - Process Instrumentation Device Specifications.

D. RTD Temperature Sensor/Transmitters:

1. Manufacturers: Rosemount, Burns, Minco Products, Weed or Pyromation
2. Transmitters shall provide 2 wire, 4-20 mA current output signal proportional to specified temperature span of transmitter and compatible with DDC equipment.
   a. These shall be 100O platinum RTD type temperature instruments for process immersion or air duct mounting
   b. Operating Temperature: -20 to +180°F
   c. Power Supply Voltage: 13 to 35 VDC unregulated
   d. Accuracy or Output Error: 0.1% of span of sensor and transmitter combination
   e. Temperature Coefficient: 0.00385 ohm/ohm/°C
   f. Thermowells: By same manufacturer as Sensor/Transmitter or approved alternate.
3. Provide local temperature indicator with 3 LCD digital readout.

E. Space Humidity Sensors/Transmitters:
1. Manufacturers: General Eastern, Automation Components Inc., Veris Industries, Hy-Cal (Honeywell), Rotronic or Vaisala
2. Space humidity sensors shall be wall mount type covers shall be custom color “bright white” to match room temperature sensors.
3. Sensing element shall be resistive bulk polymer, or thin film capacitive type. Sensor/transmitter shall have the following minimum performance:
   a. Accuracy: ± 2% rh at 25°C over range of 20-95% rh including hysteresis, linearity and repeatability
   b. Temperature Effect: Less than 0.06% per °F at baseline of 68°F
   c. Sensitivity: 0.1% rh
   d. Repeatability: 0.5% rh
   e. Hysteresis: Less than 1%
   f. Long Term Stability: Less than 1% rh drift per year
   g. Adjustment: ± 20% rh zero, non-interactive
      ± 10% rh span, non-interactive
   h. Operating Range: 0-99% rh, non-condensing, sensor
      0-95% rh, non-condensing, electronics
   i. Output: 4-20 mA, 0-100% linear, proportional
   j. Power: 12-36 VDC

F. Duct Mounted Humidity Sensors/Transmitters:
1. Manufacturers: General Eastern, Automation Components Inc., Versis Industries, Minco, Rotronic or Vaisala
2. Probe type, temperature compensated, resistive bulk polymer or thin film capacitive type. Sensor/transmitter shall have the following minimum performance.
   a. Accuracy: ± 2% rh at 25°C over 20-95% rh including hysteresis, linearity and repeatability
   b. Temperature Effect: Less than 0.06% per °F at baseline of 68°F.
   c. Sensitivity: 0.1% rh
   d. Repeatability: 0.5% rh
   e. Hysteresis: Less than 1%

f. Long Term Stability: Less than 1% drift per year
g. Adjustment: ± 20% rh zero, non-interactive
± 10% rh span, non-interactive
h. Operating Range: 0-99% rh, non-condensing, sensor
0-95% rh, non-condensing, electronics
i. Output: 4-20 mA, 0-100% linear, proportional
j. Power: 12-36 VDC

G. Combination Temperature/Humidity Transmitter:
1. Manufacturers: Automation Components Inc., Veris Industries, Vaisala, Minco or General Eastern
2. Combination Temperature and Humidity sensor/transmitter shall meet the following minimum requirements:
3. Temperature:
a. Temperature Sensor: 100 or 1000 Ohm Pt RTD
b. Temperature Coefficient: .00385 ohm/ohm/°C
c. Accuracy: ± .54°F + (0.005 X T) (Class B)
d. Accuracy: ± .27°F + (0.005 X T) (Class A)
T = Temperature of interest
e. Operating Range: -10 to 160°F
f. Supply Voltage: 18 to 36 VDC / VAC
g. Output Ranges: 2-wire, 4 to 20 mA or 3-wire, 0 to 5, 0 to 10 VDC or 4 to 20 mA (24 VAC)
4. Humidity:
a. Temperature Compensated: Full range of rh signal
b. Response Time: 30 seconds for 63% step
c. Accuracy Range: ±2% rh between 20 to 95% rh Span (including hysteresis, linearity repeatability).
d. Sensing Element: Resistance or Capacitance humidity sensor
e. Operating rh Range: 0 to 100% rh(non-condensing)
f. Supply Voltage: 24 VDC (current or voltage output) 24 VAC (contact factory)
g. Output Ranges: 4 to 20mA, 0 to 5V, 0 to 10V
h. Long Term Stability: Less than 2% rh drift per year
5. Enclosure shall be made of ABS Plastic or equivalent and include an optional LCD display on face of enclosure.
6. Optional LCD readout shall be capable of °C or °F operation with an adjustable display toggle switch to change from temperature to humidity display. Unit shall include capability of temperature and humidity setpoint value display during adjustment.

H. Dew Point Temperature Transmitter:
1. Manufacturers: General Eastern, Kele & Associates or Vaisala
2. Microprocessor type primary dew point temperature measurement using platinum RTD, 4 wire, 100 ohm temperature sensing element with 4-20 mA transmitter.

a. Accuracy: ± 1°F
b. Repeatability: ± 0.1°F
c. Hysteresis: None
d. Sensor Range: -10°F to +140°F dew point
32°F to 140°F ambient

3. Unit shall be selected for proper application (wall or duct mounted).

I. Ducted Air System Static Pressure and Differential Pressure (Velocity) Transmitters:
1. Manufacturers: GE Modus, Setra, Ashcroft XLDP or approved equal
2. Provide transducers/transmitters to convert velocity pressure differential or static duct pressure relative to sensor location into electronic signal.
3. Unit shall be capable of transmitting linear 4 - 20 mA DC output signal proportional to differential (total minus static or static minus ambient) pressure input signals with the following minimum performance and application criteria:
a. Span: Not greater than twice duct static or velocity pressure at maximum flow rate, or more than 16 times velocity pressure at minimum flow rate.
b. Accuracy: ± 1.0% of span or ± 1.0% of full scale
c. Dead Band: Less than 0.5% of output
d. Hysteresis: Within 0.5% of span or within 0.5% of full scale
e. Linearity: Within 1.0% of span or within 0.5% of full scale
f. Repeatability: Within 0.5% of output
g. Response: Less than 1 second for full span input
4. Return and exhaust air system static pressure transducers/transmitters shall be furnished with protective integral air filters on pressure sensing lines from static pressure sensing stations and with static air probes to prevent migration of moisture and particulate matter into transducers. If inputs to pressure transducers/transmitters are dead-ended, integral air filters are not required. Supply air system sensors do not require integral air filters.

J. Space Pressure Monitoring System:
1. Manufacturers: Tek-Air Systems, TSI, Siemens Building Technologies, or approved equal
2. Provide directional pressure monitoring system for clean rooms, isolation rooms. Biosafety research labs and hospital rooms. System shall include ultra-low differential pressure transmitter including thermal mass airflow sensor, two space pressure probes, room display for visual monitoring of space pressurization and LCD readout of space differential pressure.
3. Space pressure monitoring system shall have the following characteristics:
a. Accuracy: ± 2% of set range.
b. Pressure Range: 0.100 to -0.100” WC, full scale range, adjustable to ± 0.001, ± 0.005, to 0.010 or 0.10” WC.
c. Analog Resolution: 0.0001” WC.
d. Digital Resolution: ± 0.00005” WC.
e. Output: 4-20 mA DC, self-powered, 5000 ohm load max.
f. Power Supply: 24 VAC =/- 4 VAC, <10 VA.
g. Communications: RS-485, RS-232, BACnet, Ethernet or LonWorks.

K. Space Pressure Differential Transmitter:

1. Provide directional mass flow transmitter installed in 2" Schedule 40 black steel pipe between spaces to measure relative velocity created by pressure difference. Provide algorithm in software to convert air velocity to pressure differential (Delta P = C $(V/4005)^2$). Field determine coefficient C by calibrated measurement.
2. Air velocity transmitter shall be equal to Omega FMA-900 Series with the following characteristics:
   a. Accuracy: ± 1.5% full scale, ± 0.5% reading
   b. Repeatability: ± 0.2% of full scale
   c. Probe Temperature Range: -40°F to 250°F
   d. Pressure Range: 150 psig, max
   e. Response Time: 400 msec. to within 63% of final value
   f. Output Signal: 4-20 mA
   g. Accessories: Compression Fittings - Omega 55 LK with Teflon Ferrules.

L. Current Transformers:
1. Manufacturers: General Electric, Square D, Kele & Associates, N-K Technologies or Veris Industries
2. Alternating current transformers shall conform to latest applicable Standards including AEIC, EEI-NEMA, Standards for Instrument Transformers (MSJ-11) and ANSI Standard C57.13 for instrument transformers.
   a. Rated Voltage: 480 V
   b. Insulation Class: 600 V
   c. Basic Impulse Level: 60 Hz
   d. Short Time Current Rating: 100% (1 second)
   e. Accuracy Class: 0.3
   f. Continuous Current Rating: 150%

M. Rotary (Damper) Position Sensors:
1. Manufacturers: Kele & Associates, Fisher Controls or Westlock
2. Provide position 4-20 mA transmitter with potentiometer type (variable resistance) sensor for damper position measurement. Measurement to be linear to damper stroke.
   a. Performance:
      1). Power Supply: 24 VDC unregulated
      2). Accuracy: ± 1% of output span
      3). Repeatability: ± 0.5% of full span
      4). Maximum Temperature: 125°F

N. P-E Transducers (Pressure Transmitters):
1. Manufacturers: Ashcroft, Mamac, Setra, Kele & Associates or GE Modus
2. Units shall have the following characteristics:
   a. Input: Pressure 0-15 psig, minimum
   b. Output Signal: 4-20 mA, 0-5 VDC, 1-5 VDC, 1-10 VDC
   c. Accuracy: 1% of span
   d. Operating Temperature 32 to 125°F
   e. Power Requirements: 24 VDC (10-30 VDC)

O. Space CO2 Sensors
   1. Manufacturers: Vaisala, Automation Components Inc., Toxalert, or approved alternate.
   2. Provide Carbon Dioxide Monitor as listed below. The system shall be a complete package with integral sensor, monitor, alarm contacts, local indication of current measured value for sensor.
      a. Gas to be Detected: Carbon Dioxide (CO2)
      b. Power Requirements: 24 VAC, 50/60 Hz, 50 VA
      c. Signal Input: Integral Sensor
      d. Signal Output: 4-20 mA DC or 0-10 VDC
      e. Alarm Relays: 1 Amps, 120 VAC, Form C
      f. Range: 0-2000 ppm
      g. Alarm Setpoint: Field Adjustable, Factory set at 1000 ppm
      h. Sensor Infrared CO2 Sensor
      i. Mounting: Wall-mounted
   3. Provide local display for continuous reading of CO_2 levels. Data shall be recorded on system with DDC to the zone level.
   4. Unit shall have adjustable set points and self-test diagnostics.
   5. Certified by manufacturer to require calibration no more frequently than once every 5 years. Provide 120 VAC to 24 VAC transformer adjacent to Air Quality Monitor or provide 24 VAC from Temperature Control Panel nearest Air Quality Monitor.
   6. Sensors shall be wall mount type covers shall be custom color “bright white” to match room temperature sensors.

PART 3 - EXECUTION

3.1 GENERAL

A. Install control equipment, wiring and air piping in neat and workmanlike manner and in accordance with manufacturer's recommendations. Maintain clearances, straight length distances, etc., required for proper operation of each device. Mark and detail on coordination drawings, exact locations of inline devices, wells, and taps to be installed by Mechanical Contractor.

B. Coordinate timely delivery of materials and supervise activities of other trade Contractors to install inline devices such as immersion wells, pressure tappings, any associated shut-off valves, flow switches, level switches, flow meters, air flow stations, and other such items furnished by Control Contractor which are to be installed by Mechanical Contractor.

C. Install control devices in accessible location.

D. Mount motor control devices within 5 ft of disconnect switch, or starting device furnished by Electrical Contractor unless noted otherwise. Maintain required NEC clearances.

E. Control Contractor and Mechanical Contractor shall review proposed static pressure sensor and flow meter locations with Owner and Engineer for approval prior to installation.

3.2 GENERAL INSTRUMENTATION

A. Pressure Gauges (Pressure Indicators):

1. Install pressure gauge for indication of supply and control pressure in pneumatic systems at output of controllers, I/P transducers, electric air solenoid valves, pressure switches and other points where visible indication of air pressure is required for operating and maintenance purposes.
2. Provide test port for quick connection of test gauges at valve, damper motor and other actuator branch lines.
3. Pressure gauge tappings in piping will be provided by Mechanical Contractor.

B. Thermometers (Temperature Indicators):
1. Install thermometers at each point of temperature transmission and control, except for those that are indicated at local control panels. Install thermometers to permit easy reading from floor or operating platform (within 3 ft of line of sight). Provide remote bulb thermometers with readout indicators mounted within 3 ft of line of sight whenever sensing point is more than 3 ft from line of sight.
2. Thermometer wells in piping will be installed by Mechanical Contractor.

C. Local Control Panels:
1. Install remote mounted devices, controllers, I/O terminal blocks, power supplies, etc., inside of local control panels.
2. Locate panels as shown on drawings.
3. Locate panels adjacent to equipment served with minimum of 3 ft clearance in front of door. Provide sufficient clearances to allow full door swing and full access to internal components. Submit proposed panel locations with shop drawing submittals.
4. Mount top of panels between 5 and 6 ft above floor so that gauges and indicators are at eye level.

D. General Instrumentation at Local Control Panels:
1. Provide record control drawings of systems served by each local panel, in location adjacent to or inside of panel cover. Provide protective cover for drawing.

3.3 DISCRETE AND ANALOG INSTRUMENTATION

A. Wall Mounted Space Temperature Sensors:
1. Install space sensors where indicated, as required to perform specified control sequences, and as directed to meet job site conditions.
2. Mount space sensors at 5 ft above floor unless otherwise indicated.
3. Mount space sensors with accessible setpoint adjustment or temperature reading (thermometer or digital temperature readout) at 4 ft above floor.
4. Space sensors located on exterior walls shall be mounted on thermally insulated sub-base.
5. Relocate space sensors if required due to draft, interferences with cabinets, chalkboards, etc., or improper sensing.
6. Mount space sensors in corridors, stairways and public toilets 7 ft above floor.
7. Space sensors in corridor, stairways, vestibules and toilets shall be aspirating type.

B. RTD Temperature Transmitters:
1. Provide RTD temperature transmitters whenever DDCPs cannot receive RTD type inputs.

C. Static Pressure and Air Flow Stations:

1. Furnish static pressure and air flow measuring stations to Mechanical Contractor for installation.
2. Stations shall be installed in strict accordance with manufacturer's published requirements. These stations serve as primary signals for airflow control systems; therefore it shall be responsibility of Control Contractor to verify location and installation to assure that accurate primary signals are obtained.
3. Pressure differential switches shall be piped across device creating differential between fan discharge and fan suction.

D. Outdoor Static Pressure Sensor:
1. Furnish outdoor static pressure sensor as specified in control sequence. Mechanical Contractor will install sensor and associated pipe to below roof as shown on detail.

E. Direct Insertion Temperature Sensors:
1. Install sensor so that sensor is pointed down stream.

F. Temperature Switches (Aquastats):
1. Install aquastats across discharge face of coil or as close to outlet of coil on return water piping as possible.

G. Aquastats:
1. Aquastats for unit heaters and cabinet unit heats shall be mounted with sensing element in contact with leaving side of coil or the bottom of coil. If sensing element cannot be mounted in contact with coil, mount sensing element on pipe as close to discharge of coil as possible.

H. Building or Space Static Pressure Control System:
1. Extend 2" pipe between spaces for room pressure control or between space and outside for building static pressure control. Mount velocity sensor in tee fitting with one foot of straight pipe on either side of sensor. Terminal space and points inside of sheet metal plenum attached to return/exhaust grille. Terminate outside sensors on prevailing windward side of building with flapper type damper and full weather cover shroud constructed of aluminum painted to match building exterior.

I. Sensor Wells:
1. Wells mounted in pipe 3" and larger may be installed in horizontal or vertical lines provided that element is always in flow, (for condensate and other gravity return lines, install in bottom of pipe). Wells mounted in pipe 2-1/2" and smaller shall be installed at elbow tee fittings with well pointed upstream. Minimum of 2" pipe size for elbow tee installation.

J. Transmitters, Indicators, and Transducers:
1. Locate transmitters at sensing devices or within 100 ft of remote mounted transmitters. For hot systems (150°F and higher) mount electronics on side of pipe or remotely mount. For indicating type instruments, locate indicating element within 6 ft of floor with readout easily visible from floor level. Provide remote readouts if necessary.
2. Provide pressure transducers integral to DDC panels or separate components to convert digital analog signals to variable pneumatic air pressure signals.
3. Provide P-E transducers to convert analog pressure signals to analog electronic signals for input to DDC panels.

K. Air Quality Monitors:

1. Provide duct mounting hardware for mounting in return air duct and outside air duct. Where mounting in walk-in plenum, use wall mounted installation.
2. Locate in duct with 3 diameters straight run of duct before monitor for good air flow pattern. Locate wall mounted units in area with good air flow representation.
3. Provide 120 VAC to 24 VAC transformer where monitor requires 24 VAC power.

END OF SECTION

SECTION 23 0923 DIRECT DIGITAL CONTROLLERS AND NETWORKS

PART 1 - GENERAL

1.1 RELATED WORK

A. Section 23 0901 - Control Systems Integration

B. Section 23 0903 - Control Instrumentation

C. Section 23 0993 - Control Sequences

D. Control Sequences: Refer to Drawings

1.2 REFERENCE

A. Work under this Section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.

1.3 DEFINITIONS

A. The following abbreviations, acronyms, and definitions may be used in addition to those found elsewhere in Contract Documents.

1. ASC:	Application Specific Controller. A networked device or node that contains a complete, configurable application that is specific to a particular task.
2. Alarms & Events:	The exchange of data between devices related to the occurrence of a predefined condition that meets specific criteria (event).
3. BC:	Building Controller. Provide supervisory control, scheduling, trend logging & alarm handling.
4. B-OWS:	BACnet Operator Workstation
5. B-BC:	BACnet Building Controller. Same as SLC.
6. B-AAC:	BACnet Advanced Application Controller. Same as PPC.
7. B-ASC:	BACnet Application Specific Controller
8. B-SA:	BACnet Smart Actuator
9. B-SS:	BACnet Smart Sensor
10. BBMD:	BACnet Broadcast Management Device
11. BIBBS:	BACnet Interoperability Building Blocks. Specific individual function blocks for data exchange between interoperable devices.
12. Broadcasting:	The propagation of data from a device to the control network. Software objects that broadcast data to the network may include the following parameters:
13. Send on Delta:	An adjustable parameter that defines a requirement to broadcast when the data generated by the software object changes by an amount that exceeds this parameter's value. For binary data, this parameter defaults to a change of state. The broadcast of data is initiated when this criteria and the minimum send time requirement have been met. Also referred to as a "Change of Value".

14. Minimum Send Time: An adjustable parameter that defines a mandatory time period during which no broadcasting of data will occur. Once this time period has been exceeded without a broadcast, the send on delta parameter or the maximum send time parameter shall determine when a broadcast is initiated.
15. Maximum Send Time: An adjustable parameter that defines the maximum time period between broadcasts of a software object's data to the network. Should the value of a software object remain constant over an extended period of time, the value will be rebroadcast once every maximum time period.
16. BTL: BACnet Testing Laboratory.
17. Channel: One or more segments not containing a router.
18. Domain: A logical collection of devices on one or more channels.
19. FLN: Floor Level Network. BACnet MS/TP.
20. HMI: Human-Machine Interface. Graphical operator BAS interface. Same as Graphical User Interface (GUI).
21. LAN: Local Area Network. Same as Floor Level Network.
22. Maximum Send Time: Event driven communication parameter specifying the time period for which data must not be sent more than once.
23. Minimum Send Time: Event driven communication parameter specifying the time period for which data must be sent at least once.
24. PICS: Protocol Implementation Conformance Statement. Detailed description for a given BACnet device stating its inherent BACnet capabilities.
25. Point: Group of data, which corresponds to a hardware input, output, or calculated value.
26. PPC: Programmable Process Controller. Same as Advanced Application Controller (AAC)
27. Scheduling: The exchange of data between devices related to the establishment and maintenance of dates and times at which specified output actions are to be taken.
28. Send on Delta: Event driven communication parameter specifying the amount of variable change before data is to be sent between the Minimum and Maximum send times.
29. SLC: Supervisory Level Controller. Same as Building Controller.
30. Segment: A section of uninterrupted cable where multiple devices may be installed.
31. Subnet: Logical division of a domain.
32. Trending: The accumulation of (time, value) pairs at specified rates for a specified period duration.

1.4 SUBMITTALS

A. Shop Drawings:

1. Submit shop drawings for each hardware device used and submit complete description of software applications used. Submit manufacturer's printed product data sheets for each device or software program used. Datasheets shall be submitted electronically in pdf format with bookmarks provided for each individual device and table of contents listing each device manufacturer and full model number with links to device pages. Organize sheets in order of model number, alphabetically, then numerically. When a manufacturer's data sheet refers to a series of devices rather than a specific model, the data specifically applicable to the project shall be highlighted or clearly indicated by other means.
2. Submittals shall include points list of each control input and output, controlled devices, locations of devices, and symbol or label of each control point in software.

B. Operating and Maintenance Manuals: Refer to Section 23 0901 - Control Systems Integration.

C. Software Manual:

1. As part of operating and maintenance manuals, submit one software manual per workstation plus one extra copy for archive use. Software manuals shall be divided into separate parts with tabs for each part.
2. Software manual parts shall include:
    a. Complete description of operating system including all commands, configuration programs, printouts, logs, database functions and passwords. Describe general operating procedures, starting with system overview and proceeding to detailed description of each software command feature with sample printed displays and system function description for each option. Include instructions on verifying errors, status, changing passwords and initiating or disabling control programs.
    b. Complete description of programming language including all commands, configuration programs, control loop functions and testing. Describe general programming procedures, starting with system overview and proceeding to detailed description of each software command feature. Include instructions on creating or modifying any control algorithm or parameter, debugging, etc. This shall include all control functions, algorithms, mathematic equations, variables, setpoints, time periods, messages, and other information necessary to load, alter, test and execute custom or pre-written programs.
    c. Software Backup: Upon successful completion of acceptance testing, submit to Owner 2 archive copies of all accepted versions of source code and compiled code for all application programs and data files on CD ROM backup disks. All control software must be readily accessible by Owner using BAS workstation hardware and software.
    d. Web server/data historian SQL database schema (table format) for trend data and event/alarm data.
    e. Control Loop Documentation: Submit indexed summary of each control loop program. Summary shall list in tabular form, name of system, name of control loop, all I/O points used, and reference to sheet number in shop drawings to describe control sequence programmed. For each control loop submit complete printed listing of source code used, all setpoints, high/low alarm points, time event schedules, proportional gains, integrals, derivative values, and other database values.

f. BAS Points List Summary: Provide detailed summary for each point in the system. Summary shall be cross-index listing of all points in alpha/numerical order with list of control loops which use each point. For each point, include an abbreviated point name, expanded point description, detailed description of each input instrument or output device, and detailed description of exact location of all field hardware. Location descriptions shall include room names, column numbers, elevation (above ceiling, bottom of duct, etc.).

1.5 WARRANTY

A. Provide 1 year warranty on all materials and labor.

B. Warranty requirements shall include furnishing and installing software upgrades issued by the manufacturer during the 1 year warranty period.

1.6 FCC COMPLIANCE

A. Digital equipment furnished under this contract shall be tested and made to comply with limits for Class A computing devices pursuant to Subpart J of Part 15 of FCC Rules, which are designed to provide reasonable protection against interference when operated in commercial environments. Literature shall so note and equipment shall be so labeled to show this compliance.

PART 2 - PRODUCTS

2.1 DIRECT DIGITAL CONTROL (DDC) CONTROLLERS

A. General:

1. DDC controllers shall be microprocessor based, field programmable controllers, capable of performing control and energy management functions, and shall be UL listed as Signaling Systems. Each controller shall include its own microprocessor, power supply, input/output modules, and termination modules as required to perform intended function.
2. DDC controller shall receive discrete electrical and/or analog electronic field input signals, convert signals for use by controller, perform control sequences, convert controller information into output signals, and provide control output signals to actuators and field control devices. Inputs and outputs, including communication connections, shall be electrically or optically isolated from controllers.
3. All BACnet devices shall be BTL certified or BTL compliant.
4. All DDC controllers shall be provided by the same manufacturer.
5. DDC controller with analog input modules shall be capable of accepting any form of linear or non-linear voltage (0-5 VDC or 0-10 VDC), current (4-20 mA) or resistive input (0-1000 ohm).
6. DDC controller with discrete input modules shall be capable of accepting discrete inputs from any device with isolated, dry-type contacts (no grounds or no voltage) of either normally open (NO) or normally closed (NC) configuration. Provide visible status lights (LEDs) to indicate input point status.
7. Provide input modules capable of interfacing with pulsed output type sensors as required.

8. DDC controller with discrete output modules shall have isolated, dry-type contacts (no grounds or no voltage) of either normally open (NO) or normally closed (NC) configuration. Provide visible status lights (LEDs) to indicate output point status.

9. DDC controller shall have capability to scale, offset, and display proper analog value without field hardware modification. DDC controller shall convert analog input signals to digital values (A/D conversion) and convert digital values to analog outputs (D/A conversion) for modulating control purposes. Some application specific controllers may utilize tri-state or Triac outputs for floating point control of control devices. Floating point control should be limited to non-critical room temperature control and mechanical space heating and cooling.
10. Failsafe hardware shall be provided such that BAS failures result in immediate return to local control. If DDC controller uses database values from other DDC controllers and communication network fails or malfunctions, control loop outputs shall continue to function using last value received from BAS.
11. Failure of network or control devices (i.e. building level controllers, floor level controllers, application specific controllers, routers, etc.) shall be alarmed at the Operator Workstation as a Level 3 Critical Alarm.
12. All DDC Hardware shall meet the following requirements:
    a. All DDC controllers shall be connected to an ASHRAE 135 MS/TP, BACnet/IP control network and communicate via ASHRAE 135 exclusively.
    b. MS/TP controllers shall operate at a minimum baud rate of 38.4 kbps.
    c. All DDCP shall implement all required functionality of the application network interface via BACnet objects, properties, and services.
    d. All DDC controllers shall conform to the BACnet Testing Lab's Device Implementation Guidelines and be BTL Listed.
    e. Application programs and configuration settings shall be stored in a manner such that a loss of power does not result in a loss of the application program or configuration settings.
    f. All settings and parameters used by the application shall be fully configurable to the greatest extent possible, via properties of BACnet objects that can be written to via BACnet services or via properties of BACnet objects that can be written to via BACnet services for the following:
        1). Setpoint
        2). Alarm limit
        3). Schedule modification
        4). Trend modification
    g. All other settings and parameters that cannot be written to via BACnet services shall be fully configurable via either properties of BACnet objects that can be written to with a configuration tool, or via hardware settings on the controller itself to support the application.
13. Each DDC panel shall have sufficient I/O capacity to perform specified control sequences and/or include points listed in point schedules. If DDC controller does not have sufficient capacity, provide additional slave I/O panels to achieve required point count.
14. Analog and critical safety discrete control loops shall have inputs and outputs into/from same DDC panel. Analog control loops for major equipment (chilled water, hot water, convertors, air handling units, etc.) shall have PID control.

15. For function short names and building short names and numbers, contact the University Controls Engineering Department.

B. BACnet Building Controller (B-BC):
   1. BACnet Building Controllers (B-BCs) shall provide direct connection to high speed, BACnet/IP Local Area Network (LAN) and Campus Ethernet network and serve as communications router for other controllers on slower speed BACnet MS/TP Floor Level Network (FLN).
   2. B-BC controllers shall be either:
      a. Tridium N4 JACE 8000
      b. NAE55
   3. Building Controller (B-BC) shall be minimum 16 bit microcomputer based, utilizing a multi-tasking, multi-user operating system.
   4. The B-BC controllers shall permit the simultaneous operation of all control, communication facilities management and operator interface software, as programmed by the Contractor or User. Modification of the on-board B-BC controller database shall be performed on-line using the built-in software. Systems which require the B-BC to be removed from service while DDC control sequences are modified shall not be acceptable.
   5. B-BC controllers shall utilize true floating point arithmetic capabilities.
   6. All B-BC controllers shall have open licensing to connect to existing UK UEM Tridium BACnet BAS.
   7. All programming defining the functions to be performed by the B-BC, including but not limited to application programs and point database within each B-BC, shall be protected from loss due to power failure for a minimum of 72 hours. All database and backup shall be provided to the UK UEM Controls group.
   8. Communication between B-BC's shall be through BACnet/IP communication.
      a. The Building Controller shall comply with Annex J of the BACnet specification for IP connections. This device shall use Ethernet to connect to the IP internetwork. It must support interoperability on the campus area network and function as a BACnet Broadcast Management Device (BBMD) and/or a BACnet router.
   9. B-BC's shall have sufficient processor capabilities, hard-drive storage and RAM to implement all types of custom software applications and shall provide supervisory control, scheduling, trend logging & alarm handling functions as follows:
      a. Scheduling:
         1). Each B-BC shall support a minimum of 250 BACnet Schedule Objects and 250 BACnet Calendar Objects.
      b. Trending:
         1). Any object in the system (real or calculated) may be logged. Sample time interval shall be adjustable at the operator's workstation.
         2). B-BC shall periodically upload trended data to networked BAS Web Application Server for long term archiving.
         3). Archived data shall be stored in standard database format and shall be made available for use in third-party spreadsheet or database programs.
      c. Alarm Generation:
         1). Alarms may be generated within the system for any object change of value or state either real or calculated. This includes analog object value changes, binary object state changes, and various controller communication failures.

2). B-BC shall periodically upload alarm logs to networked BAS Web Application Server for long term archiving.

10. B-BC's shall have uninterrupted real time clocks capable of time of day, week, and year information to the system as needed to perform software functions. Clock shall be programmed to reset twice per year to allow for Daylight Savings Time. Clocks in multiple DDC Controllers shall be synchronized to automatically match designated B-BC's or Web server. Accuracy shall be within 1 second per day.

11. All control sequences programmed into the B-BC shall be stored in non-volatile memory, which is not dependent upon the presence of a battery, to be retained. Power failures shall not cause the GDC memory to be lost, nor shall there be any need for batteries to be recharged or replaced to maintain the integrity of the controller database. The B-BC shall allow for the creation of unique application control sequences. Batteries shall maintain real time clocks for a period of at least 72 hours during power failure. Batteries shall be maintenance free and have minimum life of 2 years. When power has been restored, the following shall occur automatically:
    a. Orderly startup of controlled equipment (user defined)
    b. Continuation of control algorithms
    c. Database revision
    d. Logging of power interruption and restoration times
    e. Battery recharging
12. Provide local visual indication and system annunciation of low battery power for each battery.
13. Each B-BC shall include its own micro-processor, power supply, input/output modules, and termination modules as required to perform intended function. Systems that only allow selection of sequences from a library or table are not acceptable.
14. B-BC controllers shall be equipped with a minimum of one operator service port for the connection of a laptop computer. The service port shall be either a built-in standard RS-232 data terminal port, USB port, CAT5 cable or RJ11/12 connection.
15. Connection of a service device, to a service port, shall not cause the B-BC controller to lose communications with its peers or other networked device controllers.
    a. BACnet UDP port number to always be set to 47808 (BAC0).
16. Display and Readout Capability
    a. The B-BC controller shall additionally provide diagnostic LED indication of device transmit and receive data communications for all communication port and peripheral ports, normal operation, abnormal operation and control relay operation indication.
17. Manual/Auto Control and Notification
    a. The B-BC controller shall provide commanded override capability from the built-in operator interface. Such overrides shall be annunciated to the head-end station. Such overrides shall be valid as long as power is applied to the controller.
18. Adjustments

a. Every control panel shall provide adjustments for the functions specified. In general, adjustments shall be provided for all setpoints used by controllers within each control panel. In addition, adjustments shall be provided for throttling ranges, mixed air damper minimum positions, or other items as specified. Adjustments shall be integral to each individual B-BC. The built-in operator interfaces shall allow the easy execution of the adjustment through named identifiers within the B-BC. From a single B-BC user interface, any other B-BC shall be accessible and full adjustment capabilities shall be provided.

19. B-BC Naming Convention
    a. B-BC devices shall be named using the following naming convention:
        1). B-BC devices shall be named using the following format:
            a). BuildingName_BuildingNumber_Floor_RoomNumber_B-BC Device Type OR
            b). BuidlingNumber_BuildingName_Floor_RoomNumber_B-BC Device Type
    b. All B-AAC points shall be named using the following format:
20. Building_Floor_RoomNumber_Device Type_Equipment ShortName_Function

C. BACnet Advanced Application Controllers (B-AAC):
1. Controls shall be microprocessor based, Advanced Application Controllers (B-AAC's). B-AAC's shall be provided for Air Handling Units, packaged Rooftops, primary and secondary pumping loop systems and other applications as shown on the drawings. B-AAC's shall be based on a minimum 16 bit microprocessor working from software program memory which is physically located in the B-AAC. The application control program shall be resident within the same enclosure as the input/output circuitry which translates the sensor signals. All input/output signal conversion shall be performed through a minimum of a 10 bit A to D converter. All input points shall be universal in nature allowing their individual function definition to be assigned through the application software. All unused input points must be available as universally definable at the discretion of the owner. If the input points are not fully universal in nature, unused points must be equal in quantity between Analog Inputs and Digital Inputs.
2. All B-AAC controllers shall have open licensing to connect to existing UK UEM Tridium BACnet BAS.
3. Contractor shall provide a minimum of one B-AAC controller per air handling or mechanical system as shown on the drawings.
4. The BAS contractor shall provide and field install all B-AAC's specified under this section. Mechanical equipment manufacturers desiring to provide B-AAC' type controls as factory mounted equipment, shall provide a separate bid for their products less all controls, actuators, valve assemblies and sensors, which are specified to be provided by the BAS/Temperature control contractor.
5. All input/output signals shall be directly hardwired to the B-AAC. Troubleshooting of input/output signals shall be easily executed with a volt-ohm meter (VOM). As a result of this intent, it is specified that power line carrier systems, or other systems which command multiple outputs over a single pair of wires, shall not be utilized.
6. B-AAC's shall be in continuous direct communication with the network which forms the facility wide Building Automation System. The B-AAC's shall communicate with the B-BC at a minimum baud rate of 9,600 baud.

7. B-AACs are defined as having sufficient processor capabilities and RAM to implement all types of custom software applications.
    a. Scheduling:
        1). The B-AAC shall be provided with integral time schedules; as a minimum, two seven day schedules with eight on/off periods per day shall be provided. Holiday override of weekly schedules shall be provided for pre-scheduling of holidays, for the year in advance.
8. B-AACs shall be capable of communicating to BAS network via BACnet MS/TP connected to Building Controller or via BACnet/IP directly.
9. All B-AACs controlling major mechanical equipment/systems and lab equipment monitoring shall communicate via BACnet/IP as indicated on BAS Network Architecture drawings.
10. Provide at least one extra communication port at each B-AAC for direct connecting a notebook computer or hand-held terminal. The port will allow the lab top direct access to any B-AAC or B-ASC in the network.
11. The B-AAC shall provide an input/output point trending utility that is capable of accumulating 48 analog point samples and 10 digital point samples per Input/Output point. Each sample shall be taken on a user defined interval. The digital readings shall be on a change of state occurrence for the digital points.
12. The samples shall be protected against loss due to power interruptions through a battery or capacitor backup method for a minimum of 30 days.
13. The B-AAC shall provide LED indication of transmit/receive communications performance as well as for the proper/improper operation of the controller itself.
14. The B-AAC shall be provided with a battery backed time clock that is capable of maintaining the time of day and calendar for up to thirty days, upon loss of power to the B-AAC, without loss of setting. The battery for the time clock shall be replaceable by the customer.
15. The B-AAC shall be capable of being mounted directly in or on the controls compartment of the air handling system. The B-AAC shall be housed in a NEMA 1 enclosure to accommodate direct mounting on the equipment to be controlled. The B-AAC shall be constructed in a modular orientation such that service of the failed components can be done quickly and easily. All logic, control system, power supply and input/output circuitry shall be contained on a single plug –in circuit board. When required to replace a printed circuit board, it shall not be necessary to disconnect any field wiring. The B-AAC shall be directly wired to sensory devices, staging relays or modulating valves for heating and cooling.
16. Non-Volatile Memory
    a. All control sequences programmed into the B-BC shall be stored in non-volatile memory, which is not dependent upon the presence of a battery, to be retained. Power failures shall not cause the GDC memory to be lost, nor shall there be any need for batteries to be recharged or replaced to maintain the integrity of the controller database. The B-BC shall allow for the creation of unique application control sequences. Systems that only allow selection of sequences from a library or table are not acceptable.
    b. All control sequences shall be fully programmable at the B-AAC, allowing for the creation and editing of an application control sequence, while at the unit.
    c. The B-AAC shall be provided with an interface port (standard RS232 data terminal port or USB port) for a laptop computer. The interface port shall allow the laptop to have full functionality as described above. From the interface port or network terminal, the laptop shall be able to directly access any B-AAC or B-ASC in the network.
    d. The B-AAC shall provide an input/output point trending utility that is capable of accumulating 48 analog point samples and 10 digital point samples, per Input/Output

point. Each sample shall be taken on a user defined interval, ranging from 1 second to 255 hours per sample. The digital readings shall be on a change of state occurrence for the digital points. All samples shall be recorded with the engineering units for the value, along with a time and date identifier for each sample taken. The samples shall be protected against loss due to power interruptions through a battery or capacitor backup method for a minimum of 30 days.

e. Systems unable to provide the above capability shall provide for the individual Input/Output point trending at the B-BC. Specifics as to how each B-AAC point will be trended, at the B-BC, shall be provided in the submittal documents. Included in the explanation shall be the sample intervals, the memory allocation in the B-BC and the number of B-AAC's per B-BC that can be expected.

f. The B-AAC shall provide LED indication of transmit/receive communications performance, as well as for the proper/improper operation of the controller itself.

g. The B-AAC shall be provided with a battery backed time clock that is capable of maintaining the time of day and calendar for up to thirty days, upon loss of power to the B-AAC, without loss of setting. The battery for the time clock shall be replaceable by the customer. The B-AAC shall be provided with integral time schedules; as a minimum, two seven day schedules with eight on/off periods per day shall be provided. Holiday override of weekly schedules shall be provided for pre-scheduling of holidays, for the year in advance.

17. Controller Location

a. To simplify controls and mechanical service troubleshooting, the B-AAC shall be capable of being mounted directly in or on the controls compartment of the air handling system. The B-AAC shall be housed in a NEMA 1 enclosure to accommodate direct mounting on the equipment to be controlled. The B-AAC shall be constructed in a modular orientation such that service of the failed components can be done quickly and easily. The modular construction should limit the quantities of printed circuit boards to a maximum of two. All logic, control system, power supply and input/output circuitry shall be contained on a single plug-in circuit board. When required to replace a printed circuit board, it shall not be necessary to disconnect any field wiring. This shall allow all controls maintenance and troubleshooting to be made while at the air handling unit. The B-AAC shall be directly wired to sensory devices, staging relays or modulating valves for heating and cooling.

b. Every controller and control panel shall be labeled with a lamacoid plate permanently secured to the device. Sticky tape or glued labels are not acceptable. The labeling shall describe the device and include related information such as MAC address, IP address, BACnet Instance numbers, etc.

c. All power feeds shall be clearly identified and shall include panel number, breaker and electrical panel location if not in the same room.

d. For compatibility to the environment of the air handling unit, B-AAC's shall have wide ambient ratings. B-AAC's shall be rated for service from -40 DegF (Degrees Fahrenheit) to 140 DegF.

e. Contractor shall submit description of location of B-AAC's on all mechanical and air handling equipment.

18. B-AAC Naming Convention

a. B-AAC devices shall be named using the following format:

1). Building_Floor_RoomNumber_B-AAC Device Type_Equipment Short Name

19. All B-AAC points shall be named using the following format:

1). Building_Floor_RoomNumber_Device Type_Equipment ShortName_Function

D. BACnet Application Specific Controllers (B-ASC):

1. Controls shall be microprocessor based Application Specific Controller (B-ASC). B-ASC's shall be provided for Unit Ventilators, Fan Coils, Heat Pumps and other applications as shown on the drawings. B-ASC's shall be based on a minimum 16 bit microprocessor working from software program memory which is physically located in the B-ASC. The application control program shall be resident within the same enclosure as the input/output circuitry which translates the sensor signals. All input/output signal conversion shall be performed through a minimum of a 10 bit A to D converter.
2. Contractor shall provide a minimum of one B-ASC controller per unitary system as shown on the drawings.
3. The BAS contractor shall provide and install all B-ASC's specified under this section.
4. All input/output signals shall be directly hardwired to the B-ASC. Troubleshooting of input/output signals shall be easily executed with a volt-ohm meter (VOM). As a result of this intent, it is specified that power line carrier systems, or other systems which command multiple outputs over a single pair of wires, shall not be utilized.
5. B-ASC's shall be in continuous, direct communication with the network which forms the facility wide building automation system. The B-ASC's shall communicate with the B-BC at a baud rate of no less than 38,400 baud.
6. B-ASCs are defined as having standard software burned into EPROM, set points in EEPROM or RAM maintained by battery, and are designed to handle specific types of control sequences. B-ASC's shall be provided for Unit Ventilators, Fan Coils, Heat Pumps and other applications as shown on the drawings.
7. Control outputs may be in the form of floating point control or true analog output control of end devices. Floating point control shall be limited to non-critical room temperature control or mechanical space heating and cooling. All input/output signal conversion shall be performed through a minimum of a 10 bit A to D converter. All input/output signals shall be directly hardwired to the B-ASC.
8. Troubleshooting of input/output signals shall be easily executed with a volt-ohm meter (VOM). As a result of this intent, power line carrier systems, or other systems which command multiple outputs over a single pair of wires, shall not be utilized.
9. Provide communication ports integral room temperature sensors/thermostats for interface with local terminal equipment controllers or a low range wireless (Bluetooth®) Commissioning tool that provides a temporary wireless connection between the MS/TP network and the laptop computer used to commission.
10. The B-ASC shall provide an input/output point trending utility that is capable of accumulating 48 analog point samples and 10 digital point samples per Input/Output point. Each sample shall be taken on a user defined interval. The digital readings shall be on a change of state occurrence for the digital points.
11. Specifics as to how each B-ASC point will be trended, at the B-BC, shall be provided in the submittal documents. Included in the explanation shall be the sample intervals, the memory allocation in the B-BC and the number of B-ASC's per B-BC that can be expected.
12. The B-ASC shall be mounted directly in the controls compartment of the unitary system. The B-ASC shall be provided with a sheet metal or polymeric enclosure that is constructed of material allowing for the direct mounting within the primary air stream, as defined by UL-465. The direct mounting shall allow all controls maintenance and troubleshooting to made while at the unitary equipment. The B-ASC shall be directly wired to sensory devices, staging relays or modulating valves for heating and cooling.

13. Contractor shall submit description of location of B-Asc's on all mechanical and unitary equipment.
14. Non-Volatile Memory
    a. All control sequences programmed into the B-ASC shall be stored in non-volatile memory, which is not dependent upon the presence of a battery, to be retained. Power failures shall not cause the B-ASC memory to be lost, nor shall there be any need for batteries to be recharged or replaced to maintain the integrity of the controller database. The B-ASC shall allow for the creation of unique application control sequences.
    b. The B-ASC shall be provided with the ability to interface with a laptop computer. The interface port shall be provided at the wall sensor or within the unitary equipment. Connection to the wall sensor must be a standard RJ-45 or USB port.
    c. The B-ASC shall provide an input/output point trending utility that is capable of accumulating 48 analog point samples and 10 digital point samples per Input/Output point. Each sample shall be taken on a user defined interval, ranging from 1 second to 255 hours per sample. The digital readings shall be on a change of state occurrence for the digital points. All samples shall be recorded with the engineering units for the value, along with a time and date identifier for each sample taken.
    d. Systems unable to provide the above capability shall provide for the individual input/output point trending at the B-BC. Specifics as to how each B-ASC point will be trended, at the B-BC, shall be provided in the submittal documents. Included in the explanation shall be the sample intervals, the memory allocation in the B-BC and the number of B-ASC's per B-BC that can be expected.
15. Controller Location
    a. To simplify controls and mechanical service troubleshooting, the B-ASC shall be mounted directly in the controls compartment of the unitary system. The B-ASC shall be provided with a sheet metal or polymeric enclosure that is constructed of material allowing for the direct mounting within the primary air stream, as defined by UL-465. The direct mounting shall allow all controls maintenance and troubleshooting to be made while at the unitary equipment. The B-ASC shall be directly wired to sensory devices, staging relays or modulating valves for heating and cooling.
    b. For compatibility to the environment of the unitary equipment, B-ASC shall have wide ambient ratings. B-ASC's shall be rated for service from 32 DegF (Degrees Fahrenheit) to 140 DegF.
    c. Contractor shall submit description of location of B-ASC's on all mechanical and unitary equipment.
16. B-ASC Naming Convention
    a. B-ASC devices shall be named using the following format:
        1). Building_Floor_RoomNumber_B-ASC Device Type

E. BACnet Router
1. BACnet MS/TP to BACnet/IP and to BACnet/IP Routers shall perform layer 3 routing of BACnet MS/TP packets over an IP network in accordance with ASHRAE 135 Annex J. The router shall provide the appropriate connection to the IP network and connections to the BACnet MS/TP network. BACnet Routers shall be capable of configuration via DHCP and Write-Broadcast-Distribution-Table messages but shall not rely on these services for configuration.

2. One router in the IP subnetwork shall be designated as the BBMD (BACnet Broadcast Management Device) and shall be indicated as so on the Network Architecture.
3. BACnet router functionality can also be incorporated into BACnet Building Controllers.

F. Power Supplies:
1. Power supplies shall operate on nominal 120 V, 60 Hz, single-phase power. DDC Controllers shall be provided with surge and noise protection. Power fluctuation shall not affect control system. Include surge protection on telephone line.
a. Isolation transformers shall be included when connections are being made between 2 separate buildings.

2.2 DIRECT DIGITAL CONTROL SOFTWARE

A. General:
1. All software required for monitoring, modifying, configuring and backup for the system shall be embedded in the controller and accessible via VT terminal, hyper-terminal or the web. This software shall allow any computer with access (and security) to the University's network to perform the work described above using a web browser or provided software. No software upgrades should be required unless provided at no additional cost to the customer. The software version used for installation of any new devices must either be at the current software version used on the University Facilities Management campus at the current JAVA version or the new software at the most current JAVA version must be installed on all devices and the current system prior to the installation of the new devices. All software is to also operate on the latest version of Microsoft Windows operating system. All configuration and programming tools required for the upgraded version must be provided at the time of installation.
2. Provide a USB, standard RS-232 9 pin female, Bluetooth, RJ11, RJ12 or RJ45 connection for on-site access. DDC Controller control strategies shall be Owner definable from engineering workstations.
3. Software functions and algorithms shall be sufficient to enable implementation of control sequences as specified and shall be able to maintain continuous control as intended.
4. Control functions shall include both mathematical and logical operators. Control algorithms shall include proportional, integral and derivative control (PID). Adaptive (self-tuning) PID loop parameters, if offered by DDC Controller manufacturer, shall not be used unless adaptive limits are used to adjust limit values based on system status; or written request is submitted and approved by Engineer.
5. Allow operators to assign unique identifiers of their choice to each connected point. Identifiers shall have at least 8 alpha/numeric characters. References to these points in programs, reports and command messages shall be by these identifiers.
6. Provide access control (user defined passwords) for system operation. There shall be minimum of 3 access levels. First level shall allow system monitoring only. Second level shall allow monitoring, set point adjustment, and scheduling revision. Third level shall allow modification of control algorithms. System shall return to secured (monitoring only) mode after 5 minutes of inactive operation.
7. Each DDC Controller shall contain self-diagnostics that continuously monitor proper operation of panel.
8. If microprocessor malfunctions, control loop outputs shall continue to function using last value received from microprocessor.

9. Control software and hardware for equipment operation shall be selected and engineered such that equipment shall function according to sequence of operation described in section 23 0993 – Control Sequences with interruption to network communication for extended periods of time.
10. Configuration software for all controllers shall be embedded in the controllers and shall be accessible through Internet Explorer, telnet, or hyper terminal.

B. Building Controller Software:
   1. Provide DDC Controller software application program modules for performing energy management control functions such as time of day change of database values (programmed start/stop, temperature setbacks, etc.), supply air temperature reset based on space load demand, economizer control, optimum start/stop based on current indoor and outdoor psychometrics, duty cycling and client tailored programs required for special applications such as VAV fan matching and supply fan control, enthalpy control, intermediate season or "dead band" control, totalizing, and holiday programming.
   2. Provide manufacturer's standard operating system for real time control of system interactions, including database information requests/transfers by system hardware or by operators. Operating system shall also have the following additional capabilities (given that operator has appropriate security access level):
      a. User interface and online system configuration software embedded in Building Controller.
      b. Support for Web services at the automation network level.
      c. Displaying database (point) value including measured values, controlled variables, setpoints, gain factors, and any other adjustable parameters.
      d. Changing or overriding any database value.
      e. Error detection, correction, re-transmission of database values, arithmetic or logical faults.
      f. Alarm reporting including sending alarms to remote workstations, User Interface Web Server or Data Historian on network.
      g. Alarm buffer to retain alarms in order of importance without losing any alarms.
      h. Creating and displaying historical trend logging of any value, limited only by available memory.
      i. Creating new variable database values (soft points) based on arithmetic calculation (including summation or totalizing) on other database values.
      j. Adding new hardware points without overall BAS shutdown.

C. B-ASC Controller Software:
   1. Manufacturer's standard software for B-ASC's may be used only if control sequences can be implemented without modification. If control sequence cannot be accomplished with standard software, provide battery backed RAM or EEPROM DDC Controller (B-AAC) capable of being programmed for specified control sequence.
   2. Provide software for portable PC units to communicate with terminal controllers at the room level network. Software shall allow access to modify, delete or create control strategies at the room sensor location.

2.3 WEB APPLICATION SERVER

A. Refer to 25 0924 – Graphical user Interface Integration.

2.4 DDC ENGINEERING (PROGRAMMING) - SOFTWARE

A. Provide engineering software for **5** Engineering Servers/Workstations.

B. Software shall have the same characteristic and capabilities as DDC Controllers. In addition, operator's workstations shall have the following features.

C. User Programmability:
   1. Engineering workstation software shall include field-engineering tools (software & hardware) for programming all controllers supplied.
   2. All application software shall be interactive, fully prompted, and menu driven and shall provide the following functionality as a minimum:
      a. Determine control strategies, which have been defined for specific piece of equipment.
      b. Add control loops to system using English language type program language equal to BASIC or other easily learned language or function block programming. (PASCAL, C, or other assembly type languages are not acceptable.)
      c. Add points to system.
      d. Create, modify or delete control strategies.
      e. Create, modify or delete system graphics.
      f. Assign sensors and/or actuators to control strategy.
      g. Tune control loops through adjustment of control loop parameters.
      h. Enable or disable control strategies.
      i. Generate hard copy records of control strategies on printer or soft copies to files compatible with Microsoft Office applications.
      j. Select points to be alarmable and define alarm state(s).
      k. Select points to be trended over a period of time and initiate recording of values.
      l. Override Input/Output points for each individual controller.

2.5 NETWORK HARDWARE

A. Provide network interface hardware for each device connected to network. Each device shall have sufficient performance as not to degrade specified processing speed.

B. Provide network cabling with sufficient performance as not to degrade specified communication speed. Cabling shall be compatible with proposed system and shall comply with requirements specified in Section 23 0901 - Control Systems Integration.

C. Provide other network support devices that are required for proper operation of network, such as file servers, network hubs, etc.
   1. Signal repeaters are not allowed for University of Kentucky building automation networks. Unless approved by the University.

D. Provide network diagnostic tool for measuring/confirming bandwidth usage on IP layer.

PART 3 - EXECUTION

3.1 GENERAL

A. Install control equipment in neat, professional manner to satisfaction of Architect and Engineer.

B. Coordinate timely delivery of materials and supervise installation of DDC Controllers and network cabling and devices.

C. Install DDC Controllers and network control devices in accessible locations.

3.2 OVERALL BAS ARCHITECTURE

A. Provide hardware/software to update database in less than 1 second for fast-acting control loops such as pressure control, air or water flow rate control, and air handling unit temperature control, or 10 seconds or less for other control loops.

B. Control software algorithm and inputs and outputs for a single system or piece of equipment shall reside on a single controller and shall not be distributed amongst multiple controllers. If multiple pieces of equipment are to be interlocked, a single “Master” controller shall provide control for all interlocked pieces of equipment, i.e. an AHU and interlocked return fan and exhaust fans.

C. Control loop software algorithm for each analog control loop shall reside on same controller as inputs and outputs required for that specific control loop.

D. Networks that operate via polled response or other types of protocols that rely on central processors, file servers, or other such devices to maintain or manage peer-to-peer communications, shall have redundant components to maintain network in event of failure at central device. Provide automatic changeover (without operator intervention) to redundant device upon failure of any central type processor.

E. Floor Level Network (FLN) network shall be multi-drop digital transmission network utilizing BACnet MS/TP (38.4kbs) communication.

F. Each multi-drop trunk shall be within manufacturer's allowable line lengths without signal degradation. Multi-drop trunks shall be interfaced to system via standard EIA or other industry recognized interfaces so that single failure does not disrupt or halt network.

G. Communications between Building Level DDC Controllers and operator's workstations shall be peer-to-peer, allowing multiple users to access and use system simultaneously with no loss of system performance.

H. Provide levels of connected networks to connect all DDC Controllers, including terminal DDC Controller. Communications to terminal devices shall be similar to capabilities and functions of other DDC Controllers and shall be transparent to operator.

I. Quantity of nodes (devices connected) on any one FLN (MS/TP) shall not exceed 50% of maximum node capacity published by equipment manufacture and Building Controller processor usage shall not be greater than 30% nominal. Provide additional hardware to meet this requirement.

J. Alarm reports from DDC Controllers shall not be impeded by use of either remote or local monitor, or control stations on network either in access mode or programming mode.

K. Provide transient voltage surge suppression devices for controllers and other electronic devices requiring separate line voltage power source.

3.3 DIRECT DIGITAL CONTROLLERS

A. DDC Controller Usage:
   1. Select DDC Controller to provide speed of response required for each control loop type. Pressure, flow rate, and air handling unit temperature control must be via Building Level DDC Controller. Application specific DDC Controller may be used for other control loop types.
   2. Each DDC Controller shall have sufficient I/O capacity to perform specified control sequences and/or include points listed in any point schedules. If DDC Controller does not have sufficient capacity, provide additional slave panels to achieve required point count.
   3. Analog and critical safety discrete control loops shall have inputs and outputs into/from same DDC Controller. Analog control loops for major equipment (chilled water, hot water, convertors, air handling units, etc.) shall have PID control. Air terminal control loops may utilize floating point control from tri-state or Triac outputs from the controller, but require some type of feedback device to prove position.
   4. Provide at least one Building Level DDC Controller per mechanical equipment room and, if required, at each PC workstation location.
   5. For valves and dampers within 100 ft of associated DDC Controller, mount current to pneumatic (I/P) converter within DDC Controller panel or in adjacent panel. Otherwise mount I/P converters at valve or damper. Provide pressure gauges on main air, and all control output signals.

B. Point Capacity:
   1. Provide point capacity required plus spare I/O point capacity in each B-AAC. Spare I/O point capacity is defined as terminal connections, which are ready to accept digital or analog inputs, dry contacts for digital outputs, and variable voltage or current terminals for analog outputs. Universal type points are acceptable for both discrete and analog type points. Spare points do not include any input or output conversion devices.
   2. Spare points in each B-AAC shall be a minimum expansion capability of 20%.

C. Building Controllers:
   1. Provide one BBMD in each IP subnet.
   2. BACnet UDP port number to always be set to 47808 (BAC0).

D. Cabinets:
   1. Provide local control cabinets for DDC Controllers. DDC Controller cabinets may be used directly if enclosures are rated for NEMA 1. All cabinets shall utilize a single master key. Provide 2 spare key sets to Owner. Otherwise shall be 0.06-inch-thick, furniture-quality steal or extruded-aluminum alloy, totally enclosed, with hinged doors and keyed lock, with manufacturer’s standard shop-painted finish and color.
   2. All control cabinets shall be labeled. Labels shall be keyed to the unique identifiers shown on the As-Built drawings.

3. Panel boards shall be wall-mounted or stand-mounted and shall be completely enclosed with engraved nameplate.
4. All panel board shall be pre-wired and brought to a main terminal strip. All relays, switches, etc., shall be installed, furnished and wired on panel board. Clearly mark each terminal strip as to which wire from which components is to be connected.
    a. Panel-Mounted equipment includes temperature controllers, humidity controllers, relays, and automatic switches (except for safety devices). Mount devices with adjustments accessible through front of panel.
    b. Door-Mounted equipment shall be flush-mount (on hinged door) manual switches, including damper-positioning switches, changeover switches, thermometers, and gages.
    c. Color-coded graphic, laminated-plastic displays, schematically showing system being controlled, with protective clear plastic sheet bonded to entire door.

E. Controller Firmware
1. Provide latest version of controller firmware. Include firmware updates for period of one year after system acceptance, coinciding with warranty period. If the upgrade of firmware causes the need to upgrade or reconfigure/reprogram related systems, controllers or software, Contractor shall notify Owner prior to upgrade and provide additional work scope in coordination with other Contractors, as required, at no cost to Owner.

3.4 DDC SOFTWARE INSTALLATION

A. Operating system (OS): Contractor shall install the OS on workstations and laptops and configure user names and passwords.

B. Virus Protection software: Contractor shall install the virus protection software on each server, laptop and workstation and shall configure weekly virus scans.

C. Contractor shall install and configure all software packages required to maintain and configure all types of controllers provided as part of this project on each engineering workstation.

D. Software from panels shall be permanently stored on CD ROM and on at least one hard disk at operator's workstation or Web Application Server. Provide auto re-boot feature on power up from system failure. System failures shall not necessitate manual reprogramming to restore normal system function.

E. Provide the latest version of all standard software, including operating system and control software. Include any software updates for period of one year, coinciding with warranty period. Beta released software shall not be used.

3.5 INITIAL PROGRAMMING

A. Control Contractor shall provide initial programming of controllers to accomplish sequences specified.

B. Provide back-up documentation per software manual submittals for all programs, in both written and electronic media formats.

C. Outputs, whether sequenced or not, shall have separate programmable hardware outputs. For air handling units, minimum outside air, maximum (economizer) outside air, return air, relief air, smoke dampers, heating valves, cooling valves, humidifier valves, etc., shall each have separate output.

D. BACnet Naming and Addressing
   1. Every BACnet device shall have an assigned and documented MAC Address unique to its network. For Ethernet networks, document the MAC Address assigned at its creation. For MS/TP, assign from range as indicated by vendor documentation.
   2. Instance number will be assigned by owner. Provide ability for changing the network number; either by device switches, network computer, or field operator interface. The BACnet internetwork (all possible connected networks) can contain up to 65,534 possible unique networks.
   3. Every BACnet Building Controller (B-BC) and BACnet Router UDP port number shall be set to 47808 (BAC0).
   4. Assign unique Device "Object_Identifier" property numbers or device instances for each device on the BACnet internetwork. Provide for future modification of the device instance number; either by device switches, network computer, or field interface. BACnet allows up to 4,194,302 possible unique devices per internetwork.
   5. The Object Name property field shall support 32 minimum printable characters. Assign Object Name properties with plain-English names descriptive of the application. Examples include "Zone 1 Temperature" and "Fan Start/Stop".

E. Minimum BACnet Object Requirements
   1. For the following points and parameters, use standard BACnet objects, where all relevant object properties can be read using BACnet's Read Property Service, and all relevant object properties can be modified using BACnet's Write Property Service: all device physical inputs and outputs, all set points, all PID tuning parameters, all calculated pressures, flow rates, and consumption values, all alarms, all trends, all schedules, and all equipment and lighting circuit operating status.
   2. The Object Description property shall support 32 minimum printable characters. For each object, complete the description property field using a brief, narrative, plain English description specific to the object and project application. For example: "HW Pump 1 Proof." Document compliance, length restrictions, and whether the description is writeable in the device PICS.
   3. Support and provide Description and/or Device Type text strings matching signal type and engineering units shown on the points list.
   4. Support and provide Inactive Text and Active Text property descriptions matching conditions shown on the points list.
   5. For devices with scheduling capability, provide at least one Calendar Object with ten-entry capacity. Enable the writeable Date List property and support all calendar entry data types.
   6. Use Schedule Objects for all building system scheduling.
   7. Use Loop Objects or equivalent BACnet objects in each applicable field device for PID control. Regardless of program method or object used, allow authorized operators to adjust the Update Interval, Setpoint and all constraints associated with Object, such as Proportional Constant, Integral Constant, and Derivative Constant for Loop Object, using BACnet read/write services.

F. Minimum BACnet Service Requirements
   1. Use commandable BACnet objects to control machinery and systems, providing the priority levels listed below.

Priority Level	Application

1	Manual-Life Safety
2	Automatic-Life Safety
3	(User Defined)
4	(User Defined)
5	Critical Equipment Control
6	Minimum On/Off
7	(User Defined)
8	Manual Operator
9	(User Defined)
10	(User Defined)
11	Load Shedding
12	(User Defined)
13	(User Defined)
14	(User Defined)
15	(User Defined)
16	(User Defined)

G. Data Sharing:
   1. Data communication from Building Controllers to Engineering Workstation and BAS web server shall be programmed to use Change of Value (COV) data sending and not continuous data polling to limit net work traffic.
   2. Data communication parameters for analog values shall be operator configurable and setup as follows:
      a. Minimum Send Time: 2 seconds
      b. Maximum Send Time: 60 seconds
      c. Send on Delta (COV) :
         1). Space Temperature: ±0.5°F
         2). Process Temperature: ±0.5°F
         3). Air Pressure, AHU: ±0.05“ W.C.
         4). Relative Humidity: ±0.5%
         5). Air Flow: ±200 cfm
         6). Water Flow: ±50 gpm
         7). Water Pressure ±0.2 psi
         8). Space Pressure: ±0.01“ W.C.
   3. Digital data points shall be sent whenever a state change occurs.

H. Historical Trending:
   1. All trending alarms, archiving, scheduling, alarm management, graphics are to be done by PPDMC..

I. PPDMC, when adding to an existing system, groupings, tag names, descriptions, engineering units, etc. shall match the existing system. Transitions from the existing system to the new system shall be seamless in look, functionality, and operation.

J. Program historical file for run-times and quantity of start/stops of motor driven equipment.

K. Program maintenance alarms based on run-times and quantity of start/stops for motor driven equipment.
   1. Provide the following additional alarms:
      a. Controller loss of communications for each controller.
      b. Controller battery alarm for each controller (where available)
      c. Out-of-range, bad, or missing data (fault) for each device.

L. Program alarms using the following levels:
   1. Level 1 - Maintenance Alarm, requiring attention within 1 to 2 days. (Examples: 2-3°F temperature variance from set point; 15-25% relative humidity variance; etc.)
   2. Level 2 - Low Level Alarm, requiring attention within 8 h, preferably during the same shift. (Examples: More than 3°F variance from set point, 30 percent relative humidity or more variance from set points; excess start/stops per day; etc.)
   3. Level 3 - Critical Alarm, requiring immediate attention. (Examples: Non-operation of primary equipment; H-O-A overrides; failure of controllers, and routers.)
   4. Level 1 and 2 alarms shall not interrupt current user operation, but shall be logged into alarm summary file, indicating status, acknowledgment, and by whom. Level 3 alarms shall interrupt user via audible and/or flashing warning until acknowledged, without losing any work in progress. When alarms are acknowledged, program shall display point group or appropriate graphic display. Level 3 alarms shall also be logged into alarm summary file in similar manner as Level 1 and 2 alarms.

M. Time Schedules:
   1. Provide time schedules for HVAC components/systems as indicated in Control Sequences.
   2. All time schedules shall be fully configured with weekly schedules and all holidays identified by the Owner.
   3. Time schedules are to reside in the Building Controllers.

3.6 POINT LIST

A. Provide points required to implement control sequences specified, whether or not they are listed in schedules. In addition to control points, provide additional points listed in point schedules or defined in Control Sequences.

B. All points shall be named per the PPDMC naming convention with a detailed description.

3.7 AUTO-DIAL ALARM MESSAGES

A. Program up to 30 types of prerecorded voice or fax messages assigned to different alarm types. Assign up to 10 phone numbers for each message. BAS shall automatically call phone numbers without answering machines in predetermined order. If an acceptable phone response is not received after 6 rings (adjustable), system shall automatic retry 3 times (adjustable) before calling next number. Systems shall print level 3 alarm message if no phone numbers were reached.

3.8 GRAPHICS PROGRAMMING

A. Graphics shall be done by PPDMC.

END OF SECTION

SECTION 23 0993 CONTROL SEQUENCES

PART 1 - GENERAL

1.1 RELATED WORK

A. Section 23 0901 - Control System Integration, applies to the work of this Section.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Refer to sections stated under related work.

PART 3 - EXECUTION

3.1 CONTROL SEQUENCE

A. Systems shall perform in accordance with the following.

B. Refer to Control/Flow Diagrams and Control Points List for additional information.

C. Alarms
   1. All Control and alarm setpoints shall be adjustable from the operator's workstation for the Tridium Enterprise System or at local controllers via laptop software unless otherwise noted.
   2. BAS shall annunciate alarm conditions when analog input values exceed their programmed ranges.
      a. Unless otherwise noted, alarm ranges shall be:
         1). Air Temperature: +/-5°F from setpoint
         2). Water Temperature: +/-10°F from setpoint
         3). Humidity: +/-10% RH from setpoint
         4). Air Pressure: +/-0.5" W.C. from setpoint
         5). Water Pressure: +/- 5 psig from setpoint
         6). Flow: +/-25% of maximum flow range
         7). Level or Value: +/-5% of maximum level or value from setpoint
   3. All references to alarms, alarm setup, and alarm enunciation are to be programmed in the UK Tridium system and shall not be programmed in the BAS to annunciate at a non-Tridium workstation. Controls contractor shall coordinate all alarming with UK staff for required alarms.
      a. The contractor is set up the alarm parameters specified by the system sequences of operations without enabling the alarms. Contractor is to provide a list of points containing alarm extensions to PPDMC. PPDMC will be responsible for doing the alarm names, alarm texts and enabling the alarm points provided on the list.
   4. Program alarm levels as indicated in sequences, based on the following levels.
      a. Urgent
      b. High Priority
      c. General Maintenance

5. All Input/Output points and BAS data objects shall have alarm parameters available for defining alarms.
6. Alarm monitoring and programming functions shall be restricted by password protection.
7. Coordinate alarm action requirements (printing, automatic dialing, etc.) with Owner.
8. Alarms shall remain active until alarm condition has cleared and alarm is reset manually.

D. Setpoints
1. All controlling setpoints shall be field-adjustable. The Control Contractor shall work in conjunction with the owner, commissioning agent, and Testing and Balancing Contractor to field adjust all final set points.
2. Control Contractor shall verify setpoints, time intervals, and limits based on actual field conditions. All setpoints, time intervals, and limits shall be optimized to achieve stable system operation, prevent damage to equipment, minimize maintenance requirements, and eliminate nuisance alarms (such as premature filter loading, false tripping of freezestats, and other similar conditions).
3. The terms 'Adjustable Temperature Sensor' and 'Non-adjustable Temperature Sensor' are used to describe space temperature sensors.
   a. Adjustable/User-Adjustable Temperature Sensor – space temperature sensor is provided with a slide or buttons that allow the space occupant to locally adjust the setpoint. All Adjustable Sensors shall be programmed with a locked/limited range. The range shall be displayed on the BAS graphic for each space and shall be adjustable from the graphic.
   b. Non-Adjustable Temperature Sensor – Flat plate type or plastic with no local adjustment. Setpoints are programmed at the BAS and shall be adjustable from the graphic for each room.

E. Switch Point Actuation
1. Provide each switch/alarm trip point with an adjustable time delay to prevent nuisance tripping. These time delays apply to all switch points whether hardware or software and for normal operation. Additional or longer delays may be necessary during start-up or shut down as noted herein.
2. Unless otherwise specified, the time delay shall be as follows:

Process or operation	Time Delay
Flow	2 minutes
Motor starter	1 minute
Liquid pressure	1 minute
Gas pressure	1 minute
Pressure differential	1 minute
Level	30 seconds
Valve limit switch	2 minutes
Temperature indoor	5 minutes
High/Low Pressure Switch	5 second
High/Low Temperature Switch	5 second

3. If the time delays are less than the controller scan rate, the minimum controller scan rate shall be the time delay.

F. Variable Frequency Drives
1. VFDs shall be switched between HAND, OFF, and AUTO modes via manual local control adjustment at each VFD.

2. Control loops other than volume/pressure control loops using VFD speed outputs, shall continue to function in the HAND mode.
3. Motors shall operate at constant speed in the HAND mode. Remote start/stop control shall be via local control at each VFD.
4. All safety devices shall be wired as to be still active in the HAND mode.
5. Coordinate communication requirements with VFD manufacturer. All monitoring and control point data from VFD interface card shall be mapped to the BAS. VFD start/stop control and speed control points shall be hard wired from the BAS controller to the drive.
6. The control contractor shall coordinate with the Testing and Balancing Contractor to establish all final minimum and maximum VFD speeds. All minimum and maximum speeds listed in this specification are initial setpoints only.

G. Safety Devices
1. All safety devices (low limits, high limits, etc.) shall have local manual reset.
2. All safety devices shall be wired as to be still active when a VFD is in the HAND mode.

3.2 POWER FAILURE MODE SEQUENCE

A. General:
1. Power failure shall be determined by position of automatic transfer switch in conjunction with test mode indication from power management system. Control Contractor is responsible for obtaining status signal and all necessary wiring for status signal from automatic transfer switches to BAS.
2. Pump and fan VFDs shall be programmed for automatic restart after a complete stop upon power resumption when normal power is lost and automatic transfer switches are in the essential power system position.
   a. Test mode indication from power management system shall be monitored by the BAS. During the monthly routine tests of the power system when test mode status is indicated, pumps and fans served by essential power shall not be shut down and restarted when automatic transfer switches are in essential power position.
3. All control valves serving reheat coils shall maintain their last control position upon loss of power or loss of control signal.

B. Managed Restart:
1. BAS shall monitor normal power indication and on loss of normal power for duration of 2 seconds (FA) or longer, all equipment shall be commanded stopped by the BAS. When Essential Power is established as indicated by automatic transfer switches, BAS shall restart system components served by Essential Power based on the following Priority Sequence. Start sequence under each automatic transfer switch shall not begin until associated automatic transfer switch has been proven switched to the generators. Equipment designated to operate on essential power, but not included in the following priority list (referred to hereinafter as “subsequent” equipment) shall not start until priority equipment start-up sequence is complete. Start-up of subsequent equipment shall not be delayed for proof of actual operation of priority equipment. Once all priority equipment has been commanded to start, proceed immediately to start-up of subsequent equipment. Provide software adjustable time delay between starting of components serving a common system (set initial delay at 5 seconds (FA)).
2. Equipment operating under essential power shall not exceed the respective system capacity requirements. Capacity control sequencing (lead-lag control for capacity control) shall remain in effect during essential power operation. The following priority sequence indicates the

equipment designated (given permission) to operate on essential power if needed by system capacity control sequence and the relative operation priority of that equipment.

C. Priority Sequence:

1. Automatic Transfer Switches shall be monitored by the BAS via MODBUS connection. Monitor the following status:
   a. Switch in Normal Position
   b. Normal Source Not Available
   c. Switch in Essential Position
2. Upon power failure, HVAC equipment shall begin restarting in sequence as indicated below upon indication the equipment's respective Automatic Transfer Switch (ATS) has switched to Essential Power. No delay shall be programmed on a switch back to Normal Power from Essential power. Refer to electrical schedules, control sequences, and DDC points schedule for equipment connected to Essential Power and ATS the equipment resides on.
3. When Equipment ATS is proven in the Essential Power position by contacts, the following HVAC devices shall be started in order listed by respective ATS as indicated in device sequences following with 5 second (FA) intervals between restart of devices:
   a. HW, RHW, CHW, MTCHW, Energy Recovery System (Konvekta)
      1). Converters
      2). Pumps
   b. All EAHUs
   c. All AHUs
   d. Humidification RO water system
   e. Terminal Units

3.3 TERMINAL UNITS - CONTROL SEQUENCES

A. General:

1. Where CO2 sensors are shown in a space with air terminal units, the BAS shall monitor the CO2 level, and a General Maintenance alarm shall be annunciated at the BAS when the space CO2 level exceeds 1000 ppm.
   a. Where multiple CO2 sensors are shown in a space, the BAS shall average the reading among the sensors and use the average reading for control.
   b. On failure of one or more CO2 sensors as, indicated by loss of control signal the control loop(s) associated with the failed transmitter(s) shall be removed from the average reading algorithm, an alarm generated at the BAS and the remaining operating CO2 sensor(s) shall be used for CO2 control.
2. When a space is provided with multiple temperature sensors, unless otherwise indicated, the BAS shall select the temperature sensor which is farthest from set point for terminal unit control.
   a. On failure of one or more temperature sensors as, indicated by loss of control signal, the control loop(s) associated with the failed transmitter(s) shall be removed from the average reading algorithm, an alarm generated at the BAS and the remaining operating temperature sensor(s) shall be used for temperature control.

3. When a space is served by multiple supply air terminals, unless otherwise indicated, controls shall modulate the reheat valves to maintain common supply air temperature from each supply air terminal which is reset to maintain space temperature.
    a. When a space is served by multiple supply air terminals, controls shall modulate the damper actuators in parallel unless otherwise noted in the sequences below.
4. Where humidity sensors are shown, the BAS shall calculate room dew point using space humidity and temperature sensors.
5. The electrical contractor shall provide an occupancy sensor with a dedicated dry contact or relay for each occupancy sensor. Occupancy sensors shall be hard wired from the dry contact/relay to the controller by the Controls Contractor. Where multiple occupancy sensors are shown within a space, wire the sensors in series or parallel to provide one occupied/unoccupied signal to the controller. Occupancy sensors shall be used for control of 'Vacant Mode' as described below in each sequence.
6. Dew point monitoring and safety control (where applicable) shall be active in occupied and unoccupied modes.
    a. When the space dew point rises above 56°F (FA), the chilled water control valve serving the space shall be commanded closed.
    b. When the space dew point drops below 56°F (FA), the chilled water control valve serving the space shall be released back to control per Air Flow Control and Temperature Control.
7. The office areas served by chilled beam shall use worst case humidity sensors located in rooms for dew point safety.
    a. When the dew point rises above 56°F (FA), the associated chilled water control valves serving the spaces shall be commanded closed.
    b. When the space dew point drops below 56°F (FA), the chilled water control valve serving the space shall be released back to control per Air Flow Control and Temperature Control.
8. Room Pressure Monitor:
    a. The room pressure shall be monitored at the BAS.

B. Occupied Modes
    1. Office Area Occupancy Modes:
        a. Each zone shall operate on an occupied/unoccupied schedule. Initial occupied schedule shall be from 7 am to 7 pm and shall be fully adjustable at the BAS. Occupancy schedule shall be globally adjustable for all zones.
            1). Occupied Mode
                a). Terminal units and space temperature shall be controlled as described below.
                b). Spaces with adjustable thermostats shall have the maximum and minimum setpoint range programmed at the BAS. Initial range shall be 68°F - 74°F (FA). Local LCD display shall not be capable of adjustment beyond the range set at the BAS.
                c). Initial Occupied setpoint for spaces with non-adjustable thermostats shall be:
                d). Interior Zones: 73°F (FA) with a field adjustable deadband between heating and cooling adjustable at the BAS.
                e). Exterior Zones: 75°F Cooling (FA) and 70°F heating (FA).
            2). Unoccupied Mode
                a). Terminal units shall close or modulate to minimum, refer to mechanical schedules.
                b). Space temperature shall be allowed to drift ±4°F (FA) from space setpoint.

c). When the space temperature drifts outside the allowable range, the air terminal and cooling terminal devices shall be released to control to bring the space back into the allowed range.

d). Relative humidity shall be allowed to drift ±5%RH (FA) from space setpoint.

e). When the space relative humidity drifts outside the allowable range, the air terminal and cooling terminal devices shall be released to control to bring the space back into the allowed range.

f). Occupant-adjustable temperature sensors shall have an occupancy override button. The occupancy override button, when pressed shall override the zone into occupied mode for 2 hours (FA). For each zone graphic, provide a button/icon to allow the BAS operator to lock out the occupancy override button.

3). Vacancy Mode

a). During Occupied Mode, when the space occupancy sensor indicates that the room is unoccupied, the room shall enter Vacant Mode.

b). During vacant mode, the space temperature shall be allowed to drift ±3°F (FA) from space setpoint. The air terminal serving the space shall remain under Occupied Mode control.

c). When the occupancy sensor indicates that the room is occupied, the space shall return to Occupied Mode.

2. Lab Occupancy Modes:
   a. Lab zones shall not have occupied/unoccupied modes. Zones shall operate continuously.
   b. Occupancy schedule shall be globally adjustable for all zones.
      1). Occupied Mode
         a). Terminal units and space temperature shall be controlled as described below.
         b). Spaces with adjustable thermostats shall have the maximum and minimum setpoint range programmed at the BAS. Initial range shall be 65°F - 75°F (FA). Local LCD display shall not be capable of adjustment beyond the range set at the BAS.
         c). Initial Occupied setpoint for spaces with non-adjustable thermostats shall be 73°F (FA) with an adjustable degree deadband between heating and cooling adjustable at the BAS.
3. Lab Occupancy Modes for zones with Aircuity
   a. Lab zones shall not have occupied/unoccupied modes. Zones shall operate continuously.
   b. Occupancy schedule shall be globally adjustable for all zones. Purge Mode (each Zone)
      1). Indicated at the BAS or Purge Push Button within the zone.
         a). For each zone graphic, provide a button/icon to allow the BAS operator to start/stop the Purge Mode.
      2). When Purge Mode is activated, Terminal units shall maintain Maximum Occupied airflow as indicated on terminal unit schedules.
   c. Occupied Mode
      1). For each zone graphic, provide a button/icon to allow the BAS operator to
      2). Occupied Mode
         a). Terminal units and space temperature shall be controlled as described below.

b). Spaces with adjustable thermostats shall have the maximum and minimum setpoint range programmed at the BAS. Initial range shall be 70°F - 74°F (FA). Local LCD display shall not be capable of adjustment beyond the range set at the BAS.

c). Initial Occupied setpoint for spaces with non-adjustable thermostats shall be 73°F (FA) with a 4 degree deadband between heating and cooling.

4. Occupancy Modes for Vivarium
   a. Vivarium spaces shall not have occupied/unoccupied modes. Zones shall operate continuously.

C. Zones will typically consist of the following units:
   1. Terminal Chilled Beams, reheat coils, and/or radiant panels:
      a. Refer to drawings IC07-30 through IC07-33 for determination of control sequence applications.
      b. Provide one control valve per zone for each type of unit, i.e. for multiple chilled beams in a zone, provide one control valve.
   2. Air terminal Valves:
      a. Laboratory Temperature and Airflow Control System contractor shall provide controls and actuators. Refer to Section 23 3614 Laboratory Temperature and Airflow Control.
      b. Air Terminal Valves are pressure independent type.
      c. Refer to Air Terminal Device Schedules and drawings IC07-53 through IC07-57 for determination of control sequence applications.
      d. Unit dampers, damper actuators, pressure sensors, are furnished and installed by unit manufacturer.
   3. Fume Hoods:
      a. Fume hood air flow set point determination (vertical sash hoods).
         1). The current sash height shall be determined by a sash position sensor installed into the hood. The sash shall be considered fully closed when it reaches any mechanical stops that limit closure.
         2). Fixed parameters for each hood shall be configured for sash width, and for hood surface area in square feet.
         3). Open face area shall equal the sash height multiplied by the sash width, in feet.
         4). Current hood air flow setpoint shall be computed based on sash position.
      b. Fume hood monitor
         1). The face-mounted fume hood monitor shall display current face velocity.
         2). The face-mounted fume hood monitor shall indicate alarm via dedicated indicator light.
   4. Aircuity air quality sensors.

D. Air Flow for Terminal Units
   1. Office
      a. Constant Volume Control
         1). Damper actuator on supply air terminal shall maintain airflow quantity scheduled. DDC Constant Air Volume (CAV) controller shall utilize airflow sensor in supply air terminal to continuously measure supply flow rate.

2). DDC controller shall utilize airflow sensors in exhaust air terminal to continuously measure room exhaust airflow. CAV controller shall continuously calculate required exhaust airflow rate necessary to maintain predetermined offset, between total exhaust and supply airflows, by subtracting or adding offset from/to total supply airflow rate to determine exhaust airflow rate. Damper actuator serving exhaust air terminal shall be modulated to maintain predetermined offset.

a). Refer to terminal unit schedules for tracking pairs, including exhaust terminals tracking multiple supply terminals.

3). Refer to terminal schedules for CFM setpoints.

b. Variable Volume Control

1). Damper actuator on supply air terminal shall modulate between maximum and minimum airflow setpoints to maintain space setpoint or CO2 level, as described below. DDC Variable Air Volume (VAV) controller shall utilize airflow sensor in supply air terminal to continuously measure supply flow rate.

2). DDC controller shall utilize airflow sensors in exhaust air terminal to continuously measure room exhaust airflow. CAV controller shall continuously calculate required exhaust airflow rate necessary to maintain predetermined offset, between total exhaust and supply airflows, by subtracting or adding offset from/to room's total supply airflow rate to determine exhaust airflow rate. Damper actuator serving exhaust air terminal shall be modulated to maintain predetermined offset.

3). Refer to terminal schedules for supply CFM minimum and maximum setpoints.

2. Laboratory

a. Constant Volume Control (Negatively Pressurized Space)

1). Damper actuator on exhaust air terminal shall maintain airflow quantity scheduled. DDC Constant Air Volume (CAV) controller shall utilize airflow sensor in exhaust air terminal to continuously measure exhaust flow rate.

2). DDC controller shall utilize airflow sensors in supply air terminal to continuously measure room supply airflow. CAV controller shall continuously calculate required supply airflow rate necessary to maintain predetermined offset, between total exhaust and supply airflows, by subtracting or adding offset from/to room's total exhaust airflow rate to determine supply airflow rate. Damper actuator serving supply air terminal shall be modulated to maintain predetermined offset.

3). Refer to terminal schedules for supply CFM minimum and maximum setpoints.

b. Constant Volume Control (Positively Pressurized Space)

1). Damper actuator on supply air terminal shall maintain airflow quantity scheduled. DDC Constant Air Volume (CAV) controller shall utilize airflow sensor in supply air terminal to continuously measure supply flow rate.

2). DDC controller shall utilize airflow sensors in exhaust air terminal to continuously measure room exhaust airflow. CAV controller shall continuously calculate required exhaust airflow rate necessary to maintain predetermined offset, between total exhaust and supply airflows, by subtracting or adding offset from/to room's total supply airflow rate to determine exhaust airflow rate. Damper actuator serving exhaust air terminal shall be modulated to maintain predetermined offset.

3). Refer to terminal schedules for supply CFM minimum and maximum setpoints.

c. Variable Volume Control (Negatively Pressurized Space)

1). Damper actuator on exhaust air terminal shall modulate between maximum and minimum airflow setpoints to maintain space setpoint or CO2 level, as described

below. DDC Variable Air Volume (VAV) controller shall utilize airflow sensor in exhaust air terminal to continuously measure exhaust flow rate.

2). DDC controller shall utilize airflow sensors in supply air terminal to continuously measure room supply airflow. VAV controller shall continuously calculate required supply airflow rate necessary to maintain predetermined offset, between total exhaust and supply airflows, by subtracting or adding offset from/to room's total exhaust airflow rate to determine supply airflow rate. Damper actuator serving supply air terminal shall be modulated to maintain predetermined offset.

3). Refer to terminal schedules for supply CFM minimum and maximum setpoints.

d. Variable Volume Control (Positively Pressurized Space)

1). Damper actuator on supply air terminal shall modulate between maximum and minimum airflow setpoints to maintain space setpoint or CO2 level, as described below. DDC Variable Air Volume (VAV) controller shall utilize airflow sensor in supply air terminal to continuously measure supply flow rate.

2). DDC controller shall utilize airflow sensors in exhaust air terminal to continuously measure room exhaust airflow. CAV controller shall continuously calculate required exhaust airflow rate necessary to maintain predetermined offset, between total exhaust and supply airflows, by subtracting or adding offset from/to room's total supply airflow rate to determine exhaust airflow rate. Damper actuator serving exhaust air terminal shall be modulated to maintain predetermined offset.

3). Refer to terminal schedules for supply CFM minimum and maximum setpoints.

e. Variable Volume Control with Fume Hood

1). Airflow control for these zones consists of three fume hood exhaust terminals, general exhaust terminal serving the open lab area, and three supply terminals – one constant volume terminal serving the fume hood room, one constant volume terminal serving chilled beams in the open lab area, and one variable volume terminal serving the open lab area.

2). Damper actuator on each fume hood exhaust air terminal shall modulate between maximum and minimum airflow setpoints to maintain sash velocity on fume hood. Refer to 23 3614. DDC Variable Air Volume (VAV) controller shall utilize airflow sensors in exhaust air terminals to continuously measure exhaust flow rates.

3). Damper actuators on the two constant volume supply air terminals shall maintain airflow quantities scheduled. DDC controller shall utilize airflow sensor in each supply air terminal to continuously measure supply flow rate.

4). DDC controller shall utilize airflow sensors in the general exhaust air terminal to continuously measure exhaust airflow. VAV controller shall continuously calculate the required exhaust airflow rate necessary to maintain total exhaust airflow equal to [general exhaust terminal scheduled maximum airflow plus combined fume hood exhaust terminal scheduled minimum airflows].

a). As the combined total airflow measured at the fume hood exhaust air terminals increases, the general exhaust air terminal shall modulate from maximum airflow to minimum airflow to maintain total exhaust airflow rate above.

5). DDC controller shall utilize airflow sensor in variable volume supply air terminal to continuously measure supply airflow. VAV controller shall continuously calculate required supply airflow rate necessary to maintain predetermined offset, between total exhaust and total supply airflows, by subtracting or adding offset from/to room's total exhaust airflow rate to determine supply airflow rate. Damper actuator serving supply air terminal shall be modulated to maintain predetermined offset.

a). Total supply airflow shall be equal to airflow measured at the terminal serving chilled beams plus airflow measured at the terminal serving the fume hood room plus airflow measured at the terminal serving the open lab space.

b). Total exhaust airflow shall be equal to total airflow measured at the terminals serving fume hoods plus airflow measured at the terminal the open lab space.

6). Refer to terminal schedules for supply CFM minimum and maximum setpoints.

E. Temperature Control

1. Heating and cooling devices in each space shall operate described below. Refer to individual sequences for order in which devices are activated to control room setpoints.
2. Heating Devices
   a. On a decrease in space temperature the following can occur in any sequence or in parallel:
      1). The space temperature sensor shall reset the terminal unit discharge air setpoint. Reheat coil valve shall modulate to maintain terminal unit discharge air setpoint.
      2). The radiant ceiling panel valve shall modulate to maintain the space setpoint.
      3). The chilled beam hot water valve shall modulate to maintain the space setpoint.
      4). The supply terminal unit shall modulate airflow to maintain the space setpoint, refer to the mechanical schedules for the maximum heating airflows.
3. Cooling Devices
   a. On an increase in space temperature the following can occur in any sequence:
      1). The chilled beam chilled water valve shall modulate to maintain the space setpoint.
      2). The supply terminal unit shall modulate the airflow to maintain the space setpoint, refer to the mechanical schedules for the maximum airflows.
4. Program a 4°F (FA) deadband between heating and cooling devices. Heating and Cooling valves shall not operate at the same time.

F. Monitor and Alarm

1. Refer to Points list for BAS monitoring points for possible points for each sequence and generate the alarms. Additionally, the BAS shall monitor all humidity, CO2, occupancy sensors, room pressure sensors, and points associated with Aircuity.
   a. Space temperature (AI)
      1). Generate High Priority alarm if space temperature exceeds setpoint by ±5°F (FA) for 15 consecutive minutes.
   b. Space temperature fault (DI)
      1). Generate High Priority alarm if space temperature sensor indicates a loss of signal.
   c. Space relative humidity (AI)
      1). Generate High Priority alarm if space temperature exceeds setpoint by ±5%RH (FA) for 15 consecutive minutes.
   d. Space CO2 Level (AI) – where shown
      a). Generate High Priority alarm when space CO2 level exceeds 1000 ppm (FA).
   e. Space CO2 fault (DI)
      1). Generate High Priority if CO2 sensor indicates a loss of signal.
   f. Supply/Return or Exhaust Offset (AD) – each room

a). Generate High Priority alarm if offset exceeds setpoint by ±25% (FA) for 15 consecutive minutes (FA).

G. Sequence #A: Office with Exterior Exposure
   1. General
      a. Refer to Detail 1 on IC-753.
   2. Zone Consists of:
      a. Terminal Supply Valve
      b. Reheat coil
      c. Radiant Ceiling Panel (each office)
      d. Chilled Beam (each office)
      e. Space temperature sensor in each office
   3. Occupancy Mode:
      a. Office Area Occupancy Mode
   4. Air Flow Control
      a. Office Variable Volume Control
   5. Temperature Control:
      a. The terminal supply valve discharge air temperature sensor setpoint shall reset to maintain the lowest space temperature setpoint. The reheat coil shall modulate to maintain the supply valve discharge air temperature setpoint.
      b. On a decrease in space temperature the following devices will modulate to maintain the office room temperature setpoint:
         1). Terminal supply valve shall modulate from max to min airflow per occupancy mode.
         2). Radiant panel valve
         3). Reheat coil
      c. On an increase in space temperature the following devices will modulate in sequence to maintain the room temperature setpoint:
         1). Chilled beam chilled water valve
         2). Then the terminal unit valve modulates airflow

H. Sequence #B: Hallways Associated with Offices
   1. General
      a. Refer to Detail 2 on Drawing IC-753.
   2. Zone Consists of:
      a. Terminal exhaust valve
   3. Occupancy Mode:
      a. Office Area Occupancy Mode
   4. Air Flow Control
      a. Office Variable Volume Control

I. Sequence #H: Main Laboratory Area & Fume Hood Room
   1. General
      a. Refer to Detail 1 on IC-754.
   2. Zone Consists of:

a. Terminal supply valve(s) with a reheat coil.
b. Terminal exhaust valve(s)
c. Aircuity
d. Chilled Beam(s)
e. Fume Hood(s)

3. Occupancy
   a. Lab Occupancy Mode with Aircuity
4. Air Flow
   a. Variable Volume Control with Fume Hood
5. Temperature Control
   a. On a decrease in space temperature the following devices will modulate in sequence to maintain the room temperature setpoint:
      1). Terminal supply valve shall modulate from max to min airflow per occupancy mode.
      2). The terminal supply valve discharge air temperature sensor setpoint shall reset to the maintain space temperature setpoint. The reheat coil shall modulate to maintain the supply valve discharge air temperature setpoint.
      3). Terminal supply valve shall modulate from min to max (max heating airflow per mechanical schedules) airflow per occupancy mode.
   b. On an increase in space temperature the following devices will modulate in sequence to maintain the room temperature setpoint:
      1). Chilled beam chilled water valve
      2). Terminal supply valve shall modulate from min to max airflow per occupancy mode.

J. Sequence #J: Linear Equipment Room
   1. General
      a. Refer to Detail 1 on Drawing IC-755.
   2. Zone Consists of:
      a. Terminal supply valve with reheat
      b. Terminal exhaust valve
      c. Chilled Beam
   3. Occupancy Mode:
      a. Lab Occupancy Mode
   4. Air Flow Control:
      a. Laboratory Constant Volume Control
   5. Temperature Control:
      a. On a decrease in space temperature the following devices will modulate in sequence to maintain the room temperature setpoint:
         1). Reheat coil valve
      b. On an increase in space temperature the following devices will modulate to maintain the room temperature setpoint:
         1). Chilled beam chilled water valve

K. Sequence #K: Wet Lab Procedure Room
   1. General

a. Refer to Detail 2 on Drawing IC-755.

2. Zone Consists of:
   a. Terminal supply valve with a reheat coil.
   b. Terminal exhaust valve
   c. Chilled Beam(s)
3. Occupancy Mode:
   a. Lab Occupancy Mode
4. Air Flow Control
   a. Laboratory Variable Volume Control
5. Temperature Control:
   a. On a decrease in space temperature the following devices will modulate in sequence to maintain the room temperature setpoint:
      1). Terminal supply valve shall operate airflow per occupancy mode.
      2). The terminal supply valve discharge air temperature sensor setpoint shall reset to the maintain space temperature setpoint. The reheat coil shall modulate to maintain the supply valve discharge air temperature setpoint.
   b. On an increase in space temperature the following devices will modulate in sequence to maintain the room temperature setpoint:
      1). Chilled beam chilled water valve
      2). Then the terminal unit valve modulates airflow

L. Sequence #L: Sterilizer/Clean/Soil Room
   1. General
      a. Refer to Detail 3 on IC-755.
   2. Zone Consists of:
      a. Terminal Supply Valve
      b. Terminal Exhaust Valve serving sterilizer
      c. Reheat coil
   3. Occupancy Mode:
      a. Lab Occupancy Mode
   4. Air Flow:
      a. Laboratory Constant Volume Control
   5. Temperature Control:
      a. On a decrease in space temperature the following devices will modulate in sequence to maintain the room temperature setpoint:
         1). Reheat coil valve
      b. On an increase in space temperature the devices will modulate in reverse of the above to maintain the room temperature setpoint.

M. Sequence #W: Environmental Room
   1. General
      a. Refer to Detail 1 on Drawing IC-756.
   2. Zone Consists of:
      a. Terminal supply valve

b. Terminal exhaust valve

3. Occupancy Mode
   a. Lab Occupancy Mode
4. Air flow Control
   a. Lab Constant Volume Control

N. Sequence #X: Constant Volume Exhaust
1. General
   a. Refer to Detail 2 on Drawing IC-756.
2. Zone Consists of:
   a. Terminal Exhaust Valve
3. Occupancy Mode
   a. Lab Occupancy Mode
4. Air flow Control
   a. Lab Constant Volume Control

END OF SECTION

SECTION 23 2116 PIPE AND PIPE FITTINGS

PART 1 - GENERAL

1.1 RELATED WORK

A. Section 20 0529 - Mechanical Supporting Devices

B. Section 23 0594 - Water Systems Test Adjust Balance

C. Section 23 0902 - Control Valves and Damper (Valves)

D. Section 23 0903 - Control Instrumentation (Wells, Taps or In-line Devices)

E. Section 23 2118 - Valves

F. Section 23 2120 - Piping Specialties

1.2 REFERENCE

A. Work under this Section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.

1.3 DESCRIPTION

A. This Section includes pipe and pipe fitting specifications and installation requirements for heating and cooling systems.

B. Specification of an item in this or any other sections shall not relieve Contractor from providing all items, articles, materials, operations, methods, labor, equipment and incidentals necessary for a complete and functional system.

C. Use only new material, free of defects, rust and scale, and guarantee for services intended.

D. Use material meeting the latest revision of ASTM specifications as listed in this specification.

E. Follow local codes if they require other types of pipe or joints.

F. Use only long radius elbows having centerline radius of 1.5 pipe diameters unless otherwise indicated.

G. Manufacturer, pressure class, size and heat code of each fitting and flange shall be permanently identified on its body in accordance with MSS SP-25.

H. Where size for a pipe segment is not indicated, the pipe segment size shall be equal to the largest pipe segment to which it is connected. Transition to smaller size shall occur on the side of fitting where smaller size is indicated.

I. Unless otherwise indicated, fittings and accessories connected to pipe shall be of the same material as the pipe.

J. Unless otherwise indicated, construct piping for highest pressures and temperatures in respective system in accordance with the latest revision of the applicable Sections of ASME Code for pressure piping, ASME B31 including the following:
   1. B31.9 Building Services Piping
   2. B31.9 Building Service Piping for building heating and distribution steam and condensate piping for 15 psig or less, or hot water heating system for 30 psig or less
   3. B31.1 Power Piping
   4. B31.3 Process Piping

K. Non-metallic piping is acceptable only for services indicated. It is not acceptable in occupied spaces and ventilation plenum spaces.

1.4 SUBMITTALS

A. Shop Drawings for each piping system for all pipe sizes including, but not limited to, the following:
   1. Name of system
   2. Pipe; ASTM number, grade if known, type, wall thickness, material
   3. Fittings; ASME number, grade if known, class, type, wall thickness, material
   4. Joint type
   5. Flanges; ASTM number, grade, class, type, material
   6. Bolts and nuts; material
   7. Thread joint sealants; material
   8. Flange gaskets; material, rating
   9. Unions; ASTM number, type, material, rating
   10. Type of welding
   11. Welding Quality Control Program
   12. Test pressure and media
   13. Pipe flushing/cleaning plan
   14. Pipe cleaning method
   15. All other appropriate data

B. Submit pipe certification as specified under Pipe Certification in this Section.

C. Submit required documents as specified under Pipe Welding in this Section.

D. Provide Flushing and Cleaning Plan:
   1. Submit pipe flushing/cleaning plan for water, fluid, steam and condensate systems for approval. Plan shall detail methods for compliance with requirements of this section, including:
      a. Flushing and cleaning procedure narratives.
      b. Size, power source, and connection points of contractor provided pumps that will be used for flushing and cleaning.
      c. If Contractor proposes to utilized project system pumps, method of protecting pumps from damage and developing required velocity of section of piping to be flushed.
      d. Method of sectionalizing piping to obtain required velocity.
      e. Minimum velocities at each section of pipe, clearly indicating any sections where 6 fps cannot be achieved.

f. Location and means of temporary bypasses for coils, control valves and other equipment.
g. Flushing schedule and drawings or diagrams that will be used for inspection and sign off prior to and after procedure, at Owner's option.

2. Submit documents showing verification of flushing/cleaning following specified requirements and results.

E. LEED Submittal
1. Product Data for IEQ Credit 4.1: For solvent cements and adhesive primers, including printed statement of VOC content.

1.5 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Furnish pipe with plastic end-caps/plugs on each end of pipe. Maintain end-caps/plugs through shipping, storage and handling to prevent pipe-end damage and eliminate dirt and construction debris from accumulating inside of pipe.

B. Where possible, store materials inside and protect from weather. Where necessary to store outside, elevate well above grade and enclose with durable, waterproof wrapping.

C. Before shipping, all carbon steel piping shall be free of rust and scale, and furnished with plastic end caps/plugs on each end of pipe.

1.6 PIPE WELDING

A. Procedure and Welding Qualification Records:
1. Submit Welding Procedure Specifications (WPSs) and their supporting Procedure Qualification Records (PQRs) to be used on the work to Engineer for review and approval prior to performing any welding. These documents shall meet requirements of ASME B31.1 and B31.9, as applicable.
2. Unless otherwise indicated, welding shall be done using only the following processes:
a. Shielded Metal Arc Welding (SMAW), also known as "stick" welding
b. Gas Tungsten Arc Welding (GTAW), also known as TIG and Heliarc welding
c. Gas Metal Arc Welding (GMAW), also known as MIG welding
d. Flux-Cored Arc Welding (FCAW), a variation of GMAW
e. Submerged Arc Welding (SAW)
3. Root pass must be applied by GTAW process with argon gas purge for high-pressure steam and condensate (400 psig and over) and high temperature hot water (450°F and over) services.
4. Root pass must be applied by only GTAW process with argon gas purge for stainless steel pipe.
5. Unless otherwise stated, fabrication, installation, inspection, examination and testing shall be in accordance with ASME B31.1 or B31.9, as applicable.
6. Backing rings (chill rings) or consumable inserts are not allowed, unless specifically requested by Owner or Engineer.

B. Quality Control Program:
1. Submit written quality control program for review and approval prior to implementing any welding on this project. Quality control program shall include the following as minimum:
a. Explanation of how Contractor will assure proper fitup for each weld.

b. Explanation of how Contractor will document welds performed by individual welding operators for systems under ASME B31.1.

c. Explanation of how Contractor will assure that proper welding procedure is being followed.

d. Credentials of personnel responsible for required weld examinations.

C. Weld Inspection and Examination:

1. Provide examination services for all welding for this Project. Examination shall be in accordance with requirements of ASME B31.1, Table 136.4 or B31.9, as applicable.
2. Periodically, as welding progresses, submit report, signed by weld examiner, indicating status of project welding quality.
3. Arrange with Owner's Inspector for observation of fitup and welding methods prior to implementing any welds, including shop welds, on this Project.
4. In addition, Owner's Inspector will perform any additional observations deemed necessary before, during, or after fabrication to assure, to Owner's satisfaction, that proper welding is provided. Owner reserves the right to perform independent examination of welds. If Owner has any concern as a result of such examination Owner reserves the right to stop in progress welding work, without any cost to Owner, until resolution satisfactory to Owner is reached.

D. Welder Qualifications:

1. Each welder and welding operator must qualify by passing required procedure test before performing any project welds. Submit copy of Manufacturer's Record of Welder or Welding Operator Qualification Tests (WPQS) as required by Section IX of ASME Boiler and Pressure Vessel Code for all welding procedures to be performed by welding operator.
2. Welder qualifications must be current. If qualification test is more than 6 months old, provide record of welding continuity for each welder.
3. Record of welding continuity is intended to show that welder has performed welding at least every 6 months since the date that welder qualification test was passed for the submitted welding procedure specification.
4. Record of welding continuity shall include, at minimum, the following:
   a. Welder's employer name and address
   b. Date Welder Qualification Test was passed
   c. Dates indicating welding continuity
5. Welders shall be qualified as required by ASME B31.1 or B31.9, as applicable. In addition, there shall be an independent witness of welder tests. That witness shall be representative of independent testing laboratory, Authorized (Code) Inspector, Owner's or Engineer's Inspector or consultant approved by National Certified Pipe Welding Bureau.
6. Welder qualifications must cover all pipe sizes and wall thickness used on this project. Test segments or coupons shall be appropriately selected for qualification. Test position shall be arranged in "6G position."

E. Weld Record:

1. For welding within the scope of ASME B31.1 Power Piping, submit to Engineer for approval an administrative procedure for recording, locating, monitoring and maintaining quality of welds to be performed on the project. This quality control document record shall include but not be limited to:

a. Drawings and schedules identifying location of each weld by individual number, identification of welder who performed each weld by individual welder's name, stamp number, date, and WPS used.

1.7 PIPE CERTIFICATION

A. Certification is required for all pipe within scope of ASME B31.1. Submit certification papers, as outlined below, within 30 days of delivery of pipe to project site.

B. Type E or S Pipe:
1. Furnish manufacturer's mill certificates (material test report) including dimensions, heat numbers, chemical analysis and tensile test results for pipe shipped to project site.

PART 2 - PRODUCTS

2.1 LOW PRESSURE STEAM (15 PSIG AND LOWER)

A. 1-1/2" and Smaller:
1. Pipe: ASTM A53, Grade A or B, Type E or ASTM A106, Grade B, Schedule 40, carbon steel
2. Fittings: ASME B16.3, Class *150* malleable iron, threaded
3. Unions: ASME B16.39, malleable iron, Class *150*. Refer to Unions and Flanges in this Section

B. 2” and Larger:
1. Pipe: ASTM A53, Grade A or B, Type E or ASTM A106, Grade B, Schedule 40, carbon steel
2. Fittings: ASTM A234 Grade WPB/ASME B16.9, standard weight, seamless, carbon steel weld
3. Flanges: Class 150. Refer to Unions and Flanges in this Section

2.2 LOW PRESSURE STEAM CONDENSATE (15 PSIG AND LOWER)

A. 1-1/2" and Smaller:
1. Pipe: ASTM A53, *Grade B* Type F, *Schedule 80* extra strong, carbon steel
2. Fittings: ASME B16.3, Class 300 malleable iron, threaded
3. Unions: ASME B16.39, malleable iron, Class *300*. Refer to Unions and Flanges in this Section

B. 2” and Larger:
1. Pipe: ASTM A53, Grade B, Type E or ASTM A106, Grade B, extra strong, *schedule 80* carbon steel
2. Fittings: ASTM A234 Grade WPB/ASME B16.9, extra strong, seamless, carbon steel weld
3. Flanges: Class *150 ~~250~~*. Refer to Unions and Flanges in this Section

2.3 HIGH PRESSURE STEAM CONDENSATE

A. 1-1/2" and Smaller:
1. Pipe: ASTM A106, Grade B, extra strong, *schedule 80,* carbon steel
2. Fittings: ASME B16.3, Class *300* malleable iron, threaded
3. Unions: ASME B16.39, malleable iron, Class *300*. Refer to Unions and Flanges in this Section

B. 2” and Larger:
1. Pipe: ASTM A106, Grade B, extra strong, *Schedule 80*, carbon steel

2. Fittings: ASTM A234, Grade WPB/ASME B16.9, extra strong, seamless, carbon steel weld fittings
3. Flanges: Class *300*. Refer to Unions and Flanges in this Section

2.4 HIGH PRESSURE STEAM (16 *PSIG AND ABOVE*)

A. 1-1/2" and Smaller:
1. Pipe: ASTM A106, Grade B, *schedule 40*, extra strong, carbon steel
2. Fittings: ASME B16.3, Class 300 malleable iron, threaded
3. Unions: ASME B16.39, malleable iron, Class *300 ~~250~~*. Refer to Unions and Flanges in this Section

B. 2"*Thru 8"*:
1. Pipe: ASTM A106, Grade B, schedule 40, carbon steel
2. Fittings: ASTM A234 Grade WPB/ASME B16.9, schedule 40, seamless, carbon steel weld
3. Flanges: Class 300. Refer to Unions and Flanges in this Section

2.5 HEATING HOT WATER

A. 2-1/2" and Smaller:
1. Pipe: ASTM B88 seamless, Type L, hard temper copper tube
2. Fittings: ASME B16.22, wrought copper solder joint
3. Joint: ASTM B32, lead free solder, Bridgit, Silvabrite, Silverflow or Canfield
4. Unions: ASME B16.18 cast copper alloy or ASME B16.22 wrought copper solder joint, Class 125. No unions to be used for line sizes 3/4" and smaller. Unions shall be used for line sizes over1".
5. Flanges: ASME B16.24, Class 250, cast copper alloy
6. Use solder joints for valves and piping specialties in copper piping

B. 3" and Larger:
1. Pipe: ASTM A53, Grade B, Type E or ASTM A106, Grade B, schedule 40, carbon steel
2. Fittings: ASTM A234 Grade WPB/ASME B16.9, schedule 40, seamless, carbon steel weld
3. Flanges: Class 250. Refer to Unions and Flanges in this Section

2.6 CHILLED WATER/MEDIUM TEMPERATURE CHILLED WATER

A. 2-1/2" and Smaller:
1. Pipe: ASTM B88 seamless, Type L, hard temper copper tube
2. Fittings: ASME B16.22, wrought copper solder joint
3. Joint: ASTM B32, lead free solder, Bridgit, Silvabrite, Silverflow or Canfield
4. Unions: ASME B16.18 cast copper alloy or ASME B16.22 wrought copper solder joint, Class 125. No unions to be used for lines sizes 3/4" and smaller. Unions shall be used for line sizes over 1".
5. Flanges: ASME B16.24, Class 250, cast copper alloy
6. Use solder joints for valves and piping specialties in copper piping.

B. 3" and Larger:

1. Pipe: ASTM A53, Grade B, Type E or ASTM A106, Grade B, schedule 40, carbon steel
2. Fittings: ASTM A234 Grade WPB/ASME B16.9, schedule 40, seamless, carbon steel weld
3. Flanges: Class 250. Refer to Unions and Flanges in this Section

C. All Chilled water piping systems to be designed for 250 PSIG working pressure, including pumps, valves, strainers, and fittings.

2.7 VENTS AND RELIEF VALVES

A. Unless otherwise indicated, use pipe and pipe fittings as indicated for the system to which relief valve or vent is connected.

B. ASTM A53, Type F, carbon steel pipe with schedule 40, carbon steel fittings may be used for steam vents smaller than 4”.

C. Use ASTM A53, Type E carbon steel pipe with ASTM A234 Grade WPB/ASME B16.9, schedule 40, seamless carbon steel weld fittings for refrigerant vent piping.

2.8 PRESSURE GAUGES AND TAPPINGS

A. Use pipe and pipe fittings as indicated for the system to which pressure gauge or tapping is connected. Use "Threadolets", "Sockolets" or tee fittings for tappings. Refer to Part 3 under General for use of "Threadolets" and "Sockolets".

B. Gauge pipe shall be 1/4" unless otherwise indicated.

C. Gauge pipe shall be 1/2" for high pressure steam (101 psig and over) systems.

2.9 COOLING COIL CONDENSATE DRAIN

A. Piping shall be one of the following, unless otherwise indicated on drawings:
1. Pipe: ASTM B88, Type L, hard temper copper tubing
2. Fittings: ASTM B16.22 wrought copper fittings
3. Joint: ASTM B32, lead free solder, Bridgit or Silvabrite

2.10 DIELECTRIC UNIONS, FLANGES AND FITTINGS (STEEL PIPE TO COPPER PIPE)

A. 2" and Smaller:
1. Use bronze ball valves specified in Section 23 2118 for dielectric purpose.
2. Dielectric fittings similar to Victaulic Style 647 or Clearflow Dielectric Waterway fittings may be used for pipe sizes 2" and smaller.
a. Clearflow fittings shall be ASTM A53 electro zinc-plated steel pipe with high temperature polyolefin polymer liner, suitable for continuous use at temperatures up to 230°F and pressures up to 300 psig.

B. 2-1/2” through 4”:
1. Watts dielectric flange fittings Series LF 3100/LF 3110 with dielectric gasket, 175 psi at 180°F.
2. Dielectric fittings similar to Victaulic Style 647 or Clearflow Dielectric Waterway fittings may be used in lieu of dielectric unions for pipe sizes 2-1/2” and larger.

a. Clearflow fittings shall be ASTM A53 electro zinc-plated steel pipe with high temperature polyolefin polymer liner, suitable for continuous use at temperatures up to 230°F and pressures up to 300 psig.

2.11 DIELECTRIC UNIONS, FLANGES AND FITTINGS (STEEL TO STEEL PIPE)

A. 1" and Smaller: Similar to Epco model HA-B with dielectric gasket, 250 psi at 210°F

B. 1-1/2" and Larger: Similar to Epco model W with bolt insulators, dielectric gasket, bolts and nuts, 175 psi at 210°F). Pikotek model VSC dielectric gasket with viton sealing element, G-10 sleeve and double washers, suitable to 350°F, may be used with specified flanges.

2.12 UNIONS AND FLANGES

A. Unions:
1. 2" and Smaller: Malleable iron, ASME B16.39 with ground joint, bronze or brass to iron. Provide black malleable iron for carbon steel piping and galvanized malleable iron for galvanized steel piping. Unless otherwise specified, pressure class and joint type of union shall be equal to that specified for fittings of respective piping service. Minimum pressure class of unions shall be Class 250.
2. 2" and Smaller: Forged steel, ASTM A105 Grade 2, ASME B16.11, 300 lb WOG with steel to steel seats. Joint type shall match that specified for fittings of respective piping service.

B. Flanges:
1. 2-1/2” and Larger: ASTM A105, ASME B16.5, hot forged steel, welding neck pattern. Slip-on pattern are not allowed. Bore dimension of welding neck flange shall match inside diameter of connected pipe.
2. Use raised face flanges for mating with other raised face flanges with self-centering flat ring gaskets. Use flat face flanges for mating with other flat face flanges with full face gaskets.
3. Flange pressure class indicated in respective piping service is minimum required. Mating flange pressure class shall match pressure class of connected device, such as valves and piping specialties.

C. Flange Gaskets:
1. General - Gasket material shall be asbestos free and suitable for pressures, temperatures and fluid of respective piping system. Non-metallic gaskets shall be in accordance with ASME B16.21 and ASTM F104.
2. Service Temperature (through 249°F) – Garlock, Klingersil or J.M. Clipper, similar to Garlock 5500. Gaskets similar to Garlock Style 3000 may be used for hydronic piping. Unless otherwise indicated or recommended by manufacturer, gaskets shall be compressed inorganic fiber with nitrile binder 1/16" thick for flanges 12" and smaller and 1/8” thick for flanges 14” and larger.
3. Service Temperature (250°F thru 800°F) - Flexitallic, Garlock, Lamos equal to Flexitallic Style CG, flexible graphite filler, 304 SS winding, carbon steel centering ring, 0.175" thickness.
4. Service Temperature (801°F thru 1500°F) - Flexitallic, Garlock, Lamos equal to Flexitallic Style CG, flexible graphite filler, 316 SS winding, carbon steel centering ring, 0.175" thickness.
5. Service Temperature (1501°F thru 1700°F) - Flexitallic, Garlock, Lamos equal to Flexitallic Style CG, flexible graphite filler, Inconel 600 winding, 316 SS centering ring, 0.175" thickness.

D. Bolting:
1. Bolts, bolt studs, nuts and washers shall have zinc plated finish.

2. Thread shall be in accordance with ASME B1.1, Class 2A tolerance for external threads and Class 2B tolerance for internal threads. Threads shall be coarse-thread series except that alloy steel bolting 1/8" and larger in diameter shall be 8 pitch thread series.
3. Threaded rods are not allowed as fastening elements.
4. For Class 150 and Class 300 flanges not exceeding 400°F temperature, use carbon steel bolts or stud bolts conforming to ASTM A307, Grade B with nuts conforming to ASTM A194.
    a. Bolts conforming to ASTM A307, Grade A may be used for piping governed by ASME B31.9.
5. For Class 400 and 600 flanges at 750°F or lower temperature, use alloy steel bolts or stud bolts conforming to ASTM A193, Grade B7 or B16, with nuts conforming to ASTM A194, Grade 2H.

2.13 THREADED JOINT SEALANTS

A. Paste type for brush application or cord type. Products shall be non-toxic, chemically inert, non-hardening, rated for -50°F to 400°F and up to 10,000 psi (liquids) and 3000 psi (gases), certified by UL, CSA, and NSF.

B. Use sealant similar to Loctite Model 54531 for piping handling oil or petroleum products.

2.14 WELD BRANCH OUTLET FITTINGS (WELDOLETS, THREADOLETS AND SOCKOLETS)

A. Weld branch outlet fittings shall conform to MSS-SP-97, ASME B16.9 for weldolets, ASME B1.20.1 for threadolets and ASME B16.11 for sockolets.

B. Materials shall match material of header piping and wall thickness of outlet or branch end shall match wall thickness of branch pipe.

PART 3 - EXECUTION

3.1 GENERAL

A. Remove foreign materials before erection. Ream ends of piping to remove burrs.

B. Install piping parallel to building walls and ceilings and at such heights so as not to obstruct any portion of window, doorway, stairway, or passageway. Install piping to allow adequate service space for equipment. Refer to drawings and/or manufacturer's recommendations. Install vertical piping plumb. Where interferences develop in field, offset or reroute piping as required to clear such interferences. In all cases, consult drawings for exact location of pipe spaces, ceiling heights, door and window openings or other architectural details before installing piping.

C. Provide anchors, expansion joints, swing joints and expansion loops so that piping may expand and contract without damage to itself, equipment or building.

D. Mitered elbows, welded branch connections, notched tees and "orange peel" reducers are not allowed. Unless specifically indicated, reducing flanges and reducing bushings are not allowed. Reducing bushings may be used for air vents and instrumentation connections.

E. Unless otherwise indicated, use fittings as specified in Part 2 of this Section for elbows, tees, reducers, etc.

F. "Weldolets" with outlet size 2-1/2" and larger and "Threadolets" or "Sockolets" with outlet size 2" and smaller may be used for branch connections up to one pipe size smaller than main. Use "Threadolets" where threaded fittings are specified and use "Sockolets" where socket weld fittings are specified. Install in accordance with PFI (Pipe Fabrication Institute) Standard ES49.

G. Install drains throughout systems to permit complete drainage of entire system.

H. Do not install piping over electrical panelboards, switchgear, switchboards or motor control centers.

I. Install valves, control valves and piping specialties, including items furnished by others, as specified and/or detailed.

J. Make connections to all equipment installed by others where that equipment requires piping services indicated in this Section.

K. For piping within the scope of ASME B31.1 Power Piping, transfer piping material specification and "Heat Number" to each segment of pipe prior to cutting.

3.2 THREADED PIPE JOINTS

A. Threads of pipe and fittings shall conform to ASME B1.20.1.

B. Ream pipe ends after cutting and clean before erection. Apply thread sealants to cleaned male threads. Assemble joint to appropriate depth and remove any excess pipe joint compound from tightened joint.

3.3 FLANGED JOINTS

A. Clean flange surfaces and align them parallel. Bolt holes of gaskets shall be cut slightly larger than bolt diameter. Gasket ID shall be slightly larger than flange ID.

B. Position gasket concentrically so compression is equally distributed over entire gasket surface.

C. Lubricate bolts and run nuts down by hand.

D. By using torque wrench, tighten nuts in the proper sequence so gasket is compressed evenly, and to the appropriate torque specified by bolt manufacturer.

E. Re-torque bolts 12 to 24 h after start up.

3.4 WELDED PIPE JOINTS

A. Inspect pipe and pipe fittings for roundness before they are fit-up or set in place.

B. Properly clean and prepare pipe base material before fit-up. Verify joint land and bevel.

C. Preheat pipe base material as required by welding procedure specification. Temperature of pipe material must be minimum of 32°F before welding.

D. Properly align and adjust joint as required by welding procedure and thickness of material. Verify tolerances after tacking sequence.

E. Use weld material diameter as procedurally required for type and thickness of work being done.

F. Use sufficient argon pre-purge and argon post-purge for GTAW processes. Post purge should be until weld is no longer glowing plus 5 seconds. Maintain purge for at least 2 layers of weld material.

G. Properly store welding materials.

H. Clean tacks before welding out. Remove slag after each pass by grinding to avoid slag inclusion.

I. Weld reinforcement shall not exceed limits established in Chapter V of ASME B31.1.

J. Brush each weld free of rust and paint with rust resistant product that matches piping surface color.

K. For piping within scope of ASME B31.1, each weld shall be permanently marked by welder performing weld. Each welder shall sign and date field welding log record for all welds performed by welder as indicated in Part 1.

L. Conduct radiographic test for sections or joints that cannot be tested by hydrostatic test methods (such as joints cut into existing piping systems) by qualified radiographic testing firm.

3.5 COPPER PIPE JOINTS

A. Cutting of tubing shall not make tubing out of round. Ream cut tube ends to full inside diameter.

B. Remove slivers and burrs remaining from tube cut by reaming and filing both pipe surfaces. Clean fitting and tube with emery or sand cloth. Remove residue from cleaning operation, apply flux and assemble joint. Use solder or brazing to secure joint as specified for specific piping service.

3.6 STEAM AND STEAM CONDENSATE

A. Pitch steam mains down at 1" per 40 ft in direction of flow. Pitch runouts to terminal equipment and control valves at 1/2" per 1 ft for proper condensate drainage. Install drip traps at each rise and at horizontal termination of each steam main.

B. Pitch steam condensate lines down at 1" per 20 ft in direction of flow.

C. Unless otherwise indicated, use eccentric fittings for changes in horizontal pipe sizes with fittings installed for proper condensate drainage (bottom of pipe straight). Concentric fittings may be used for changes in vertical pipe sizes.

D. For steam branch connections and runouts, use top or top 45° connection to main.

E. For condensate branch connections to condensate mains, use top or top 45° connection to main.

F. For condensate connections from steam mains, use bottom connection to main.

G. Install minimum of 3 elbows in each pipe runout to terminal equipment to provide flexibility for expansion and contraction of piping system.

3.7 WATER SYSTEMS

A. Unless otherwise indicated, install horizontal piping level. Install manual air vents at all high points where air may collect. If vent is not in accessible location, extend air vent piping to nearest code acceptable drain location with vent valve located at nearest accessible location to pipe.

B. Main branches and runouts to terminal equipment may be made at top, top 45°, side or bottom 45° of main provided that there are drain valves suitably located for complete system drainage and manual air vents are located as described above.

C. Unless otherwise indicated, use top or top 45° connection to main for upfeed risers, and use side or bottom 45° connection to main for downfeed risers. Bottom connection is not allowed.

D. Use minimum of 3 elbows in each pipeline to terminal equipment to provide flexibility for expansion and contraction of piping systems. Offset pipe connections at equipment to allow for service, such as removal of terminal device.

E. Unless otherwise indicated, use concentric fittings for changes in pipe sizes and for valves smaller than pipe sizes.

F. Notch and dimple branch tubes. Braze joints. Apply heat properly so that pipe and tee do not distort. Remove distorted connections.

3.8 VENTS AND RELIEF VALVES

A. Install vent and relief valve discharge lines as indicated on drawings, as detailed, and as specified for each specific valve or piping specialty item.

3.9 COOLING COIL CONDENSATE DRAIN

A. Trap each cooling coil drain pan connection with trap seal of sufficient depth to prevent conditioned air from moving through piping. Extend drain piping to nearest code approved drain location. Construct trap with plugged tee for cleanout purposes.

B. Pitch pipe down at 1/4" per one foot for proper drainage.

3.10 DIELECTRIC UNIONS AND FITTINGS

A. Install dielectric unions, flanges or fittings in main and branch piping of water systems at each point where copper to steel pipe connection occurs. Dielectric unions or fittings shall not be used at terminal device connections.

B. Concealed dielectric unions and fittings are not allowed.

3.11 UNIONS AND FLANGES

A. Install union or flange at each automatic control valve and at each piping specialty or piece of equipment that requires tube pull or removal for maintenance, repair or replacement. If required, provide additional unions or flanges in order to facilitate removal of piping sections that interfere with tube pulls or equipment removal. Where valve is located at piece of equipment, provide flange or union connection on equipment side of valve.

B. Concealed unions or flanges are not allowed.

3.12 PIPING SYSTEM PRESSURE TESTS

A. Owner and/or Owner's representative may elect to witness pressure test. Notify Owner and/or Owner's representative at least 3 days in advance.

B. Conduct pressure test prior to flushing and cleaning of piping systems.

C. Conduct hydrostatic (HYDRO) test in accordance with ASME B31.1 137.4. Test pressure shall be in accordance with ASME B31.1, but shall not be lower than the minimum test pressure listed below.

D. If leaks are found, repair with new materials and repeat test until leaks are eliminated. Caulking will not be acceptable.

E. Pressure tests may be made of isolated portions of piping systems to facilitate general progress of installation. Any revisions made in piping systems require retesting of affected portions of piping systems.

F. No systems shall be insulated until it has been successfully tested. If required for additional pressure load under test, provide temporary restraints at expansion joints or isolate them during test. Unless otherwise noted, minimum test time shall be 4 h plus such additional time as may be necessary to conduct examination for leakage.

G. No pressure drop shall occur during test period. Any pressure drop during test period indicates leakage.

H. Provide pumps, gauges, instruments, test equipment, temporary piping and personnel required for tests and provide removal of test equipment and draining of pipes after tests have been made.

I. For hydrostatic tests, remove air from piping being tested by means of air vents. Measure and record test pressure at high point in system. Where test pressure at high point in system causes excessive pressure at low point in system due to static head, portions of piping system may be isolated and tested separately to avoid undue pressure. However, every portion of piping system must be tested at the specified minimum test pressure.

J. Conduct pressure tests with parameters indicated below:

System	Minimum Test Pressure	Remarks
Low pressure steam and condensate	75 psig	HYDRO
High pressure steam and condensate		
16 thru 100 psig	150 psig	HYDRO
Heating hot water	100 psig	HYDRO
Chilled water/medium temperature chilled water	100 psig	HYDRO
Glycol water	100 psig	HYDRO

K. Contractor shall provide all pumps, gauges, instruments; test equipment, flow meters, temporary piping and personnel required for tests and provide removal of test equipment and draining of pipes after tests have been made.

L. If piping system is drained after testing and left empty or untreated for more than 3 days, add Nalco 2572 at recommended dosages for dry system lay-up.

3.13 FLUSHING AND CLEANING PIPING SYSTEMS

A. Notify Owner and/or Owner's representative at least 7 days in advance.

B. Flush new water, fluid, steam and condensate systems thoroughly for 15 minutes or longer, as required to ensure removal of dirt and foreign matter from piping system. Bypass pumps and equipment and remove strainers from strainer bodies. Provide circulation by Contractor-supplied portable pumping apparatus.

C. Provide temporary piping or hose to bypass coils, control valves, heat exchangers, other factory-cleaned equipment, and any component that may be damaged.

D. Sectionalize system to obtain minimum velocity of 6 fps. Provide temporary piping to connect dead-end supply and return headers as necessary. Flush bottoms of risers.

E. For pipes 18" and larger, maintain velocity as close as 6 fps possible, but not below 5 fps.

F. After initial flushing of system, use portable pumping apparatus to circulate cold water detergent for water systems. Refer to Section 23 2514 - Chemical Treatment Systems for pipe cleaning.

G. After initial flushing of system, use portable pumping apparatus for continuous 24 h minimum circulation of cold water detergent similar to Nalco 2567 cleaner. Flush detergent clear with continuous draining and raw water fill for additional 12 h or until all cleaner is removed from system. Replace strainers and reconnect permanent pumping apparatus and all apparatus bypassed.

H. Refer to Section 23 2514 - Chemical Treatment Systems for water analysis – Issued under Core and Shell document package.

I. Use oil when flushing hydraulic piping.

J. Flush gas piping with clean, dry compressed air for one (1) h minimum. Open and clean drip legs. Repeat flushing until no debris is found in drip legs.

K. Flush compressed air piping with clean, dry compressed air for one (1) h minimum. Open and clean drip legs. Repeat flushing until no debris is found in drip legs.

3.14 FLUSHING AND CLEANING CHILLED WATER PIPING SYSTEM

A. Contractor shall visually inspect internal portion of each length of pipe during installation. Remove all dirt and foreign matter prior to installing additional lengths. After each major section of piping has been installed, it shall be cleaned and flushed utilizing a high pressure water "hydro-jet" process. The hydro-jet process involves passing a high pressure, high volume spray type cleaning head through the piping. The head is inserted in each section of piping and activated with full water pressure and flow. Through hydraulic force from directional spray nozzles the head propels itself forward up the pipe section. Once the head reaches the end of the pipe section it is retracted while maintaining maximum water pressure and flow. The length of the piping section shall be determined ahead of time so that the proper amount of travel can be tracked with calibrated markings on the spray head feed water hose or a meter on the hose reel. While traveling through the piping the pressurized water spray knocks debris loose and carries it back to the open end of the piping where it is collected and removed from the system. For each section of piping the process shall be performed a minimum of two times and shall be repeated until the water exiting the end of the pipe is clear and free of debris as determined by the Owner/Engineer.

B. The hydro-jet equipment utilized shall be capable of providing a minimum of 50 gpm at 2000 psi.

C. All cleaning and flushing shall be performed such that all debris will be pulled or flushed downhill.

D. All cleaning and flushing shall be initiated from all low points in the system and shall terminate at the nearest adjacent high point in the system.

E. Coordinate the limitations and requirements of hydro-jet process with the flushing subcontractor such that the piping is installed in a sequence and manner that allows every section of the new pipeline to be cleaned and flushed. Limitations may include maximum length of the pipe section, maximum number and/or degree of bends in the pipe section, maximum slope of the pipe section, equipment and excavation access requirements, and the minimum size of the openings required in the piping to allow for insertion and retraction of the cleaning head.

F. Contractor shall provide access at all low points through valves, tees, flanges, etc. to facilitate the cleaning and flushing process. If temporary fittings or piping is required, it shall be provided by the Contractor and removed by the Contractor after successful cleaning.

G. After flushing and cleaning is completed, Contractor shall provide necessary pipe and fittings required to complete the piping system. Each cleaned section of piping shall be capped and protected to keep mud, debris, water, etc. from entering the piping. If a piping section is left open or unprotected, or is found to be contaminated, it shall be re-cleaned prior to being filled and activated at no cost to the Owner.

H. Contractor shall provide all water for flushing and testing. Coordinated rental of fire hydrant meters with local Fire Department(s), or the University as required.

I. Contractor shall provide all temporary piping from water source to piping system and shall provide means for conducting cleaning water from underground piping system to the appropriate sewer; i.e. pumps, piping, hoses, tanks, etc. Contractor to remove all temporary piping, pumps, hoses, etc. from site immediately after flushing has been completed.

3.15 INITIAL SYSTEM FILL AND VENT

A. Fill and vent systems with proper working fluids.

B. Use fluids chemically treated as specified in Section 23 2514 - Chemical Treatment Systems. – Issued under Core and Shell document package

C. Glycol system shall be filled with treated glycol as specified in Section 23 2514 - Chemical Treatment Systems.

3.16 PIPE PAINTING

A. Exposed exterior carbon steel, black iron or other ferrous pipe and fittings shall be prepared and painted by qualified painters using corrosion inhibitive paints. Pipe shall be prepared in accordance with paint manufacturer's instructions and primed (2 coats) and finish painted (2 coats). Paint type shall be approved by Architect/Engineer.

B. Protect piping from weather and paint promptly to prevent corrosion.

END OF SECTION

SECTION 23 2118 VALVES

PART 1 - GENERAL

1.1 RELATED WORK

A. Section 20 0700 - Mechanical Systems Insulation

B. Section 23 0902 - Control Valves and Dampers

C. Section 23 2120 - Piping Specialties (Flow Sensors and Meters)

1.2 REFERENCE

A. Work under this Section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.

1.3 SUBMITTALS

A. Shop Drawings for each system for all sizes including, but not limited to, the following:
   1. Name of system
   2. Manufacturer's name
   3. Type
   4. Model number
   5. Materials of construction
   6. Temperature/pressure ratings
   7. Manufacturer's data sheets clearly cross-referenced
   8. All other appropriate data

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Globe valves, check valves, and drain valves: Crane, Nibco, Stockham, Powell, Milwaukee, Hammond, or Grinnell equal to manufacturer's Figure number listed. Provide valves of same make for these services.

B. Other valves: acceptable manufacturers and Figure Number listed under each item.

2.2 WATER SYSTEM VALVES – HEATING WATER

A. General:
   1. Valves 2" and smaller in steel piping shall have threaded ends.
   2. Valves 2" and smaller in copper piping shall have solder ends.
   3. Provide valve stem extensions with sufficient length to allow for insulation where insulation is specified.

B. Ball Valves:

1. *2"* and Smaller: ASTM B584 bronze body, chrome plated brass/bronze or stainless steel ball, full port for 3/4" and smaller and conventional port for 1" and larger, Teflon seat rings, blowout-proof stem, 2-piece construction, 600 psi WOG, 150 psi SWP, Nibco Fig. T(S)-580-70, Apollo No. 70, Watts, Milwaukee BA-150, Hammond, Kitz or Anvil.
2. Ball valves shall comply with MSS SP-110.

C. Shut-Off Valves:
1. 2" and Smaller: ball valves as specified in this Section
2. 2-1/2" and Larger: butterfly valves as specified in this Section

D. Balancing Valves:
1. 2" and Smaller: calibrated balancing valves:
   a. Variable orifice with multiple turn valve type as manufactured by Armstrong Series CBV or ABV, Tour & Andersson (Victaulic) Series 786 or 787, NIBCO 1709 or 1710, or fixed orifice with ball valve type as manufactured by Flow Design Inc. (FDI), Preso, Gerand, Nexus, HCi or Taco. Bronze or brass body, 250 psi maximum working pressure, 250°F maximum operating temperature. Furnish valve with adjustable memory stop and quick disconnect taps with built-in check valve for pressure differential measurement, integral valve setting index and memory locking device.
   b. Valves shall measure down to 0.3 gpm with accuracy of ±5%.
   c. Valves shall be leak-tight at full rated working pressure.
   d. Unless otherwise indicated, size balancing valves so that at design flow rate, pressure drop across balancing valve with valve approximately 50% open will be at minimum 25% of reading range of meter used for balancing.
2. 2-1/2" and Larger: Armstrong Series CBV or Tour and Anderson (Victaulic) Series 788/789, ductile iron body, ASME/ANSI B16.42 Class 150 flange, 250 psi maximum working pressure, 250°F maximum operating temperature. Fixed orifice with ball valve or butterfly valve as manufactured by FDI, Presco or Gerand, Class 150 flange, 225 psi maximum working pressure, 250°F maximum operating temperature will be acceptable up to 4" size. Butterfly valves, as specified in this Section, together with averaging Pitot tube flow sensors, as specified in Section 23 2120 - Piping Specialties, under Flow Sensors and Meters between check valve and butterfly valve may be used when sizes for Armstrong or T/A valves are not available. Furnish butterfly valves with adjustable memory stops to limit return of valves to preset open position after shut-off.
3. Furnish portable meter kit within durable case similar to Gerand Model "R". Furnish meter with minimum 4-1/2" diameter aluminum or brass body/brass internals with reading range of either 0" to 50" or 0" to 100" water column differential as appropriate, 200°F maximum temperature, 300 psi working pressure. Meter accuracy shall be ± 2% full scale. Provide in kit: equalizing valves, 10 ft purge hose and size devices specified. Meter shall become property of Owner.
4. Contractor shall furnish meter for calibration and shall retain meter after final calibration.

E. Terminal Unit Valve Assembly
1. Terminal unit valve assembly may be used instead of individual valve and other components, provided each valve and component meets specified requirements.
2. Victaulic, Nexus, Griswold, HCi or FDI are acceptable.
3. Inlet assembly shall be combination of isolation ball valve, y-strainer, union, and PT test port similar to Victaulic Coil Pack Series 78 Y, and outlet assembly shall be combination of isolation ball valve, union, PT test ports and balancing valve similar to Victaulic Coil Pack Series 78K and 784.

F. Butterfly Valves (High Performance):
   1. Manufacturers: DeZurik Type BHP, Xomox, Jamesbury, Bray Series 40, or Posi-Seal
   2. Carbon steel or stainless steel body, ANSI Class 150 design rated for 275 psi at 100°F, bidirectional bubble-tight shut off at 275 psi, threaded lug type, upper and lower body bearings with thrust bearings, one piece single or double offset shaft of 316 stainless steel and centerless ground and polished to minimize bearing and packing wear, PTFE seats, PTFE adjustable V-ring packing, capable of service in temperature ranges of -100 to 300°F, 316 stainless steel discs and totally enclosed, factory lubed, handwheel rotary actuator with external disc position indication.
   3. Dead end pressure rating shall be 275 psi without downstream flanging.

G. Water Pressure Regulating Valves:
   1. Manufacturers: Thrush, Watts, Cash-Acme, Taco, or B & G
   2. Brass or bronze body, spring and diaphragm operated, pressure adjustable with check valve and inlet strainer and designed for maximum working pressure of 125 psig and maximum operating temperature of 160°F.

H. Lockshield Valves:
   1. Ball valves as specified above with locking handles for padlocking in open or closed position.

I. Drain Valves:
   1. Ball valve as specified above with threaded hose adapter and cap. Provide 3/4" minimum drain valve for piping larger than 1/2", except strainer blowdown valves shall be blowdown connection size. Provide 1/2" drain valve for 1/2" piping. If 3-piece ball valves are specified, use 2-piece ball valves with same construction.

J. Pressure Compensating Flow Control Valves:
   1. All metal construction, factory set to automatically maintain flow rate within plus/minus 5% accuracy over operating pressure differential range of at least 14 times minimum required for control, self-contained spring loaded perforated cartridge control mechanism, passivated stainless steel internal working parts, rated for 200 psi pressure at 250°F.
   2. Valves 2" and under to have threaded ends with ground joint union; 2-1/2"and larger to have flanged ends.
   3. Each automatic flow control valve to have pressure tappings with quick disconnect fittings suitable for use with portable measuring instrument specified, to verify pressure differential across flow control orifice.
   4. Certified performance data based on independent laboratory tests to be available.
   5. Manufacturers: Griswold, Autoflow or Dole
   6. Furnish to Owner portable pressure-temperature measuring kit consisting of 2 pressure gauges with 4-1/2" dial, air bleed device, hoses, quick-connect fittings, protected thermometer, instructions and carrying case. Kit to be used to read pressure drop across flow control orifice and temperature at that point.

2.3 WATER SYSTEM VALVES – CHILLED WATER/MEDIUM TEMPERATURE CHILLED WATER

A. General:
   1. Valves 2" and smaller in steel piping shall have threaded ends.
   2. Valves 2" and smaller in copper piping shall have solder ends.

3. Provide valve stem extensions with sufficient length to allow for insulation where insulation is specified.
4. All chilled water valves to be rated for 250 psig WOG working pressure.
5. Valves for 3”-4”: Resilient seated, lug style, butterfly valves with bubble tight bi-directional shutoff at 250 psig, ductile iron body with locking handle, lever operators, 150 ANSI bolt pattern.
6. Valves for 6” and up: Resilient seated, lug style, butterfly valves with bubble tight bi-directional shutoff at 250 psig, ductile iron body with gear operator and hand wheels, 150 ANSI bolt pattern.

B. Ball Valves:
1. 2" and Smaller: ASTM B584 bronze body, chrome plated brass/bronze or stainless steel ball, full port for 3/4" and smaller and conventional port for 1” and larger, Teflon seat rings, blowout-proof stem, 2-piece construction, 600 psi WOG, 150 psi SWP, Nibco Fig. T(S)-580-70, Apollo No. 70, Watts, Milwaukee BA-150, Hammond, Kitz or Anvil.
2. Ball valves shall comply with MSS SP-110.

C. Shut-Off Valves:
1. 2" and Smaller: ball valves as specified in this Section
2. 2-1/2" and Larger: butterfly valves as specified in this Section

D. Balancing Valves:
1. 2" and Smaller: calibrated balancing valves:
   a. Variable orifice with multiple turn valve type as manufactured by Armstrong Series CBV or ABV, Tour & Andersson (Victaulic) Series 786 or 787, NIBCO 1709 or 1710, or fixed orifice with ball valve type as manufactured by Flow Design Inc. (FDI), Preso, Gerand, Nexus, HCi or Taco. Bronze or brass body, 250 psi maximum working pressure, 250°F maximum operating temperature. Furnish valve with adjustable memory stop and quick disconnect taps with built-in check valve for pressure differential measurement, integral valve setting index and memory locking device.
   b. Valves shall measure down to 0.3 gpm with accuracy of ±5%.
   c. Valves shall be leak-tight at full rated working pressure.
   d. Unless otherwise indicated, size balancing valves so that at design flow rate, pressure drop across balancing valve with valve approximately 50% open will be at minimum 25% of reading range of meter used for balancing.
2. 2-1/2" and Larger: Armstrong Series CBV or Tour and Anderson (Victaulic) Series 788, ductile iron body, ASME/ANSI B16.42 Class 150 flange, 250 psi maximum working pressure, 250°F maximum operating temperature. Fixed orifice with ball valve or butterfly valve as manufactured by FDI, Presco or Gerand, Class 150 flange, 225 psi maximum working pressure, 250°F maximum operating temperature will be acceptable up to 4" size. Butterfly valves, as specified in this Section, together with averaging Pitot tube flow sensors, as specified in Section 23 2120 - Piping Specialties, under Flow Sensors and Meters between check valve and butterfly valve may be used when sizes for Armstrong or T/A valves are not available. Furnish butterfly valves with adjustable memory stops to limit return of valves to preset open position after shut-off.
3. Furnish portable meter kit within durable case similar to Gerand Model "R". Furnish meter with minimum 4-1/2" diameter aluminum or brass body/brass internals with reading range of either 0" to 50" or 0" to 100" water column differential as appropriate, 200°F maximum temperature,

300 psi working pressure. Meter accuracy shall be ± 2% full scale. Provide in kit: equalizing valves, 10 ft purge hose and size devices specified. Meter shall become property of Owner.

4. Contractor shall furnish meter for calibration and shall retain meter after final calibration.

E. Terminal Unit Valve Assembly
   1. Terminal unit valve assembly may be used instead of individual valve and other components, provided each valve and component meets specified requirements.
   2. Victaulic, Nexus, Griswold, HCi or FDI are acceptable.
   3. Inlet assembly shall be combination of isolation ball valve, y-strainer, union, and PT test port similar to Victaulic Coil Pack Series 78 Y, and outlet assembly shall be combination of isolation ball valve, union, PT test ports and balancing valve similar to Victaulic Coil Pack Series 78K and 784.

F. Butterfly Valves (High Performance):
   1. Manufacturers: DeZurik Type BHP, Xomox, Jamesbury, Bray Series 40, or Posi-Seal
   2. Carbon steel or stainless steel body, ANSI Class 150 design rated for 275 psi at 100°F, bidirectional bubble-tight shut off at 275 psi, threaded lug type, upper and lower body bearings with thrust bearings, one piece single or double offset shaft of 316 stainless steel and centerless ground and polished to minimize bearing and packing wear, PTFE seats, PTFE adjustable V-ring packing, capable of service in temperature ranges of -100 to 300°F, 316 stainless steel discs and totally enclosed, factory lubed, handwheel rotary actuator with external disc position indication.
   3. Dead end pressure rating shall be 275 psi without downstream flanging.

G. Water Pressure Regulating Valves:
   1. Manufacturers: Thrush, Watts, Cash-Acme, Taco, or B & G
   2. Brass or bronze body, spring and diaphragm operated, pressure adjustable with check valve and inlet strainer and designed for maximum working pressure of 250 psig and maximum operating temperature of 160°F.

H. Lockshield Valves:
   1. Ball valves as specified above with locking handles for padlocking in open or closed position.

I. Drain Valves:
   1. Ball valve as specified above with threaded hose adapter and cap. Provide 3/4" minimum drain valve for piping larger than 1/2", except strainer blowdown valves shall be blowdown connection size. Provide 1/2" drain valve for 1/2" piping. If 3-piece ball valves are specified, use 2-piece ball valves with same construction.

J. Pressure Compensating Flow Control Valves:
   1. All metal construction, factory set to automatically maintain flow rate within plus/minus 5% accuracy over operating pressure differential range of at least 14 times minimum required for control, self-contained spring loaded perforated cartridge control mechanism, passivated stainless steel internal working parts, rated for 250 psi pressure at 250°F.
   2. Valves 2" and under to have threaded ends with ground joint union; 2-1/2"and larger to have flanged ends.
   3. Each automatic flow control valve to have pressure tappings with quick disconnect fittings suitable for use with portable measuring instrument specified, to verify pressure differential across flow control orifice.

4. Certified performance data based on independent laboratory tests to be available.
5. Manufacturers: Griswold, Autoflow or Dole
6. Furnish to Owner portable pressure-temperature measuring kit consisting of 2 pressure gauges with 4-1/2" dial, air bleed device, hoses, quick-connect fittings, protected thermometer, instructions and carrying case. Kit to be used to read pressure drop across flow control orifice and temperature at that point.

2.4 LOW PRESSURE STEAM AND CONDENSATE SYSTEM VALVES (15 PSIG AND LOWER)

A. Globe Valves:
   1. 1-1/2" and Smaller: ASTM B62, bronze body, bronze trim, threaded, renewable TFE seat disc, union bonnet, malleable iron handwheel, Class 150 (150 psi WP steam), conforming to MSS SP-80, Nibco Fig. T-235
   2. 2" and Larger: iron body, bronze trim, OS&Y, flanged, bolted bonnet, renewable bronze seat and disc, Class 150 -(125 psi WP steam), conforming to MSS SP-85, Nibco Fig. F-718

B. Swing Check Valves:
   1. 1-1/2" and Smaller: ASTM B62, bronze body, threaded, regrinding, Y-pattern swing type, renewable TFE seat disc, Class 150 (150 psi WP steam), conforming to MSS SP-80, Nibco Fig. T-433
   2. 2" and Larger: iron body, bronze or brass trim, renewable seat and disc, Class 150 (125 psi WP steam), conforming to MSS SP-71, Nibco Fig. F-918

C. Shut-Off Valves:Use ball or globe valves as specified above.

D. Drain Valves:
   1. Ball valve as specified above with threaded hose adapter and cap. Provide 3/4" minimum drain valve size except strainer blowdown valves to be blowdown connection size.

2.5 HIGH PRESSURE STEAM & CONDENSATE SYSTEM VALVES (*16PSIG* THROUGH 200 PSIG)

A. Globe Valves:
   1. 1-1/2" and Smaller: ASTM B61, bronze body, threaded, union bonnet, stainless steel plug disc and seat rings, malleable iron handwheel, Class 300 (300 psi WP steam), conforming to MSS SP-80, Powell Fig. No. 2612
   2. 2" and Larger: ASTM A216, WCB, steel body, stainless steel disc and seat rings, flanged, bolted bonnet, Class 300, (300 psi WP at 500 degrees F), conforming to ASME B16.5, B16.10 and B16.34, Stockham Fig. 30-GSF, Powell Fig. 3031, Crane, Milwaukee 3060, Velan Fig. 1074C, or Williams 302

B. Swing Check Valves:
   1. 1-1/2" and Smaller: ASTM B61, bronze body, threaded, regrinding, renewable TFE or cast bronze seat disc, Y pattern, Class 300 (300 psi WP steam), conforming to MSS SP-80, Nibco Fig. T-473.
   2. 2" and Larger: ASTM A216, WCB, steel body, stainless steel seats and discs, bolted bonnet, Class 300, (300 psi WP at 500 degrees F), conforming to ASME B16.5, B16.10 and B16.34, Stockham Fig. 30-SF, Powell Fig. 3061, Crane, Milwaukee 3070, Velan Fig. 1114C, or Williams 301

C. Shut-Off Valves:

1. Use ball or globe valves as specified above.

D. Drain Valves:
   1. Ball or golbe valve as specified above with hose thread adapter and cap. Provide 3/4" minimum drain valve size, except strainer blowdown valves shall be blowdown connection size.

E. Butterfly Valves:
   1. Manufacturers: Saunders MS, Vanessa, Adams HTK or Bray Tri-Lok Series
   2. Valves shall be triple offset design and constructed of all metal construction with no elastomers or polymers used for sealing. Valves shall have stainless steel resilient seal ring on disc edge and machined seat in valve body. Valves shall meet API 598 shut-off rate of zero leakage, bi-directional.
   3. Valves shall be double flanged, ANSI Class 300 for steam pressure up to 100 psig and Class 300 for steam pressure 101 psig through 200 psig. Valve body shall be one piece cast double flanged, welded bodies not permitted.
   4. Body shall be carbon steel ASTM A216WCB. Disc shall be conical carbon steel ASTM 216WCB nickel-plated or phosphate coated. Sealing surfaces shall be stainless steel laminated and seal ring and seat have matching conical shape and shall be suitable for application and recommended by manufacturer. Valve disc shall be connected to the stem by an internal splined connection or shaft to disc connections shall be with "keys" top and bottom and shall not be rigidly pinned so as to allow shaft and disc to properly move with thermal expansion and continue to provide ease of operation and zero leakage.. Disc shall have one hub and steam shall not be exposed to the flow.
   5. Stem shall be one-piece design. Stem shall be stainless steel and shall be provided with a position indicator. Stem shall be provided with blow-out prevention ring outside of the pressure boundary.
   6. Bearings shall be designed to minimize the load and wear. Bearings shall include replaceable graphite seal.
   7. Valve shall be tested in accordance with API 598 and have zero leakage.
   8. Manual gear actuators shall be sized for installation of valve in non-preferred flow direction. Maximum rim pull for valve operation shall not exceed 100 pounds.

2.6 WATER PRESSURE RELIEF VALVES

A. Manufacturers: Kunkle, Consolidated, Thrush, Watts, Cash-Acme, Lonergan, Keckley, or B & G. Iron or bronze body, direct pressure actuated, Teflon seat, stainless steel stem and spring, and suitable for maximum working pressure of 125 psig at 240°F.

B. Valves to conform to State Requirements and have ASME Stamps.

2.7 GAUGE VALVES

A. Unless otherwise indicated, gauge valves for steam, steam condensate and feedwater services shall be ball or globe valves. Gauge valves for all other services shall be needle valves, brass body, 2000 psig, 300°F, similar to Trerice Model 735. Gauge valve size shall match gauge pipe size as specified in Section 23 2116 - Pipe and Pipe Fittings.

2.8 SELF-CONTAINED THERMOSTATIC CONTROL VALVES

A. Manufacturers: Danfoss or Braukmann equal to Danfoss Model RA. Valve assembly to be capable of maximum working pressure of 150 psi hot water or 15 psi steam, maximum working temperature of 248°F and maximum differential pressure of 17 psi.

B. Valve body to be made of cast brass and to have interchangeable threaded type tail piece. Valves to be furnished with manual adjustment to enable use during final construction period without installing control unit.

C. Valve to be furnished with stainless steel spindle riding against o-ring within packing gland. This o-ring packing gland to be replaceable with standard tools while system is in operation and without any need for isolation valves.

D. Control unit to be capable of being locked or limited and be adjustable from 45°F to 85°F and incorporate sensor and bellows. Bellows to be balanced by adjustment spring.

E. Control unit accuracy to be within ±1°F and to be fail-safe such that should failure occur, valve body will automatically open to protect against freezing.

F. Unless otherwise noted, valves to be 3/4" angle, straight or side mount as required.

G. Sensor to be built-in type.

H. Provide remote sensing bulb mounted underneath fin tube radiation element.

I. Provide remote wall mounted control thermostat. Install capillary tube in wall.

PART 3 - EXECUTION

3.1 GENERAL

A. Install valves as shown on plans, details and according to manufacturer's installation recommendations.

B. After piping systems have been pressure tested and put into service, but before final adjusting and balancing, inspect valves for leaks. Adjust, replace packing or replace valves to stop leaks.

C. Install control valves furnished under Control Systems. Provide reducing fittings as required.

D. Refer to Section 23 2116, Part 3 for reducing fittings requirement for valves smaller than pipe size.

E. Provide chain operators for manually operated valves 4" and larger, located more than 8 ft above equipment room floor.

3.2 SHUT-OFF VALVES

A. Provide shut-off valves at all equipment, at riser take-offs at each floor, and at each automatic valve for servicing.

B. Install steam system shut-off valves in horizontal piping. Shut-off valves are not allowed in vertical piping.

3.3 BALANCING VALVES

A. Provide balancing valves where indicated on drawings and as required for complete balancing of water systems.

B. Provide straight inlet and outlet pipe length in accordance with manufacturer's recommendation.

C. For buildings with multiple stories, provide balancing valve in return line at riser take-offs at each floor. Provide shut off valve in supply line at each riser take-off.

3.4 GAUGE VALVES

A. Provide gauge valves at each pressure gauge as shown and at each pressure tapping where pressure sensing tubing is connected.

3.5 DRAIN VALVES

A. Provide drain valves at all low points of piping systems for complete drainage of systems.

3.6 WATER PRESSURE REGULATING VALVES

A. Set valves for pressure required or as scheduled.

3.7 WATER RELIEF VALVES

A. Unless otherwise indicated, provide one relief valve in each closed water system in the pump inlet piping.

3.8 SPRING LOADED CHECK VALVES

A. Provide spring loaded check valve in each pump discharge line.

3.9 SWING CHECK VALVES

A. Provide swing check valves at steam condensate lines if lifted at outlet of traps. Install check valve between trap and shutoff valve.

3.10 COMBINATION SHUT-OFF, CHECK AND BALANCING VALVES

A. Contractor may provide combination shut-off, check and balancing valve in lieu of providing separate shut-off valve, check valve and balancing valve in pump discharge line.

3.11 AUTOMATIC NON-RETURN STOP VALVES

A. Provide automatic non-return stop valve in each steam boiler outlet before header in high pressure steam systems.

END OF SECTION

SECTION 23 2120 PIPING SPECIALTIES

PART 1 - GENERAL

1.1 RELATED WORK

A. Section 23 0594 - Water Systems Test Adjust Balance

B. Section 23 0903 - Control Instrumentation (Temperature and Pressure Sensing Requirements)

C. Section 23 2118 - Valves

1.2 REFERENCE

A. Work under this Section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.

1.3 REFERENCE STANDARDS

A. Metal bellows expansion joints shall be constructed and applied in accordance with "Standards of the Expansion Joint Manufacturer's Association", 8th Edition, 2003.

1.4 SUBMITTALS

A. Shop Drawings for all items in this Section including, but not limited to, the following:
   1. Manufacturer's name and model number
   2. Identification as referenced in the Documents
   3. Materials of construction
   4. Dimensional data
   5. Capacities/ranges
   6. Temperature/pressure ratings
   7. Pressure drop
   8. Expansion joint schedule indicating joint tag no., system, proximity to rotating or reciprocating equipment, required movement in all planes, service pressure, test pressure, service temperature, fluid velocity and cycles to failure (both thermally and seismically, if applicable).
   9. All other appropriate data.

B. LEED Submittal
   1. Product Data for IEQ Credit 4.1: For adhesives and sealants, including printed statement of VOC content.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Unless otherwise specified, select devices for highest pressures and temperatures existing in respective systems in accordance with ANSI Specifications.

B. Piping specialties in copper piping shall have bronze or brass body with solder ends.

2.2 THERMOMETERS

A. Manufacturers: Taylor, Trerice, Weksler, Miljoco, Winters, or Weiss

B. Pipeline mounted thermometers: 9" scale cast aluminum case and frame, clear acrylic plastic window front, permanently stabilized glass tube with mercury free indicating fluid, adjustable angle stem, extended neck suitable for insulated piping as required, and compatible with sockets as specified herein.

C. Panel or remote mounted thermometers: vapor actuated dial type with remote bulb, 4-1/2" minimum diameter cast metal casing with double front. Sensing bulbs shall be of length to suit pipe diameter with extended necks as required for insulated piping, suitable for insertion in separable brass sockets as specified herein.

D. Duct type thermometers: dial type with minimum dial size of 4-1/2" and maximum graduations of 2°F, complete with swivel mounting arrangement to permit up to 45° rotation for easy reading.

E. Range of thermometers shall be:

Service	Scale Range	Increment
Chilled Water	0°F to 100°F	1°F
Heating Hot Water	30°F to 240°F	2°F
Steam Condensate	30°F to 300°F	2°F

F. Thermometers by temperature control manufacturer meeting above Specification will be acceptable.

2.3 THERMOWELLS AND TEST WELLS

A. Brass construction for carbon steel piping with threaded connections suitable for thermometer bulbs and control sensing devices, well length suitable for pipe diameter with extended neck as required to suit pipe insulation. Trerice 5550 Series or approved equal.

B. For test wells for stainless steel piping, use same material as piping.

2.4 PRESSURE GAUGES

A. Manufacturers: Ashcroft, U.S. Gauge, Marsh, Trerice, Miljoco, Marshalltown, Weksler, Winters or Weiss equal to Trerice 450600 Series

B. Minimum 4-1/2" diameter die cast aluminum case, glass or acrylic plastic window, phosphor bronze bourdon tube with bronze bushed movement, recalibration from front of gauge dial and 1/4" NPT forged brass socket.

C. Gauge accuracy shall meet ANSI B40.100 Grade 1A (±1% full scale).

D. Reading range of gauges shall be:

Service	Scale Range
Chilled Water	0 to 100 psig

Heating Hot Water	0 to 100 psig
Low Pressure Steam	30" mercury vacuum to 30 psig
High Pressure Steam	0 to 150 psig for maximum steam pressure of 80 psig.
High Pressure Steam	0 to 250 psig for maximum steam pressure of 180 psig.

E. Pressure Snubbers:
   1. 1/4" or 1/2" size, matching gauge pipe size as specified in Section 23 2116 - Pipe and Pipe Fittings, 1000 psig WP. Brass for carbon steel pipe or copper pipe. Stainless steel for stainless steel pipe.

F. Coil Syphons:
   1. 1/4" or 1/2" size, matching gauge pipe size as specified in Section 23 2116, 500 psig WP. Material shall match gauge pipe material.

2.5 PRESSURE/TEMPERATURE TEST STATIONS

A. Pete's plugs made by Peterson Equipment Company, Sisco, Super Seal by Flow Design Inc. (FDI), or approved equal.

B. Test plugs shall be 1/4" or 1/2" NPT, brass body and cap, 1-1/2" length for non-insulated pipe and 3" length for insulated pipe, with Nordel self-closing valve cores, rated at 500 psig at 275°F, and shall receive either temperature or pressure probe with 1/8" OD.

C. Furnish portable test kit within durable case containing the following:
   1. A compound pressure gauge,3-1/2" dial, 30" Hg – 100 psi, field calibration screw, surge protector and stainless steel gauge adapter with 1/8" diameter probe (2% accuracy of mid range).
   2. Two pocket testing thermometers, 1-3/4" dial, 5" long stainless steel stem, 0 - 220°F and 25 - 125°F ranges with external calibration (1% accuracy of entire scale).

2.6 PIPE EXPANSION DEVICES

A. Expansion Loops:
   1. Size expansion loops including L-bends and Z-bends as indicated on drawings or as scheduled.
   2. Size expansion loops including L-bends and Z-bends to allow adequate expansion of main straight runs of system within stress limits specified in ANSI B31.1.

B. Expansion Compensators:
   1. Manufacturers: Metraflex, Vibration Mountings and Controls Inc., Hyspan, Expansion Joint Systems, or Flexonics
   2. Compensators shall be constructed of 2 ply stainless steel bellows with carbon steel shrouds and end fittings.
   3. Furnish compensators with internal guides full length of bellows travel and positive internal anti-torque devices to prevent twist or torque during installation. Furnish properly located positioning clips to insure installation at correct end-to-end dimension allowing full rated traverse.
   4. Expansion compensators shall be suitable for system pressure and temperature.

C. Flexible Expansion Loops:

1. Manufacturers: Metraflex
2. Flexible expansion loops shall be Metraflex Metraloop consisting of 2 flexible sections of hose and braid, two 90° elbows, and a 180° return, with factory supplied, center support nut located at bottom of 180° return and drain/air release plug.
3. Flexible loops shall impart no thrust loads to system support anchors or building structure.
4. Unless otherwise indicated, material of construction, end fitting type and pressure ratings shall be consistent with pipe material, pipe connection fittings and pressure rating as specified in specification Section 23 2116 - Pipe and Pipe Fittings.
5. Hose and braid material shall be 316L.

2.7 PIPELINE STRAINERS

A. Manufacturers: Metraflex, Mueller Steam Specialty, Hoffman, Eaton (formally Hayward), Sarco, Keckley, Armstrong, Wheatley, Conbraco or Streamflo

B. Liquid System:
1. 2" and Smaller: full pipeline size, Y-type, with removable screen caps, cast iron, Class 250 (400 psi/150°F WOG), threaded ends for carbon steel piping and bronze, Class 150 (200 psi/150°F WOG),, solder ends for copper piping. Screen caps shall have threaded blowdown connection.
2. 2-1/2" and Larger: full pipeline size, Y-type, Class 125(200 psi/150°F WOG), cast iron, flanged ends. Furnish strainer with bolted screen retainer and off-center blowdown connection.
3. Liquid Service Screens: stainless steel with screen perforation as indicated below. For strainers serving equipment where manufacturer requires specific screen perforation, provide per manufacturer requirements. Maximum pressure drop shall be 4 ft WG through clean strainer.

Pipe Size	Closed System	Open System
2" and smaller	1/32" (20 mesh)	1/8"
2-1/2" to 4”	1/16”	1/8"
5" and over	1/8"	1/8"

C. Steam and Condensate System (through 100 psig):
1. 2" and Smaller: full pipeline size, Y-type, Class 250, cast iron, threaded ends with removable screen caps. Screen caps shall have threaded blowdown connection.
2. 2-1/2" and Larger: full pipeline size, Y-type, Class 125, cast iron, flanged ends. Furnish strainer with bolted screen retainer and off-center blowdown connection.

D. Steam Service Screens: stainless steel for low pressure and monel for high pressure with screen perforation size as indicated below. For strainers serving equipment where manufacturer requires specific screen perforation, provide per manufacturer requirements. Net area of screen shall be at least 4 times that of connected pipe.

Pipe Size	Perforation Size
2" and smaller	1/50" (30 mesh)
2-1/2" to 10"	3/64"(.045")
12" and over	1/16"(.062")

2.8 STEAM TRAPS

A. Manufacturers: Armstrong, Sarco, Hoffman, or Watts

B. Trap bodies shall be suitable for minimum 1.5 times system pressure, but not less than 125 psig.

C. Traps shall have threaded end connections.

D. Unless otherwise indicated, determine trap capacity with the following safety factor, differential pressure and steam pressure at apparatus inlet. Minimum trap size (pipe connection size) shall be 3/4" for all types.
   1. Apply safety factor to maximum steam rate of apparatus served and at saturated steam temperature.
   2. 0-15 psig steam:
      a. Safety factor of 2:1 at 1/2 psi pressure differential
   3. 16-30 psig steam:
      a. Safety factor of 2:1 at 2 psi pressure differential
   4. Above 30 psig steam:
      a. Safety factor of 3:1 at 1/2 of maximum pressure differential across trap

E. Size main drip, end-of-main or drip-and-rise traps with 2:1 safety factor at full differential pressure for supervised warm-up load, but not less than 250 lb per hour and not smaller than 3/4" size.

F. Where 2 traps are shown in parallel, each trap shall have full design capacity of equipment without safety factor.

G. Thermostatic Traps:
   1. Cast brass body with removable cover, renewable stainless steel seats, plungers and diaphragm or bellows.

H. Thermodynamic Traps: Carbon, alloy or stainless steel body with stainless steel bellows

I. Float and Thermostatic Traps:
   1. Cast iron or semi-steel body with removable cover, stainless steel float, diaphragm or bellows thermostatic operator, and stainless steel valve mechanism.

J. Inverted Bucket Traps:
   1. Cast iron or semi-steel body with removable cover, stainless steel bucket, and stainless steel valve mechanism assembly.

2.9 AIR VENTS

A. Manual Air Vents:
   1. Manufacturers: Bell & Gossett Model 4V, 125 psig at 210°F or approved equal. Use 1/2" ball valve for main pipes.

B. Automatic Air Vents:
   1. Manufacturers: Amtrol, Watson McDaniel, B&G, or Hoffman
   2. Metal construction, non-corrosive working parts, 150 psig WP at 240°F
   3. Normal capacity vent shall be similar to B&G Model 87
   4. High capacity vent shall be float actuated and shall have minimum air elimination rate of 10 cfm at 100 psig, similar to B&G Model 107A.

C. Thermostatic Air Vents:
   1. Balanced pressure type, cast bronze body, bronze bellows caged in stainless steel, stainless steel valve and seat, 1/2" threaded connection, 125 psig WSP, equal to Armstrong Model TV-2.

2.10 VACUUM RELIEF/BREAKERS

A. Kadant Johnson Series VB-8 with brass body, stainless steel ball, EPR seat, stainless steel spring, suitable for pressures to 300 psig at 365°F, or Sarco Model VB-14.

2.11 STRAIGHTENING VANES

A. Manufacturers: Daniel Industries, Inc., Houston, Texas or approved equal

B. Straightening vane assembly shall consist of series of carbon steel pipes firmly welded together and to line size pipe. Furnish vanes with class 150 psi flanges for insertion into piping system.

PART 3 - EXECUTION

3.1 GENERAL

A. Install piping specialties as indicated on plans, details and according to manufacturer's recommendations.

3.2 THERMOMETERS

A. Install thermometers in thermowells in locations indicated.

3.3 THERMOMETER TEST WELLS

A. Install test wells in locations as shown and at each point where temperature-sensing device is required under Control Systems.

3.4 PRESSURE GAUGES

A. Install gauges for services other than steam with pressure snubbers and gauge valves.

B. Install gauges for steam service with coil syphons and gauge valves.

3.5 PRESSURE GAUGE TAPPING

A. Install tappings with gauge valves at each point where sensing device is required under Control Systems and at gauge locations as shown.

B. Use threadolets or tee fittings to mount gauge tappings or test stations. Install fittings for side mounting to avoid collection of air or dirt.

3.6 PRESSURE/TEMPERATURE TEST STATIONS

A. Pete's plug may be used in lieu of thermometer test well and pressure gauge tappings.

B. Use threadolets or tee fittings to mount gauge tappings or test stations. Install fittings for side mounting to avoid collection of air or dirt.

3.7 PIPE EXPANSION DEVICES

A. Stretching of expansion joints or connectors to correct for piping misalignment is not allowed.

B. Install expansion loops, L-bends, Z-bends, and compensators where shown on drawings and as necessary to allow expansion and contraction in piping systems.

C. Flexible Expansion Loops:

1. Install loops in neutral or pre-extend condition as required for application. For steam service, install loops with flexible legs horizontal to prevent condensate buildup. Install and guide per manufacturer's recommendations.

3.8 PIPELINE STRAINERS

A. Provide drain valve at each strainer blowdown connection with hose threaded adapter and cap. Valve size shall be same as blowdown connection size.

B. Install strainers in steam system on entering side of all automatic control valves and as indicated elsewhere. Install Y-type strainers in horizontal lines so that basket is in horizontal plane to prevent condensate build-up in basket.

C. Install strainers in water systems on suction side of all pumps, entering side of automatic control valves of heating and cooling coils of air handling units, and as indicated elsewhere.

D. Install clamped cover basket strainers in condenser water system as indicated.

3.9 STEAM TRAPS

A. Install steam traps on discharge side of all steam using terminal apparatus, at steam headers, at steam mains, at end of steam mains, at end of branch piping exceeding 10 ft, at points where steam piping must rise, and elsewhere as indicated on drawings. Individually trap each coil of steam coil bank. Unless otherwise indicated, provide steam main drip/legs at intervals not exceeding 300 ft.

B. Install to permit gravity flow of condensate to trap.

C. Install valved test tee on discharge of each trap.

D. Unless otherwise shown, do not lift condensate from discharge of any trap without written permission of Engineer.

E. Support traps weighing over 25 lbs independently of connecting piping.

F. Unless otherwise indicated, drip traps serving steam lines:

1. less than 15 PSI shall be inverted bucket.
2. 15 PSI or greater shall be thermodynamic

G. Unless otherwise indicated, equipment traps shall be float and thermostatic.

3.10 AIR VENTS

A. Install manual air vents at all high points in water systems where air may collect and where shown on drawings.

B. Install automatic air vent at top of air separator and where shown on drawings. Provide shut-off valve to isolate air vent from system. Pipe automatic air vent to the nearest floor drain.

C. Install high capacity automatic air vent at air separator.

3.11 THERMOSTATIC AIR VENTS

A. Install thermostatic air vents where shown. Install vents at the highest points of steam chambers. Locate vents higher than outlet connections to chambers.

3.12 VACUUM BREAKERS

A. Install vacuum breakers at steam condensate outlet from steam heating coils, at steam-to-water heat exchangers, and as required for proper condensate drainage at any other steam using apparatus.

3.13 FLOW ELEMENTS/FLOWMETERS

A. Flow elements/flowmeters located in common piping after multiple pump discharge lines shall be furnished with hot tap feature.

B. If flow elements/flowmeters are furnished by Control Contractor, this Contractor shall install them in accordance with manufacturer's installation instructions. Wiring of flowmeters will be provided by Control Contractor.

3.14 STRAIGHTENING VANES

A. Provide straightening vanes where flow sensor manufacturer's installation instructions require greater length of straight upstream piping than can be obtained in available space.

END OF SECTION

SECTION 23 2514 CHEMICAL TREATMENT SYSTEMS

PART 1 - GENERAL

1.1 RELATED WORK

A. Section 23 0993 - Control Sequences

B. Section 23 2116 - Pipe and Pipe Fittings

1.2 REFERENCE

A. Work under this Section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.

1.3 SUBMITTALS

A. Shop Drawings for each system including, but not limited to, the following:
   1. Manufacturer's name and model number
   2. Capacities/ratings
   3. Chemicals; description of chemicals, its composition and function
   4. Operating sequence
   5. Composite wiring diagrams
   6. Materials of construction
   7. Dimensions and weights
   8. Manufacturer's installation instructions
   9. All other appropriate data

B. Submit complete make-up water analysis.

C. Submit directly to Owner, Material Safety Data Sheets (MSDS) for all chemicals used in chemical treatment systems. Include with MSDS written notice of Owner's responsibility to notify its employees of the use of those chemicals.

1.4 MAINTENANCE SERVICE

A. Provide service and maintenance of treatment systems for 1 yr from date of substantial completion.

B. Provide monthly technical service visits to perform field inspections and make water analysis on site. Detail findings in writing on proper practices, chemical treating requirements, and corrective actions needed. Submit 2 copies of field service report after each visit.

C. Provide laboratory and technical assistance services for warranty period.

D. Provide site inspection of equipment during scheduled shutdown to evaluate success of treatment program. Make recommendations in writing based on these inspections.

1.5 WATER ANALYSIS

A. Submit complete water analysis and results of performance test of each system signed by manufacturer's service representative.

B. Water analysis shall include the following:
   1. Hot and/or Medium Temperature Chilled Water:
      a. Hardness
      b. pH
      c. M" alkalinity
      d. Inhibitor level
      e. Total dissolved solids
      f. Temperature
   2. Glycol Water (SER):
      a. Corrosion inhibitor level
      b. Percentage of glycol by volume
      c. Freeze point
      d. "M" alkalinity
      e. Conductivity
      f. Test data for dilution water including total dissolved hardness and conductivity. (If on-site deionizer is used for dilution water, provide test of initial and final water coming from deionizer.)

1.6 DESIGN CRITERIA

A. Periodic test procedure and chemical shall be recommended for each system.

B. Chemicals shall be suitable for pipe material, fluid medium and intended treatment.

C. Materials of construction for equipment used shall be compatible with water treatment chemicals provided.

D. Treat the following systems:
   1. Medium Temperature Chilled water
   2. Hot water
   3. Glycol-water (SER)

E. Provide initial chemical treatment and equipment for all systems based on complete system fluid analysis, including make-up water, prior to equipment installation.

F. Initial supply of chemicals for chemical treatment of each system shall be adequate for start up and testing period, for the time systems are being operated by Contractor for temporary heating and cooling, and for 1 yr after start-up of system.

G. Chemicals used in condenser water treatment system shall be liquid only and contain no chromates.

1.7 WATER QUALITY REQUIREMENTS

A. The following levels of chemicals are to be maintained in the respective systems:
   1. Heating hot water –
      a. 200 - 300 ppm Molybdate
      b. 150 – 250 ppm Nitrite
      c. 5 – 20 ppm Azole
   2. Glycol systems
      a. 50% Ethylene glycol premixed by manufacturer with corrosion inhibitors specifically formulated for the pipe materials used.
   3. Medium temperature chilled water
      a. 200 - 300 ppm Molybdate
      b. 150 – 250 ppm Nitrite
      c. 5 – 20 ppm Azole

B. Minimum water quality requirements for closed hot and/or medium temperature chilled water systems shall be as follows:

1.	pH	8.5 – 10.0
2.	TDS	< 500 ppm
3.	Hardness as CaCO3 and Alkalinity	< 120 ppm
4.	Chlorides	< 200 ppm
5.	Sulphates	< 200 ppm
6.	Iron	< 1.0 ppm
7.	Dissolved Oxygen	<0.1 ppm
8.	Ryznar Index	>6.0
9.	Suspended Solids	≤10 micron
10.	Bacteria Counts	
	a. Total Aerobic Bacteria Counts	≤100 cfu per mL
	b. Total Anaerobic Bacteria Counts	≤10 cfu per mL

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers:
   1. Suez
   2. Bluegrass KESCO

2.2 PIPING SYSTEM CLEANER

A. Use cleaning compound to remove organic soil, hydrocarbons, flux, pipe mill varnish, pipe compounds, iron oxide, and like deleterious substances, with or without inhibitor, suitable for system metals without deleterious effects. Cleaner shall not contain phosphate.

2.3 GLYCOL WATER TREATMENT

A. Mix treated glycol with water in ratio of **50**% ethylene glycol by volume.

B. Glycol shall be pre-treated ethylene glycol Dow Therm SR-1, Nalco 2812, HOH GLY KOOL 38 or Intercool NFE by Interstate Chemical Co., with corrosion inhibitors and stability compounds.

C. Use pre-diluted solution produced by glycol manufacturer. Dilution water shall be distilled water, deionized water or water having chloride and sulfate levels less than 25 ppm each, total hardness less than 60 ppm and iron less than 0.5 ppm. If glycol needs to be diluted at site, submit test results of water for approval prior to mixing.

PART 3 - EXECUTION

3.1 APPLICATION OF CHEMICALS

A. Apply initial chemical treatment for each system after systems have been cleaned and flushed.

B. Add, adjust or modify treatment based on results of period tests until turned over to Owner.

3.2 PROCEDURE

A. Outage is scheduled with the University of Kentucky.

B. A pre-test is conducted on the system to determine the chemical content prior to the work to establish an existing baseline. If this outage and work will be an extended period of time with the affected work portion being isolated from the remainder of the system, then this pre-test should occur approximately 48 hours prior to the refilling of the system. This pre-test should have the involvement of the University of Kentucky Preventative Maintenance Manager or his designee to agree on the baseline.

C. Outage is initiated by the University of Kentucky and the contractor does the required work (additions, modifications or repairs) to the affected system.

D. Upon completion of the work, the contractor is to clean and flush the affected piping systems per the procedure outlined in the project specifications.

E. When the system is adequately cleaned and flushed, the contractor is responsible for refilling the section of the affected piping with water and appropriate chemicals to meet the required levels noted above.

F. After the outage section is filled, the affected area will be opened up back into the overall system by the University of Kentucky.

G. The system will be allowed to operate normally and circulate throughout the system for 48 hours.

H. The chemical levels will be tested in the mechanical room that contains the system equipment and also in the area where the work was completed. This test is to confirm that the chemical has been adequately dispersed throughout the system and meets the required chemical levels. This testing is also done in conjunction with the University of Kentucky PM Manager or designee for agreement on the chemical level.

I. Should the test not meet the desired level, then additional chemicals should be added by the contractor and steps 7 through 9 repeated until the level is satisfactory.

J. Final test reports from the water testing/treatment company shall be submitted to the University upon completion and acceptance of the procedure.

3.3 PERFORMANCE TEST

A. Conduct performance test for each system to determine required capacity and performance of chemical treatment system. Refer to Part 1 for water analysis and water quality requirements.

B. Conduct water quality test in all systems weekly and submit test result reports to Mechanical Contractor and Owner until project is turned over to Owner.

C. Conduct water quality tests before and after new work tie-in to existing systems.

3.4 PIPE CLEANING

A. General:
   1. Piping systems shall be cleaned before they are used for any purpose except pressure tests, which shall be conducted before cleaning. Add cleaner to closed systems at concentrations as recommended by cleaner manufacturer. Remove water filter elements from system before starting circulation.
   2. Use neutralizer agents on recommendation of system cleaner supplier and approval of Architect/Engineer.
   3. Remove, clean, and replace strainer screens or filters.
   4. Inspect, remove sludge, and flush low points with clean water after cleaning process is completed.
   5. New piping system shall not be connected to existing system for operation until flushing and cleaning have been completed. Obtain permission from Owner prior to opening up new work to existing system.

B. Water Systems:
   1. Piping systems shall be filled, vented and circulated employing chemical cleaner solution for period of at least 24 hours or more in accordance with manufacturer's recommendations and job site chemical tests. Bring concentration to level, which raises M Alkalinity to manufacturer's recommended value above that for existing water used for fill. Conduct chemical tests to verify levels and submit results to Architect/Engineer. Flush detergent clear with continuous draining and make-up water fill for period of at least 12 hours or more until original M Alkalinity level is achieved (or until pH of system water is within 0.5 pH of make-up water). Conduct chemical tests to verify levels and submit results to Architect/Engineer. When cleaning process is complete, replace strainers or filters and reconnect permanent pumping apparatus.

3.5 GLYCOL WATER TREATMENT

A. Provide 50% ethylene glycol treatment for all systems that have glycol.

B. Follow procedure outlined above.

C. Follow glycol manufacturer's recommendation for pipe cleaning, flushing and fill preparation and procedure.

D. For existing system, verify whether municipality requires off-site disposal of glycol solution, particularly ethylene glycol.

END OF SECTION

SECTION 23 3114 DUCTWORK

PART 1 - GENERAL

1.1 RELATED WORK

A. Section 20 0130 - HVAC System Cleaning

B. Section 20 0529 - Mechanical Supporting Devices

C. Section 20 0700 - Mechanical Systems Insulation

D. Section 23 0550 - Vibration Isolation

E. Section 23 0595 - Air Systems Test Adjust Balance

F. Section 23 0902 - Control Valves and Dampers

G. Section 23 3314 - Ductwork Specialties

1.2 REFERENCE

A. Work under this Section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.

1.3 SUBMITTALS

A. For each duct system, submit schedule utilizing reinforcement tables from SMACNA HVAC Duct Construction Standards Metal and Flexible where applicable. Each duct system schedule shall include, but not be limited to, the following:
   1. Name of Contractor/manufacturer fabricating each duct system
   2. Material and gauge
   3. Pressure class
   4. Transverse joint type and length and reinforcement rigidity class with designated joint T number or proprietary duct connection if utilized for each system
   5. Certified test results of proprietary joint products, if used, tested in accordance with SMACNA procedures
   6. Intermediate reinforcement spacing and rigidity class with metal angle dimensions and gauge
   7. Type of longitudinal seam
   8. Fitting construction details
   9. Support methods including spacing, upper attachments, and lower attachments
   10. Sealant and gasket
   11. Sealing class

B. Duct leakage testing methods, apparatus and apparatus certification signifying meter is in conformance with ASME Requirements for testing meters.

C. Submit the following information for welded sheet metal ductwork:
   1. Welding Procedure Specification (WPS) for welded joints. Form to be similar to ANSI/AWS D9.1-2006 Code, Appendix "D".
   2. Procedure Qualification Record (PQR) for each WPS. Form to be similar to ANSI/AWS D9.1-2006 Code, Appendix "E".
   3. Welder and Welding Operator Qualification Test Record (satisfactory performance) for each field or shop welder. Form to be similar to ANSI/AWS D9.1-2006 Code, Appendix "F".

D. LEED Submittals:
   1. Product Data for IEQ Prerequisite 1: Documentation indicating that duct systems comply with ASHRAE 62.1-2007, Section 5 – "Systems and Equipment".
   2. Product Data for EA Prerequisite 2: Documentation indicating that duct systems comply with ASHRAE/IESNA 90.1-2007, Section 6.4.4 – "HVAC System Construction and Insulation".
   3. Leakage Test Report for EA Prerequisite 2: Documentation of work performed for compliance with ASHRAE/IESNA 90.1-2007, Section 6.4.4.2.2 – "Duct Leakage Tests".
   4. Duct Cleaning Test Report for IEQ Prerequisite 1: Documentation of work performed for compliance with ASHRAE 62.1-2007, Section 7.2.4 – "Ventilation System Start-Up".
   5. Product Data for IEQ Credit 4.1: For adhesives and sealants, including printed statement of VOC content.

1.4 DELIVERY, STORAGE AND HANDLING

A. Protect duct and fittings from damage due to normal handling during shipment and storage. Protection shall be applied to ends of duct to prevent dirt and moisture from entering ducts and fittings.

1.5 DESCRIPTION

A. Furnish and erect ductwork free of objectionable vibration, chatter, and pulsations. Verify dimensions at site, making field measurements and drawings necessary for fabrication and erection.

B. Duct sizes indicated are net inside dimensions.

C. Where size for a duct segment is not indicated, the duct segment size shall be equal to the largest duct segment to which it is connected. Transition to smaller size shall occur on side of fitting where smaller size is indicated.

1.6 DESIGN CRITERIA

A. All products shall conform to NFPA 90A and shall possess flame spread rating of not over 25 and smoke developed rating no higher than 50.

B. Unless otherwise indicated, construct all ductwork of galvanized sheet metal for pressure class not less than 2" WG for positive pressure ductwork and not less than -2" WG for negative pressure ductwork.

C. Ductwork shall comply with Local, State and Federal requirements.

D. Unless otherwise indicated, pressure class for VAV system supply ductwork between supply fan discharge and air terminal unit inlet shall be equal to static pressure at fan discharge but not less than 4" WG; pressure class.

E. Pressure Class for return or exhaust ductwork:
   1. Between air inlet and terminal unit: Not more than -2" WG.
   2. Between terminal unit and suction side of air handling unit or return/exhaust fan: Equal to static pressure at inlet of return fan but not more than -4" WG.

F. Unless otherwise indicated, pressure class for fume hood exhaust ductwork between exhaust fan inlet and exhaust air terminal device outlet shall be equal to static pressure at exhaust fan inlet but not more than -4" WG.

G. Unless otherwise indicated, pressure class for constant air volume system ductwork shall be equal to external static pressure (fan entrance or discharge pressure minus associated unit internal component pressure drop), but not less/more than ± 2" WG.

H. Duct transverse joints and reinforcement material, including angle ring flanges and stiffeners, shall be of same material as duct.

I. Except as modified in this Section of specifications or on drawings, use material, weight, thickness, gauge, construction and installation methods as outlined in the following SMACNA publications:
   1. HVAC Duct Construction Standards Metal and Flexible, 3rd Edition, 2005, for rectangular and round ductwork up to positive 10" WG and negative 10" WG and flat oval ductwork up to positive 10" WG.
      a. Tie rods shall be 1/2" or 3/4", galvanized steel EMT/conduits with bolt assembly consisting of rubber washer and friction anchored threaded insert similar to Ductmate Easyrod or PPI Condu-Lock.
      b. Internal tie rods are not allowed for welded ductwork and special exhaust systems, such as fume hood exhaust, BSC exhaust, animal room exhaust, BSL-3 exhaust, cagewash exhaust, shower room exhaust, kitchen hood exhaust, dishwasher exhaust, etc.
      c. Internal tie rods or bracing are not allowed for ductwork 36" and smaller.
   2. Round Industrial Duct Construction Standards, 2nd Printing 1999
   3. Round Industrial Duct Construction Standards, 2nd Edition, September 1999
   4. Rectangular Industrial Duct Construction Standards, 2nd Edition, 2004
   5. Accepted Industry Practice for Industrial Duct Construction, 2nd Edition, 2008, for round ductwork -4" to 20" WG (Table 1-A) and for rectangular ductwork -4" to 20" WG (Table 2-A).
   6. Adhesives and sealants used on installation of ducts shall comply with South Coast Air Quality Management District (SCAQMD) Rule #1168; Indoor Environmental Quality Section, Credit IEQ-4.1.

1.7 WELDING REQUIREMENTS

A. The following requirements cover arc and braze welding of nonstructural sheet metal ductwork for HVAC, architectural metal and other FDA process applications where pressures do not exceed 120" WG (positive or negative). These requirements also apply to welding of structural members whose sole purpose is stiffening, supporting, or reinforcing of sheet metal material, as well as attachment of brackets or other accessories/components required to provide complete systems.

B. Procedure and Qualification:
   1. Welding Procedure Specification (WPS) and Procedure Qualification Record (PQR) shall be prepared by installing contractor and/or fabricator prior to execution of related work. Qualification of welding procedure shall meet or exceed requirements of the latest revision of American Welding Society, Sheet Metal Welding Code ANSI/AWS D9.1.

2. Provide certification of satisfactory performance testing for all welders and welding operators, which provide welding services on Project.
3. Establish and provide written quality assurance/quality control (QA/QC) procedures to ensure compliance with specification requirements. Clearly identify appropriate steps for safe welding procedures (review Appendix J of D9.1) including additional safety material, screens, eye, personnel and clothing protection, fire suppression equipment, and fume extraction equipment needed adjacent to welding work area.

PART 2 - PRODUCTS

2.1 GALVANIZED STEEL SHEET

A. Lock Former Quality (LFQ), cold rolled, open hearth soft steel sheet capable of double seaming without fracture, ASTM A924/A924M or ASTM A653/A653M. Galvanized coating shall be G90.

B. Use G90 Galvaneal or Zincgrip where painting is specified.

2.2 ALUMINUM SHEET

A. Aluminum alloy, ASTM B209, Type 3003H-14 capable of double seaming without fracture.

2.3 STAINLESS STEEL SHEET

A. First quality, cold rolled annealed, pickled, ASTM A240 and A480, Finish No. 2B for concealed work and Finish No. 4 for exposed work. Unless otherwise indicated, use Type 316L where welded duct construction is specified and Type 316 where non-welded duct construction is allowed.

2.4 FLEXIBLE DUCT

A. Manufacturers: Thermaflex, or Flexmaster

B. Factory fabricated, UL listed under UL-181 as Class 1 duct, meeting requirements of NFPA 90A with flame spread of 25 or less and smoke developed rating of 50 or under.

C. Flexible duct shall have minimum ratings as follows:

1.	Operating Temperature:	-20ºF to 250ºF
2.	Internal Working Pressure:	Positive: 6” WG
		Negative: 1” WG
3.	Burst Pressure:	2-1/2 times working pressure
4.	Velocity:	5000 fpm

D. Unless otherwise indicated, duct shall be nonmetallic insulated type composed of polyester film, polyethylene film, nylon film, CPE film, or coated woven fiberglass liner bonded permanently to corrosion resistant coated steel wire helix without adhesive.

E. Insulation shall be flexible fiberglass insulation with minimum R-value of 6 at mean temperature of 75ºF. Vapor barrier jacket shall be aluminum foil reinforced, polyethylene, or metalized polyester film with minimum perm rating of 0.05 permper ASTM.

F. Insulation material shall not be exposed to air stream.

G. Lined flexible duct shall have the following minimum acoustical performance in accordance with ARI Standard 885. Dynamic Insertion Loss in each octave band of 5 ft or 10 ft straight duct shall not be less than the following:

Dynamic Insertion Loss (dB)

Duct Diameter (in)	Octave Band Center Frequency (Hz) (Based on 5 ft length)					
	125	250	500	1000	2000	4000
6”	6	9	18	22	24	15
8”	6	10	18	20	21	12
10”	5	11	18	18	18	9

Duct Diameter (in)	(Based on 10 ft length) 125	250	500	1000	2000	4000
6”	10	15	28	33	35	22
8”	10	18	29	32	32	20
10”	9	19	28	31	29	18

2.5 SNORKEL (LOCAL EXHAUST VENT) DUCT CONSTRUCTION

A. Equal to Dura-Vent Model 2PA, two-ply polyester-acrylic urethane blend coating, white color, -40ºF to 250ºF.

B. Use stainless steel ductwork for snorkel to the point connected to main exhaust ductwork.

2.6 MANUFACTURED ROUND DUCTWORK (POSITIVE PRESSURE)

A. Single Wall:
   1. Manufacturers: Lindab, Semco or McGill AirFlow, equal to McGill AirFlow Uni-Seal duct and fittings suitable to positive 10” WG.
   2. Ducts shall be machine formed round and/or flat oval as shown on drawings, constructed of G90 galvanized steel. Use spiral lockseam construction. Longitudinal seam construction may be used for ductwork over 80” diameter with minimum 16 ga. Use fittings as indicated on drawings, as specified, and as required in accordance with manufacturer's published data.
   3. Unless otherwise indicated, connection shall be slip type with minimum 2” insertion length or flanged joint in accordance with manufacturer's recommendations. When flange joints are required, use Van Stone angle rings welded to duct.
   4. Internal bracing is not allowed.
   5. Pre-sealed snaplock pipe system “Greenseam +” as manufactured by Ductmate Industries may be used for low pressure supply air duct.

B. Double Wall (insulated):
   1. Manufacturers: Lindab, Semco or McGill AirFlow duct and fittings suitable to positive 10” WG.
   2. Ducts shall be machine formed round as shown on drawings, constructed of G90 galvanized steel. Use spiral lockseam construction. Inner liner shall be solid, and annular space shall be filled with 1” thick fiberglass insulation. Use fittings with solid liner as indicated on drawings, as specified, and as required in accordance with manufacturer's published data.

3. Unless otherwise indicated, connection shall be slip type connection with minimum 2” insertion length or flanged joint in accordance with manufacturer's recommendations. When flange joints are required, use Van Stone angle rings welded to duct.
4. Internal bracing is not allowed.

2.7 MANUFACTURED ROUND DUCTWORK (NEGATIVE PRESSURE)

A. Manufacturers: McGill AirFlow Industrial duct and fittings. Semco and Lindab are acceptable manufacturers, provided meeting requirements in this Section.

B. Ducts shall be machine formed round duct constructed of G90 galvanized steel. Use spiral lockseam construction unless otherwise indicated. Use fittings as indicated on drawings, as specified, and as required in accordance with manufacturer's published data.

C. Connection shall use slip coupling, angle ring or Van Stone connectors in accordance with manufacturer's recommendations.

2.8 DUCT SEALANTS AND GASKETS

A. Sealant:
1. Flexible, water based, adhesive sealant compounded specifically for sealing joints and seams in ductwork. Hardcast, McGill AirSeal, Ductmate PROseal, Mon-Eco Industries, Childers, DP1010 or H.B. Fuller/Foster.
2. Sealants shall be UL 723 (ASTM E84) classified, and meet NFPA 90A and 90B.
3. Sealants shall comply with requirements for LEED IEQ 4.1.
4. Select sealants as recommended by manufacturer for specific application.
5. Submit sealant manufacturer's data sheets including performance data, pressure ratings, surface burning characteristics data, VOC compliance with LEED IEQ 4.1, detailed installation instructions.
6. Duct tapes are not allowed.

B. Gaskets:
1. Butyl, copolymer or neoprene based tape similar to Ductmate 440 Gasket Tape or Neoprene Gasket Tape for flanged joints.

C. Duct Sealant and Gaskets for Fume Hood Exhaust Ductwork:
1. Sealant shall be similar to Hardcast Sure-Grip 404 or Ductmate Proseal.
2. Gasket material shall be Butyl tape similar to Ductmate 440 Gasket tape or neoprene gaskets.
3. Gasket thickness and width shall be as required for flange and surface irregularities to seal joint air tight.

D. Duct sealant for high temperature ductwork:
1. Sealant shall be 100% silicone and rated to 500°F continuous operation, similar to Surebond SB-188 or ASI 600.

2.9 CABLE SUSPENSION SYSTEM

A. Suspension system shall be similar to Gripple Hang-Fast as manufactured and supplied by Gripple Incorporated or Ductmate Industries “Clutcher” cable hanging system.

B. Suspension system shall be load rated and verified by SMACNA Testing and Research Institute to be in compliance with SMACNA HVAC Duct Construction Standards, 2005, Chapter 5.

2.10 ACOUSTIC DUCT ENCLOSURE

A. Enclosure shall consist of inner layer (2" thick, minimum 3 psf glass or mineral fiber similar to Type R insulation specified in Section 20 0700 - Mechanical Systems Insulation) and outer layer of 2 layers of 5/8" sheet rock with staggered seams, attached to sheet metal studs. Sheet rock shall be attached to structure not ductwork.

2.11 ACOUSTIC DUCT COVERING

A. Sound barrier material shall be similar to Kinetics Model KNM-100B or EAR Lag-10. Barrier material to have acoustic ratings of STC-27, 1.0 lb/ft^2 weight, and minimum continuous operating range from -10°F to 180°F.

B. Minimum sound transmission loss at each octave band shall be as follows:

Sound Transmission Loss (dB) Octave Band Center Frequency (Hz)					
125	250	500	1000	2000	4000
15	18	21	27	32	37

PART 3 - EXECUTION

3.1 GENERAL

A. Install ductwork parallel to building walls and ceilings and at such heights not to obstruct any portion of ceiling, window, doorway, stairway, or passageway. Install ductwork to allow adequate access and service space for equipment. Refer to drawings and/or manufacturer's recommendations. Install vertical ductwork plumb. Where interferences develop in field, offset or reroute ductwork as required to clear such interferences. In all cases, consult drawings for exact location of duct spaces, ceiling heights, door and window openings or other architectural details before installing ductwork.

B. Make allowances for beams, pipes or other obstructions in building construction and for work of other contractors. Check plans showing work of other trades and consult with Engineer in event of interference. Transform, divide, or offset ducts as required, in such a manner as to maintain same cross sectional area of duct as indicated on drawings. Where it is necessary to install pipes or similar obstructions through ducts, consult with Engineer and obtain written approval from Engineer and Owner. If approved, provide streamlined encasement or collar designed in accordance with SMACNA Standards and seal to prevent air leakage.

C. Ductwork shall be free of kinks and dents.

D. Fabricate and install duct, fittings, joints, seams, reinforcement, supports, sealing, etc., in sizes indicated on drawings and in accordance with manufacturer's published data and SMACNA Standards except as modified in this section of specifications or on drawings.

E. Provide transitions where different size or different shape ductwork segments are connected. Use concentric transitions unless otherwise shown. Unless otherwise indicated, make diverging

transitions with maximum angle of 15° per side (30° total diverging) and converging transitions with maximum angle of 25° per side (50° total converging).

F. Provide transitions at ductwork system components and connections to equipment. Refer to Specification Section 23 3713 – Diffusers, Registers, and Grilles, for additional information regarding diffuser/register/grille connections.

G. Refer to ductwork symbols list on drawings for additional and dimensional requirements for fittings.

H. Seal duct seams and joints to meet SMACNA Class A as minimum for all ductwork including low-pressure ductwork.

I. Construct ductwork so that interior surfaces are smooth. Internal duct hangers and internal bracing are not allowed. Refer to Part 1, Design Criteria for internal tie rods.

J. Support coils, filters, air terminals, dampers, sound attenuator devices or other devices installed in duct systems with angles or channels, and make all connections to such equipment including equipment furnished by others. Secure frames with gaskets, nuts, bolts and washers.

K. Air terminal devices may be supported by strap hangers if air terminal manufacturer approves. Strap hangers are not allowed for fan powered devices, double wall type and Titus Steri-Loc type devices.

L. Install outside air intake duct to pitch down at minimum 1” per 20 ft toward intake louver or plenum and to drain to outside of building. Solder or seal seams to form watertight joints.

M. Install exhaust air duct to pitch down at minimum 1” per 20 ft toward exhaust louver.

N. Blank off unused portion of outside air intake or exhaust louvers.

O. Where 2 different metal ducts meet, install joint in such a manner that metal ducts do not contact each other by using proper gasket seal or compound.

P. Install motor operated dampers and connect to or install equipment furnished by others. Provide necessary blank-off plates or transitions to mount control dampers as specified in Section 23 0901 - Control Systems Integration.

Q. Do not install ductwork over electrical panelboards, switchgear, switchboards or motor control centers.

R. When original galvanized finish is altered or damaged, apply field galvanizing paint as follows:
   1. Prepare surface with use of power sanders or wire brushes to remove rust, paint, etc.
   2. Apply cold galvanizing material equal to ZRC Products, Inc.

3.2 ELBOWS

A. Rectangular Duct (SA/RA/EA):
   1. Use radius elbows with centerline radius to width ratio of 1.5 (SMACNA Type RE 1).
   2. Where 1.5 centerline radius elbows do not fit, use radius elbows with centerline radius to width ratio of 1.0 (SMACNA Type RE 3).
   3. Where 1.0 centerline radius elbows do not fit, use radius elbows with centerline radius to width ratio of 0.75 (SMACNA Type RE 3) or 45° throat with radius heel elbows (SMACNA Type RE 8).

4. Use splitter vanes for 1.0 radius elbows, 0.75 radius elbows and 45° throat with radius heel elbows as follows;
   a. No vanes for duct with width less than 24”
   b. Single vane for duct with width 24” to 36”
   c. Two vanes for duct with width over 36”
5. Fabricate splitter vanes in accordance with SMACNA HVAC Duct Construction Standards, Chart 4-1, (p. 4.11) and Figure 4-9 (p. 4.13).
6. Square throat elbows with or without turning vanes are not allowed unless specifically indicated.

B. Round and Oval Duct:
   1. Unless specific type is indicated, use radius elbows with centerline radius to diameter ratio of 1.5 regardless of duct velocity. Where 1.5 radius elbows do not fit, use 1.0 radius elbows.

3.3 LONGITUDINAL SEAM

A. Rectangular Duct:
   1. Unless otherwise indicated, use Pittsburgh lock seam.
   2. Seal longitudinal seams with approved sealant or pre-sealed with encapsulated mastic.
   3. Button punch snap lock construction (SMACNA L-2) may be used for ductwork that is both 2” WG (+ or -) and lower, and 36” and smaller in width or height. For ductwork over 24” in width or height, add screw 4” from each end.
   4. Button punch snap lock construction is not allowed for ductwork in chases and areas above inaccessible ceiling.
   5. Button punch snap lock construction is not allowed on aluminum ductwork.

B. Round and Oval Duct:
   1. Unless otherwise indicated, longitudinal seams shall be in accordance with SMACNA HVAC Duct Construction Standards with the following exceptions.
      a. SMACNA seam types RL-3, 6A, 6B, 7 and 8 shown in Figure 3-2 are not allowed.

3.4 TRANSVERSE JOINT

A. Rectangular Duct:
   1. Transverse joints shall be in accordance with SMACNA HVAC Duct Construction Standards.
   2. Ductmate 25/35 connection systems with corner clips or optional nuts and bolts may be used. Incorporate use of all Ductmate accessories to ensure integrity of transverse connection. Install joints in strict accordance with the latest edition of Ductmate 25/35 Assembly and Installation Instruction Manual and Duct Construction Standards. Nexus or WDCI will be acceptable.
   3. Lockformers TDC or Engles TDF may be used in accordance with T-25 flanges of SMACNA HVAC Duct Construction Standards Metal and Flexible, 2005, provided that corner pieces with bolts are used. If TDF/TDC flanges are damaged, replace the damaged joint(s) by straightening and reinforcing with minimum 1-1/2” x 1-1/2” x 1/4" angle at each side of transverse joint.

B. Round Duct:
   1. Unless otherwise indicated, use beaded sleeve joints (SMACNA RT-1) with minimum 2” insertion length or flange joints (SMACNA RT-2 or RT-2A).

2. Connection systems manufactured by Ductmate Industries (Spiralmate and Ovalmate) or McGill AirFlow (Uni-flange) may be used for supply air ductwork.
3. AccuFlange connected systems may be used with gaskets specified in Part 2 of this Section.

3.5 DUCT SUPPORTS

A. Unless otherwise indicated, use straps or Z bar hangers with 3/8” rods to support rectangular ducts 60” wide and smaller and trapeze hangers with rods or angles to support rectangular ducts over 60” wide.
   1. Use trapeze hangers to support externally insulated ductwork with weight bearing inserts. Refer to Section 20 0700 – Mechanical Systems Insulation and details.

B. For round ducts 24” diameter or smaller, use single hanger.
   1. Cable Suspension System may be used up to 16” diameter at spaces higher than 8 ft above floor or platform.
   2. Round Duct Strap Bracket by Ductmate Industries may be used up to 24” diameter.

C. For round ducts 25” diameter or larger, use 2 minimum 3/8” rods, with trapeze in accordance with the following schedule:

Duct Size	Trapeze (Half Round)
25” to 36”	1-1/2” x 1-1/2” x 1/8"
37” to 48”	1-1/2” x 1-1/2” x 1/4" or 2” x 2” x 1/8"
49” to 60”	2” x 2” x 1/4"
61” to 84”	2-1/2” x 2-1/2” x 1/4"

D. Refer to Section 20 0700 - Mechanical Systems Insulation for ductwork insulation, weight bearing inserts and insulation protection shield requirements.

E. Support vertical ducts at every floor, but not exceeding 12 ft.

F. Support flexible duct at manufacturer’s recommended intervals but at least every 5 ft. Maximum sag shall be 0.5” per ft between supports. Hanger or saddle material in contact with flexible duct shall be minimum 0.5” wide.

G. The following upper attachments, upper attachment devices, lower hanger attachments, hanger devices, and/or hanger attachments are not allowed except where specifically indicated:
   1. Nailed pin fasteners
   2. Expansion nails without washers
   3. Powder actuated fasteners (forced entry anchors). Forced entry anchors may be used for upper attachments of flexible ductwork supports.
   4. Beam or "C" clamps without retaining clips or friction clamps (provide retaining clips for "C" clamps)
   5. Friction clamps for ductwork over 12”
   6. Non-factory manufactured upper attachments for metal pan deck including wire coil and double circle (Items 16 and 17 of Fig 5-4 of SMACNA HVAC Duct Construction Standards 2005)
   7. Wire hanger
   8. Trapeze hangers supported by wires or straps
   9. Rods, straps or welded studs directly attached to metal deck

10. Drilled hole with attachment to structural steel
11. Lag screw expansion anchor
12. Rivets
13. Non-metallic hangers or straps

H. Supporting devices shall be standard products of manufacturers having published load ratings.

I. Refer to Section 20 0529 - Mechanical Supporting Devices for additional support requirements including attachments to structures.

J. For welded ducts, soldered ducts or ducts with water tight joints, do not use supports utilizing screws or other penetrations into ductwork.

K. Unless Architectural Documents indicate the required framing, provide angle iron framing around roof opening where duct penetrates through roof decking, to maintain roof decking structural integrity in accordance with roof decking manufacturer's recommendations. This is not required for concrete decking. For concrete decking, consult with the project structural engineer for location and size of opening prior to execution of Work.

3.6 SHEET METAL WELDING

A. Welded ductwork shall be butt-welded unless otherwise indicated. Backing material and slip joints are not allowed.

B. Attach welding cable leads directly to base metal to be welded. Do not jumper welding cable leads through building structure, to avoid emission of stray voltage/current through building structure.

C. Welds on exposed ductwork in occupied spaces shall be brush polished with stainless steel brush.

D. Welds at exterior of building shall be ground smooth and brush polished with stainless steel brush to prevent atmospheric contamination and rust formation.

3.7 PROTECTION OF DUCTWORK

A. Protect ductwork during construction against entry of foreign matter and construction dirt.

B. Keep ductwork capped when work is complete for the day or when duct is not being worked on or added to. Use of polyvinyl (VISQUEEN) with duct tape wrap is an adequate measure as long as it is secure with no openings or tears in product.

C. If ductwork is not protected, remove dirt and foreign matter from the duct system and obtain inspection and approval from Engineer upon completion of cleaning before operating fans.

D. Return fans are not allowed to operate during construction to avoid intake of construction dirt/dust into return air ductwork.

3.8 DUCT LEAKAGE TEST

A. Refer to Test and Balancing portion of Section 20 0000 - General Mechanical Requirements.

B. Owner and/or Owner's representative may elect to witness leakage tests. Notify Owner and/or Owner's representative at least 3 days in advance.

C. Test each supply, return, and exhaust ductwork as follows, unless otherwise indicated in this section or in schedules.
   1. Test 25% of total installed duct area for duct pressure positive or negative Class 3" wg and higher.
   2. Test 25% of total installed duct area for duct pressure positive or negative Class 2" wg.
   3. Test 100% of total installed duct area for ductwork located in inaccessible spaces including shafts.
   4. Engineer will select sections of ductwork to be tested.
   5. If test results are acceptable to Engineer, remainder of ductwork is permitted to proceed without further testing. If ductwork fails test, repair all ductwork including ductwork not tested. Then repeat leakage tests for new sections of ductwork as described above.

D. Leakage test procedures shall be in accordance with test method described in Section 3 of SMACNA HVAC Air Duct Leakage Test Manual, except as modified in this Section. Test apparatus shall be in accordance with Section 5 of SMACNA HVAC Air Duct Leakage Test Manual.

E. Test pressure shall be equal to duct pressure class. Negative pressure ductwork shall be tested with negative test pressure.

F. Air leakage shall not exceed limits specified or scheduled. If leakage exceeds allowable limits, identify leaked areas, repair, seal and retest.

G. Provide filter system on duct inlet to test blower. Filter system shall be equal to final filtering efficiency of AHU supply air duct system. Filters are not required for negative pressure testing.

H. Do not insulate ductwork until it has been successfully tested.

I. Maximum permitted leakage (L) in cfm/100 sf duct surface area of each ductwork shall be calculated by:

   $L = C_L \times P^{0.65}$
   1. P = test pressure (duct pressure class).
   2. C_L = duct leakage class, 2 for round/oval ducts and 4 for rectangular ducts and flexible ducts.
   3. Total allowable leakage in a duct section:
      = L x (total duct surface area of the section)

J. Welded ductwork shall be air and watertight and shall have no air leakage with allowance stated below.
   1. When using test apparatus and procedure described in SMACNA HVAC Air Duct Leakage Test Manual, 1st Edition, Chapter 5 (modified for negative pressure), the following losses can be expected during testing and are acceptable:
      a. 1 cfm per 1" WG of static pressure is allowed for the test equipment and test connections (e.g. 3 cfm when testing at 3" WG).
      b. 0.10 cfm per inch of diameter of temporary caps, regardless of pressure (e.g. 1 cfm for a cap on 10" diameter duct).
   2. To the extent possible, walk and observe welded ductwork under test to check for cracked or hissing welds. All leaks in welded sections of ductwork shall be reported to the Client's Representative and repaired by welding. No caulking or sealing is allowed.

3.9 LOW PRESSURE DUCT CONSTRUCTION (PRESSURE CLASS 2” WG AND UNDER)

A. Use welds, rivets or nuts, and bolts for fabricating ductwork. Fully threaded sheet metal screws may be used on duct hangers, transverse joints and other SMACNA approved locations if screw does not extend more than 1/2” into duct. Sheet metal "TEK" screws 3/4” in length may be used as fasteners in conjunction with factory made transverse joints.

B. Unless otherwise indicated, construct branch take-off fittings as follows:
   1. For branch take-offs including branch ducts serving more than one diffuser or grille, use 45° entry fittings. For supply air ducts, expanded or conical taps may be used.
   2. For take-offs serving single diffuser, register or grille, use straight spin-in collars with manual balancing dampers.

C. Splitter dampers and/or extractors are not allowed.

3.10 DUCT LININGS

A. No duct linings exposed to the airstream shall be allowed for the Project.

3.11 HIGH PRESSURE DUCT CONSTRUCTION (PRESSURE CLASS 3” WG AND OVER)

A. Use manufactured ductwork or contractor fabricated ductwork meeting specified Construction Standards and fitting performance.

B. Submit construction details including materials, type of service, reinforcing methods, and sealing procedures.

C. Use elbows, tees, laterals, crosses and accessory fittings as shown on drawings and as required to fabricate duct system.

D. Use conical tees for round ductwork and 45 degree entry fittings for branch take-offs from mains unless otherwise indicated.

E. Provide manufactured bellmouth fittings at each fan supply air plenum to provide smooth entrance of air into duct system.

F. Provide positive pressure relief doors as indicated on drawings.

G. Provide negative pressure relief doors as indicated on drawings.

H. Construct high pressure ductwork for WG pressure class indicated in following section.

3.12 FLEXIBLE DUCT

A. Install flexible ducts in accordance with manufacturer's installation instructions and SMACNA Standards, except as modified in this Section of Specifications.

B. In supply air systems without air terminal devices, flexible ducts may be used for final connections to diffusers, grilles, and registers. Flexible ducts shall be of minimum length required to make connections, but shall not be greater than 3 ft in length, unless noted otherwise.

C. In supply air systems with air terminal devices, flexible ducts shall be used for duct connections to diffusers, grilles, and registers for sound attenuation purposes, except above non-accessible ceilings. Flexible ducts shall not be greater than 3 ft in length.

D. Centerline radius of bends shall not be less than 1.5 duct diameters. FlexFlow Elbow supports by Thermaflex or similar products shall be used at diffuser/grille connection to assure full radius elbow.

E. Support flexible ductwork with min 1-1/2" wide saddle, with no portion lying on ceiling supporting system.

F. Individual sections of flexible ductwork shall be of one-piece construction. Splicing of short sections is not allowed.

G. Connect flexible duct liner to collars and rigid duct with stainless steel draw bands. If collars have beads, position draw bands behind beads.

H. Pull insulation and vapor barrier jacket over liner connection and secure with draw band. For terminations at externally insulated ductwork, fittings, grilles, diffusers, etc., secure flexible duct jacket to ductwork insulation jacket with compatible vapor barrier tape.

I. Flexible ducts are not allowed above non-accessible ceilings.

J. Flexible ducts are not allowed in high pressure ductwork.

K. Flexible ducts are not allowed for use in any exhaust systems.

L. Flexible ducts are not allowed to pass through any partition, wall, floor or ceiling.

3.13 FUME EXHAUST DUCT CONSTRUCTION

A. General:
   1. Construct elbows with centerline radius to width or diameter ratio of at least 1.5 and 45° lateral branch take-offs from mains.

B. Duct pressure class shall be as follows:
   1. Negative -6" WG for all fume exhaust ductwork.

C. Duct pressure class to be as follows:

1.	From fume hood or biosafety cabinet to exhaust air terminal	-2" WG
2.	From general exhaust air grille to exhaust air terminal	-2" WG
3.	From exhaust air terminal to exhaust main or branch main	-4" WG
4.	Exhaust mains to vertical risers	-4" WG
5.	Vertical risers	-6" WG
6.	From vertical risers to exhaust plenum	-6" WG
7.	Exhaust plenum	-10" WG
8.	From exhaust plenum to exhaust fan	-10" WG
9.	From exhaust fan to exhaust stack	+2" WG

   10. Fume hood exhaust shall be stainless steel from the fume hood to the point in the penthouse where it connects to the general exhaust ductwork. Above and below ceilings or exposed in space, use 18 ga or heavier stainless steel sheet with externally welded, ground and polished joints and seams.

D. Stainless Steel Ducts:
   1. Use 18 ga or heavier 316 stainless steel sheet with all joints and seams butt-welded airtight.

2. Use longitudinal seam construction with seam at top on horizontal runs. Spiral seams are not allowed on round duct.

3.14 STERILIZER EXHAUST DUCT CONSTRUCTION

A. Use aluminum duct for exhaust from sterilizer piping spaces when enclosed in separate room and for exhaust located above sterilizer doors. Fabricate all duct work downstream of first location where this occurs to point where sterilizer exhaust mixes with general exhaust of aluminum construction. Seal or weld aluminum duct air and water tight. Fan discharge duct and other exhaust duct located upstream of point where aluminum duct is required may be of aluminum or galvanized steel construction sealed in accordance with its pressure class.

END OF SECTION

SECTION 23 3314 DUCTWORK SPECIALTIES

PART 1 - GENERAL

1.1 RELATED WORK

A. Section 23 0595 - Air Systems Test Adjust Balance

B. Section 23 0902 - Control Valves and Dampers (Control and Smoke Dampers)

1.2 REFERENCE

A. Work under this Section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.

1.3 SUBMITTALS

A. Shop Drawings including, but not limited to, the following:
   1. Manufacturer's name and model number
   2. Capacities
   3. Temperature/pressure ratings
   4. Materials of construction
   5. Dimensions
   6. Manufacturer's installation instructions and/or detailed drawings
   7. All other appropriate data

B. LEED Submittals:
   1. Product Data for IEQ Prerequisite 1: Documentation indicating that duct systems comply with ASHRAE 62.1-2007, Section 5 – “Systems and Equipment”.

1.4 DESIGN CRITERIA

A. Products and materials shall conform to NFPA Section 90A, possessing flame spread rating of not over 25 and smoke developed rating no higher than 50.

B. Ductwork specialties exposed to air stream, such as dampers, turning vanes and access doors, shall be of same material as duct or unit at where the specialties are mounted, unless otherwise noted.

C. Unless otherwise noted, ductwork specialties shall be designed and constructed for pressure class of ductwork in which they are installed.

PART 2 - PRODUCTS

2.1 MANUAL BALANCING DAMPERS

A. Manufacturers: Ruskin, Greenheck, Vent Products, Pottorff or Air Balance, constructed in accordance with SMACNA HVAC Duct Construction Standards, except as modified below.

B. Rectangular Dampers:

1. For low pressure ductwork, for damper blade height up to 12”, use single blade type with minimum 22 ga galvanized steel blade with minimum 3/8” rod for blade width up to 18”, and with minimum 18 ga galvanized steel blade with minimum 1/2” continuous rod for blade width from 19” to 48”. For damper blade height more than 12”, use multiple blade type with minimum 16 ga galvanized steel channel frames, opposed blade linkage operation, with blades minimum 16 ga and 6” to 8” maximum blade width, minimum 1/2” continuous rod and 1/2” x 1/2" galvanized steel angle blade stops. Bearings shall be nylon or molded synthetic. Construct dampers over 48” in width or height in multiple sections with mullions.
2. For high pressure ductwork, dampers shall be constructed to withstand maximum pressure of 6” WG at closed position and maximum velocity of 2500 fpm at open position. Frame and blades shall be constructed of minimum 16 ga with minimum 1/2” diameter or square rod.

C. Single Blade Round Dampers:
1. For low pressure ductwork, damper shall have blade 24 ga, but no less than two gauges more than duct gauge. Rod shall be minimum 3/8” diameter or square continuous. Bearings shall be nylon or molded synthetic.
2. For high pressure ductwork, damper blade shall be minimum 16 ga. Rod shall be minimum 1/2” square continuous and tack welded to blade. Provide sealed end bearing similar to Ventlok #609 and acorn nut type dial regulator similar to Ventlok #635 or 641.

D. Provide damper operators with locking devices and damper position indicators. Sheet metal screws are not allowed in construction or installation of dampers. Use rivets or tack welds.

E. Dampers shall be properly stiffened and fabricated to prevent vibration, flutter or other noise.

F. Extend damper shafts through duct insulation or use elevated regulators for externally insulated ducts to accommodate specified insulation thickness.

G. Segmented Blade (Iris) Dampers:
1. Damper shall be segmented blade (iris) type with 22 ga 316 stainless steel frame and blades. Casing leakage shall not exceed 6 cfm.
2. Iris blade segments shall be internally linked and driven by manual adjustment knob. Linkage parts shall be fully encapsulated and out of air stream. Manual adjustment knob shall be factory calibrated to the exact aperture position and aligned with the K factor set point to provide linear response flow control.
3. Accuracy of flow measurement shall be ±5%. Assembled units shall be furnished with specific charts designed for exact size and blade aperture configuration. Air pressure taps shall be integral to damper frame and positioned on either side of blade segments.
4. Dampers shall be similar to Ruskin Model VFBD35.

2.2 TURNING VANES

A. Construct turning vanes in accordance with SMACNA HVAC Duct Construction Standards.

B. Square Throat Elbow Turning Vanes (Vane Runner Length up to 18” and Vane Length up to 36”):
1. Use single thickness vanes having 2” radius and 1-1/2” spacing, 24 ga minimum. Construct vanes in accordance with SMACNA HVAC Duct Construction Standards.

C. Square Throat Elbow Turning Vanes (Vane Runner Length over 18” or Vane Length over 36”):
1. Use double thickness vanes having 4.5” radius and 3.25” spacing, 24 ga minimum.

D. Radius Elbow Splitter Vanes:
   1. Splitter vanes for radius elbows shall be extended entire length of fitting and constructed in accordance with SMACNA HVAC Duct Construction Standards.

2.3 BACKDRAFT DAMPERS

A. Manufacturers: Ruskin or Greenheck

B. Dampers shall be multi-blade, weighted type with counter-balanced blades and with 12 ga galvanized steel frame and extruded aluminum airfoil-shaped blades equal to Ruskin Type CBS 92. Blade edges shall have silicon rubber seals with ball bearings. Dampers shall be suitable for flange and gasket connection to ductwork or fan outlet.

C. Dampers shall be rated to maximum velocity of 4000 fpm, maximum temperature of 250°F and maximum system pressure of 5” WG for damper width of 60” and 14” WG for damper width of 12”.

D. Maximum damper leakage shall be 13.5 cfm/sf based on pressure differential of 1” WG.

2.4 FIRE DAMPERS

A. Manufacturers: Air Balance, Prefco, Greenheck, Nailor, Cesco, Pottorff Louvers and Dampers, or Ruskin

B. Fire damper assemblies shall be listed by UL 555 with 165°F fusible link and shall meet construction standards as set forth in NFPA 90A.

C. Fire resistance rating of fire dampers shall be as shown on drawings.

D. Dampers shall be dynamic type dampers rated to minimum 2000 fpm and 4” WG.

E. Dampers shall be curtain type with blades out of air stream when in open position. Where curtain type dampers are not available because of size, use multiple blade type dampers.

F. For round ducts, dampers equal to Ruskin Model FDR25 may be used.

G. Damper fire rating shall be compatible with rating of building surface in which damper is used.

H. Submit UL installation details to showing mounting method and duct connection method.

I. Where ceiling fire dampers are used, they are to be equal to Ruskin CFD(R) 2 or 3, UL Classified for installation in fire rated floor or roof/ceiling assemblies.

2.5 COMBINATION FIRE AND SMOKE DAMPERS

A. Manufacturers: Ruskin, Air Balance, Prefco, Greenheck, Nailor, Cesco, Pottorff, Louvers and Dampers similar to Ruskin FSD-60

B. Dampers shall meet requirements of NFPA 90A. Dampers shall be 1-1/2 or 3 h rated as shown on drawings, leakage rated at no higher than leakage Class I (4 cfm/ft^2 at 1" WG and 8 cfm/ft^2 at 4" WG) under UL 555/555S at temperature category 350°F, and compatible with system static pressures. Furnish dampers with factory-mounted, caulked sleeves and damper operators.

C. Dampers shall use airfoil shaped damper blades. Dampers shall be rated for minimum 4” WG static pressure and 2000 fpm air velocity.

D. For round ducts, dampers equal to Ruskin Model FSDR 25 may be used.

E. Operators shall be 120 V electric powered with auxiliary switch built in for position indication, factory installed outside airstream, linked to dampers for fail closed operation, and be UL Listed and labeled for the application. Operators to be capable of closing damper at pressures encountered in system.

F. Dampers shall be furnished with heat sensor set at 165°F.

G. Smoke detector required at each damper will be provided by Electrical Contractor.

H. Submit UL installation details showing mounting method and duct connection method.

2.6 SMOKE DAMPERS

A. Manufacturers: Air Balance, Johnson Controls, Ruskin, Greenheck, Nailor, NCA Manufacturing, Cesco, Pottorff, Louvers and Dampers or Prefco, similar to Ruskin SD-60.

B. Dampers shall be leakage rated at no higher than Leakage Class I (4 cfm/ft^2 at 1" WG and 8 cfm/ft^2 at 4" WG) under UL 555S at temperature category 250°F. Furnish dampers with factory-mounted, caulked sleeve and actuator assemblies. Damper shall have 16 ga or heavier frame with air foil-shaped blades, rated to minimum 4” WG in closed position and to 2000 fpm in open position.

C. For round ducts, dampers equal to Ruskin Model SDRS 25 may be used.

D. Actuator assemblies shall be installed outside airstream, linked to damper for fail (normally) closed operation. Actuator shall be capable of closing damper at pressures encountered in system.

E. Size smoke dampers as close as possible to duct size, but in no case is damper size to be less than duct size.

F. Actuators shall be 120 V electric powered with auxiliary switch built in for position indication.

G. Furnish damper test switch similar to Ruskin Model DTS.

H. Smoke detector required at each damper will be provided by Electrical Contractor.

2.7 ACCESS DOORS

A. Access doors shall be rectangular, minimum 22 ga frame and minimum 24 ga door, fit air tight with neoprene gasket and shall be suitable for duct pressure class. When access doors are installed in insulated ductwork or equipment provide insulated doors with insulation equivalent to what is provided for adjacent ductwork or equipment. Access doors constructed with sheet metal screw fasteners are not acceptable.

B. Low Pressure Ducts (Pressure Class 2” and Under):
   1. Doors shall be hinged type with sash lock for exposed application and non-hinged type with cam latches for concealed application.
   2. Access doors constructed in accordance with SMACNA HVAC Duct Construction Standard (Figure 7-2) or similar to Ruskin Model ADC or ADH will be acceptable.
   3. Sandwich style access doors made by Ductmate, Ward Industries, Greenheck, or Flexmaster are acceptable, provided that they meet insulation requirements.

C. High Pressure Ducts (Pressure Class 3” and Over):

1. Use access doors factory fabricated and rated by manufacturer's published literature for installation in systems with pressures to positive or negative 10” WG.
2. Sandwich access doors made by Ductmate, Ward Industries, Pottorf, Greenheck, or Flexmaster are acceptable, provided that they meet insulation requirements.

D. Kitchen Grease Exhaust Ducts:
1. Access doors shall be grease and air tight, passing ASTM E 2336 test standard, shall have ICC ESR. Access doors shall be furnished by duct wrap manufacturer as part of duct wrap system.

2.8 DUCT FLEXIBLE CONNECTIONS

A. Manufacturers: Unless specifically indicated, Ventfabrics, Inc. or Duro Dyne, equal to Duro Dyne model indicated. Material shall be glass fabric, fire retardant, waterproof, air tight and comply with NFPA 90A and 701 (formally UL 214).

B. General Supply, Return and Exhaust Ductwork:
1. Material for indoor use to be 30 oz per square yard, double coated with neoprene, tensile strength of 500 lbs x 500 lbs, tear strength of 13 lbs x 13 lbs, suitable for -40°F to 200°F continuous operation similar to Duro Dyne Neoprene.
2. Material for outdoor use shall be combination of inner layer of Duro Dyne Neoprene and outer layer of 24 oz per square yard, coated with Hypalon, UV resistant, suitable for -40°F to 250°F, similar to Duro Dyne Durolon.

C. Special Exhaust Ductwork:
1. Material for indoor use shall be 17 oz per square yard, teflon or silicon coated, tensile strength of 200 lbs x 250 lbs, tear strength of 50 lbs x 40 lbs, suitable for -65°F to 500°F, similar to Duro Dyne Thermafab.
2. Material for outdoor use shall be combination of inner layer of Duro Dyne Thermafab and outer layer of Durolon.

2.9 SOUND ATTENUATING DEVICES

A. Manufacturers: Industrial Acoustics Company, Semco, United McGill, Aeroacoustic, Vibro-Acoustics, VAW Systems, Price, or Ruskin

B. Units shall be tested in accordance with ASTM E-477-06a silencer test standard in aero-acoustic test facility which is NVLAP accredited for ASTM E-477-06a Standard. Each test shall have been conducted within last 12 month period. Submit copy of laboratory's NVLAP accreditation certificate on dynamic insertion loss, self-noise power levels, and aerodynamic performance.

C. Outer casing of units shall be not less than 22 ga G90 galvanized steel in accordance with recommendations in the latest edition of ASHRAE Guide and Data Book for high pressure rectangular ductwork for 8” WG or pressure class indicated for duct system, if it is higher than 8” WG. Seams shall be lock formed or continuously welded and mastic filled.

D. Acoustic Materials:
1. Media shall be non-fiberglass containing 100% natural cotton fibers treated with EPA registered, non-toxic borate solution, "flash dried" to actively inhibit growth of mold, mildew, bacteria and fungi. Media shall not contain any formaldehydes, phenolic resins or Volatile Organic Compounds (VOC's) that can off-gas, and/or cause health concerns. Media shall be

100% recyclable. Media shall comply with UL181 and NFPA 90A. Media shall not cause or accelerate corrosion of aluminum or steel.

E. Covering Materials:
   1. Covering material shall be Mylar film.
   2. Provide spacers between covering material and perforated metal.

F. Ends of attenuators shall be covered at factory with plastic, heavy-duty paper, cardboard, or other appropriate material to prevent entrance of dirt, water, or any other foreign matter to inside of attenuators. Caps shall not be removed until attenuator is installed in duct system.

G. Unless otherwise indicated, sound attenuating devices shall meet acoustical performance requirements as scheduled in each octave band frequency under the flow conditions.

H. Sound Attenuating Devices for Exhaust Air Terminal Units Serving Fume Hood and Snorkel Exhaust:
   1. Tubular type constructed entirely of Type 304 stainless steel, in accordance with recommendations in the latest edition of ASHRAE Guide and Data Book for high pressure rectangular ductwork. Seams shall be continuously welded. Units shall contain no sound absorptive material. Attenuation shall be accomplished by controlled impedance membranes and broadly tuned resonators. Units shall not fail structurally when subjected to differential air pressure of 8” WG, inside to outside of casing.
   2. Unless otherwise indicated, sound attenuating devices shall meet acoustical performance requirements as scheduled in each octave band frequency under the flow conditions.

I. Sound Attenuating Devices for General Exhaust Air Terminal Units of Laboratory or Vivarium Exhaust Systems:
   1. Tubular type constructed entirely of galvanized steel, in accordance with recommendations in the latest edition of ASHRAE Guide and Data Book for high pressure rectangular ductwork. Seams shall be continuously welded. Units shall contain no sound absorptive material. Attenuation shall be accomplished by controlled impedance membranes and broadly tuned resonators. Units shall not fail structurally when subjected to differential air pressure of 8” WG, inside to outside of casing.
   2. Unless otherwise indicated, sound attenuating devices shall meet acoustical performance requirements as scheduled in each octave band frequency under the flow conditions.

J. Sound Attenuating Devices for Fume Hood Exhaust Fans:
   1. Provide units at exhaust fan intakes and discharges as scheduled. Unit length shall be as scheduled.
   2. Rectangular type constructed entirely of Type 304 stainless steel, in accordance with recommendations in the latest edition of ASHRAE Guide and Data Book for high pressure rectangular ductwork. Seams shall be continuously welded. Units shall contain no sound absorptive material. Attenuation shall be accomplished by controlled impedance membranes and broadly tuned resonators. Units shall not fail structurally when subjected to differential air pressure of 8" WG inside to outside of casing.

2.10 AIR FLOW MEASURING UNITS

A. Furnished by Control Contractor.

2.11 REMOTE OPERATED VOLUME CONTROL DAMPERS

A. Young Regulator Co. or Metropolitan Air Technology similar to Young Regulator Model 830 dampers, furnished with Bowden 270 Series remote cable controls.

2.12 INSTRUMENT TEST HOLES

A. Manufacturers: Ventlok 699 (up to 1" insulation thickness) or Ventlok 699-2 (over 1" insulation thickness).

B. Use concave gaskets for round ductwork.

2.13 CONTROL DAMPERS

A. Furnished by Control Contractor.

PART 3 - EXECUTION

3.1 MANUAL BALANCING DAMPERS

A. Install manual balancing dampers in supply, return and exhaust branch ducts, as shown on drawings and as required to regulate airflow to meet air balance requirements.

B. Install manual balancing damper in branch duct to each diffuser and grille. Install dampers as close as possible to take-offs.

C. Install balancing dampers so as not to flutter or vibrate and as far as possible upstream from the air outlet.

D. Do not install balancing dampers in supply ductwork upstream of air terminal devices.

E. Balancing damper is not required where terminal air device serves a single diffuser or grille.

F. Do not install manual balancing dampers in the following exhaust ductwork:
   1. Fume hood exhaust ductwork.
   2. Kitchen hood exhaust ductwork.

3.2 TURNING VANES AND SPLITTER VANES

A. Install turning vanes and splitter vanes as shown on drawings and as specified in Section 23 3114 – Ductwork, for rectangular elbows. Install turning vanes and splitter vanes in accordance with SMACNA Standards and/or manufacturer's recommendations.

B. Turning vanes are not required in transfer air ducts.

3.3 BACKDRAFT DAMPERS

A. Install backdraft dampers where indicated on drawings.

B. Where motorized dampers are shown in exhaust fan discharge duct, or in duct connecting to relief or exhaust louver, backdraft dampers are not required unless specifically indicated. Where motorized dampers are not shown, provide backdraft dampers in these locations.

3.4 FIRE DAMPERS AND COMBINATION FIRE/SMOKE DAMPERS

A. Install dampers where shown on drawings in accordance with manufacturer's installation instructions and requirements of NFPA 90A. Install dampers complete with mounting collars, retaining angles, connections to adjoining ductwork and duct access doors. Install duct access door at each damper with door size large enough to permit replacement of fusible links and resetting of dampers.

B. Test and demonstrate proper operation of each damper after system is installed and ready for operation.
   1. Manually test each damper for proper operation by removing fusible link or actuating EFL or PFL. Repair or replace any damper that does not close completely. Replace fusible link and certify in writing that each damper was installed according to manufacturer's installation instructions and that each damper can be expected to close completely when fusible link melts.
   2. Notify Owner and/or Owner's representative at least 48 h prior to testing to allow for witnessing.

C. Contractor shall provide letter from manufacturer's representative indicating that dampers are installed per manufacturer's installation instructions.

3.5 ACCESS DOORS

A. Install access doors where specified, indicated on drawings, and in locations where maintenance, service, cleaning or inspection is required, including automatic dampers, fire dampers, smoke dampers, smoke detectors, fan bearings, heating and cooling coils, reheat coils, humidifiers, filters, bird/insect screens, valves and control devices within duct or casing, at outside air intake duct and at inlet side of turning vanes in return ductwork.

B. Locate access doors for greatest ease of access.

C. Size and quantity of duct access doors shall be sufficient to perform intended service, but not less than the following:

Rectangular Duct Size	Minimum Access Door Quantity and Size
14"and smaller	(1) 8" x 8"
12" to 15" and smaller	(1) 12" x 10"
16" to 21"	(1) 18" x 14"
22" to 27"	(1) 18" x 18"
28" to 47"	(1) 24" x 24"
48" to 96"	(2) 24" x 24"

Round Duct Size	Minimum Access Door Size
10" and smaller	8" x 4"
15" and smaller	12" x 8"
29" and smaller	16" x 12"
30" and over	24" x 18"

D. Increase duct size to accommodate access door size indicated above where required.

E. Access doors for fire dampers to be minimum 12x12 or larger as indicated above.

3.6 FLASHINGS

A. Install counterflashings where shown on drawings. Install in accordance with SMACNA recommendations.

3.7 DUCT FLEXIBLE CONNECTIONS

A. Connect ductwork to fans or casings containing rotating equipment or mounted on vibration isolators with duct flexible connections. Installed width shall be suitable for specific application but shall not be less than 4". Install flexible connections in accordance with SMACNA Standards with double lock or "Grip Loc" connection.

B. Duct flexible connections are not allowed for fan connection serving kitchen hood, or perchloric acid hood.

3.8 SOUND ATTENUATING DEVICES

A. Install sound attenuating devices as indicated on drawings and/or as scheduled.

B. For modular installation of sound attenuators, install galvanized steel holding frame, gaskets, seals, supports and fasteners in accordance with manufacturer's recommendations for multiple unit installation.

3.9 INTAKE AND RELIEF HOODS

A. Install hoods as shown on the drawings and/or as scheduled.

B. General Contractor will install curbs furnished with hoods unless otherwise indicated.

3.10 AIR FLOW MEASURING UNITS

A. Install where indicated on the drawings and/or as scheduled and in accordance with manufacturer's recommendations.

3.11 REMOTE OPERATED VOLUME CONTROL DAMPERS

A. Install remote operated volume control dampers and remote operators as indicated on drawings.

B. Install connecting wire in the wall.

3.12 PRESSURE RELIEF DOORS

A. Install doors vertically where shown on drawings and in accordance with manufacturer's recommendations.

3.13 CONTROL DAMPERS

A. Install dampers in locations indicated on drawings, as detailed and according to manufacturer's instructions.

B. Install blank-off plates or transitions as specified in Control Sections.

C. Provide adequate operating clearance and access to operators.

D. For dampers located outdoor, provide weather protection enclosure for parts of damper such as linkage and actuator located outside of duct. Enclosure shall be removable and made of galvanized steel sheet.

3.14 SMOKE DAMPERS AND DETECTORS

A. Install smoke dampers in locations indicated on drawings. Allow room for operator installation and access to operator. Install access door in ductwork for access to damper. When damper is installed in location other than in smoke or fire rated wall, use SMACNA seal class A for ductwork between smoke damper and smoke rated wall for affected zone.

B. Smoke detectors will be provided by Electrical Contractor in locations indicated on drawings. Install access door in ductwork for access to detector sampling device.

3.15 INSTRUMENT TEST HOLES

A. Provide instrument test holes at air entering and air leaving side of all internal air handling system components for static pressure differential (Delta P) or temperature differential (Delta T) measurements.

B. Provide ductwork instrument test holes as shown on drawings, or as directed by TAB personnel, or Engineer.

END OF SECTION

SECTION 23 3600 AIR TERMINAL DEVICES

PART 1 - GENERAL

1.1 RELATED WORK

A. Section 23 3114 - Ductwork (Support)

B. Section 23 3314 - Ductwork Specialties (Access Doors)

C. Section 23 8214 - Heating and Cooling Terminal Devices

1.2 REFERENCE

A. Work under this Section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.

1.3 SUBMITTALS

A. Shop Drawings including, but not limited to, the following:
   1. Manufacturer's name and model number
   2. Identification as referenced in the documents
   3. Capacities/ratings
   4. Materials of construction
   5. Sound rating data
   6. Dimensions
   7. All other appropriate data

B. LEED Submittal:
   1. Product Data for IEQ Prerequisite 1: Documentation indicating that units comply with ASHRAE 62.1 – 2010, Section 5 – “Systems and Equipment.”

1.4 QUALITY ASSURANCE

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

B. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1 – 2010, Section 5 – “Systems and Equipment” and Section 7 – “Construction and System Start-Up.”

1.5 DESIGN CRITERIA

A. Where any of air terminal devices are indicated on drawings to control space conditions in conjunction with reheat coil, that reheat coil may be furnished as integral part of or standard accessory to devices specified below. See related work above.

B. When air terminal devices are furnished with reheat coils, either integrally or remotely mounted, control panels of terminal devices shall be mounted on the same side of air terminal device as reheat coil piping connection.

C. Unless otherwise stated, units shall be system pressure independent and maintain air volume within ± 5% of required airflow regardless of system air pressure. Inlet velocity pressure sensor shall be multi-point center averaging type and be capable of amplifying pressure signals.

D. Unless otherwise stated, unit casings shall be constructed of galvanized steel or aluminum meeting SMACNA or ASHRAE Standards, but not lighter than 22 ga.

E. Joints and seams of air terminal devices shall be sealed with appropriate sealant to minimize casing air leakage. Seal joints and seams not factory sealed in field as specified in Part 3.

F. Unit performance shall be certified in accordance with AHRI Standard 880 including sound rating data certified for both casing discharge and radiated sound levels from 125 through 4000 Hz.

G. Supply air units shall be capable of operating from minimum inlet static pressure scheduled to 3" WG.

H. Air valve leakage shall not exceed 1% of maximum inlet rated airflow at 3" WG inlet pressure.

I. Casing leakage rates shall not exceed the following maximum values:

Unit Size	0.5" Ps	1.0" Ps
4, 5, 6	2	3
7, 8	2	3
9, 10	2	3
12	2	3
14	2	3
16	3	4

J. Provide supply air units with internal thermal insulation faced with minimum 0.001" thick aluminum foil. Insulation shall be compressed glass fiber with minimum 3/4" thick, 4 lb/ft^3 density with R-value of 3.5 (h·ft^2·°F)/Btu. Insulation and facing shall meet requirements of UL 181 (Air Erosion, Mold growth and Humidity), and NFPA 90A (Flame 25/Smoke 50) and ASTM C665 (Fungi Resistance). Secure liner with full-seam-length, galvanized steel angles or Z-strips, which enclose and seal all edges. Tape or adhesive will not be acceptable. Liner assembly shall be similar to Titus Steri-Loc.

K. Unit manufacturer or manufacturer's designated representative will be required to verify air terminal device performance and adjust or replace device within warranty period when it is determined that problem exists in area served by device.

1.6 CONTROLS COORDINATION –

A. Unit manufacturer shall provide unit inlet flow sensor, pneumatic tubing and control enclosure for Control Contractor's use.

B. Control Contractor shall furnish all actuators, linkages if required, differential pressure transmitters, controllers and any other devices required for unit control that are not provided by unit

manufacturer for unit manufacturer's factory mounting. Unit manufacturer and Control Contractor shall coordinate for proper factory installation.

C. Unit manufacturer shall factory install devices furnished by Control Contractor to result in complete functioning unit. Unit manufacturer shall be responsible for reviewing compatibility of devices furnished by Control Contractor with units being provided.

D. Unit manufacturer shall perform preliminary calibration based on scheduled airflow rates.

E. Control Contractor shall be responsible for calibrating actuators and controllers through TAB work for scheduled airflow rates.

F. Control Contractor's field mounting will be acceptable, provided Control Contractor coordinates proper installation with unit manufacturer. Control Contractor shall be responsible for complete functioning unit.

PART 2 - PRODUCTS

2.1 VARIABLE VOLUME AIR TERMINAL DEVICES

A. Manufacturers: Titus, Price, Krueger, Enviro-Tec (ETI), Nailor, Carnes, Tuttle and Bailey, Metalaire, Trane, JCI or Carrier

B. Units shall be suitable for 24 V electric control system. Control Contractor shall be responsible for wiring from control panels to each terminal unit.

C. Unit inlet flow sensor shall be removable without additional access doors, similar to Price SP300.

D. Furnish units with reheat coils having capacities as indicated in schedules.

E. Provide access doors for all air terminal devices with reheat coils at inlet and outlet side of coils. Refer to Section 23 3314 - Ductwork Specialties for access doors. Unit manufacturer's standard access doors are acceptable, provided that access doors are appropriately sized and internally lined with same materials as unit casing. If access doors are provided in separate sections as extension of units, these sections shall be internally lined in same manner as units.

2.2 VENTURI TYPE AIR TERMINAL DEVICES

A. Manufacturers: Phoenix Controls

B. Venturi Type Air Terminal Devices shall be used unless otherwise shown on air terminal schedules in design documents.

C. Units shall be linearized Venturi type pressure independent and capable of modulating to fully closed position.

D. Supply Air and General Exhaust Air Valves:

1. Unit housings and cones shall be uncoated aluminum construction. Shaft and all hardware exposed to airstream to be 316 stainless steel.

E. Fume Exhaust Air Valves:

1. Valve body and cone shall be baked phenolic coated aluminum.

2. Shafts to be Teflon coated 316 stainless steel and bushings to be polypropylene. Spring to be baked phenolic coated 302/304 stainless steel.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install units as shown on drawings and according to manufacturer's installation instructions.

B. Install units with sufficient service space to unit control, actuators and access panels.

C. Seal joints and seams of units not factory sealed to meet allowable leakage rate specified for low pressure ductwork.

D. Provide minimum length of 3 times box inlet diameter of straight rigid duct at box inlet.

E. Provide access doors for terminal devices with reheat coils at inlet and outlet side of coils.

F. Provide access panels compatible with ceiling for all units located above non-accessible ceilings.

G. If venturi type air terminal devices are used for supply air application, provide external insulation in accordance with Section 20 0700 - Mechanical System Insulation.

END OF SECTION

SECTION 23 3614 LABORATORY TEMPERATURE AND AIRFLOW CONTROL SYSTEM

PART 1 - GENERAL

1.1 RELATED WORK

A. Division 01 - Submittal Procedures

B. Section 23 0595 - Air Systems Balance

C. Section 23 0901 - Control Systems Integration

D. Section 23 0902 - Control Valves and Dampers

E. Section 23 0993 - Control Sequences

F. Section 23 3314 - Ductwork Specialties (Sound attenuators and access doors)

G. Section 23 8214 - Heating and Cooling Terminal Devices

1.2 REFERENCE

A. Work under this Section is subject to requirements of Contract Documents including General Conditions of the Contract, Supplementary Conditions, and sections under Division 01 General Requirements.

1.3 DESCRIPTION

A. This specification is for procurement and installation of laboratory temperature and airflow control system, complete with air terminals, fume hood controllers, fume hood sash sensors, electric/pneumatic transducers, air terminal controllers, master controllers, control wiring, pneumatic tubing, space temperature sensors, and all accessories required, except where otherwise specified, to provide complete and functional system. System shall include all equipment necessary to control fume hoods, air terminals, sound attenuators, and reheat coils as specified in control sequences included in specification Section 23 0993 - Control Sequences, with exception of furnishing and installing reheat coil control valves. Reheat coil control valves to be furnished by Temperature Control Contractor and installed by Mechanical Contractor. Refer to Specification Section 23 0902 - Control Valves and Dampers.

B. Air terminal devices shall be installed in the ductwork system by Laboratory Temperature and Airflow Control System (LTACS) Contractor. Laboratory Temperature and Airflow Control System Manufacturer shall coordinate delivery and installation schedule of air terminal devices with Mechanical and Controls Contractor.

C. Laboratory Temperature and Airflow Control System Contractor shall assist Project Expeditor in preparation of coordination drawings as specified in Section 20 0000 - General Mechanical Requirements. As part of this effort, this Contractor shall provide locations of control components to Project Expeditor, review schedule for preparation of Coordination Drawings as prepared by Project Expeditor, and attend meetings as required to assist in preparation of documents, and actively participate to resolve layout issues in timely manner.

D. This specification applies to all spaces indicated in Air Terminal Device schedules as having Laboratory air terminals and applies to lab control sequences as specified in specification Section 23 0993 - Control Sequences.

1.4 SUBMITTALS

A. Refer to Division 01 - Submittal Procedures

B. Submit Shop Drawings for all supply, general exhaust, and fume exhaust air terminals, actuators, sash sensors, fume hood controllers/monitors, controllers, master controllers, control wiring, pneumatic tubing, space temperature/humidity sensors and all accessories. Shop drawings shall be complete in all respects and shall include, but not be limited to the following:
   1. Manufacturer's printed product data sheets indicating name and model number of all pieces of equipment.
   2. Name, address and phone number of supplier
   3. Name, address and phone number of local representative
   4. Identification as referenced in documents
   5. Capacity/ratings and dimensional data
   6. Materials of construction and installation requirements

C. Bill of material identifying actual product model number used for each control device for each schematic drawing.

D. Control drawings with graphic representation of system components. Identify controlled devices as referenced on plans with unique valve and damper tag numbers.

E. Electrical characteristics indicate any field wiring which is to be performed by others, type of signal wiring, and installation methods including raceway type and grounding method.

F. Supply and exhaust air terminal certified sound data for both casing discharge and radiated sound levels from 125 through 8000 Hz as tested in accordance with ASHRAE/ANSI Standard 130, S12.12 or AHRI Standard 880.

G. Instrument specifications

H. Controller description

I. System/network architecture configuration diagram showing all controller / control panel types and locations and interconnecting wiring and interface points.

J. Written control sequences describing method of control, alarms, setpoints referenced to tag number of device.

K. Outline drawing showing overall dimension, component location and spacing, and interfacing connections sizes and locations.

L. Identify setpoint or adjustable control range for each control device.

M. Submit Completion Check List as specified in Section 23 0901 - Control Systems Integration.

N. Shop Drawings and complete equipment and software descriptions shall be submitted in sufficient detail to assess equipment’s conformance to this specification and physical size of equipment.

O. Organize submittal with table of contents and tabs for each section arranged by logical groups of devices.

1.5 DESIGN CRITERIA

A. Unit manufacturer, or his designated representative, will be required to verify air terminal device performance and adjust or replace device(s) within warranty period when it is determined that problem exists in area served by device(s).

B. Actuators and linkages shall be furnished and factory installed by Laboratory Temperature and Airflow Control Manufacturer.

C. Standard actuator of manufacturer is acceptable provided it meets criteria specified herein.

D. Actuator and its controller shall be calibrated and either factory set or field set through TAB work for scheduled airflow rates. Air terminals shall be capable of field calibration and readjustment with external gauge taps.

E. Refer to Air Terminal Device schedules for definition of minimum inlet static pressure requirement for each air terminal device as well as sizing criteria.

F. Provide all components not specifically indicated or specified, but necessary to make system function within intent of specification and in accordance with control sequences specified in Section 23 0993 - Control Sequences.

G. Size all control apparatus including all air terminals to provide stable control of systems and equipment served throughout specified operating range.

H. Any devices subject to corrosion, such as in fume hood exhaust ducts, shall be provided with appropriate corrosion protection.

1.6 CODES AND STANDARDS

A. All materials and workmanship described herein shall be in accordance with latest edition and addenda of codes and standards listed below:

1. AMCA Air Movement and Control Association
2. AHRI Air Conditioning, Heating, and Refrigeration Institute
3. ASTM American Standards Testing and Materials
4. NEC National Electrical Code
5. NEMA National Electrical Manufacturers Association
6. NFPA National Fire Protection Association
7. UL Underwriters Laboratories

1.7 FCC COMPLIANCE

A. All equipment furnished under this Contract shall have been tested and made to comply with limits for Class A computing device pursuant to Subpart J of part 15 of FCC Rules, which are designed to provide reasonable protection against interference when operated in commercial environment. Literature shall so note and all equipment shall be so labeled to show this compliance.

1.8 ADJUSTMENT, PERFORMANCE TEST AND CERTIFICATION

A. After completion of installation, regulate and adjust all equipment provided in this contract as outlined in Completion Check List.

B. Conduct complete performance test for all systems to assure compliance with contract documents. Any components on systems found defective or not performing satisfactorily shall be readjusted and retested after necessary corrective measures are performed. Corrective measures may include modification or addition of equipment and devices, control strategies and/or software program.

C. Provide written certification signed by applicable person(s) for incorporation in O&M manuals stating date when successful completion of performance tests is achieved. Letter shall verify all controls are installed and software programs have been completely exercised for proper equipment operation.

1.9 WARRANTY

A. Warrant all work, materials, equipment, and controls against defects in workmanship and material per Article 42 of General Conditions and provide service for period of 1 yr from date of final acceptance by Owner.

B. Replace any defective workmanship or material developing within that time as soon as possible at no charge to Owner.

C. After completion of installation, manufacturer shall regulate and adjust equipment provided in this contract prior to final acceptance.

1.10 OWNER TRAINING

A. Laboratory Temperature and Control System Contractor shall have designated representative available to monitor/modify lab control systems after systems have been started and are regularly used until Owner has completed on-site training specified.

B. Provide minimum of 24hours of on-site training to Owner's representatives. Conduct training sessions during normal working hours after system start-up and acceptance by owner. Scheduling of training session(s) will be established by Owner and shall include both classroom and hands-on training. Portions of training may be performed before system is completely operational, but no sooner than 1 month before system is planned to be fully operational. Final training session shall be held after systems are complete, including all graphics programming.

C. Training sessions shall include, but not be limited to, the following topics:
   1. Explanation of control sequences. Include which sensors are used and how output device operates.
   2. Explanation of control drawings and manuals, including symbols, abbreviations, and overall organization.
   3. Walk-through of Project to identify controller locations and general routing of network cabling.
   4. Review of operation and maintenance of hardware devices including controllers, instruments, and sensors. Include schedule for routine maintenance.

D. Instructions on how to monitor and operate system hardware and software, and how to change system set points, flow rates, etc and respond to alarms.

E. Review interface for troubleshooting using operator interface device.

F. Training sessions shall be conducted during separate visits to site from site visits for system adjustment, performance test and certification.

1.11 OPERATING AND MAINTENANCE MANUALS

A. Refer to Division 01 - General Requirements

B. Operating and maintenance manuals shall provide descriptions of maintenance on all system components including sensors and controlled devices. These shall include Control Contractor's completion check list, inspection requirements, periodic preventative maintenance, cleaning methods and materials, troubleshooting guide, calibration instructions and tolerances, repair parts lists, and manufacturer representative's name, address, and phone number.

C. O&M Manuals shall also include interconnection wiring diagrams with identified and numbered system components and devices.

D. Provide the latest version of all standard software, including any software updates for period of one year, coinciding with warranty period. Beta released software shall not be used.

E. Provide all software tools needed to program, communicate with, or diagnose system controllers.

F. Provide software manual as specified in section 23 0923 1.4 C.

1.12 RECORD DRAWINGS

A. Refer to Division 01 - General Requirements

B. Submit revised Shop Drawings indicating all changes made during project including any changes to operating sequences or setpoints.

C. Update control diagrams to include all tuning parameters and setpoints applicable to systems as depicted as of date of system completion. This information shall be incorporated with sequence of operation of each system.

D. Record actual locations of control components including control units, temperature/humidity sensors, air terminals and any controlled devices on As-Built ductwork/piping plans provided by Mechanical Contractor.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Design of Contract Documents, are based on laboratory temperature and airflow control system as manufactured by Phoenix Controls Corporation.

2.2 GENERAL

A. Materials shall be new and unused and free from defects and imperfections.

B. Laboratory temperature and airflow control system shall be fully stand-alone for each individual laboratory or laboratory support space. System shall not use or rely on information from controllers

in other laboratory areas or from outside laboratory space to control functions within its laboratory. Refer to drawings for location of control panel for each lab space.

C. Laboratory airflow control system shall employ individual Average Face Velocity controllers that directly measure area of fume hood sash opening and proportionally control hood's exhaust airflow in variable volume mode to maintain constant face velocity over minimum range of 25 to 100 % of full sash opening. Safety and energy savings shall be insured through corresponding minimum change in hood exhaust flow of 4 to 1.

D. Electrically actuated terminal units shall be pressure independent with airflow accuracy of ±5% over airflow range of terminal. Air terminal units shall be balanced to conform to requirements of Section 23 0595 - Air Systems Test Adjust Balance.

E. Laboratory airflow control system shall use volumetric offset to maintain room pressurization. Offset airflow is indicated for each lab on Air Terminal Device schedule.

F. Vertical sash sensor shall be provided to measure height of each vertically moving fume hood sash. Horizontal sash sensor shall be provided for each pair of horizontal or overlapping sashes that are located on horizontal, combination, or walk-in type fume hoods. Operational life of sensors shall be minimum of 250,000 cycles. Sash sensors mounted on fume hood sashes shall extend to within 1/8” or less of the edge of the sash trim edge.

G. Provide an individual fume hood controller for each fume hood, which shall maintain face velocity set point in response to sash position. Controller shall maintain constant average face velocity as fume hood sashes are opened and closed. Controller shall modulate exhaust airflow between minimum and maximum air flow rates scheduled in Air Terminal Device Schedules.

H. Control wiring and pneumatic tubing shall meet requirements of specification Section 23 0901 - Control Systems Integration.

I. Control panels (including routers and power supplies) shall be located near entry to each lab as shown on plans. Coordinate location of control panel with all trades to provide access to panel for maintenance. Provide communications jack as part of or adjacent to space temperature sensor to allow communication between laptop computer and control panel. Provide one control panel for each lab as shown on plans.

J. Provide sound attenuator for each air terminal device. Refer to Section 23 3314 - Ductwork Specialties for sound attenuator specification.

2.3 PHOENIX CONTROLS SYSTEM

A. General:

1. The following requirements apply to laboratory temperature and airflow control system manufactured by Phoenix Controls Corporation.

B. Air Terminal Devices - General:

1. Air terminals shall be pressure independent over a 0.3” or 0.6 to 3.0” WG drop across the air terminal. An integral pressure independent assembly shall respond and maintain specific airflow within one second of a change in duct static pressure irrespective of the magnitude of pressure and/or flow change or quantity of airflow controllers on a manifold system.
2. Airflow accuracy shall be ±5% of airflow (not velocity pressure) over an airflow turndown range of no less than 10 to 1.

3. Provide differential pressure switch mounted across each air terminal or other means to signal alarm under low flow condition at each fume hood.

C. Supply and General Exhaust Air Terminals:
   1. Air terminals for non-corrosive airstreams, such as supply and general exhaust air, shall be constructed of 16 ga aluminum. The air terminal shaft and shaft support bracket shall be made of 316 stainless steel. The pivot arm and internal mounting brackets shall be made of a combination of aluminum and stainless steel. The pressure independent springs shall be of combination 302 and 316 stainless steel. All shaft bearing surfaces shall be made of a Teflon or Celenex composite.
   2. Refer to Air Terminal Devices schedule for definition of materials of construction for each air terminal.
   3. Provide external insulation of each supply air terminal device as specified in Section 20 0700 - Mechanical Systems Insulation

D. Fume Exhaust Air Terminals:
   1. Air terminals for corrosive airstreams, such as fume hoods, biosafety cabinets, snorkel, flammable storage cabinets and equipment exhaust shall have the following construction:
      a. Valve body and cone: Baked phenolic coated aluminum
      b. Shaft: Teflon coated 316 SS
      c. Shaft support brackets: Baked phenolic coated 316 SS
      d. Spring: Baked phenolic coated 302/304 SS
      e. Pivot arm: Baked phenolic coated 316 SS
   2. Refer to Air Terminal Devices schedules for definition of materials of construction for each air terminal.

E. Air Terminal Actuators
   1. For VAV operation, pneumatic actuator shall be factory mounted to air terminal. Loss of pneumatic main air or control power shall cause exhaust air terminals to fail open to maximum scheduled design flow and supply air terminals to fail to minimum scheduled design flow. Constant volume air terminals do not require actuators and shall be manually set for scheduled air flow.

F. Certification
   1. Each air terminal shall be factory calibrated to job specific airflows as detailed on plans and specifications using NIST traceable air stations and instrumentation having combined accuracy of at least ±1% of signal over entire range of measurement.
   2. Air terminals shall be individually marked with air terminal specific model number, and quality control inspection numbers. Information shall be stored on computer CD diskette in ASCII Format by manufacturer for future retrieval or for hard copy printout to be included with as-built documentation.

G. Air Terminal Controllers:
   1. Controller shall use electronic-based, closed loop control to regulate airflow.
   2. Response time to vary air terminal's airflow to within 90% of its commanded setpoint value shall be no more than one (1) second with less than 5% undershoot or overshoot.

H. Laboratory Temperature and Airflow Control System :

1. A Celeris 2 Controller(s) mounted on supply air terminal(s) with I-to-P interfaces with Phoenix devices shall control the supply and/or general exhaust air flow air terminal devices to maintain proper room pressurization polarity (positive or negative) via airflow offset. Each laboratory suite shall have a dedicated sub network defined by a Celeris 2 router.
2. Supply/exhaust terminal controller shall be microprocessor-based digital controller. It shall control and communicate digitally via LON – 78kbps (a high-speed room level digital network) with up to thirty two digital fume hood, snorkel, flammable storage, equipment, general exhaust, makeup, and laboratory office air flow control devices within a particular pressurization zone.
3. Supply/exhaust terminal controller shall maintain a constant design offset between the sum of the room's total exhaust and make-up/supply air flows. This offset shall be field adjustable from the BAS graphic for the suite and represents the volume of air which will enter (or exit) the room from adjacent spaces.
4. LON routers shall have the capability for full stand alone operation and shall be capable of communicating digitally with up to 100 routers or LON network devices over a secondary high-speed building wide digital laboratory control system digital network Lon-1.25Mbs. High-speed building wide network not provided for this work.
5. Terminal controllers shall provide an EIA-232 port for connecting a notebook computer, desktop computer, modem, or alarm printer. This EIA-232 port shall provide access to all points of the LON networks.
6. Terminal controllers shall accommodate sufficient point to address temperature control and non-network sensors.
7. Routers shall be panel mounted in a NEMA enclosure and shall operate on 24 V AC power. Mount 24 V AC transformers for the routers in an enclosure that is accessible or adjacent to the routers.
8. All network components shall meet FCC Part Subpart L Class A, and be UL 916 listed.
9. Supply air terminal controller shall provide control signal to reheat coil control valve, radiant panel control valve, and/or chilled beam control valve to maintain space temperature. Provide devices as required to interface with electronic control of reheat coil control valves. Refer to Specification Section 23 0901, 23 0902, and 23 0993.

I. Fume Hood Controller:
1. Provide for each fume hood an individual fume hood controller, which shall maintain face velocity setpoint (adjustable) in response to sash position. Controller shall maintain constant average velocity as fume hood sash is raised and lowered, or moved horizontally. The controller shall calculate average face velocity from exhaust cfm and hood open area. This face velocity is compared to the setpoint to calculate the required exhaust air flow. The actual airflow must be measured and used for control.
2. Controller shall be UL 916 Listed.
3. Controller shall support fume hood sash configurations utilized in this project. Coordinate with fume hood manufacturer.
4. Initial setpoint for face velocity shall be 100 fpm with 18" sash open height for all hoods except radioisotope hoods, which have setpoint of 125 fpm with 18" sash open height.
5. Provide general alarm output for use with auxiliary devices.
6. Momentary or extended losses of power shall not change or affect any of control system's setpoints, calibration settings, or emergency exhaust mode status. After power returns system shall continue operation exactly as before without need for operator intervention. Under no circumstances shall loss of power command exhaust system to full flow upon return of power.

J. Fume Hood Monitor:
   1. A FHM 430-ENG fume hood monitor shall be provided for each fume hood to comply with laboratory safety standards. Standard Operation: Fume hood is operating within acceptable tolerance levels (Face Velocity = SETPOINT ±15%)
   2. Standby Operation: (Setback feature based on hood zone presence sensor OR time of day is when configured into system)
   3. Caution/Low Flow Alert (also triggers integral audible alarm) as derived by:
      a. Insufficient exhaust static pressure as indicated by PDS (integral to controller) across VEV-(*) Static Pressure < 0.15 kPa (0.6" WC).
      b. Inferred air flow (as indicated by integral actuator position feedback sensor) does not match controller output.
      c. Emergency Exhaust Alert (also triggers integral audible alarm): hood is operating in Emergency Exhaust Mode as initiated by integral Emergency Exhaust pushbutton on FHM.
   4. Device shall provide the following control functions:
      a. Alarm mute: Integral pushbutton to silence the audible alarm except during emergency purge mode. During a non-emergency mode, the audible alarm shall re-activate if it has not cleared after a 10 to 15 minute period from the Alarm mute button being pressed.
      b. Emergency Exhaust: Integral pushbutton to command exhaust valve VEV-(*) 100% open.
      c. There shall be no local indication of face velocity.

K. Room Temperature Sensors:
   1. Sensors shall be 10K ohm thermistor type by Automation Components, Inc. (ACI) or Building Automation Products Incorporated (BAPI). Thermistor shall incorporate jumpers and RJ-11 connector specific to the “Phoenix” option. Sensor shall include communication jack to allow remote programming via laptop computer. Temperature sensors shall have remote sensor located in room general exhaust duct and adjustable setpoint adjustment and temperature adjustment in wall enclosure for each laboratory or laboratory support space and shall be programmable with adjustable deadband set point between 72°F and 78°F.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Furnish and install fume hood monitors and sash sensors at each fume hood. Coordinate installation requirements with fume hood manufacturer.

B. Install units as shown on drawings, schedules and details. Coordinate with Mechanical Contractor to verify appropriate ductwork configuration to allow for accurate measurement and control of airflow.

C. Laboratory Temperature and Airflow Control System manufacturer shall furnish, install and terminate all low voltage control wiring and 24 VAC power supplies. Laboratory Temperature and Airflow Control System manufacturer shall furnish and install pneumatic control tubing required for laboratory control devices that are pneumatically operated.

D. Air Terminals and Reheat Coils:

1. Laboratory Temperature and Airflow Control System Contractor shall furnish to Mechanical Contractor to install air terminals, sound attenuators, reheat coils and access doors as shown on drawings and according to manufacturer's instructions. Mechanical Contractor shall install reheat coil control valves furnished by Temperature Control Contractor. Mechanical Contractor shall provide necessary ductwork transitions as required for mounting equipment provided by LTACS Contractor.
2. Mount actuators on same side of air terminal device as coil connections to ensure service access.
3. Connect air terminals to ductwork with removable type joints as detailed.
4. Transition from supply air terminal to reheat coil shall not exceed 15° per side.
5. Provide access doors for supply air terminals with reheat coils. Mount access door at inlet side of coil. Refer to Section 23 3314 - Ductwork Specialties for access door requirements.

E. Fume Hood Controls:
1. Furnish to fume hood manufacturer templates for required hood mounted devices including vertical and horizontal sash sensors, interface boxes, and fume hood monitors required for complete installation of fume hood exhaust air control system. Fume hood manufacturer shall provide necessary cut outs with blank cover plates.
2. Fume hood size and sash configuration are called out in Lab Furnishings documents. Verify with fume hood manufacturer fume hood sizes, sash configurations and installation requirements for each device.
3. Laboratory Temperature and Airflow Control System manufacturer shall field install, mount and wire required hood mounted devices.

F. Control Air:
1. Source for control air will be provided at each floor. Verify locations and pressures required with Mechanical and/or Piping Contractors.
2. Laboratory Temperature and Airflow Control System manufacturer shall provide pneumatic piping and devices required for complete and proper system functioning from control air source at each floor.
3. Provide filter stations to Temperature Control Contractor to be mounted in control air piping at source of control air to provide required air quality.

G. Control and Power Wiring:
1. Laboratory Temperature and Airflow Control System (LTACS) manufacturer shall provide control wiring from laboratory control panel to and between other laboratory control system components as required for complete and proper functioning, including but not limited to air terminals, control valves, sensors, transducers, controllers, panels, and interface modules.
2. Electrical Contractor will provide one spare 20 A circuit at each emergency power electrical panel, serving laboratory. LTACS supplier shall provide required conduit, wire, junction boxes, disconnect switches and circuit breakers as specified in Division 26 as required to wire electrical panel to each laboratory control panel.
3. LTACS supplier will provide power wiring to routers and terminal controllers in each laboratory suite.

H. Laboratory Control Panels and Power Supplies:
1. Mount laboratory control panels and power supplies in accessible location within laboratory room as shown on plans.

2. Coordinate location of electrical power panels with Division 26 Contractor.

I. Laboratory Control System Start-up:
   1. System startup shall be provided by factory authorized representative of system manufacturer.
   2. Coordinate timing of start-up with Mechanical Contractor to confirm HVAC Systems are operating as specified.
   3. Startup shall be performed on complete laboratory temperature and air flow control system and shall include calibration of each laboratory control system component; check out of air terminals, actuators, fume hood sash sensors, temperature sensors, and verification that each system operates in compliance with specified control sequences.
   4. Laboratory Temperature and Airflow Control System manufacturer shall measure and set up fume hood average face velocity. Coordinate with and work in conjunction with TAB Contractor.
   5. Laboratory Temperature and Airflow Control System manufacturer shall set up system supply, general exhaust, and fume exhaust air flows in cooperation with TAB Contractor. TAB Contractor will take required air flow measurements.
   6. Laboratory Temperature and Airflow Control System manufacturer shall provide a visual demonstration that the laboratory airflow systems are maintaining specified hood containment performance requirements. If the performance requirements cannot be demonstrated, then system supplier shall be responsible for any costs and labor necessary to meet minimum performance requirements. Coordinate with and work in conjunction with TAB Contractor.
   7. Laboratory Temperature and Airflow Control System manufacturer shall demonstrate that, with specified room offset, system maintains proper room directional air flows under both static and dynamic operating conditions, and can recover to proper flow direction within one second of change in room/system conditions such as raising and lowering of any hood sashes. Verification shall be provided by temporary visual indication, using smoke wand. If performance requirements can not be demonstrated, then laboratory control system manufacturer shall be responsible for any costs and labor necessary to meet minimum performance requirements. Coordinate with and work in conjunction with TAB Contractor.

END OF SECTION

SECTION 23 3615 FACILITY MONITORING SYSTEM

PART 1 - GENERAL

1.1 RELATED WORK

A. Division 01 - Submittal Procedures

B. Section 23 05 95 - Air Systems Balance

C. Section 23 09 01 - Control Systems Integration

D. Section 23 09 02 - Control Valves and Dampers

E. Section 23 09 93 - Control Sequences

F. Section 23 33 14 - Ductwork Specialties (Sound attenuators and access doors)

G. Section 23 82 14 - Heating and Cooling Terminal Devices

1.2 SUBMITTALS

A. Shop Drawings shall include:

1. Index: The first sheet of the Shop Drawings shall be an Index of all sheets in the set.
2. Legend: A description of symbols and acronyms used shall be provided at the beginning of the set of Shop Drawings.
3. Communications Riser: A single-page diagram depicting the system architecture complete with a communications riser. Riser shall include room locations and addressing for each Air Data Router and Sensor Suite. Include a Bill of Material for all equipment in this diagram but not included with the unique controlled systems.
4. Device Addressing Scheme: Install controllers implementing an addressing scheme consistent with a reference-document. The addressing scheme shall be submitted, reviewed and approved by the owner's BAS Group prior to implementation.
5. Equipment Numbering: Equipment numbering scheme shall be submitted, reviewed and approved by the owner's BAS Group prior to implementation.
6. Systems Summary: Drawings shall include a table listing each piece of equipment and the area(s) served by each piece of equipment.
7. System Schematic: Drawings shall include a single-line representation of all areas being monitored and/or controlled, including all field devices required for properly controlling equipment and implementing the sequences of operation for this project.
8. Point-to-point Wiring Details: Drawings shall include point-to-point wiring details and must show all field devices, routers, sensor suites, controllers, panel devices, wiring terminal numbers and any special information (i.e. shielding requirements) for properly monitoring areas and controlling equipment.
9. Bill of Material: Drawings shall include a bill of the material necessary and used for properly controlling equipment and implementing the required sequences of operation.
10. Configuration Details: Drawings shall include test and cluster sequence schedules for each test point.
11. As-Built Drawings shall be created after the final system checkout, by modifying and adding to the Shop Drawings. As-Built Drawings shall show exact installation. As-Built Drawings will be acknowledged in writing by the project design engineer and the owner's representative after the final

checkout of the system. The system will not be considered complete until the As-Built Drawings have received their final approval. The FMC shall provide electronic version of As-Built Drawings.

B. Operating and Maintenance Manuals
   1. Operating and Maintenance (O&M) manuals for the system shall include project specific, detailed information describing the specific installation. Manual shall contain as a minimum:
      a. System overview
      b. Networking architecture
      c. Established test sequences and cluster schedules
      d. Hardware cut-sheets and product descriptions
      e. Wiring diagrams for all controllers and field hardware
      f. Installation, mounting and connection details for all field hardware and accessories
      g. Commissioning and setup parameters for all field hardware
      h. Maintenance procedures, including final tuning and calibration parameters
   2. Provide the latest version of all standard software, including any software updates for period of one year, coinciding with warranty period. Beta released software shall not be used.
   3. Provide all software tools needed to program, communicate with, or diagnose system controllers.
   4. Provide software manual as specified in section 23 0923 1.4 C.

1.3 OVERVIEW

A. This document contains the specification and input/output summaries for a Facility Monitoring System (FMS). The system architecture shall utilize local room sensors, duct and outside air probes networked to distributed Air Data Routers and Sensors Suites communicating over a data and air sampling network. The air sampling network shall consist of an air packet transportation network that shall transport air samples from the environment being monitored to distributed Sensor Suites located throughout the facility. The air sampling network shall consist of intelligent air packet routers, an electrically conductive MicroDuct® network, and structured cable. Gathering of air samples shall occur via room, duct mounted, and outside air sampling sensors and probes located as indicated in the documents. The FMS shall provide continuous monitoring of environmental conditions as prescribed in the Sensor Suite section, and provide protected information access via a web based user interface to analytical summaries in onscreen graphical form and as a comma separated values (.csv) file format. The FMS shall interface with other analog and microprocessor based building subsystems as shown on the drawings, specified herein and in other sections.

1.4 DEFINITIONS

A. BAS refers to the Building Automation System. (Similar terms are: EMS, Energy Management System; BMS, Building Management System; or ATC, Automatic Temperature Control.)

B. FMC refers to the Facility Monitoring System Contractor. The FMC is the Contractor responsible for the implementation of this Section of the Specifications.

C. FMS refers to the hardware, software and other components comprising the Facility Monitoring System as herein described.

D. I/O refers to Input/Output. Thus, "I/O device" means "Input/Output device".

1.5 CONTRACTOR (FMC) EXPERIENCE AND PERFORMANCE

A. The FMC shall have a local office or representative, staffed with factory trained engineers, fully capable of providing instruction, routine maintenance, and emergency maintenance service on all system components. The FMC shall be responsible for replacement of all products supplied at all times for a period of not less than 5 year following project completion, including sensor calibration and hardware, and shall provide a 4 hour response to a service/warranty call from the owner.

1.6 SENSOR PROPOSAL

A. A proposal shall be furnished to the owner at the time of the bid noting all annual service costs for the sensors and sensor elements to be provided within the Sensor Suite; and all costs to insure their ongoing performance. The proposal shall detail all costs for sensor element replacement, calibration services, diagnostics, software upgrades, materials and equipment necessary for ongoing sensor operation. As a minimum, twice a year, provide calibration with NIST approved calibration gases and test instrumentation, functional testing, sensor element evaluation to determine useful life and element replacement as required, and evaluation services to insure the ongoing performance of all sensors as installed system per this specification. This service shall include, but not be limited to the following:

1. Provide a factory certified depot to remove all sensors within the sensor suite on a periodic basis (as a minimum, twice per year), and replace with pre-packaged, certified, industry traceable, factory calibrated sensors. Removed sensors shall be returned to the FMC for factory recalibration, upgrades, sensor element replacement, and component and board repairs. Written records shall be provided to the owner for every visit indicating the performance of such calibrations along with all pertinent data.
2. All costs for the repair and replacement of any defective sensor, and for any consumable element or part on the sensor shall be included.
3. All system software upgrades to correct bugs, fixes and patches for the sensors shall be included.

PART 2 - PRODUCTS

2.1 CONTRACTOR RESPONSIBILITIES:

A. The FMC shall furnish all necessary hardware, wiring, structured cable, tubing, computing equipment and software required to provide a complete and functional system necessary to perform the design intent and as defined in this specification.

B. Installation of all FMS components; and all electrical work required as an integral part of this section as noted in Part 3.0 Execution including but not limited to Sensor Suites, Air Data Routers, Room Sensors, Duct Probes, Transformers, Vacuum Pumps, Information Management Servers, Structured Cable, etc., shall be by this contractor.

C. A separate proposal shall be furnished to the owner by the FMC at the time of the bid noting all annual service costs for the sensors in the Sensor Suite; including sensor element replacement, calibration, warranty, and diagnostic services as specified in paragraph 2.7.

2.2 SYSTEM REQUIREMENTS

A. All material and equipment used shall be standard components, regularly manufactured and available by the manufacturer and not custom designed especially for this project. All systems and components, except site specific software, shall have previously been thoroughly tested and proven in actual use prior to installation on this project.

B. The system architecture shall be fully modular permitting expansion of application software, system peripherals, and field hardware.

C. The system, upon completion of the installation and prior to acceptance of the project, shall perform all operating functions as detailed in this specification.

D. EQUIPMENT
   1. System Hardware
      a. The FMC shall provide the following:
         1). All Air Data Routers, Sensor Suites, Sensor Suite Sensors, Room Sensors, Duct Probes, Outside Air Probes (installed in the supply ductwork), Information Management Servers, Vacuum Pumps, Structured Cable, transformers required to perform the functions listed.
   2. System Software
      a. The FMC shall provide all software identified in this specification. The database required for implementation of these specifications shall be provided by the FMC, including point descriptors, test sequences, reports and point summaries. The FMC shall provide and create the system using the latest software release, at the time of Shop Drawing approval.
      b. The FMC shall provide a BACnet compatible integration server and software to interface with the facility's BAS.
   3. Building Ethernet Connection Cabling:
      a. The FMC shall provide CAT-5e or CAT-6 cabling and installation between the Information Management Server and the owner's Building Ethernet Connection. Final Building Ethernet Connection shall be coordinated with the owner's IT Group.
   4. Codes and Regulations
      a. All electrical equipment and material and its installation shall conform to the current requirements of the following authorities:
         1). Occupational Safety and Health Act (OSHA)
         2). National Electric Code (NEC)
         3). National Fire Code
   5. All Air Data Routers and Sensor Suites shall be listed per:
         1). Underwriters Laboratories UL916 for Open Energy Management
   6. 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.
   7. The control system manufacturer shall have quality control procedures for design and manufacture of facility monitoring systems for precision monitoring, indoor air quality, energy savings and preventative maintenance.
   8. The FMC shall provide all test area attribute data and programming and shall coordinate object naming conventions and network map requirements with the owner's internal BAS department. The naming convention shall be submitted with the FMC Shop Drawings for review and approval by owner's BAS department.

2.3 AIR DATA ROUTERS

A. The Air Data Router shall be furnished as a complete, self-contained, unit housing all electronics, air solenoid valves, sampling manifolds, firmware, and software. Unit shall be furnished with all internal devices and wiring assembled and tested at the factory.

B. Air Data Routers shall receive commands from the Sensor Suite to open the solenoid valve of each test area to be monitored while simultaneously closing all the other solenoid valves in the system. A direct path between the test area and the virtual sensors located with the Sensor Suite shall be established to draw a continuous stream of air through the Structured Cable.

C. Air Data Routers shall consist of an enclosure; terminations areas for both field wiring and Structured Cable connections; a communications/processor board; high capacity solenoid valves; and sampling manifold.

D. Air Data Router shall have provisions to interface to the FMS Structured Cable. Air Data Router shall utilize an internal, factory pre-assembled air sampling manifold to interface to the on-board solenoid valves, and push to connect speed fittings for ease of interface to the Structured Cable. Romex connectors and knockouts shall be factory furnished and installed on the Router.

E. Air Data Routers shall be capable of sampling of up to four test areas. Air Data Routers shall be sized and configured with the appropriate number of air sampling solenoid valves including all hardware and software to accommodate the number of test areas noted on the plans and/or specifications.
   1. Air Data Router shall have the capacity to sense per test area the temperature at the room, duct or outside air via a room temperature sensor, duct probe, or outside air probe. A total of four sensor inputs shall be provided that corresponds to the air sampling of the respective four test areas.
   2. Air Data router shall be capable of accepting universal 0-10Vdc and 4-20mA inputs and outputs through expansion boards for interfacing to other third party devices and controllers.

F. Up to 30 Air Data Routers shall communicate on an isolated RS-485 network with the Sensor Suite.

G. All point data, algorithms and application software within the Air Data Routers shall be programmable from the Information Management Server. Each Air Data Router shall contain both software and firmware to receive and perform full test sequencing schemes downloaded from the Server.

H. Each Air Data Router shall contain a serial port for the interface with a portable computer. Air Data Router and network interrogation shall be possible through this port.

I. Air Data Routers shall be capable of proper operation in an ambient temperature environment of 40 degrees F to 120 degrees F (4.4° – 49°C), 0 – 90% RH.

J. Air Data Routers shall have LED indication for visual status of communication and power.

K. Air Data Routers shall operate on 24Vac power fed from a common 120/24Vac transformer connected to the Sensor Suite that serves the Air Data Router. Low voltage power shall be distributed to the Air Date Routers through the associated structured cable.

2.4 SENSOR SUITE

A. The Sensor Suite shall be a distributed, network based, multipoint sensing device. The Sensor Suite shall be furnished as a complete, self contained unit housing all electronics, sensing card cage, sampling manifolds, flow regulators, pressure regulators, firmware, and software.

B. The Sensor Suite shall provide communications between the Air Data Router sub network and the Information Management Server over an isolated RS-485 network. The Sensor Suite shall support communications with a sub network of 30 Air Data Routers; 30 other Sensor Suites, and an Information Management Server.

C. The Sensor Suite base unit shall consist of an enclosure; hinged door with keyed lock; terminations area for both field wiring and Structured Cable connections; a communications/processor board; electronic flow measurement and controller assembly; and sensor bay.

D. The Sensor Suite shall utilize a card cage to allow for the ease of selection and installation of a diverse array of environmental and specialty sensors. At a minimum, the Sensor Suite shall incorporate the following sensors to meet the required applications:

E. The Sensor Suite shall be modular in nature, and allow for the addition and removal of the sensors for application specific sensing requirements, and ease of calibration and service. Additional, modular sensor bay expansion capabilities shall be provided for additional sensors.

F. The Sensor Suite shall house an on-board flow regulator, orifice plate, and differential pressure sensor to maintain a continuous, regulated flow rate through the Structured Cable.

G. On-board diagnostics shall continuously perform system checks.

H. Each Sensor Suite shall contain a serial port for the interface with a portable computer. Sensor Suite and network interrogation shall be possible through this port.

I. Sensor Suites shall be capable of proper operation in an ambient temperature environment of 40 degrees F to 120 degrees F (4.4° – 49°C), 0 – 90% RH.

J. Sensor Suites shall have LED indication for visual status of communication and power.

K. Sensor Suites shall operate on 24Vac power fed from a common 120/24Vac transformer connected to the Sensor Suite provided by the FMC. Transformer shall also distribute low voltage power to the Air Date Routers connected to the Sensor Suite through the associated structured cable.

2.5 HIGH FLOW VACUUM PUMP

A. Each Sensor Suite will be equipped with a High Flow Vacuum Pump (HFP) that will draw samples from the sampling ports in the system, through the Sensor Suite, and then discharge them. Samples will be discharged local to the pump.

B. The HFP will meet the following specifications:
   1. Maximum Vacuum pressure: 24 inches Hg
   2. Minimum Flow Rate: 1.2 SCFM

C. Pump Control Module shall be capable of continuously monitoring vacuum levels and enable back-up pump. Rest to primary pump operation shall be via push-button. Status shall be reported to Information Management Server.

D. Pump mounting: Pump shall be mounted securely to prevent it from moving due to vibration, and in a location where the sound of the pump will not be heard outside the immediate area.

2.6 INFORMATION MANAGEMENT SERVER

A. The Information Management Server (Server) shall provide network management of Sensor Suites, integration to the BAS, and interface to the web based Aircuity Knowledge Center for viewing and outputting graphs, charts and data derived from the Facility Monitoring System. Server to be located in room 146A.

B. The hardware platform for the Server shall, at a minimum, consist of:
   1. PC processor with minimum 64-bit word structure.
   2. Minimum 1.8 GHz processor speed.
   3. Minimum 2GB on board RAM
   4. Hard drive or equal high-speed data storage, minimum 250 gigabytes.
   5. Network Interface Card: (10/100)
   6. RS-232 Serial Port
   7. Operating System shall be Windows XP.

C. The FMS contractor shall provide CAT-6 cabling and installation between the Information Management Server's Network Interface Card and the owner's Building Ethernet Connection, located within room 146A. Final Building Ethernet Connection shall be coordinated with the owner's IT Group.

2.7 STRUCTURED CABLE

A. The FMS shall utilize a pre-engineered system of Structured Cable to facilitate network wide communications; distribution of low voltage power to Air Data Routers and Sensor Suites; and provide a sampling conduit for air samples all within a single cable.

B. The cable shall consist of a plurality of wires to distribute communications, data and low voltage power throughout the FMS. As a minimum, Structured cable shall consist of:
   1. Communications – 22 AWG twisted shield pair with drain wire
   2. Low Voltage Power – 18 AWG, 3 wire

C. An inner pathway, MicroDuct, shall be furnished as an integral part of the Structured Cable to facilitate collection of test area air samples. MicroDuct shall be lined with a smooth, electrically conductive, chemically inert surface to insure air samples remain pure and uncorrupted and do not adhere to the wall lining during transport. Aircuity OSC or stainless steel tubing only. No exceptions. Polyethylene tubing, copper tubing, galvanized pipe are not acceptable. See below for stainless steel specifications.

D. Structured cable shall not require any specialized tools for installation. Installation of the cable shall follow traditional local area network practices.

E. Structured cable shall be suitable for riser and plenum applications, be Underwriter's Laboratories Listed to UL CMP and C-UL CMP standards, and carry the appropriate markings throughout the cable length.

2.8 ROOM SENSORS/DUCT PROBES

A. Room Sensors:
   1. A semi-flush mounted, room temperature sensor with an integral air sampling port are to be housed within one enclosure; the port within the enclosure will accept the MicroDuct from the Structured Cable.
   2. Temperature Sensing Element:
      a. Thermistor: range 30 – 120 °F (-1 – 49 °C)
      b. Accuracy: + 0.75 °F (+ .42 °C)
   3. Internal coarse filter to screen out large particulate matter from entering the MicroDuct.
   4. Terminations:
      a. Sensor – one wire
      b. Power – three wire
      c. MicroDuct – integral hose clamp
   5. Option to only include the MicroDuct sampling, the internal temperature sensor shall not be included.
   6. Duct Probe – Duct and Outdoor Air Mount
      a. A duct temperature sensor and air sample probe is to be mounted within one enclosure. Duct sample probe to accept integral MicroDuct from Structured Cable.
      b. Temperature Sensing Element:
         1). Platinum RTD: range -30 – 130°F (-34 – 54 °C)
         2). Accuracy: + .30 °F (+ .17 °C)
      c. Internal coarse filter to screen out large particulate matter from entering the MicroDuct.

d. Terminations:
   1). Sensor – one wire
   2). Power – three wire
   3). MicroDuct – speed fitting

e. Option to only include the MicroDuct sampling, the internal temperature sensor shall not be included.

f. Outdoor Air Locations – A NEMA 4X weatherproof enclosure shall be provided.

2.9 SYSTEM SOFTWARE OVERVIEW

A. The FMC shall provide all software required for operation of the FMS system specified herein. All functionality described herein shall be regarded as a minimum. The FMC shall provide the following as a minimum:
   1. Completed database.
   2. Configuration of all Air Data Router, Sensor Suite, Server and user interface application programs.
   3. All Configuration Tools, and all software licenses, required to configure and operate all products installed on this project.

2.10 SYSTEM CONFIGURATION

A. Database Creation and Modification. All changes shall be done utilizing standard procedures. The system shall allow changes to be made at the local site through the Information Management Server.

B. The system shall permit the operator to perform, as a minimum, the following:
   1. Add and delete points/objects
   2. Modify point parameters
   3. Create and modify control sequences and programs
   4. Reconfigure application programs

2.11 WEB BASED USER INTERFACE AND DATA MANAGEMENT SYSTEM

A. Included with the system shall be a fully integrated web based user interface and data management system. The data management system shall be password protected and shall be able to store sampled data from all test areas for online viewing and reporting.

B. Unlimited data access, viewing, report generation and remote data storage shall be provided with the FMS for the duration of the project commissioning and for the entire warranty period.

2.12 TEST SEQUENCING

A. The system shall allow the operator to designate any test area to be scheduled with an operator command through the Information Management Server.

B. The operator shall be able to make all schedule additions, modifications and deletions to the test schedules. The operator shall have the capability to edit all schedules and then download any or all schedule changes to the FMS.

PART 3 - EXECUTION

3.1 GENERAL

A. Verify that systems are complete and ensure that the systems are capable of being started and operated in a safe and normal condition before attempting to operate the FMS.

B. Install software in Air Data Routers, Sensor Suites and Server. Implement all features of programs to specified requirements and as appropriate for sequence of operation.

C. Connect and configure equipment and software to achieve sequence of operation specified.

3.2 WIRING INSTALLATION

A. Install systems and materials in accordance with manufacturer's instructions, rough-in drawings and equipment details. Install electrical components and use electrical products complying with requirements of applicable Division 23 09 23 sections of these specifications.

B. All wiring shall be installed neatly and professionally, in accordance with requirements of applicable Specification Division 23 09 23 section and all national, state, and local electrical codes. All the wiring shall be installed in accordance with the current National Electrical Code (NEC).

C. Provide wiring as required by functions as specified and as recommended by equipment manufacturer to serve specified control functions.

D. Install wiring and cables according to Division 23 09 23 section and as follows:
   1. Bundle and harness multi-conductor cable in place of single cables where several cables follow a common path.
   2. Fasten flexible conductors, bridging cabinets and doors, along hinge side; protect against abrasion. Tie and support conductors.

E. All control wiring shall be installed in a neat and workmanlike manner parallel to building lines with adequate support. Both conduit and plenum wiring shall be supported from or anchored to structural members. Conduit or plenum wiring supported from or anchored to piping, duct supports, the ceiling suspension system, is not acceptable. Wiring buried in slab-on-grade concrete or explosion-proof areas shall be in rigid metal conduit. Provide adequate strain relief for all field terminations.

3.3 CONTROL DEVICE INSTALLATION

A. All room sensors shall be mounted so as to be accessible in accordance with ADA Guidelines, unless otherwise noted on the drawings.

B. Freestanding enclosures and panels shall be supported on steel unistrut frames, or approved equal, and be securely anchored to the floor and be well braced.

C. Enclosures and panels mounted directly to the wall shall be provided with a minimum airspace of 2" between the enclosure and the wall.

D. A minimum of 3' working clearance shall be provided in front of all enclosures and panels; clearance shall be ensured to permit the enclosure door to open at least 90° from its closed position.

E. Mounting height shall be a maximum 6'-6" to the top of the Sensor Suite enclosure.

F. A field-installed, 14-gage galvanized steel drip shield shall be provided where enclosures and panels may be subjected to dripping water.

3.4 CONTROL POWER

A. Provide power for Air Data Routers, Sensor Suites, Server and associated FMS components from nearest electrical control panel noted below or as indicated on the electrical drawings—coordinate with Electrical Contractor.
   1. Power supply for Air Data Routers, Sensor Suites, Server and associated FMS components shall be connected via a dedicated circuit to the building normal electrical distribution panel. A grounding conductor shall be run from building service entrance panel ground bus. Conductor shall be insulated and isolated from other grounded conductors and building conduit system.
   2. Power supply for Air Data Routers, Sensor Suites, Server and associated FMS components serving critical spaces (i.e. Animal Rooms) shall be connected via a dedicated circuit to the building emergency distribution panel.

3.5 IDENTIFICATION

A. The FMC shall label each system device with a point address or other clearly identifiable notation inside the device cover - labels shall be permanent. All FMS equipment shall be clearly identified as noted on the approved submittals.

3.6 ACCEPTANCE OF COMPLETED FMS INSTALLATION

A. Upon completion of the installation, the FMC shall start up the system and perform all necessary calibration, testing, and debugging operations. An acceptance test shall be performed by the FMC in the presence of the design engineer, job site project manager, and owner’s representative. Acceptance test shall be scheduled with at least 10 working days advance notice. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including piping and electrical connections.

B. After electrical circuitry has been energized, start units to confirm proper unit operation. Remove malfunctioning units, replace with new units, and retest.

C. Demonstrate compliance with specifications, including calibration and testing, and air sampling test sequences. Adjust, calibrate, and fine tune circuits and equipment to achieve sequence of operation specified.

D. The acceptance test shall include, but not be limited to:
   1. The FMC shall verify the proper operation of all input/outputs.
   2. The FMC shall verify all inputs meet or exceed manufacturer’s stated tolerances for accuracy.
   3. The FMC shall verify that all on-line graphical displays of air sampling test data accurately represent the real time state of the field conditions.
   4. The FMC shall verify the reliability of all communications of all Air Data Routers and Sensor Suites.
   5. The test shall include functional verification of all interfaces and system integration required to meet the scope of this project.

E. Acceptance: When the field test procedures have been successfully demonstrated to the design engineer, job site project manager, or owner’s representative and the system performance is deemed satisfactory, the system parts will be accepted for beneficial use and placed under warranty. At this time, a "notice of completion" shall be issued by the owner’s representative and the warranty period shall start.

3.7 TRAINING

A. The FMC shall provide factory-trained instructor to give full instructions to designated personnel in the operation, maintenance, and programming of the system, a minimum of 8 hours of training on separate

days shall be provided. Instructors shall be thoroughly familiar with all aspects of the subject matter they are to teach. The training shall be specifically oriented to the system and interfacing equipment installed.

B. Instructions shall include 2 parts, the “New Equipment Orientation” and the “Product Training”.

C. New Equipment Orientation: A “walk-through” session shall include showing where all field equipment is located throughout the area involved in the project.

D. Product Training: Train technical services and maintenance personnel on-site to adjust, operate, and maintain the FMS. As a minimum:
   1. Train personnel on procedures and schedules for starting and stopping test sequences, troubleshooting, servicing, and maintaining equipment.
   2. Provide operator training on modification of data display, test area descriptors, executing commands, resetting default values, and requesting reports.

END OF SECTION

SECTION 23 3713 DIFFUSERS, REGISTERS AND GRILLES

PART 1 - GENERAL

1.1 SUBMITTALS

A. Shop Drawings including, but not limited to, the following:
   1. Manufacturer's name and model number
   2. Identification as referenced in the Documents
   3. Capacities/ratings
   4. Materials of construction
   5. Sound ratings
   6. Dimensions
   7. Finish
   8. Color selection charts where applicable
   9. Manufacturer's installation instructions
   10. All other appropriate data

1.2 DESIGN CRITERIA

A. Performance data shall be based on tests conducted in accordance with ASHRAE Standard 70-2006.

B. Screw holes on surface shall be counter sunk to accept recessed type screws.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Titus, Price, Carnes, Nailor, Anemostat, Metalaire, or Krueger

B. Acceptable manufacturers for specialty products are listed under each item.

2.2 CEILING DIFFUSERS

A. Diffusers shall be aluminum or steel as scheduled, unless otherwise indicated, and furnished with frame type appropriate to installation. Furnish diffusers with equalizing grids where it is not possible to maintain minimum 2 times duct diameter straight duct into diffuser. Equalizing grids shall consist of individually adjustable vanes designed for equalizing airflow into diffuser neck and providing directional control of airflow.

B. Diffuser models, sizes and finishes shall be as shown on drawings and/or as scheduled. Unless noted otherwise, diffusers shall have baked enamel or powder coat finish with white color as approved by Architect.

C. Perforated face ceiling diffusers shall have minimum 51% free face area and pattern controllers accessible through removable or hinged faceplate. Unless otherwise indicated, pattern controllers shall be curved vane type mounted in neck of diffuser. Unless otherwise indicated, furnish diffusers with round neck inlets with minimum 1” depth.

2.3 REGISTERS AND GRILLES

A. Registers and grilles shall be aluminum or steel as scheduled unless otherwise indicated, and furnished with frame type appropriate to installation.

B. Supply registers and grilles shall be double deflection type blades to provide for air deflection adjustment in all directions.

C. Return and exhaust registers and grilles shall have fixed blade core.

D. Registers shall be furnished complete with opposed blade volume control dampers, operable from face.

E. Register and grille models, sizes and finishes shall be as shown on drawings and/or as scheduled. Unless noted otherwise, registers and grilles shall have baked enamel finish with color selected by Architect.

2.4 ADJUSTABLE LINEAR DIFFUSERS

A. Linear diffusers shall be extruded aluminum and furnished with frame type appropriate to installation with diffuser elements being removable from frame. Diffuser vanes shall provide both air pattern and flow rate adjustment with air pattern having full 180° adjustment. Diffuser vanes of single slot shall be segmented on 2 ft or 3 ft centers.

B. Diffuser models, lengths and slot sizes shall be as shown on drawings and/or as scheduled. Unless otherwise indicated, frame face shall have baked enamel or powder coat finish with color selected by Architect. Diffuser vanes and frame interior shall be finished in flat black.

2.5 FIXED BLADE LINEAR DIFFUSERS AND GRILLES

A. Linear diffusers and grilles to be extruded aluminum with frame type appropriate to sidewall, sill or ceiling installation as indicated.

B. Diffuser and grille models, lengths, blade spacing and blankoff strips to be as shown on drawings and/or as scheduled.

C. Diffusers used for supply air to be furnished with straightening or equalizing vanes. Blades to be fixed at 0 or 15° deflection as scheduled.

D. Unless otherwise indicated, diffusers and grilles shall have anodized aluminum finish with color selected by Architect.

2.6 LABORATORY AND FUME HOOD ROOM CEILING DIFFUSERS

A. Diffusers shall be unidirectional flow (laminar flow) type and constructed of 304 stainless steel.

B. Diffusers shall have integral internal baffle for even distribution air over entire perforated diffuser face.

C. Diffusers shall have integral volume dampers accessible and adjustable through diffuser face.

D. Diffusers shall be similar to Price Model LFD.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install grilles, registers and diffusers as shown on drawings and according to manufacturer's instructions.

B. Unless otherwise indicated, size ductwork drops to diffusers or grilles to match unit collar sizes.

C. Seal connections between ductwork drops and diffusers/registers/grilles air tight.

D. Support independently diffusers and grilles designed for T-bar mounting that exceed weight limit of ceiling suspension system in which they are to be installed.

E. Unless otherwise shown, provide wire mesh screen at end of each open ended duct (OED) that is exposed in occupied spaces.

F. Blank off unused portion of linear diffusers and grilles.

G. Where diffusers, registers and grilles cannot be installed to avoid seeing inside duct, paint inside of duct with flat black paint to reduce visibility.

H. Protect diffusers, registers and grilles from construction dirt. Clean or replace those soiled or stained prior to turnover to Client.

I. In clean rooms and animal holding rooms, caulk space between diffuser or grille and ceiling or wall to be air and water tight. Use clear, non-hardening silicone sealant compatible with ceiling or wall surface. Sealant shall be resistant to microbiological growth and shall meet CGMP requirements. Refer to Section 20 0000 – General Mechanical Requirements for sealant.

END OF SECTION

SECTION 23 8214 HEATING AND COOLING TERMINAL DEVICES

PART 1 - GENERAL

1.1 RELATED WORK

A. Section 20 0513 - Motors

1.2 REFERENCE

A. Work under this Section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.

1.3 SUBMITTALS

A. Shop Drawings for all items in this Section including, but not limited to, the following:
   1. Manufacturer's name and model number
   2. Identification as referenced in the documents
   3. Capacities/ratings
   4. Materials of construction
   5. Dimensions and weights
   6. Color selection chart where applicable
   7. Wiring diagrams
   8. Motor data (refer to Section 20 0513 - Motors)
   9. For chilled beams, submit performance data from independent testing agency. Performance data to include cooling capacity at supply water temperatures scheduled, air pressure drop, sound data, and water pressure drop for each beam length.
   10. All other appropriate data

B. LEED Submittal:
   1. Product Data for IEQ Prerequisite 1: Documentation indicating that units comply with ASHRAE 62.1-2007, Section 5 – “Systems and Equipment.”

1.4 REFERENCE STANDARDS AND DESIGN CRITERIA

A. Duct Reheat Coils: Ratings shall be certified in accordance with AHRI Standard 410.

B. Units including electrical work shall be UL Listed.

C. Electric Heaters: Shall be listed by UL, bear appropriate UL Label, contain the latest devices for protection of installation, and shall be installed in strict accordance with the latest revision of National Electric Code and other applicable State and Local Codes. Provide grounding lugs on all apparatus.

D. Flexible hose connections are only acceptable at chilled beams. All other devices shall be hard piped. Install flexible hose for chilled beams as specified below.

PART 2 - PRODUCTS

2.1 DUCT REHEAT COILS (HOT WATER)

A. Manufacturers: Carrier, Trane, McQuay, RAE, Marlo, Temtrol, or Heatcraft

B. Reheat coils furnished with air terminal devices will be acceptable, provided coils are meeting requirements specified in this section.

C. Coils shall be constructed of 0.016” minimum tube wall, 1/2" or 5/8" OD copper tubes with aluminum fins suitable for minimum working pressure to 200 psig and temperatures to 220°F.

D. Coils having steel nipples for connection are not allowed.

E. Coil fins shall be continuous serpentine or plate fin type.

F. Coil headers shall be heavy seamless copper with all tubes brazed to header.

G. Casing shall have G90 galvanized steel end supports and top and bottom channels of rigid construction with allowance for expansion and contraction of finned tube section.

H. Coil frame shall be suitable for drive slip or flange and gasket connection to ductwork.

2.2 UNIT HEATERS

A. Manufacturers: Modine, McQuay, Sterling, Vulcan, Sigma, Rittling or Trane

B. Heating elements shall be constructed of copper tubing with aluminum fins and tested at 250 psig air under water.

C. Casings shall be steel phosphatized and finished in baked enamel.

D. Furnish directional louvers for horizontal units and louver cone diffuser for projection units.

E. Fans shall have aluminum blades, factory balanced and quiet in operation and furnished with safety guard.

2.3 ACTIVE CHILLED BEAMS

A. Manufacturers: Dadanco, Trox, Semco, Price, or approved equal. Basis of design is Dadanco model ACB40 2-way throw.

B. Units shall be active chilled beam design with primary air connections, induction nozzles, chilled water coils, integral air diffusers and removable perforated induction inlet grille. Units shall be designed for 2-pipe, cooling only duty or 4-pipe heating and cooling duty as scheduled.

C. Units shall have removable and interchangeable plastic induction nozzles.

D. Inlet/discharge grille framework shall be constructed of aluminum or pressed steel components. Inlet grille shall be perforated steel or aluminum, of sufficient gauge to avoid sagging. Air plenum shall be constructed of minimum 22 ga steel. Interior of plenum shall be painted black if visible from room side.

E. Diffuser and induction grille face shall be powder coat or baked enamel finish of manufacturer's standard white color.

F. Units shall be designed with standard US (IP) dimensions and NPT pipe connections.

G. Units shall be nominal 24" wide as scheduled and shall be compatible with t-bar ceiling grid and hard gypsum ceilings as identified by architectural plans.

H. Unit face shall be drop-face or flat-face as scheduled.

I. Housing shall be formed/stamped aluminum or galvanized steel with manufacturer's standard baked white enamel finish.

J. Housing shall be complete with flush mounted, removable perforated induction grille in center portion for access to cooling coil, supply air plenum with inlet duct collars as required 4" minimum diameter, induction nozzles, and slotted supply diffusers in 1-way or 2-way configuration as scheduled.

K. Induction inlet grille on one-way or two-way throw units shall be removable for coil access. Grilles shall have safety cables or chains to support grille core during coil access.

L. Provide adjustable support tabs/brackets, minimum 4 per unit for hanger support from structure.

M. Supports shall be in accordance with California Mechanical Code (2007) and City of Los Angeles Code.

N. Water coils shall be constructed of 1/2" or 5/8" OD seamless copper tubes with minimum wall thickness of 0.016" with aluminum fins suitable for minimum working pressure to 300 psig at 75ºF temperature. Coil connections shall be NPT threaded.

O. Where scheduled, provide dual coils with factory pre-piped single point supply and return connections for additional capacity.

P. Provide flexible metal hose pipe connectors with stainless steel braided outer jacket for each chilled beam. Minimum live length of metal flexible hose shall be 12" with a maximum length of 18". Flexible connectors shall be rated for minimum working pressure of 150 psig at 70ºF and each connector shall be factory leak tested prior to shipment.

Q. Submittals shall include performance data from independent testing agency. Performance data to include cooling/heating capacity at supply water temperatures scheduled, air pressure drop, supply air throw performance, sound data and water pressure drop for each chilled beam length and throw configuration.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install units as indicated on drawings, and according to manufacturer's installation instructions.

B. Install branch piping to each unit with minimum of 3 elbows to allow for expansion and contraction.

C. Protect units during construction against entry of foreign matter and construction dirt.

3.2 DUCT REHEAT COILS

A. Comb out fins when bent or crushed before enclosing coils in ductwork. Clean dust and debris from each coil to ensure its cleanliness.

B. Seal or gasket coil connection to ductwork to meet maximum allowable leakage rate specified in Section 23 3114 - Ductwork, Part 3.

C. Protect units during construction against entry of foreign matter and construction dirt.

D. Unless otherwise specified, connect piping to coils with multiple rows for counter-flow arrangement.

3.3 ELECTRIC HEATERS

A. Units shall be provided by Mechanical Contractor and wired by Electrical Contractor.

3.4 ACTIVE CHILLED BEAMS

A. Mount units in ceilings as shown on drawings and on reflected ceiling plans.

B. Support units independently of ceiling grid and directly from building structure, with minimum of 4 supports per chilled beam, using threaded rod or approved cable supported system. Wire supports are not allowed.

C. Where necessary, provide strut supports spanning under wide obstructions (ducts) to allow for proper alignment of chilled beam to ceiling grid.

D. Install manual air vents for complete venting of air from system. Provide drain valves at low points of main or branch main piping.

END OF SECTION

SECTION 23 8314 RADIANT CEILING PANELS

PART 1 - GENERAL

1.1 RELATED WORK

A. Section 20 0700 - Mechanical Systems Insulation

B. Section 23 0594 - Water Systems Test Adjust Balance

C. Section 23 2116 - Pipe and Pipe Fittings

D. Section 23 2118 - Valves

1.2 REFERENCE

A. Work under this Section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.

1.3 SUBMITTALS

A. Shop Drawings including, but not limited to, the following:
   1. Manufacturer's name and model number
   2. Identification as referenced in the documents
   3. Capacities/ratings
   4. Materials of construction
   5. Dimensions
   6. Manufacturer's installation instructions
   7. All other appropriate data

B. Submit complete 1/8" or 1/4" scale plans showing layouts and complete details of all areas where radiant ceilings are shown.

C. Submit color samples of panels.

1.4 DELIVERY, STORAGE AND HANDLING

A. Deliver materials in manufacturer's original protective packaging. Store materials in area protected from weather, moisture, dirt or dust. Handle material to prevent damage, paint chipping or deformation.

1.5 SYSTEM DESCRIPTION

A. Provide complete radiant panel ceiling system where shown on drawings, as scheduled, and as herein specified.

B. Supervise installation of all equipment in ceiling panels. Provide special protection in areas where work must occur after ceiling panel installation, to avoid damage or soiling of ceiling panels.

C. Restore to original condition or replace materials damaged, or with surface defects.

1.6 RADIANT CEILING PANEL PERFORMANCE REQUIREMENTS

A. Radiant ceiling panels shall be heating only.

B. Radiant ceiling panel's performance shall be as shown on drawings and/or schedules.

C. Water pressure drop per each circuit shall not exceed **5** ft WG.

1.7 TESTING AND FILLING

A. Test each radiant panel zone including all interconnecting piping between supply and return points at 100 psig for minimum one hour before corrections are made to water circulating system. No loss of pressure shall occur during test.

B. All system piping shall be thoroughly cleaned, flushed, drained and refilled as specified in Section 23 2116 - Pipe and Pipe Fittings before radiant panels are connected into system.

C. Notify Architect and/or Engineer in writing at least 3 days before starting final testing and filling process.

D. Upon completion of testing, submit test data to Architect and/or Engineer.

1.8 QUALIFICATION AND GUARANTEE

A. Contractor shall install system in accordance with manufacturer's recommendation, complete, and to the satisfaction of Architect and/or Engineer.

B. Guarantee radiant ceiling panel system to perform as specified and to function without objectionable noise generated from thermal expansion/contraction or hydronic resonance to Architect's and/or Engineer's satisfaction and acceptance.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Air-Tite, Airtex, Rittling, Sterling, Aerotech or Shelly, Price

2.2 METAL CEILING PANELS

A. Extruded Aluminum Linear Panels:
   1. System shall be equal to Price TWA.
   2. Construct panels of extruded aluminum having thickness of not less than 0.06". 1/2" ID copper tubing shall be mechanically attached to aluminum faceplate. Copper tubing shall be formed into oval shape and heat conductive paste, of non-hardening kind, shall be placed between copper tubing and aluminum faceplate. Oval tube shall be held in place by aluminum saddle, which extends more than halfway around diameter of tube. Use of adhesive and/or clips to attach copper tube to extrusion will not be acceptable.

B. Panel Surface Finish:
   1. Panel surface finish shall be 2 coats of baked enamel color to be selected by Architect.

2.3 INSULATION

A. 1" thick glass fiber insulation blanket equal to Johns Manville "R" Series Microlite.

2.4 PIPING

A. Interconnecting piping between radiant panels shall be 1/2" OD type L soft drawn seamless copper tubing with wrought copper or bronze fittings. Use lead free solder equal to Bridgit or Silvabrite.

B. Tubing shall be sufficient length to allow for expansion and contraction and tubing for panels requiring access above ceiling shall be at least 6 ft in length so as to allow lowering of panel. Final 3 ft of supply and return piping connection to panels shall be made with type L soft drawn seamless copper tubing and direct connection without fitting.

PART 3 - EXECUTION

3.1 DIMENSION VERIFICATION

A. Verify all field conditions and dimensions before commencing installation. Panel lengths shall be verified against architectural reflected ceiling plans prior to fabrication to confirm wall to wall fit.

3.2 VALVES, DRAINS, AIR VENTS, ETC.

A. For branch pipe feeding radiant panels, use top take-off for branch pipe connection to main with manual air vents.

B. Install valves, drains, air vents, etc. as shown on drawings. Install air vent at end of each radiant panel circuit.

3.3 INSULATION

A. Install insulation above radiant panels.

B. Install edges of insulation tightly butted.

C. Locate vapor barrier foil jacket top side of insulation. Jacket shall cover insulation completely so that no fiberglass insulation is exposed to ceiling plenum space.

END OF SECTION

SECTION 26 0000 GENERAL ELECTRICAL REQUIREMENTS

PART 1 - GENERAL

1.1 REFERENCE

A. Work under this Section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.

1.2 DESCRIPTION

A. Intent of drawings and Specifications is to obtain complete systems tested, adjusted, and ready for operation.

B. Except as otherwise defined in greater detail, the terms "provide", "furnish" and "install" as used in Division 26 Contract Documents shall have the following meanings:
   1. "Provide" or "provided" shall mean "furnish and install".
   2. "Furnish" or "furnished" does not include installation.
   3. "Install" or "installed" does not include furnishing.

C. Include incidental details not usually shown or specified, but necessary for proper installation and operation.

D. Check, verify and coordinate work with drawings and specifications prepared for other trades. Include modifications, relocations or adjustments necessary to complete work or to avoid interference with other trades.

E. Included in this Contract are electrical connections to equipment provided by others. Refer to Architectural, Mechanical, Plumbing, and final shop drawings for equipment being furnished under other sections for exact locations of electrical outlets and various connections required.

F. Information given herein and on drawings is as exact as could be secured but is not guaranteed. Do not scale drawings for dimensions.

G. Where architectural features govern location of work, refer to Architectural Drawings.

H. Perform work in "neat and workmanlike" manner as defined in ANSI/NECA 1, Standard Practices for Good Workmanship in Electrical Contracting.

1.3 RELATED WORK

A. Temporary Utility Services:
   1. Include costs for temporary service, temporary routing of service or other requirements of a temporary nature associated with utility service.

B. Temporary Services:
   1. Division 01 - Temporary Facilities and Controls.

C. Continuity of Service:
   1. No service shall be interrupted or changed without permission from Architect and Owner. Obtain written permission before work is started.

2. When interruption of services is required, Architect, Owner and other concerned parties shall be notified and shall determine a time.

D. Concrete Work:
   1. Provide cast-in-place concrete as required by Contract Documents unless otherwise noted.
   2. Concrete shall comply with Division 03 - Concrete.
   3. Provide anchor bolts, metal shapes and templates to be cast in concrete or used to form concrete as required for anchoring and supporting electrical equipment.

E. Painting:
   1. Furnish equipment with factory-applied finish coats or paint equipment per Division 09 – Finishes unless specified otherwise.
   2. Furnish equipment with factory applied prime finish unless otherwise specified.
   3. If factory finish on equipment furnished by Contractor is damaged in shipment or during construction, refinish equipment to satisfaction of Architect.
   4. Furnish one can of touch up paint for each final factory-applied finish coat of product.
   5. Paints and coatings used on the interior of the building shall comply with VOC limits per Section 01352 LEED requirements.

F. Sustainable Architecture and LEED Requirements:
   1. Provide services, documentation, and product data required to meet LEED credits involving an electrical component such as:
      a. Credit SS Prerequisite 1 – Construction Activity Pollution Prevention
      b. Credit SS 8 – Light Pollution Reduction
      c. Credit EA Prerequisite 1 – Fundamental Commissioning of the Building Energy Systems
      d. Credit EA Prerequisite 2 – Minimum Energy Performance
      e. Credit EA 1 – Optimize Energy Performance
      f. Credit EA 3 – Enhanced Commissioning
      g. Credit EA 6 – Green Power
      h. Credit ID 1.1 – Low Mercury Lamps
      i. Credit ID 1.2 – Exemplary Green Power
      j. Credit MR 2 – Construction Waste Management
      k. Credit MR 4 – Recycled Content
      l. Credit MR 5 – Regional Materials
      m. Credit EQ 4.1 – Low Emitting Materials, Adhesives & Sealants
      n. Credit EQ 4.2 – Low Emitting Materials, Paints & Coatings
      o. Credit EQ 6.1 – Controllability of Systems, Lighting

G. Sustainable Architecture and LEED Requirements:
   1. Provide services, documentation, and product data required to meet LEED credits involving an electrical component such as:
      a. Credit LT – Green Vehicles
      b. Prerequisite SS – Construction Activity Pollution Prevention
      c. Credit SS – Light Pollution Reduction
      d. Credit WE – Water Metering

e. Prerequisite EA – Fundamental Commissioning of the Building Energy Systems
f. Prerequisite EA – Minimum Energy Performance
g. Prerequisite EA – Building-Level Energy Metering
h. Credit EA – Enhanced Commissioning
i. Credit EA – Optimize Energy Performance
j. Credit EA – Advanced Energy Metering
k. Credit EA – Demand Response
l. Credit EA – Renewable Energy Production
m. Credit EA – Green Power and Carbon Offsets
n. Prerequisite MR – Construction and Demolition Waste Management Planning
o. Credit MR – Building Product Disclosure and Optimization – Environmental Product Declarations
p. Credit MR – Building Product Disclosure and Optimization – Sourcing of Raw Materials
q. Credit MR – Building Product Disclosure and Optimization – Material Ingredients
r. Credit MR – Construction and Demolition Waste Management
s. Credit MR 4 – Recycled Content
t. Credit MR 5 – Regional Materials
u. Credit EQ – Low Emitting Materials
v. Credit EQ – Construction Indoor Air Quality Management Plan
w. Credit EQ – Interior Lighting
x. Credit EQ – Daylighting
y. Credit EQ – Acoustic Performance
z. Credit ID – Innovation

H. Sustainable Architecture and LEED Requirements:
1. Provide services, documentation, and product data required to meet LEED credits involving an electrical component such as:
a. Credit LT – Green Vehicles
b. Prerequisite SS – Construction Activity Pollution Prevention
c. Credit SS – Light Pollution Reduction
d. Credit WE – Water Metering
e. Prerequisite EA – Fundamental Commissioning of the Building Energy Systems
f. Prerequisite EA – Minimum Energy Performance
g. Prerequisite EA – Building-Level Energy Metering
h. Credit EA – Enhanced Commissioning
i. Credit EA – Optimize Energy Performance
j. Credit EA – Advanced Energy Metering
k. Credit EA – Demand Response
l. Credit EA – Renewable Energy Production
m. Credit EA – Green Power and Carbon Offsets
n. Prerequisite MR – Construction and Demolition Waste Management Planning
o. Prerequisite MR – PBT Source Reduction - Mercury

p. Credit MR – Building Product Disclosure and Optimization – Environmental Product Declarations
q. Credit MR – Building Product Disclosure and Optimization – Sourcing of Raw Materials
r. Credit MR – Building Product Disclosure and Optimization – Material Ingredients
s. Credit MR – PBT Source Reduction - Mercury
t. Credit MR – PBT Source Reduction – Lead, Cadmium, and Copper
u. Credit MR – Design for Flexibility
v. Credit MR – Construction and Demolition Waste Management
w. Credit MR 4 – Recycled Content
x. Credit MR 5 – Regional Materials
y. Credit EQ – Low Emitting Materials
z. Credit EQ – Construction Indoor Air Quality Management Plan
aa. Credit EQ – Interior Lighting
bb. Credit EQ – Daylighting
cc. Credit EQ – Acoustic Performance
dd. Credit ID – Innovation

1.4 REQUIREMENTS OF REGULATORY AGENCIES

A. Rules and regulations of Federal, State and local authorities and utility companies, in force at time of execution of Contract shall become part of this specification.

1.5 REFERENCE STANDARDS

A. Agencies or publications referenced herein refer to the following:
1. AEIC Association of Edison Illuminating Companies
2. ANSI American National Standards Institute
3. ASME American Society of Mechanical Engineers
4. ASTM American Society for Testing and Materials
5. BICSI Building Industry Consulting Services International
6. EIA Electronic Industries Association
7. FIPS Federal Information Processing Standards
8. FCC Federal Communications Commission
9. ICEA Insulated Cable Engineers Association
10. IEEE Institute of Electrical & Electronics Engineers
11. IESNA Illuminating Engineering Society of North America
12. NEC National Electrical Code
13. NECA National Electrical Contractors Association
14. NEMA National Electrical Manufacturers Association
15. NESC National Electrical Safety Code
16. NETA National Electrical Testing Association
17. NFPA National Fire Protection Association
18. NIST National Institute of Standards & Technology
19. OSHA Occupational Safety and Health Administration

20. TIA Telecommunications Industries Association
21. UL Underwriters Laboratories, Inc.

B. Work shall be in accordance with latest edition of codes, standards or specifications unless noted otherwise.

1.6 LISTING

A. Install materials bearing UL label or UL listing, unless UL label or listing is not available for that type of material.

B. Other nationally recognized testing agencies, acceptable to AHJ, are approved.

1.7 ENCLOSURES

A. Typical NEMA Enclosures and Usage
1. NEMA 1 - Indoors. Falling dirt.
2. NEMA 2 - Indoors. Falling dirt. Falling liquids. Light splashing.
3. NEMA 3 - Outdoors. Sleet, snow, rain. Windblown dust.
4. NEMA 3X - Same as NEMA 3 plus corrosion resistant.
5. NEMA 3S - Same as NEMA 3 plus mechanism operable when ice covered.
6. NEMA 3SX - Same as NEMA 3S plus corrosion resistant.
7. NEMA 3R - Outdoors. Rain, snow, sleet.
8. NEMA 3RX - Same as NEMA 3R plus corrosion resistant.
9. NEMA 4 - Indoors. Falling dirt. Falling and light splashing liquids. Flying dust, lint and fibers. Hose down.
10. NEMA 4X - Same as NEMA 4 - Indoors plus corrosion resistant.
11. NEMA 4 - Outdoors. Rain, sleet, snow. Wind blown dust. Hose down.
12. NEMA 4X - Same as NEMA 4 - Outdoors plus corrosion resistant.
13. NEMA 5 - Indoors. Falling Dirt. Falling Liquids. Settling dust, lint and fibers.
14. NEMA 6 - Indoors. Falling dirt. Falling and light splashing liquids. Flying dust, ling and fibers. Hose down. Temporary submersion.
15. NEMA 6P - Same as NEMA 6 - Indoors plus corrosion resistant. Prolonged submersion.
16. NEMA 6 - Outdoors. Rain, snow, sleet. Windblown dust. Hose down. Temporary submersion.
17. NEMA 6P - Same as NEMA 6 - Outdoors plus corrosion resistant. Prolonged Submersion.
18. NEMA 7 - Indoors. Class I, Division 1 or 2, Groups A, B, C or D. (Flammable gas).
19. NEMA 9 - Indoors. Class II, Division 1 or 2. Groups E, R, or G. (Combustible dust).
20. NEMA 12 - Indoors. Falling Dirt. Falling liquids. Flying dust, lint and fibers. Oil or coolant seepage.
21. NEMA 13 - Same as NEMA 12 plus oil or coolant spraying or splashing.

1.8 SUBMITTALS

A. Shop Drawings (Product Data):
1. Refer to Division 01 - Submittal Procedures.

2. Note that for satisfying submittal requirements for Division 26, "Product Data" is usually more appropriate than true "Shop Drawings" as defined in Division 01. However, the expression "Shop Drawings" is generally used throughout Specification.
3. Submit shop drawings for equipment and systems as requested in respective specification sections. Submittals which are not requested may not be reviewed.
4. Specifically mark general catalog sheets and drawings to indicate specific items submitted and its correlation to specific designation for product in drawings.
5. Specifically indicate proper identification of equipment by name and/or number, as indicated in specification and shown on drawings.
6. When manufacturer's reference numbers are different from those specified, provide correct cross-reference number for each item. Clearly mark and note submittal accordingly.
7. Submit complete record of required components when luminaires, equipment and items specified include accessories, parts and additional items under one designation.
8. Include wiring diagrams for electrically powered or controlled equipment.
9. Submit electrical equipment room layouts drawn to scale, including equipment, raceways, accessories and required working clearances. Submit electrical equipment room layouts concurrently with electrical distribution equipment submittals.
10. Where submittals cover products containing non-metallic materials, include "Material Safety Data Sheet" (MSDS) from manufacturer stating physical and chemical properties of components and precautionary considerations required.
11. Submit shop drawings or product data as soon as practicable after signing contracts. Submittals must be approved before installation of materials and equipment.
12. Submittals that are not complete, not permanent, or not properly checked by Contractor, will be returned without review.
13. "Coordination Drawings", which are normally prepared by Contractor to coordinate work among various trades and to facilitate installation, shall not be submitted for Division 26 work unless specifically requested in technical sections. These types of drawings typically include dimensioned piping, ductwork or electrical raceway layouts.
14. Unless specifically requested in Division 26 technical sections, submittals of coordination drawings will be returned without review.

B. Certificates and Inspections:
   1. Obtain and pay for inspections required by authorities having jurisdiction and deliver certificates approving installations to Owner unless otherwise directed.

C. Operation and Maintenance Manuals:
   1. Refer to Division 01 - Operation and Maintenance Data.
   2. Upon completion of work but before final acceptance of system, submit to Architect for approval, 3 copies of operation and maintenance manuals in loose-leaf binders. If "one copy" is larger than 2” thick or consists of multiple volumes, submit only one set initially for review. After securing approval, submit 3 copies to Owner.
   3. Organize manuals by specification section number and furnish table of contents and tabs for each piece of equipment or system.
   4. Manuals shall include the following:
      a. Copies of shop drawings
      b. Manufacturer's operating and maintenance instructions. Include parts lists of items or equipment, with component exploded views and part numbers. Where manufacturer's data includes several types or models, designate applicable type or model.

c. CD ROM's of O&M data with exploded parts lists where available
d. Phone numbers and addresses of local parts suppliers and service companies
e. Internet/WEB page addresses where applicable
f. Wiring diagrams
g. Start up and shut down procedure
h. Factory and field test records
i. Additional information, diagrams or explanations as designated under respective equipment or systems specification section

5. Instruct Owner's representative in operation and maintenance of equipment. Instruction shall include complete operating cycle on all apparatus.
6. Furnish O&M manuals and instructions to Owner prior to request for final payment.

D. Record Documents:
1. Refer to General Conditions of Contract and Division 01 - Project Record Documents. Prepare complete set of record drawings in accordance with Division 01.
2. Use designated set of prints of Contract Documents as prepared by Architect to mark-up for record drawing purposes.

1.9 JOB CONDITIONS

A. Building Access:
1. Arrange for necessary openings in building to allow for admittance of all apparatus.

B. Coordination:
1. Equipment provided under other Divisions of these specifications.
a. Motors
b. Electrically powered equipment
c. Electrically controlled equipment
d. Starters, where specified
e. Variable frequency drives, where specified
f. Control devices, where specified
g. Temperature Control wiring
2. Provide the following devices required for control of motors or electrical equipment, unless noted otherwise:
a. Starters
b. Disconnect devices
c. Control devices:
1). Pushbuttons
2). Pilot lights
3). Contacts
d. Conduit, boxes and wiring for Power wiring
e. Conduit, boxes and wiring for Control wiring, except temperature control wiring
3. Connect and wire equipment complete and ready to operate according to wiring diagrams furnished by various trades.
4. Wire starters or other similar control devices furnished by others.

5. This contractor's drawings and/or specifications show number and HP rating of motors furnished by others, together with their actuating devices. Should any change in size, HP rating, voltage, or means of control be made to any motor or other electrical equipment after Contracts are awarded, Contractor responsible for change shall immediately notify this Contractor. Additional costs due to these changes shall be responsibility of Contractor initiating change.
6. Equipment and wiring shall be selected and installed for conditions in which it will be required to perform. (i.e., general purpose, weatherproof, rain tight, explosion proof, dust tight, or any other special type as required.)
7. Comply with local utility motor starting requirements and provide starters for motors furnished by others as specified herein or under various trade sections of those specifications.

C. Cutting and Patching:
1. Refer to General Conditions of the Contract and Division 01 - Cutting and Patching.
2. Perform cutting and patching required for complete installation of systems, unless otherwise noted. Patch and restore work cut or damaged to original condition. This includes openings remaining from removal or relocation of existing system components.
3. Provide materials required for patching unless otherwise noted.
4. Do not pierce beams or columns without permission of Architect and then only as directed. If openings are required through walls or floors where no sleeve has been provided, hole shall be core drilled to avoid unnecessary damage and structural weakening.
5. Where alterations disturb lawns, paving, walks, etc., replace, repair or refinish surfaces to condition existing prior to commencement of work. This may include areas beyond construction limits.

D. Housekeeping and Cleanup:
1. Refer to Division 01 - Closeout Procedures.
2. As work progresses or as directed by Architect, periodically remove waste materials from building and leave area of work broom clean. Upon completion of work, remove tools, scaffolding, broken and waste materials, etc. from site.

1.10 WARRANTY

A. Refer to Division 01 for general warranty requirements.

B. Refer to technical sections for warranty requirement for each system.
1. Where no warranty requirements are called out, warrant for 1 year after acceptance by Owner equipment, materials, and workmanship to be free from defect.

C. Repair, replace, or alter systems or parts of systems found defective at no extra cost to Owner.

D. In any case, wherein fulfilling requirements of any guarantee, if this contractor disturbs any work guaranteed under another contract, this contractor shall restore such disturbed work to condition satisfactory to Architect and guarantee such restored work to same extent as it was guaranteed under such other contract.

E. Warranty shall include labor, material, and travel time.

1.11 BUILDING SYSTEMS COMMISSIONING:

A. An independent third party Commissioning Agent will document completion of the Mechanical, Fire Suppression, Plumbing, HVAC, Electrical, Communications and Electronic Safety and Security Systems for the project. The Construction Manager and Division Contractors are members of the Commissioning Team and will facilitate completion of the Commissioning process. Refer to section 019113 "Building Systems Commissioning" for the project Commissioning requirements and roles and responsibilities of each member of the Commissioning Team."

PART 2 - PRODUCTS

2.1 PRODUCT SUBSTITUTIONS

A. Refer to Division 01 - Product Requirements.

PART 3 - EXECUTION

3.1 GENERAL

A. Verify elevations and dimensions prior to installation of materials.

3.2 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to the site under provisions of Division 01.

B. Store and protect products under provisions of Division 01.

C. Store in clean, dry space.

D. Maintain factory wrapping or provide cover to protect units from dirt, water, construction debris, and traffic.

E. Handle in accordance with manufacturer's written instructions.

F. Handle carefully to avoid damage to components, enclosure, and finish. Lift only with lugs provided for the purpose.

G. Provide supplemental heat if required to prevent moisture contamination.

3.3 FLOOR, WALL, ROOF AND CEILING OPENINGS

A. Coordinate location of openings, chases, furred spaces, etc. with appropriate Contractors. Provide sleeves and inserts that are to be built into structure during progress of construction.

B. Remove temporary sleeves, if used to form openings, prior to installation of permanent materials. Utilize minimum 24 ga galvanized sheet metal for permanent sleeves unless otherwise noted.

C. Provide Schedule 40 carbon steel pipe with integral water stop for steel sleeves required below grade or to exterior.

D. Submit to Structural Engineer for review and approval size and location of core-drilled holes prior to execution.

E. Submit product data and installation details for penetrations of building structure. Include schedule indicating penetrating materials, (steel conduit, PVC conduit, cables, cable tray, etc.), sizes of each, opening sizes and sealant products intended for use.

F. Where penetrations of fire-rated assemblies are involved, seal penetrations with appropriate firestopping systems as specified in Section 26 0593 - Electrical Systems Firestopping.

G. Adhesives and sealants used on the interior of the building shall comply with VOC limits per section 01352 LEED requirements.

H. Submit complete penetration layout drawings showing openings in building structural members including floor slabs, bearing walls, shear walls, etc. Indicate and locate, by dimension, required openings including those sleeved, formed or core drilled. Submit drawings for approval prior to preparing openings in structural member.

I. Provide 2” clearance around penetration openings intended for raceways and cables. Where fire resistant penetrations are required, size openings in accordance with written recommendations of firestopping systems manufacturer.

J. Seal non fire-rated floor penetrations with non-shrink grout equal to Embeco by Master Builders, or urethane caulk, as appropriate.

K. Seal non-rated wall openings with urethane caulk.

L. Where penetrations occur through exterior walls into building spaces, use steel sleeves with integral water stop, similar to type "WS" wall sleeves by Thunderline Corporation. Seal annular space between sleeves and pipe with "Link-Seal" modular wall and casing seals by Thunderline Corporation, or sealing system by another manufacturer approved as equal by Engineer. Sealing system shall utilize Type 316 stainless steel bolts, washers and nuts.

M. Finish and trim penetrations as shown on details and as specified.

N. Provide chrome or nickel plated escutcheons where raceways pass through walls, floors or ceilings and are exposed in finished areas. Size escutcheons to fit raceways for finished appearance. Finished areas shall not include mechanical/electrical rooms, janitor’s closets, storage rooms, etc., unless suspended ceilings are specified.

O. In Animal holding and Wash down areas,
   1. Exposed conduit penetrations shall be sealed as follows:
      a. Escutcheons shall not be used when conduits are exposed in finished areas and penetrate finished surfaces.
      b. Cut and patch penetration to within 1/4” of conduit.
      c. Seal openings around conduit and patch work with sprayable, flexible, liquid polyvinyl chloride coating equal to ANDEK "COCOON® 72634-USDA". Sealant shall be installed per manufacturer's application requirements.
      d. ANDEK Corp., 850 Glen Avenue, P.O. Box 392, Moorestown, New Jersey 05857-0392.

   2. Penetrations other than conduits (junction boxes, light fixtures, etc.) including wiring devices shall be sealed as follows:
      a. Seal non-rated opening with silicone sealant.
      b. See drawings for details.

c. Confirm selected sealant is compatible with paint provided by others prior to application.

d. Product: One-Part Mildew-Resistant Silicone Sealant: Type S; Grade NS; Class 25; Uses NT, G, A, and as applicable to nonporous joint substances indicated, O; formulated with fungicide; intended for sealing interior joints with nonporous substrates and subject to in-service exposure to conditions of high humidity and temperature extremes; subject to compliance with requirements. Provide one of the following:

1). 786 Mildew Resistant Silicone Sealant; Dow Corning Corp.

2). Sanitary 1700 Silicone Sealant; General Electric Co.

3). 898 Silicone Sanitary Sealant; Pecora Corp.

4). Tremsil 600; Tremco Corp.

5). OmniPlus; Sonneborn Building Products Div., Rexnord Chemical Products, Inc.

3.4 EQUIPMENT ACCESS

A. Install raceways, junction and pull boxes, and accessories to permit access to equipment for maintenance. Relocate raceways or accessories to provide maintenance access at no additional cost to Owner.

B. Install equipment with sufficient maintenance space for removal, repair or changes to equipment. Provide ready accessibility to equipment and wiring without moving other future or installed equipment.

C. Access doors in walls, chases, or inaccessible ceilings will be provided under Division 08 - Access Doors and Frames, unless otherwise indicated. Access doors for equipment shall provide access for servicing, repairs and/or maintenance.

D. Provide necessary coordination and information to the Trade Contractor under Division 08 - Access Doors and Frames. This information shall include required locations, sizes and rough-in dimensions.

E. Provide access doors in walls, chases or inaccessible ceilings for equipment requiring access for servicing, repairs and maintenance, unless otherwise noted. Access frames and doors shall be as manufactured by Milcor, Incorporated, or similar, of style applicable to surface. Provide access doors used in fire-rated construction with UL label. Provide steel, prime-coated access doors in dry locations. Provide stainless steel access doors for use in ceramic tile walls, toilet rooms, locker rooms, and in areas subject to excessive moisture. Provide access doors of sufficient size to allow complete maintenance. Coordinate location of access doors with General Contractor and rough-in equipment accordingly.

F. Locate electrical outlets and equipment to fit details, panels, decorating or finish at space. Architect reserves right to make minor position changes of outlet locations before work has been installed.

G. Verify door swings before installing room light switch boxes. Install boxes on latch side of door unless otherwise noted

3.5 EQUIPMENT SUPPORTS

A. Provide supporting steel not indicated on drawings as required for installation of equipment and materials including angles, channels, beams, hangers, etc.

B. Provide steel shell with plug type concrete anchors for attaching equipment to concrete. Plastic, rawhide or anchors using lead are not allowed.

C. Do not support equipment or luminaires from metal roof decking.

3.6 SUPPORT PROTECTION

A. In occupied areas, mechanical and electrical rooms and areas requiring normal maintenance access, guard certain equipment to protect personnel from injury.

B. Provide minimum 1/2” thick Armstrong Armaflex insulation or similar product applied with Armstrong 520 adhesive on lower edges of equipment, including bus duct, cable tray, pull boxes and electrical supporting devices suspended less than 7 ft above floors, platforms or catwalks in these areas.

C. Protect threaded rods or bolts at supporting elements as described above. Trim threaded rods or bolts such that they do not extend beyond supporting element.

3.7 LEAD SHIELDING

A. Wherever installation of this contractor's equipment destroys radiological integrity of wall, floor, or ceiling, this contractor shall be responsible to provide suitable lead shielding to restore that integrity. Coordinate these requirements with General Contractor.

3.8 ELECTRICAL SYSTEMS IDENTIFICATION

A. Refer to Section 26 0553 – Electrical Systems Identification.

3.9 ACCEPTANCE TESTING

A. Contractor shall engage testing and inspection agency to perform acceptance tests. Equipment to be tested is noted as "Testing by Testing Agency" in technical specification sections. Perform in accordance with Section 26 0812 – Power Distribution Acceptance Tests and Section 26 0813 – Power Distribution Acceptance Test Tables.

B. When testing is to be witnessed by Architect/Engineer or Inspector, notify them at least 10 days prior to testing date.

C. When equipment or systems fail to meet minimum test requirements, replace or repair defective work or materials as necessary and repeat inspection and test until equipment or systems meet test requirements. Make repairs with new materials.

D. Contractor is responsible for certifying in writing equipment and system test results. Certification shall include identification of portion of system tested, date, time, test criteria and name and title of person signing test certification documents.

E. Maintain copies of certified test results, including those for any failed tests, at project site. At completion of project, include copies of test records and certifications in O&M Manuals.

3.10 START-UP

A. Systems and equipment shall be started, tested, adjusted, and turned over to Owner ready for operation. This includes "Owner-Furnished, Contractor-Installed" (OFCI) and "Contractor-Furnished, Contractor-Installed" (CFCI) systems and equipment.

B. Follow manufacturer's pre-start-up checkout, start-up, trouble shooting and adjustment procedures.

C. Contractor shall provide services of technician/mechanic knowledgeable in start-up and checkout of types of systems and equipment on project.

D. Provide start-up services by manufacturer's representative where specified or where Contractor does not have qualified personnel.

E. Coordinate start-up with all trades.

3.11 CLEANING

A. Clean systems after installation is complete.

B. Vacuum debris from panelboards, switchboards, motor starter and disconnect switch enclosures, junction boxes and pull boxes two weeks before energization and again prior to completion.

C. Where louvers are provided in switchgear or transformer enclosures, vacuum louvers free of dust and dirt.

D. Clean luminaire lenses and lamps at time of installation and clean lens exteriors just prior to final inspection.

E. Thoroughly clean equipment of stains, paint spots, dirt and dust. Remove temporary labels not used for instruction or operation.

F. During construction, maintain indoor air quality per general contractors IAQ plan for LEED credit.

3.12 CONSTRUCTION WASTE MANAGEMENT

A. Construction waste management shall be managed in accordance with provisions of Section 01524 Construction Waste Management. Documentation shall be submitted to satisfy the requirements of that section.

END OF SECTION

SECTION 26 0519 LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 RELATED WORK

A. Section 26 0529 - Hangers and Supports for Electrical Systems

B. Section 26 0553 - Electrical Systems Identification

C. Section 26 0593 - Electrical Systems Firestopping

D. Section 26 0812 - Power Distribution Acceptance Tests

E. Section 26 0813 - Power Distribution Acceptance Test Tables

1.2 REFERENCE

A. Work under this section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.

1.3 DESCRIPTION

A. Section includes conductors and cables rated 600 V and less, connectors, splices, and terminations rated 600 V and less, sleeves and sleeve seals for cables.

B. Conductor and conduit sizes in these contract documents are based on copper wire, and only copper wire shall be used.

1.4 REFERENCE STANDARDS

A. ASTM A 53/A 53M – Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless.

B. ASTM B 1 – Standard Specification for Hand-Drawn Copper Wire.

C. ASTM B 8 – Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft.

D. NEMA WC 3 – Rubber-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy (ICEA S-19-81).

E. NEMA WC 5 – Thermoplastic-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy (ICEA S-61-402).

F. NEMA WC 70 – Non-Shielded Power Cable 2000 V or less for the Distribution of Electrical Energy (ICEA S-95-668).

G. NFPA 70 – National Electrical Code.

H. UL 44 – Thermoset-Insulated Wires and Cables.

I. UL 83 – Thermoplastic-Insulated Wires and Cables.

J. UL 486A-486B – Wire Connectors.

K. UL 486C – Splicing Wire Connectors.

L. UL 486D – Standard for Insulated Wire Connector Systems for Underground Use or in Damp or Wet Locations.

M. UL 486E – Standard for Equipment Wiring Terminals for Use with Aluminum and/or Copper Conductors.

1.5 SUBMITTALS

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

B. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation.

C. Test Reports: Indicate field test and inspection procedures and interpret test results and corrective action taken for compliance with specification requirements.

D. Closeout Submittals:
   1. Project Record Documents:
      a. Record actual locations of components and circuits.
   2. Operation and Maintenance Data:
      a. Include manufacturer's recommended operating instructions, maintenance procedures and intervals, and preventive maintenance instructions.

1.6 QUALITY ASSURANCE

A. Regulatory Requirements:
   1. Comply with NFPA 70 for components and installation.
   2. Furnish products listed and classified by Underwriters Laboratories, Inc., as suitable for purpose specified and indicated.

B. Wire and cable boxes and reels shall bear the date of manufacture.
   1. Date of manufacture shall not precede contract date by more than one year.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Store in clean, dry space. Protect from dirt, fumes, water, corrosive substances, and construction debris.

1.8 WARRANTY

A. Refer to Division 01 and Section 26 0000 – General Electrical Requirements for general warranty requirements.

B. Manufacturer shall provide standard 1 yr warranty against defects in materials and workmanship for products specified in this Section. Warranty period shall begin on date of substantial completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Cerrowire

B. General Cable Corporation

C. Senator Wire & Cable Company

D. Southwire Company

E. Approved equal

2.2 DESCRIPTION

A. NEMA WC 70; single copper conductor insulated wire; 600V rated insulation; 90°C maximum operating temperature for dry and wet or damp locations.
   1. Thermoplastic-insulated wires and cables: NEMA WC 5, UL 83; Type THHN, THWN, THHW.
   2. Thermoset-insulated wires and cables: NEMA WC 3, UL 44; Type XHHW-2.

2.3 REMOTE CONTROL AND SIGNAL CIRCUITS

A. Class 1
   1. Copper conductor, single insulated wire.
   2. Insulation type THHN, THHW rated 90°C, 600 V insulation class.
   3. Type XHHW-2 for ambient temperature less than 32°F.
   4. UL 83 listed, ASTM B 1 for solid conductors; ASTM B 8 for stranded conductors.

B. Classes 2 and 3
   1. Copper conductor, multiple twisted conductors covered with an overall non-metallic jacket unless otherwise noted.
   2. Insulation type XLE, rated 105°C, 300 V insulation class.
   3. UL listed for use in space in which circuits will be installed.

2.4 CONNECTORS, SPLICES, AND TERMINALS

A. Manufacturers:
   1. AFC Cable Systems, Inc.
   2. Burndy Division of Hubbell Incorporated
   3. Hubbell Power Systems, Inc.
   4. Ideal Industries, Inc.
   5. O-Z/Gedney; EGS Electrical Group LLC.
   6. 3M; Electrical Products Division
   7. Thomas and Betts Division of ABB
   8. Tyco Electronics Corp.
   9. Approved equal

B. Description: UL 486A-486B, UL 486C, UL 486D, UL 486E; factory-fabricated connectors, splices, and terminals of size, ampacity rating, material, type, and class for application and service indicated.

2.5 TERMINATIONS

A. Compression set, bolted or screw type lug, or direct to bolted or screw type terminal.

2.6 PLASTIC CABLE TIES

A. Nylon or approved; locking type; metallic ties not permitted.

PART 3 - EXECUTION

3.1 INSTALLATION OF CONDUCTORS AND CABLES

A. Install conductors in a raceway system, unless otherwise specified or indicated.

B. Install conductors only after:
   1. Building interior is enclosed and weather tight
   2. Mechanical work likely to damage conductors has been completed
   3. Raceway installation is complete and supported

C. Pull conductors into raceway at same time.

D. Neatly train and lace conductors inside boxes, equipment, and panelboards.

E. Conceal cables in finished walls, ceilings, and floors, unless otherwise indicated.

F. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.

G. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips that will not damage cables or raceway.

H. Provide adequate support for conductors not in raceway. Do not support conductors from ceiling grid or from accessible ceiling support systems.

I. Support cables and conductors in vertical raceways per requirements in Section 26 0529 - Hangers and Supports for Electrical Systems.

J. Identify and color-code conductors and cables according to Section 26 0553 - Electrical Systems Identification.

K. Wiring at Outlets: Install conductor at each outlet, with minimum 12" of slack.

L. Limit conduit fill to a maximum of 9 current-carrying conductors.

M. Install stranded conductors where conductors terminate in crimp type lugs. Do not place bare stranded conductors directly under terminal screws.

3.2 CONDUCTOR MATERIAL APPLICATIONS

A. Feeders and Branch Circuits: Solid or stranded #10 AWG and smaller; stranded for #8 AWG and larger.

B. Minimum conductor sizes shall be as follows:
   1. #12 AWG – Branch circuits of any kind.
   2. #14 AWG – Remote control and signal systems, fire alarm system.

C. Branch wiring length limitations:
   1. 208Y/120 V circuits over 100’ in length: Increase wire size one size for each 100’ of length. Increase conduit size as required.
   2. 480Y/277 V circuits over 150’ in length: Increase wire size one size for each 150’ of length. Increase conduit size as required.

3.3 CONDUCTOR INSULATIONS AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

A. Feeders: Type THHW, THWN, XHHW-2, rated 75°C for wet locations, single conductors in raceway.

B. Branch Circuits: Type THHN, XHHW-2, rated 90°C for dry and wet or damp locations, single conductors in raceway.

C. Wiring in Fluorescent Fixture Channels: Type THHN, rated 90°C for dry and damp locations, single conductors.

D. Cord Drops and Portable Appliance Connections: Type SO, hard service cord with stainless-steel, wire-mesh strain relief device at terminations to suit application.

3.4 REMOTE CONTROL AND SIGNAL CIRCUITS

A. Sizing – #14 AWG minimum.

B. Installation:
   1. Install cables in cable tray and cable rings.
   2. Provide protection for exposed cables where subject to damage.
   3. Support cables above accessible ceilings; do not rest on ceiling tiles.
   4. Use suitable cable fittings and connectors.

3.5 CONNECTORS, SPLICES AND TERMINALS

A. Connectors:
   1. Except where equipment is furnished with bolted or screw type lug, use compression set pressure connectors with insulating covers. Use compression tools and die compatible with connectors being installed.
   2. Use compression-set type with application of insulating tape, pre-stretched or heat-shrinkable insulating tubing for splices and taps of #8 AWG conductors and larger. Install with hydraulic compression tool.
   3. Use pre-insulated “twist-on” connectors with integral spring for splices and taps of #10 AWG normal power conductors and smaller.

4. Use compression-set, insulated type for splices of #10 AWG and smaller conductors serving life safety loads. "Twist-on" connectors are not allowed in life safety circuits.
5. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.

B. Splices:
1. Splice wires and cable only in accessible locations such as within junction boxes.
2. Make splices to carry full capacity of conductors with no perceptible temperature rise.
3. Splices are to be made with compression barrel connector where no taps exist or allowance for future taps is being made.
4. Where the splice includes provisions for taps, use Burndy insulated Unitap. Locate in pull or junction box sized for all conductors to be spliced and tapped.
5. Make below-grade splices in manholes and handholes watertight with pre-stretched or heat-shrinkable insulating tubing, or resin-filled insulator.
6. Use electrical tape to build up insulation level equivalent to cable insulation and cover with not less than two half-lapped layers of plastic electrical tape, for joints, taps, and splices of #1 AWG conductors and larger.
7. Plastic snap-on or piercing type mechanical splice insulators are not allowed.
8. Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.

C. Terminals:
1. All terminals are to be compression type.
2. Train wires to eliminate fanning of stands, crimp with proper tool and die.
3. Insulate ends of spare conductors with electrical tape and identify spare circuit number where appropriate.
4. Eye type crimped terminal for removable screw type terminal. Forked torque terminal when screw terminal cannot be removed.
5. Torque screw termination per manufacturer's recommended values.
6. Terminate motors connections using the following methods:
   a. 300V and below: Use compression-set, insulted eye terminal for screw lug connections or barrel type cable to cable connections.
   b. Above 300V: Use 3M 5300 series insulated motor lead splicing kit.

3.6 CABLE TIES

A. Neatly bundle conductors and cables together for support. Size cable ties sufficiently to accommodate the multiple cables being supported.

3.7 FIELD QUALITY CONTROL

A. Test 600 volt conductors and cables per requirements in Sections 26 0812 – Power Distribution Acceptance Tests and 26 0813 – Power Distribution Acceptance Test Tables.

B. Interpret test results in writing and submit to Engineer.

C. Replace conductors and cables that are found defective, at no expense to Owner.

END OF SECTION

SECTION 26 0519.16 MANUFACTURED WIRING SYSTEM

PART 1 - GENERAL

1.1 RELATED WORK

A. Section 26 0000 – General Electrical Requirements

B. Section 26 0519 – Low-Voltage Electrical Power Conductors and Cables

C. Section 26 0533 – Raceway and Boxes for Electrical Systems

D. Section 26 0553 – Electrical Systems Identification

E. Section 26 5000 –Lighting

1.2 REFERENCE

A. Work under this section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.

1.3 DESCRIPTION OF SYSTEM

A. At Contractor's option, provide Manufactured Wiring System for connection to Luminaires instead of wire and conduit system.

1.4 REFERENCE STANDARDS

A. UL 183 - Manufactured Wiring Systems.

1.5 SUBMITTALS

A. Submit shop drawings for equipment provided under this Section.

B. Submit as-built floor plans of fixture interconnections.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Manufacturers: Day-brite, Electro/Connect Walker Flexible Systems, Reloc, and Hubbell.

2.2 PRODUCTS

A. Provide luminaires and/or other equipment with power-in and power-out connector. Flush mount all connectors.

B. Provide factory prewired luminaires with system fixture receptacle assemblies and ship to job site ready for connection.

C. Provide coordination between system used and luminaire manufacturer.

D. Provide system components that are prewired, labeled as to function, voltage, number of circuits, capacity of each circuit, catalog number, and manufacturer's name and address.

E. Identifications can be embossed, painted, or stick-on label type.

F. Provide proper interfacing between system and out-of-system components.

G. Provide whips that have female power-in receptacle on one end and power-out receptacle or pre-stripped leads on other end.

H. Provide leads that are a minimum of 6” long.

I. Provide plugs that couple, lock, and complete circuit only with receptacles of like configuration.

J. Provide whips that are of ample length to make proper connection without bending damage to cable.

K. Provide polarized connectors.

L. Wiring shall be #12 AWG, 90°C insulated wire and rated at 20 A.

M. Carry an equipment grounding conductor throughout all system components, except those that are serving only low-energy power circuits, signaling circuits, or other remote control circuits.

N. Provide conversion units to convert from permanent wiring to flexible wiring, cable sets, junction units, fixture receptacles. Provide switch and receptacle whips to feed switches and receptacles from flexible system. Provide cable couplers and splitters as required.

O. Provide connectors that are held in place to prevent accidental disconnection.

P. Route cable in accordance with manufacturer's instructions.

Q. Provide 5% extra splitters.

R. Color code plugs and receptacles.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install components and materials in accordance with code requirements, manufacturer's instructions, and approved shop drawings.

B. Install switch whips and wiring adapters with nonsystem components in approved manner, ready for interface with flexible wiring system.

C. When conversion units, luminaires, and switching units have been installed, complete manufactured wiring system by connecting system components with cable sets of lengths, types, and color coding as indicated or required.

D. Support cable sets with nylon tie wraps or metal clips designed for purpose at 4 ft on center.

E. Cap unused receptacles and connectors with dust cover.

END OF SECTION

SECTION 26 0526 GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED WORK

A. Related Division 26 Sections include:
   1. Section 26 0812 - Power Distribution Acceptance Tests
   2. Section 26 0813 - Power Distribution Acceptance Test Tables
   3. Section 26 4113 - Lightning Protection for Structures

B. Related sections in other Divisions of Work:
   1. Section 27-0526 - Grounding and Bonding for Communications Systems

1.2 REFERENCE

A. Work under this Section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.

1.3 DESCRIPTION

A. Section includes methods and materials for grounding systems and equipment, as required by State Codes, NFPA 70, applicable portions of other NFPA codes, as indicated herein.
   1. Common ground bonding with lightning protection system.

B. Maximum resistance to ground shall be less than 5 ohms.

1.4 REFERENCE STANDARDS

A. ANSI J-STD-607-B - Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications

B. ASTM B 3 – Specification for Soft or Annealed Copper Wire

C. ASTM B 8 – Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard or Soft

D. ASTM B 33 – Specification for Tinned Soft or Annealed Copper Wire for Electrical Purposes

E. IEEE C2 – National Electrical Safety Code (ANSI)

F. NETA MTS – Maintenance Testing Specifications

G. NFPA 70 – National Electrical Code

H. NFPA 70B – Recommended Practice for Electrical Equipment Maintenance

I. NFPA 780 – Lightning Protection Systems

J. UL 96 – Lightning Protection Components

K. UL 467 – Grounding and Bonding Equipment

1.5 SUBMITTALS

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

B. Field Quality-Control Test Reports:
   1. Indicate field test and inspection procedures and interpret test results and corrective action taken for compliance with specification requirements.
   2. Test reports of resistance to earth. Each test report shall include:
      a. Date of test, soil moisture content, and soil temperature
      b. Test operator
      c. Instrument or other test equipment used
      d. Electrode designation or location
      e. Ground impedance in ohms
      f. Assumptions made - if required

C. Closeout Submittals:
   1. Operation and Maintenance Manuals: Include the following:
      a. Instructions for periodic testing and inspection of grounding system.
         1) Instructions to perform tests to determine if ground resistance or impedance values remain within specified maximums, and instructions shall recommend corrective action if they do not.
         2) Include recommended testing intervals.

1.6 QUALITY ASSURANCE

A. Regulatory Requirements:
   1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70.
   2. Comply with UL 467 for grounding and bonding materials and equipment.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Store products in clean, dry space. Protect from dirt, fumes, water, corrosive substances, and construction debris.

1.8 WARRANTY

A. Refer to Division 01 and Section 26 0000 – General Electrical Requirements for general warranty requirements.

B. Manufacturer shall provide standard 1 yr written warranty against defects in materials and workmanship for products specified in this Section. Warranty period shall begin on date of substantial completion.

PART 2 - PRODUCTS

2.1 CONDUCTORS

A. Insulated Conductors: Copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction, insulation color: green.

B. Bare Copper Conductors:
   1. Solid Conductors: ASTM B 3.
   2. Stranded Conductors: ASTM B 8.
   3. Tinned Conductors: ASTM B 33.
   4. Counterpoise and Bonding Conductor: Bare stranded conductor, size as indicated on drawings.

C. Grounding Bus: Horizontal rectangular bars of annealed copper, 1/4” by 2” in cross section; with insulators, length as indicated on drawings. Minimum length is 24”.

2.2 CONNECTORS

A. Listed and labeled by a nationally recognized testing laboratory acceptable to authorities having jurisdiction for applications in which used, and for specific types, sizes, and combinations of conductors and other items connected.

B. Bolted Connectors for Conductors and Pipes: Copper or copper alloy, bolted pressure-type, with at least two bolts.
   1. Pipe Connectors: Clamp type, sized for pipe.

C. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

D. Compression Connectors: Irreversible type.

2.3 GROUNDING ELECTRODES

A. Ground Rods: Copper-clad, 3/4” in diameter by 10 ft in length.

PART 3 - EXECUTION

3.1 APPLICATIONS

A. Exposed Bonding Conductors: Install solid conductor for #6 AWG and smaller and stranded conductors for #4 AWG and larger, unless otherwise indicated.

B. Equipment Grounding Conductors: Install solid conductor for #12 AWG and smaller and stranded conductors for #10 AWG and larger. Conductors are to have green insulation for #10 AWG and smaller and identified with green tape at terminations, boxes and splices for sizes #8 AWG and larger.

C. Underground Grounding Conductors: Install bare copper conductor. Sized as indicated on drawings.
   1. Bury at least 24” below grade.

2. Ductbank Grounding Conductor: Bury 12” above ductbank when indicated as part of ductbank installation.

D. Grounding Bus: Install in electrical and communications rooms, in rooms housing service equipment.
   1. Install bus on insulated spacers 1”, minimum, from wall; 6” above finished floor in locations as indicated on drawings.

E. Conductor Terminations and Connections:
   1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors
   2. Underground Connections: Welded connectors, except at test wells and as otherwise indicated
   3. Connections to Ground Rods at Test Wells: Bolted connectors
   4. Connections to Structural Steel: Welded connectors

3.2 EQUIPMENT GROUNDING

A. Install insulated equipment grounding conductors with feeders and branch circuits. Install for each branch circuit neutral originating from panelboards, including lighting circuits.

B. Install insulated equipment grounding conductors with the following items, in addition to those required by NFPA 70:
   1. Feeders and branch circuits
   2. Lighting circuits
   3. Receptacle circuits
   4. Single-phase motor and appliance branch circuits
   5. Three-phase motor and appliance branch circuits
   6. Flexible raceway runs
   7. Armored and metal-clad cable runs

C. Duplex receptacles of any amperage: Install separate jumper between grounding terminal on device and metallic box.

D. Size of equipment grounding conductors for branch circuits: As indicated in NFPA-70, except minimum size shall be #12 AWG.

E. Size of branch panel feeder originating at switchboards/switchgear: As indicated in NFPA-70, except in no instance smaller than #8 AWG.

F. Signal and Communication Equipment: For telephone, alarm, voice and data, and other communication equipment, install insulated grounding conductor (sized as indicated on drawings) in raceway from grounding electrode system to each service location, terminal cabinet, wiring closet, and central equipment location.
   1. Telecom Grounding Bus: Terminate grounding conductor on grounding bus located in telecom room.
   2. Terminal Cabinets: Bond cabinet grounding terminal to telecom grounding bus.
   3. Cable Tray: Bond cable tray to telecom grounding bus.

G. Install equipment grounding conductor from secondary side of each transformer to grounding electrode system as required for separately derived system.

H. Install grounding for service entrance equipment room consisting of ground bus, ground conductors, and copperclad grounding rods arranged as indicated on drawings.

I. Install grounding conductor to luminaires hanging form conduit swivel hangers.

3.3 SEQUENCING, SCHEDULING

A. Permanently attach service grounds before permanent building service is energized.

B. Permanently attach equipment grounds prior to energizing equipment.

3.4 INSTALLATION

A. Connections: Exposed and visible for inspection at all times. Do not install insulation over ground connections.

B. Identify all grounding conductors by system and room number of termination at building grounding electrode point.

C. Grounding Conductors: Route along shortest and straightest paths possible, unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.

D. Common Ground Bonding with Lightning Protection System: Comply with NFPA 780 and UL 96 when interconnecting with lightning protection system. Bond electrical power system ground directly to lightning protection system grounding conductor at closest point to electrical service grounding electrode. Use bonding conductor sized same as system grounding electrode conductor, and install in conduit.

E. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance, except where routed through short lengths of conduit.
   1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
   2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install so vibration is not transmitted to rigidly mounted equipment.
   3. Use exothermic-welded connectors for outdoor locations, but if a disconnect-type connection is required, use a bolted clamp.

F. Grounding and Bonding for Piping:
   1. Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes, using a bolted clamp connector or by bolting a lug-type connector to a pipe flange, using one of the lug bolts of the flange. Where a dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end. Water pipe, by itself, is not an adequate grounding electrode and must be supplemented by another electrode system. Bond system together.
   2. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.

G. Bond laboratory gas piping at point of origin and at each floor of distribution to service entrance grounding bus bar.

H. Make grounding connections on surface that has been cleaned of paint, dirt, oil, etc., so that connections are bare metal to bare metal contact.

I. Make grounding connections tight with UL listed grounding devices, fittings, bushings, etc.

J. Equipment Grounding Conductor: Terminate in panelboard at green wire ground bus.

K. Multiple Conductors on Single Lug: Not permitted. Terminate each grounding conductor on its own terminal lug.

L. Flexible Metallic Conduit, Non-Metallic Rigid Conduit, or Liquid Tight Flexible Conduit: Install green wire grounding conductor with phase conductors in conduit.

3.5 FIELD QUALITY CONTROL

A. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
   1. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal at ground test wells. Make tests at ground rods before any conductors are connected.

B. Test grounding systems per requirements in Section 26 0812 – Power Distribution Acceptance Tests and 26 0813 – Power Distribution Acceptance Test Tables.

C. Interpret test results in writing and submit to Engineer.

D. Inspect completed system by commissioning authority, prior to backfilling.

END OF SECTION

SECTION 26 0529 HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED WORK

A. Section 26 0533 – Raceway and Boxes for Electrical Systems

B. Section 26 2200 – Low-Voltage Transformers

C. Section 26 2300 – Low-Voltage Switchgear

D. Section 26 2413 – Switchboards

E. Section 26 2416.13 – Lighting and Appliance Panelboards

F. Section 26 2416.16 – Distribution Panelboards

G. Section 26 2419 – Motor-Control Centers

H. Section 26 2500 – Enclosed Bus Assemblies

I. Section 26 2816 – Enclosed Switches and Circuit Breakers

J. Section 26 2913 – Enclosed Controllers

K. Section 26 3353.13 – Static Uninterruptible Power Supply

L. Section 26 3623 – Automatic Transfer Switches

1.2 REFERENCE

A. Work under this section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions and sections under Division 01 General Requirements.

1.3 DESCRIPTION

A. Section includes the following:
   1. Manufactured hangers and supports for individual raceways and cables, slotted channel and angle systems for multiple conduit runs, and most electrical equipment that is not floor mounted.
   2. Construction requirements for concrete housekeeping pads for floor-mounted electrical equipment.

1.4 REFERENCE STANDARDS

A. AWS D1.1/D1.1M – Structural Welding Code-Steel.

B. ASTM A 36/A 36M – Carbon Structural Steel.

C. ASTM A 325 – Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength.

D. ASTM A 780 – Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings.

E. MSS SP-58 – Pipe Hangers and Supports - Materials, Design and Manufacture.

F. MSS SP-69 – Pipe Hangers and Supports - Selection and Application.

G. MFMA-4 – Metal Framing Standards Publication.

H. NECA 1 – Standard Practices for Good Workmanship in Electrical Construction.

I. NECA 101 – Standard for Installing Steel Conduits (Rigid, IMC, EMT).

J. NFPA 70 – National Electrical Code.

K. SSPC-PA 1 – Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel.

1.5 SUBMITTALS

A. Product Data: For the following:
   1. Steel slotted support systems.
   2. Raceway and cable supports.
   3. Support for conductors in vertical raceway.
   4. Structural steel for fabricated supports and restraints.
   5. Mounting, anchoring, and attachment components:
      a. Powder-actuated fasteners.
      b. Mechanical-expansion anchors.
      c. Concrete inserts.
      d. Clamps for attachment to structural steel.
      e. Through bolts.
      f. Toggle bolts.
      g. Hanger rods.

B. Shop Drawings: Include concrete anchors application, size, and placement. Include concrete inserts application, size, loading, and placement. Show fabrications and installation details and include calculations for the following:
   1. Trapeze hangers. Include product data for components.
   2. Steel slotted channel systems. Include product data for components.
   3. Fabricated metal equipment support assemblies.

C. Welding certificates.

D. Schedule of hangers and support devices with support spacing.

1.6 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, “Structural Welding Code – Steel.”

B. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

A. Rated Strength: Adequate in tension, shear, and pullout force to resist maximum loads calculated or imposed for this Project, with a minimum structural safety factor of 5 times the applied force.

B. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.
   1. Finishes
      a. Metallic Coatings:
         1) Factory standard primed, galvanized of electroplated finish and applied according to MFMA-4, for indoor applications.
         2) Hot-dip galvanized after fabrication and applied according to MFMA-4, for outdoor applications.
      b. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
   2. Channel Dimensions: Selected for applicable load criteria.
   3. Manufacturers:
      a. Allied Support Systems; Power-Strut Unit.
      b. Cooper B-Line, Inc.; A division of Cooper Industries.
      c. ERICO International Corporation.
      d. GS Metals Corporation.
      e. Thomas & Betts Corporation.
      f. Unistrut; Tyco International, Ltd.
      g. Wesanco, Inc.
      h. National Pipe Hanger Corporation.
      i. Michigan Hanger Co., Inc.; O-Strut Division.
      j. Approved equal.

C. Raceway and Cable Supports: As described in NECA 1 and NECA 101.

D. Raceway and Cable Support Devices: Steel hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.

E. Support for Conductors in Vertical Raceway: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suite individual conductors or cables supported. Body shall be malleable iron.

F. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

G. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:

1. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
    a. Manufacturers:
        1) Hilti Inc.
        2) ITW Ramset/Red Head; A division of Illinois Tool Works, Inc.
        3) MKT Fastening, LLC.
        4) Simpson Strong-Tie Co., Inc.; Masterset Fastening Systems Unit
        5) Approved equal
2. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel, for use in hardened portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.
    a. Manufacturers:
        1) Cooper B-Line, Inc.; A division of Cooper Industries
        2) Empire Tool and Manufacturing Co., Inc.
        3) Hilti Inc.
        4) ITW Ramset/Red Head; A division of Illinois Tool Works, Inc.
        5) MKT Fastening, LLC.
        6) Approved equal
3. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.
4. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.
5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
6. Toggle Bolts: All-steel springhead type.
7. Hanger Rods:
    a. MSS SP-58; threaded steel, with adjusting and lock nuts; electroplated zinc finish.
    b. MSS SP-58; nonmetallic, with adjusting and lock nuts.

2.2 FABRICATED METAL FRAMING EQUIPMENT SUPPORT ASSEMBLIES

A. Description: Welded or bolted, structural steel shapes, shop or field fabricated to fit dimensions of supported equipment.

B. Materials: Comply with requirements in Division 05 Section “Metal Fabrications” for steel shapes and plates; not be lighter than 12 gauge.

C. Finish: Electro-galvanized.

D. Manufacturers: Same as in paragraph 2.1.B.3 above.

2.3 CONTINUOUS INSERT CHANNELS

A. Length and support capabilities to be suitable for application.

B. Brackets, inserts and accessories suitable for channel insert selected.

C. Manufacturers:

1. Unistrut; Tyco International, Ltd.
2. Cooper B-Line, Inc.; A division of Cooper Industries
3. Michigan Hanger Co., O-Strut Division
4. Anvil International, Inc.
5. Approved equal

PART 3 - EXECUTION

3.1 APPLICATION

A. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems except if requirements in this Section are stricter.

B. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMT, IMC, and RMC as required by NFPA 70.

1. Size steel hanger rods for individual hangers and trapeze supports as indicated in the following schedule. Total weight of equipment shall not exceed limits indicated.

Maximum Loads (lbs)	Rod Diameter (")	Maximum Pipe Size With Single Rod
730	3/8	2"
1130	1/2	3"
1818	5/8	5"

C. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted support system, sized so capacity can be increased by at least 25% in future without exceeding specified design load limits.

1. Secure raceways and cables to these supports with single-bolt conduit clamps using spring friction action for retention in support channel.

D. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2" and smaller raceways serving branch circuits and communication systems above suspended ceilings and for fastening raceways to trapeze supports.

3.2 SUPPORT INSTALLATION

A. Comply with NECA 1 and NECA 101 for installation requirements, except as specified in paragraphs below.

B. Raceway Support Methods: In addition to methods described in NECA 1, raceways may be supported by openings through structure members, as permitted in NFPA 70.

C. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.

D. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:

1. To Wood: Fasten with lag screws or through bolts.

2. To New Concrete: Bolt to concrete inserts.
3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
4. To Existing Concrete: Expansion anchor fasteners.
5. Instead of expansion anchors, powder-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard-weight concrete 4" thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4" thick.
6. To Steel: Spring-tension clamps or beam clamps.
7. To Light Steel: Sheet metal screws.
8. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate.

E. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

F. Do not support raceway by other raceway.

G. Do not support equipment or raceway from metal roof decking or floor decking.

H. Do not impose weight of electrical equipment, raceways, or lighting fixtures on support provided for other trades or systems.

I. Do not support loads from bottom chord member of trusses or open web chord.

J. Suspend hangers by means of hanger rods. Perforated band iron and flat wire (strap iron) are not allowed.

K. Use conduit-mounting pedestals for piping on roof. Install bottom of pedestal flat on roof deck and insulate exterior of pedestal, flush and counter flush. Coordinate roof mounting methods with roof system installer to maintain roof warranty provided by roof system installer.

L. Minimize use of concrete anchors and inserts after concrete pour.

M. Punching, drilling, welding of building structural steel or welding attachment to building structural steel is not allowed, unless approved by structural engineer.

3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

A. Comply with installation requirements in Division 05 Section "Metal Fabrications" for site-fabricated metal supports.

B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.

C. Field Welding: Comply with AWS D1.1/D1.1M.

3.4 CONCRETE HOUSEKEEPING PADS

A. Construct concrete housekeeping pads for all floor-mounted electrical equipment.

B. Dimensions: 3.5" high and not less than 4" larger in both directions than supported equipment, so anchors will be a minimum of 10 bolt diameters from edge of the base.

C. Housekeeping pads (equipment pads) for oil-filled transformers and generators: See structural drawings, details and specifications for equipment pad dimensions and requirements.

D. Use 3000 psi, 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in Division 03 Section “Cast-in-Place Concrete.”

E. Anchor equipment to concrete housekeeping pad.
   1. Place and secure anchorage devices. Use supported equipment manufacturer’s setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   2. Install anchor bolts to elevations required for proper attachment to supported equipment.
   3. Install anchor bolts according to anchor-bolt manufacturer’s written instructions.

F. Coordinate with Architect installation of housekeeping pads on roof.

3.5 PAINTING

A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
   1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.

END OF SECTION

SECTION 26 0533 RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED WORK

A. Section 26 0519 – Low-Voltage Electrical Power Conductors and Cables

B. Section 26 0526 – Grounding and Bonding for Electrical Systems

C. Section 26 0529 – Hangers and Supports for Electrical Systems

D. Section 26 0553 – Electrical Systems Identification

E. Section 26 0593 – Electrical Systems Firestopping

F. Section 26 2726 – Wiring Devices

G. Related sections in other Divisions of Work:
   1. Section 27-0528.33 - Raceway and Boxes for Communications Systems

1.2 REFERENCE

A. Work under this section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.

1.3 DESCRIPTION

A. Section includes raceways, fittings, wireways, outlet boxes, pull and junction boxes, floor boxes, tap boxes and raceway seals.

1.4 REFERENCE STANDARDS

A. ANSI/NECA 1 – Standard Practices for Good Workmanship in Electrical Contracting

B. ANSI C80-1 – Rigid Steel Conduit-Zinc Coated (GRS)

C. ANSI C80-3 – Electrical Metallic Tubing-Zinc Coated (EMT)

D. ANSI C80-6 – Intermediate Metal Conduit-Zinc Coated (IMC)

E. ASTM A 53/A 53M – Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless

F. ETL PVC-001 – Intertek ETL SEMKO High Temperature H^2O PVC Coating Adhesion Test Procedure for 200hrs.

G. NEMA 250 – Enclosures for Electrical Equipment (1000 V Maximum)

H. NEMA FB 1 – Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing and Cable

I. NEMA OS 1 – Sheet-Steel Outlet Boxes, Device Boxes, Covers, and Box Supports

J. NEMA TC 2 – Electrical Polyvinyl Chloride (PVC) Conduit

K. NEMA TC 3 – PVC Fittings for Use with Rigid PVC Conduit and Tubing

L. NFPA 70 – National Electrical Code

M. UL 1 – Flexible Metal Conduit

N. UL 6 – Electrical Rigid Metallic Conduit-Steel

O. UL 360 – Liquid-Tight Flexible Steel Conduit

P. UL 514A – Metallic Outlet Boxes

Q. UL 514B – Conduit, Tubing, and Cable Fittings

R. UL 651 – Schedule 40 and 80 Rigid PVC Conduit and Fittings

S. UL 797 – Electrical Metallic Tubing-Steel

T. UL 870 – Wireways, Auxiliary Gutters, and Associated Fittings

U. UL 1242 – Electrical Intermediate Metal Conduit-Steel

V. UL 1660 – Liquid-Tight Flexible Nonmetallic Conduit

W. BICSI – Telecommunications Reference Manual (TDMM), Latest Edition

X. University of Kentucky - Communications and Network Systems – Telecommunications Standards

1.5 SUBMITTALS

A. Product Data:
   1. Raceways
   2. Fittings
   3. Wireways
   4. Outlet boxes
   5. Pull and junction boxes
   6. Floor boxes
   7. Tap boxes
   8. Raceway seals

B. Manufacturer's Installation Instructions:
   1. Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation and installation of product.

C. Closeout Submittals:
   1. Project Record Documents:
      a. Record actual routing of raceways 2" and larger.

b. Record actual location and mounting heights of wireways, floor boxes, tap boxes, outlet, pull and junction boxes.

1.6 QUALITY ASSURANCE

A. Regulatory Requirements:
   1. Comply with NFPA 70.
   2. Furnish products listed and classified by Underwriters Laboratories, Inc., as suitable for purpose specified and indicated.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Store in clean, dry space. Maintain factory wrapping or provide additional canvas or plastic cover to protect from dirt, water, construction debris, and traffic.

B. Protect PVC conduit from sunlight.

C. Comply with manufacturer's written instructions.

1.8 WARRANTY

A. Refer to Division 01 and Section 26 0000 – General Electrical Requirements for general warranty requirements.

PART 2 - PRODUCTS

2.1 RIGID METAL CONDUIT (RMC)

A. Rigid Steel Conduit (RSC): ANSI C80.1, UL 6; heavy wall galvanized steel**.**

B. Intermediate Metal Conduit (IMC): ANSI C80.6, UL 1242; thinner wall, galvanized steel**.**

C. Fittings (couplings, conduit bodies, connectors and bushings): NEMA FB 1, UL 514B; aluminum alloy; threaded; connectors with double locknuts and steel insulating bushings, thermoplastic insulating bushings; conduit bodies cover: stamped steel, with stainless steel screws and neoprene gaskets**.**

D. Fittings Manufacturers: Cooper Crouse-Hinds; Carlon Electric Products; O-Z/Gedney; Appleton; Hubbell; Robroy Industries – Perma-Cote.

2.2 ELECTRICAL METALLIC TUBING (EMT)

A. ANSI C80.3, UL 797; galvanized steel tubing

B. Fittings (couplings, conduit bodies, and connectors): NEMA FB I, UL 514B; steel, watertight gland compression type connectors with double locknuts and insulated throat; conduit bodies cover: stamped steel, with stainless steel screws and neoprene gaskets. Indentor, drive-on, die-cast or pressure cast fittings not permitted.

C. Fittings Manufacturers: Same as manufacturers listed in 2.1.D.

2.3 FLEXIBLE METAL CONDUIT (FMC)

A. UL 1; interlocked steel

B. Fittings: NEMA FB I, UL 514B; steel

2.4 LIQUIDTIGHT FLEXIBLE METAL CONDUIT (LFMC)

A. UL 360; interlocked steel, with PVC jacket

B. Fittings: NEMA FB 1, UL 514B; steel

2.5 RIGID NONMETALLIC CONDUIT (RNC)

A. NEMA TC 2, UL 651; Schedule 40 PVC

B. Fittings: NEMA TC 3, UL 651

C. NEMA TC 2, UL 651; Schedule 40 and 80 PVC

D. Fittings: NEMA TC 3, UL 651

2.6 OPTICAL FIBER CABLE RACEWAY AND FITTINGS

A. Per requirements in Division 27.

2.7 METAL WIREWAYS

A. NEMA 250, UL 870; galvanized sheet metal troughs with hinged or removable cover, Type 1 for indoor and 3R for outdoor, unless otherwise indicated.

B. Size: cross section and length as indicated on drawings.

C. Fittings and Accessories: Couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mated with wireways as required for complete system.

D. Wireways Covers: Screw-cover type for indoor, flanged-and-gasketed type for outdoor.

E. Knockouts: none.

F. Finish: Manufacturer's standard enamel finish

G. Manufacturers: Same as listed in Section 2.9F.

2.8 OUTLET BOXES

A. Sheet Metal Outlet Boxes: NEMA OS 1, UL 514A; galvanized steel with stamped knockouts.
   1. Luminaire and Equipment Supporting Boxes: Rated for weight of equipment supported; 1/2" male fixture studs, where required
   2. Concrete Ceiling Boxes: Concrete type
   3. Communications outlet boxes:
      1) Back Box: 5" square, 2-7/8" deep.
      2) Provide opening for Division 27 manufacturer bezel or mounting strap.
   4. Plaster ring: Match depth to provide flush faceplates.

B. Cast-Metal Outlet Boxes: NEMA FB 1, cast aluminum or cast iron (galvanized), Type FD, with gasketed cover and threaded hubs

C. Gangable type boxes are not allowed

D. Manufacturers: O-Z/Gedney; Raco; Cooper Crouse-Hinds; Approved equal

2.9 MULTISERVICE FLOOR BOXES

A. Above Grade: Stamped steel, watertight design approved for use on above-grade concrete floor applications, with four independent wiring compartments and capacity for up to four duplex receptacles and/or communication services. The box: fully adjustable providing pre-pour and after-pour adjustment, tunnel compartment, and two receptacle brackets. Conduit knockouts per drawing requirements. Comply with UL 514A and UL 514C scrub water exclusion test for tile, terrazzo, carpet and wood floors.

B. On Grade: Cast iron or steel pour box, watertight design approved for use in on-grade and above-grade concrete floor applications, with four independent wiring compartments and capacity for up to four duplex receptacles and/or communication devices. The box: fully adjustable providing pre-pour and after-pour adjustment, tunnel compartment, and two receptacle brackets. Conduit knockouts per drawing requirements. Comply with UL 514A and UL 514C scrub water exclusion test for tile, terrazzo, carpet and wood floors.

C. Covers: Activation Covers – Die-cast aluminum with textured aluminum finish, and black or brass powder-coated paint finishes as selected by the Architect. Cover: flanged or flangeless, as required, with options for tile or carpet inserts, blank covers, or covers with one or two **27 mm(1”)** liquid tight conduit openings for furniture feed applications.

D. Communication Modules Mounting Accessories: Complete line of faceplates and bezels provided by floor box manufacturer to facilitate mounting of fiber optic, coaxial, high-performance twisted-pair cabling, and communication devices. Cabling type and faceplate configurations per requirements in Section 27 1500 – Communications Horizontal Cabling (if applicable). The box shall accommodate workstation connectivity outlets and modular inserts and other system devices specified in Division 27 specifications. Coordinate mounting inserts, mounting plates, or bezels with Section 27 1500.

E. Manufacturers:
   1. Poke-thrus:
      a. FSR – SmartFit-8 Complete Series
      b. Hubbell – SystemOne Series
      c. Legrand – Evolution Series
   2. On-Grade:
      a. FSR – FL-200 Series
      b. Hubbell - HBLCFB Series
      c. Spider - AFB/CFB Series
      d. Legrand - Evolution Series

2.10 PULL AND JUNCTION BOXES

A. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1; galvanized steel

B. Cast-Metal, Pull, and Junction Boxes: NEMA FB 1; cast aluminum or galvanized, cast iron with ground flange, gasketed cover and stainless steel cover screws

C. Minimum size: 4” square by 2-1/8” deep for use with 1” conduit and smaller; 4-11/16” square by 2-1/8” for use with 1-1/4” conduit and larger

D. Sheet Metal Boxes Larger Than 12” in any direction: Hinged cover or a chain installed between box and cover
   1. Sheet metal boxes larger than 24” in any direction: Split hinged cover.

E. Field-fabricated boxes not allowed without prior approval of local authority having jurisdiction.

F. Manufacturers: O-Z/Gedney; Raco; Cooper Crouse-Hinds; Hubbell-Weigmann; Hoffman; J&A Sheet Metal Inc. Austin Electrical Enclosures; Approved equal

2.11 EXPANSION FITTINGS

A. Malleable iron, hot dip galvanized allowing 4” allowing 2” raceway movement.

B. Manufacturers: OZ/Gedney AX Series; or equivalent by manufacturer listed in 2.1.D.

2.12 RACEWAY PENETRATION SEALS

A. Thruwall and Floor Seals.

B. Manufacturers: New construction – OZ/Gedney FSK Series; existing construction – OZ/Gedney CSM Series; or equivalent by manufacturer listed in 2.1.D.

2.13 RACEWAY SEALING FITTINGS

A. For one through four conductors: Manufacturers: OZ/Gedney CSB Series; Approved equal

B. For greater than four conductors: Manufacturers: OZ/Gedney EYA Series with sealing compound; Approved equal

C. Low-temperature or hazardous locations: Manufacturers: OZ/Gedney EYA Series with sealing compound; Approved equal

2.14 CABLE SUPPORTS

A. Manufacturers: OZ/Gedney Type S; or equivalent by manufacturer listed in 2.1.D.

2.15 SLEEVES FOR RACEWAYS

A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends, with integral water stop.

B. Integral Water Stop: Manufacturer: Thunderline Corporation; Approved equal
   1. High density polyethylene (HDPE). Type Century-Line engineered sleeve with end caps.
   2. Steel. Type WS engineered sleeve.

2.16 SLEEVE SEALS

A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and cable.
   1. Sealing Elements: EPDM interlocking links shaped to fit surface of cable or conduit. Include type and number required for material and size of raceway or cable.

2. Pressure Plates: Carbon steel. Include two for each sealing element.
3. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements. Include one for each sealing element.

PART 3 - EXECUTION

3.1 GENERAL

A. Division 26 Contractor shall provide all Division 27 pathway infrastructure as specified and shown on plans, including but not exclusive to back boxes, conduits, pull boxes, cable trays, surface raceways, and floor boxes.
   1. Coordinate communication outlet opening size and location with Division 27 contractor.

3.2 COORDINATION

A. Coordinate with Architect/Engineer size and location of required built-in openings in building structure, including those sleeved, formed or core drilled.

B. Coordinate with Architect/Engineer cutting, removing, or piercing general or mechanical insulation, fire-rated walls, ceilings or steelwork.

C. Verify with Architect/Engineer all surface raceway installations except in mechanical, electrical, and communications rooms.

D. Coordinate routing of any through-wall or through-roof conduits.

E. Coordinate sleeve selection and application with selection and application of firestopping specified in Section 26 0593 – Electrical Systems Firestopping.

F. Verify that exterior wall or wet location boxes are gasketed type cast boxes with matching cover.

G. Verify with manufacturer that “touch-up” paint kit are available for use.

3.3 EXAMINATION

A. Examine surfaces to receive raceways and boxes for compliance with installation tolerances and other conditions affecting performance of raceway’s installation. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.4 INSTALLATION

A. Raceways:
   1. Comply with ANSI/NECA 1 and NFPA 70 for installation requirements applicable to products specified in Part 2 except where requirements on drawings or in this Section are stricter.
   2. Arrange raceways to maintain headroom and present neat appearance.
   3. Raceway routing is shown in approximate locations, unless dimensioned. Route to complete raceway installation before starting conductor installation.
   4. Keep raceways at least 12” away from parallel runs of fuels, steam, hot-water pipes or ductwork. Install horizontal raceway runs above water and steam piping. Install raceways level and square and at proper elevations: 6’-6” minimum headroom, except in exit pathways 7’-0” minimum headroom. Do not block access to junction boxes, mechanical equipment or prevent removal of ceiling panels, etc.

5. Run raceways concealed in construction to avoid adverse conditions such as heat and moisture, to permit drainage, and to avoid materials and equipment of other trades, except where noted otherwise.
6. Avoid exposed raceway runs. Run raceways exposed where impractical or impossible to conceal or where specific approval is obtained. Run exposed raceways grouped and parallel or perpendicular to construction. Do not route exposed raceways over boilers or other high-temperature machinery or in contact with such equipment. Offset exposed raceways at boxes.
7. Route raceways installed above accessible ceilings parallel or perpendicular to construction.
8. Install raceway in structural or topping floor slabs, where noted on plans, as follows:
    a. Center raceways in structural slabs clear of reinforcing steel, except where crossing same, and spaced on centers equal or exceeding 3 times the raceway diameter. Secure raceways to reinforcing rods to prevent sagging or shifting during concrete placement. Space raceways laterally to prevent voids in concrete.
    b. Outside diameter of raceway shall not exceed 1/3 the structural slab thickness.
    c. Obtain approval from Engineer for each run of raceway 1” or larger.
    d. Do not run raceways through cast-in-place support elements without approval from the structural engineer.
    e. Do not install raceways in topping slabs of 3” or less.
    f. Locate raceways to avoid conflict with equipment, door bucks, partitions and other equipment bolted to floor.
    g. Use concrete tight set screw conduit connectors.
    h. Arrange stub-ups so curved portions of bends are not visible above finished slab. Install with an adjustable top or coupling threaded inside for plugs set flush with finished floor. Extend conductors to equipment with rigid steel conduit; use flexible metal conduit 6” above the floor. Install threaded plugs flush with floor for future equipment connections.
    i. Change from nonmetallic raceway to RMC or IMC before rising above floor.
9. Cut raceways square using saw or pipecutter.
10. Use hydraulic one-shot raceway bender or factory elbows for bends in raceway larger than 1”, unless sweep elbows required. Bend raceways according to manufacturer’s recommendations. Do not use torches or open flame to aid in bend of PVC conduit.
11. Use raceway fittings compatible with raceways and suitable for use and environment.
12. Provide bushings on all raceways.
13. Raceways minimum sizes:
    a. Minimum raceway size 3/4”, except as noted on drawings.
    b. Minimum homerun size 1”, except as noted on drawings.
    c. Minimum size for flexible metal conduit is 3/4”, except as noted on drawings.
    d. Minimum size for liquidtight flexible metal conduit is 3/4”.
14. All Communications pathway shall be sized for 40% maximum fill, including 50% future growth.
15. Install empty raceways with 200 lb nylon pull cord; leave at least 12” of slack at each end of pull wire. Cap raceways at both ends.
16. Feed devices on same wall vertically from above or junction box in suspended ceiling.
    a. Do not install horizontal bends in conduit around corners.
17. Raceways Supports:

a. Independently support or attach raceway system to structural parts of construction. Suspended ceiling systems shall not be considered as structural parts of construction for raceway support. Do not attach raceways to piping system.
b. Raceway supports for horizontal or vertical single runs:
    1) Hot dipped galvanized heavy-duty sheet steel straps, mineralac clamps or steel slotted support channel system with appropriate components.
c. Raceway supports for horizontal and vertical multiple runs:
    1) Trapeze-type supports fabricated with steel slotted channel systems with appropriate components.
    2) Support horizontal runs with appropriately sized rods.
    3) Anchor vertical runs to structure.
d. Vertical raceway runs 1-1/4" and larger passing through floors: Support at each floor with pipe riser clamps.
e. Do not support raceways with wire, perforated pipe straps or plastic tie-wrap. Remove wires used for temporary support.
f. Secure raceways in metal stud walls to prevent rattling.
g. Arrange raceway supports to prevent misalignment during wiring installation.
h. Do not fasten raceways to corrugated metal roof deck.
i. For fasteners and supports, including steel slotted support systems, support devices, support spacing, support of conductors in vertical raceways, and hanger rod size, refer to Section 26 0529 – Hangers and Supports for Electrical Systems and NFPA 70.

18. Identify raceways per requirements in Section 26 0553 – Electrical Systems Identification.
19. Ground raceways per requirements in Section 26 0526 – Grounding and Bonding for Electrical Systems.
20. Flexible Conduit Connections: Use maximum of 72" of flexible conduit for recessed and semi-recessed lighting fixtures, equipment subject to vibration, noise transmission, or movement; and for transformers and motors.
    a. Use LFMC in damp or wet locations subject to severe physical damage.
    b. Do not use LFMC in plenum spaces or within air handling equipment.
    c. Use FMC in dry locations not subject to severe physical damage.
21. Install stainless steel raceway clamps, mounting hardware, supports, hangers, etc., when located in wet areas.
22. Power and Communications Raceways: Minimum 12" separation when run parallel, cross perpendicular.
23. Communications Raceway Requirements:
    a. All Communications raceways shall conform to industry, BICSI, and UK-CNS standards.
    b. All voice, data, video wiring inside rooms shall be protected by metallic conduit or other means such as surface raceway or in-floor troughs.
    c. Bond conduits to cable tray to provide grounding continuity.
    d. No more than an equivalent of 180 degrees of bend, including offsets, are allowed in a conduit run between junction boxes or pull boxes.
    e. No "LBs" are allowed.
    f. Pull boxes shall be provided in conduit runs longer than 100 feet.
    g. Maximum individual conduit run including a pull box shall not exceed 150 feet.
    h. All EMT fittings shall be compression type on conduits less than 2-1/2" in diameter.

i. Conduits ending at a cable tray shall have plastic bushings and be bonded to the tray.
j. Conduits terminating within a Communications room shall have plastic bushings and be bonded to the telecommunication grounding bus bar located in that room.
k. Each horizontal communications conduit shall be home-run to the nearest cable tray. No device to device conduit runs are allowed.
l. Communications conduit bend radii shall be:
    1) Six (6) times the internal conduit diameter for conduit 2" or less internal diameter.
    2) Ten (10) times the internal conduit diameter for conduit greater than 2" internal diameter.
m. Conduit bends shall be smooth, even, and free of kinks or other discontinuities that may have detrimental effects on pulling tension or cable integrity during or after installation

B. Wireways:
1. Install in accordance with manufacturer's instructions.
2. Use screws, clips and straps to fasten raceway channel to surfaces.
3. Mount plumb and level.
4. Use suitable insulating bushings and inserts at connections to outlets and corner fittings.
5. Supports: Per manufacturer's recommendations.
6. Close ends of raceway channel and unused conduit openings.

C. Boxes:
1. Install boxes to accommodate device indicated by symbol, in conformance with code requirements, number and size of conductors and splices and consistent with type of construction.
2. Install boxes to accommodate minimum Communications cable bend radii and service loop lengths.
3. Install each above-ceiling Communications outlet box for immediate accessibility after all trades are installed.
4. Install the appropriate cover on surface-mounted boxes:
    a. Raised device covers on 4 square and handy boxes.
    b. Device covers that are square drawn or square cut on boxes in block.
    c. Tile covers on boxes in tile.
    d. Round drawn device covers on boxes in lath and plaster walls or dry wall only.
    e. Set front edge of device boxes flush with finished wall surfaces except on walls of non-combustible materials where boxes may have maximum set back of 1/4". Secure flush-mounted box to interior wall and partition studs. Accurately position to allow for surface finish thickness.
5. Set outlet boxes parallel to construction and independently attached to same.
6. Do not install back-to-back and through-the-wall boxes. Install with minimum 6" horizontal separation between closest edges of the boxes. Install with minimum 24" separation in acoustic-rated walls and fire-rated walls.
    a. All boxes installed in acoustic-rated walls shall be installed with acoustic putty pads.
7. Conduit penetrations plus inset boxes for panels, receptacles, or other functions shall not derate acoustical integrity of acoustical demising partitions. Provide acoustical sealant or resilient fire caulking for penetrations.

8. Install multi-ganged boxes where 2 or more devices are in same location, unless otherwise noted.
9. Box Support:
    a. Mount boxes straight.
    b. Install horizontal bracing at top or bottom of box for 3 or more gang device boxes in stud walls.
    c. Install stud support one side, with short piece of stud, for up to 2 gang device boxes.
    d. Do not support boxes with tie-wire.
    e. For one and two gang box support, manufactured bracket supports shall be accepted alternate.
    f. Support boxes independently of raceways.
    g. Install adjustable steel channel fasteners for hung ceiling outlet box.
    h. Install stamped steel bridges to fasten flush-mounted outlet box between studs.
    i. Do not install boxes to ceiling support wires or piping systems.
10. Install partitions in multi-ganged boxes where different types of devices are installed, or devices installed operate at different voltages.
11. Mount boxes in block walls at block joint nearest to indicated height.
12. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall.
13. When boxes are installed in fire-resistive walls and partitions, limit penetrations to 16 sq in per penetration and not to exceed a total of 100 sq in per 100 sq ft of wall area. Use FireBlok fire suppression gaskets or fire stop putty pads acceptable to the fire marshal.
14. Pull and junction boxes: Install as shown, or as necessary to facilitate pulling of wire and to limit number of bends within code requirements. Install above accessible ceilings and in unfinished areas.
15. Install boxes to be permanently accessible.
16. Do not intermix conductors from more than one system in same junction box or pull box, unless shown or specifically authorized otherwise.
17. Adjust box location up to 10’ prior to rough-in to accommodate intended purpose.
18. Orient boxes to accommodate wiring devices oriented as specified in Section 26 2726 – Wiring Devices.
19. Inaccessible Ceiling Areas: Install outlet and junction boxes no more than 6” from ceiling access panel or from removable recessed luminaire.
20. The drawings do not necessarily show every outlet, pull or junction box required. Add all required boxes as necessary.

D. Floor Boxes:
    1. Set floor boxes level and flush with finished floor surface.
    2. Install floor boxes and fittings to preserve fire-resistant rating of slabs and other elements, using materials and methods specified in Section 26 0593 – Electrical Systems Firestopping.

E. Expansion Fittings:
    1. Install raceway expansion and deflection fittings in all raceway runs embedded in or penetrating concrete where movement perpendicular to axis of the raceway may be encountered.

2. Install raceway expansion fittings complete with bonding jumpers in raceway runs that cross expansion joints in structure and raceway runs mechanically attached to 2 separate structures.
3. Install fitting(s) that provide expansion and contraction for at least 0.0004" per ft of length of straight run per °F of temperature change.
4. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at time of installation.

F. Raceway Penetration Seals:
1. Seal space outside of sleeves with grout for penetrations of concrete and masonry and with approved joint compound for gypsum board assemblies.
2. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and raceway, using joint sealant appropriate for size, depth, and location of joint.
3. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at raceway penetrations. Install sleeves and seal with firestop materials. Comply with Section 26 0593 – Electrical Systems Firestopping.
4. Roof-Penetration Sleeves: Seal penetration of individual raceways with flexible, boot-type flashing units applied in coordination with roofing work.
5. Aboveground, Exterior-Wall Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1" annual clear space between pipe and sleeve for installing mechanical sleeve seals.
6. Underground, Exterior-Wall Penetrations: Install cast-iron "wall pipes" for sleeves. Size sleeves to allow for 1" annual clear space between raceway and sleeve for installing mechanical sleeve seals.
7. Sleeve-Seal Installation: Use type and number of sealing elements recommended by manufacturer for raceway material and size. Position raceway in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
8. Provide chrome- or nickel-plated escutcheons where raceways pass through walls, floors or ceilings and are exposed in finished areas. Size escutcheons to fit raceways for finished appearance. Finished areas shall not include mechanical/electrical rooms, janitor's closets, storage rooms, etc., unless suspended ceilings are specified.
9. Remove temporary sleeves, if used for form wall openings, prior to installation of permanent materials.

G. Raceway Sealing Fittings:
1. Install listed watertight seals to prevent the passage of moisture and water vapor through raceway, where raceway passes from interior to exterior of the building, where raceway passes between areas of different temperatures such as into or out of cold rooms, freezers and air handling units, where raceway enters room which at any time is subject to low or high temperatures and where raceway enters a room which at any time is subject to internal air pressures above or below normal.
2. Install watertight seals in interior of all raceways passing through building roof, ground floor slab (when the raceway does not extend beyond building footprint), or through outside walls of building above or below grade. Seal on the end inside building, using raceway sealing fittings manufactured for the purpose. Locate fittings at suitable accessible locations. For concealed raceways install each fitting in flush steel box with blank coverplate to match finish of adjacent plates or surfaces.

H. Raceway and Outlet Box Sealing in Bio-sensitive Areas (including holding rooms, cage wash and other washdown spaces):
   1. Where outlet boxes and raceways are recessed mounted, seal box to adjacent wall, ceiling, or floor surface with silicone caulk.
   2. See drawing details for additional raceway and outlet box requirements.
   3. Where outlet boxes and raceways are surface mounted (surface mounting permitted only upon prior approval from A/E):
      a. Seal box to adjacent wall, ceiling, or floor surface with continuous bead of silicone caulk.
      b. Seal both sides of surface-mounted raceway to adjacent surfaces with silicone caulk. Where raceways are threaded rigid steel on minimum 3/4" standoffs, sealing of raceway sides is not required.
   4. Install gasketed device cover plates with additional continuous bead of silicone caulk between device plate and adjacent wall, ceiling, or floor surface.
   5. After wiring is installed, surround wiring with 1” barrier of silicone caulk around conductors within device box hub.
   6. Silicone or Urethane Caulk: Resistant to microbiological growth. See section 26 0000 for additional product requirements.
   7. No escutcheons are allowed where raceways pass through walls, floors or ceilings and are exposed in finished areas. Cut and patch holes to within 1/4" of raceway and seal opening with sprayable vinyl, flexible PVC coating equal to Cocoon material.
   8. Mockup at least one location with a sample of a completed installation for backbox, wiring and raceway in a holding room for review by Owner, Architect and Engineer prior to installation of other locations.

I. Sleeve Installation for Electrical Penetrations:
   1. Coordinate sleeve selection and application with selection and application of firestopping specified in Section 26 0593 – Electrical Systems Firestopping.
   2. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.
   3. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
   4. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies, unless openings compatible with firestop system used are fabricated during construction of floor or wall.
   5. Cut sleeves to length for mounting flush with both surfaces of walls.
   6. Extend sleeves installed in floors 2” above finished floor level.
   7. Size pipe sleeves to provide 1/2” annular clear space between sleeve and raceway, unless sleeve seal is to be installed.
   8. Communications sleeve requirements:
      a. Extend Communications sleeves installed in floors 6" above finished floor level.
      b. Communications floor sleeves shall be rigid metallic conduit.
      c. Communications floor sleeves shall have threaded bushings on both ends.
      d. Communications floor sleeves shall be bonded to the Telecommunications grounding busbar.

3.5 APPLICATION

A. Raceway uses permitted and not permitted per NFPA 70 requirements and as described below.

B. Rigid Metal Conduit (RMC) permitted to be installed as follows:
   1. Installations below grade and in or under concrete slabs
   2. All locations except corrosive atmospheres
   3. Hazardous locations
   4. Locations requiring mechanical protection
   5. Stub up through slabs

C. Intermediate Metallic Conduit (IMC) permitted to be installed as follows:
   1. Installation below grade and in or under concrete slabs
   2. All locations, except corrosive atmospheres
   3. Hazardous locations
   4. Locations requiring mechanical protection

D. Electrical Metallic Tubing (EMT) permitted to be installed as follows:
   1. Interior partitions
   2. Above suspended ceilings
   3. In concrete slabs
   4. Above 6 ft AFF in exposed areas of mechanical equipment rooms
   5. Exposed in areas not subject to damage
   6. Sizes 2” and smaller except as approved

E. Flexible Metal Conduit (FMC) permitted to be installed as follows:
   1. Use flexible metal conduit not over 4 ft in length for final connections for:
      a. Vibrating equipment (including transformers and hydraulic, pneumatic, electric solenoid, or motor-driven equipment) in dry locations.
      b. Final connections to recessed luminaires in lengths not to exceed 6 ft.

F. Liquid Tight Flexible Metal Conduit (LFMC) permitted to be installed as follows:
   1. Use liquid tight flexible conduit, not over 4 ft in length, for final connections to:
      a. Vibrating equipment (including transformers and hydraulic, pneumatic, electric solenoid, or motor-driven equipment) in wet locations.
      b. Instruments and control devices
      c. PVC coated LFMC is not allowed in environmental air plenum spaces or air handling equipment.

G. Rigid Nonmetallic Conduit (RNC) permitted to be installed as follows:
   1. Direct burial, concrete encased
   2. Direct burial, in sand fill on bottom and top
   3. Corrosive atmospheres
   4. Use steel elbow in concrete encased runs

H. One-half inch raceway permitted:
   1. Between controller and its control or pilot device
   2. Between lighting switch and nearest outlet for luminaire
   3. Control wiring where mounted on equipment where conduit must follow contour of equipment

4. Protective and signal systems where noted
5. Where shown on plans

3.6 RACEWAY WIRING METHODS

A. Underground: Install galvanized rigid steel conduit or thickwall nonmetallic conduit encased in concrete; threaded conduit fittings for steel; primed and solvent glue fittings for PVC.

B. In Slab: Install electrical metallic tubing; concrete tight set screw conduit fittings; install cast metal boxes.

C. Outdoor Locations, Above Grade: Install galvanized rigid steel conduit or intermediate metal conduit; threaded conduit fittings; install cast metal or nonmetallic outlet boxes with threaded hubs.

D. Wet and Damp Indoor Locations: Install galvanized rigid steel conduit or intermediate metal conduit; threaded conduit fittings; install cast metal or nonmetallic outlet, junction, and pull boxes with threaded hubs. Install flush mounting outlet boxes in finished areas.

E. Concealed and Exposed Dry Locations Not Subject to Damage: Install electrical metallic tubing; install sheet metal boxes; install flush mounting outlet boxes in finished areas.

F. Exposed Subject to Damage: Install galvanized rigid steel conduit or intermediate metal conduit; threaded conduit fittings; install cast metal boxes with threaded hubs. Open public spaces such as parking garages and common areas are considered subject to damage.

3.7 FIELD QUALITY CONTROL

A. Inspect raceway, boxes, indoor service poles, and wireways for physical damage, proper alignment, supports and seismic restraints, where applicable.

B. Replace any damaged component of the raceway system, or install new raceway system.

C. Inspect components, wiring, connections and grounding.

3.8 REPAINTING

A. Repair damage to galvanized finishes with manufacturer-supplied zinc-rich paint kit. Leave remaining paint with Owner.

B. Repair damage to PVC or paint finishes with manufacturer-supplied touch-up coating. Leave remaining coating with Owner.

3.9 ADJUSTING

A. Adjust flush-mounted boxes pre-pour and after-pour to be flush with finished materials.

B. Install knockout closures in unused openings in boxes.

C. Align adjacent wall-mounted outlet boxes for switches and similar devices.

D. Adjust outlet boxes to allow luminaires to be positioned as indicated on drawings.

3.10 CLEANING

A. Clean interior and exterior of boxes, wireways, and indoor poles to remove dust, debris and other material.

3.11 LABELING

A. All labeling shall comply with the published labeling UKPPDMC standard.

B. Stencil systems pull boxes:
   1. Communications as “COMM”

END OF SECTION

SECTION 26 0533.13 SURFACE RACEWAY SYSTEM

PART 1 - GENERAL

1.1 RELATED WORK

A. Section 26 0519 – Low-Voltage Electrical Power Conductors and Cables

B. Section 26 0526 – Grounding and Bonding for Electrical Systems

C. Section 26 0553 – Electrical Systems Identification

D. Section 26 2726 – Wiring Devices

E. Section 27 0553 – Communications Systems Identification

F. Section 27 1500 – Communications Horizontal Cabling

1.2 REFERENCE

A. Work under this section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.

1.3 DESCRIPTION

A. Section includes surface metallic raceway system for branch circuits and other low-voltage wiring.

B. Surface raceway system shall consist of raceway bases, appropriate fittings, and device mounting plates necessary for a complete installation.

C. The lengths of the raceways shown on drawings are illustrative and diagrammatic only and are not accurate. Raceways shall be provided completely installed to match lengths of cabinets and shelving as indicated on drawings.

1.4 REFERENCE STANDARDS

A. ANSI/NECA 1 – Standard Practices for Good Workmanship in Electrical Contracting

B. NFPA 70 – National Electrical Code

C. UL 5 - Surface Metal Raceways and Fittings

1.5 SUBMITTALS

A. Product Data: Catalog cuts of components.

B. Shop Drawings:
   1. Complete layout, with locations of raceway components.
   2. Grounding, branch circuiting, and wiring including locations of service entrances.
   3. Receptacle types, manufacturers, and spacing.
   4. Receptacle labeling with proper voltage, phase, circuit and panelboard designations, as indicated on drawings.

5. Communication faceplate types, manufacturers and labeling.

C. Manufacturer's Installation Instructions:
   1. Indicate application conditions and limitations of use. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product.

D. Closeout Submittals:
   1. Project Record Documents
      a. Record actual locations of surface raceways with receptacle types, locations and circuits identified.
   2. Operation and Maintenance Data:
      a. Include manufacturer's recommended operating instructions, maintenance procedures and intervals, and preventive maintenance instructions.
      b. Include spare parts data listing, source, and current prices of replacement parts and supplies.

1.6 QUALITY ASSURANCE

A. Obtain surface raceways from one source and by single manufacturer.

B. Regulatory Requirements:
   1. Comply with NFPA 70 for components and installation.
   2. Furnish products listed and classified by Underwriters Laboratories, Inc., as suitable for purpose specified and indicated.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Store in clean, dry space. Maintain factory unopened packaging until ready for installation.

B. Comply with manufacturer's written instructions.

1.8 WARRANTY

A. Refer to Division 01 and Section 26 0000 – General Electrical Requirements for general warranty requirements.

B. Manufacturer shall provide standard 1 yr written warranty against defects in materials and workmanship for products specified in this Section. Warranty period shall begin on date of substantial completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Metallic Raceways:
   1. Mono-Systems
   2. Post Glover
   3. Square D
   4. Wiremold

2.2 FABRICATION

A. UL 5

B. Fabrication:
   1. Steel
   2. Suitable for use in dry interior locations only.
   3. Two-piece with base and snap-on cover
   4. Base: two or three compartments with fixed dividers and cover plate, as indicated on drawings
   5. Sizes:
      a. 2-7/8” wide by 1-7/8” deep
         1) Hubbell HBL3000 series
         2) Wiremold Series 3000
      b. 4-3/4” wide by 1-3/4” deep
         1) Hubbell HBL4750 series
         2) Wiremold Series 4000
      c. 4-3/4” wide by 3-9/16” deep
         1) Wiremold Series 6000
      d. 6-3/4” wide by 2-11/50
         1) Hubbell 6750 Series
   6. Covers with cutouts for device plates as shown on drawings.

C. Material:
   1. Steel Raceways: Galvanized steel, minimum thickness 0.040”.
   2. Fittings: Same material and metal thickness as linear raceway components.

D. Finish:
   1. Steel Raceway :
      a. Electrostatically painted, refer to Architectural specifications for color.
   2. Fittings: Color to match linear raceway components.

E. Accessories:
   1. Fittings: Available as standard accessories, including external corner units, internal corner units, flat units, blank end units, internal and external elbows, coupling for joining raceway sections, and device mounting brackets and plates.
   2. Wire Clips: One for every 2 linear ft of indicated raceway configuration.
   3. Corner elbows and tee fittings, to maintain 2” cable bend radius that meets requirements for communications pathways and specifications for fiber optic, coaxial, and high-performance twisted-pair cabling.
   4. Device Mounting Brackets and Plates: Plastic device mounting brackets and trim plates allowing installation of indicated wiring devices, and communications outlets horizontally in raceways; trim cover sized to overlap device cut-out in raceway, concealing seams; finished to match linear raceway components; plastic compatible with UL 94; brackets and plates, to match raceway width, and with device mounting holes.

F. Communications Outlets and Accessories:

1. Cabling Type: Per requirements in Section 27 1500 – Communications Horizontal Cabling.
2. Mounting faceplates and bezels: Faceplates configuration per requirements in Section 27 1500 – Communications Horizontal Cabling.

PART 3 - EXECUTION

3.1 COORDINATION

A. Coordinate cover plate openings with the wiring devices contained within.

B. Provide manufacturer's 'touch-up' paint kit.

C. Coordinate surface raceways installation with casework shop drawings to match lengths of cabinets and shelving.

D. Verify location of raceways with architectural interior elevation drawings.

3.2 EXAMINATION

A. Do not begin installation until substrates have been properly prepared.

B. If substrate preparation is the responsibility of another installer, notify Architect/Engineer of unsatisfactory preparation before proceeding.

3.3 INSTALLATION

A. Install in accordance with ANSI/NECA 1 and manufacturer's instructions.

B. Install flathead screws, clips and straps to fasten surface raceways to substrates, ensuring they are permanently and mechanically anchored. Double-sided adhesive is not acceptable. Mount plumb and level. Use suitable insulating bushings and inserts at connections to outlets and corner fittings.

C. Install wiring devices and communications outlets of type, quantity and spacing as indicated on drawings. Provide opening for Division 27 manufacturer bezel or mounting strap.

D. Mount raceways on wall and casework parallel to or at right angles to structure and casework.

E. Feed raceways mounted on walls from a backbox through a wall box connector. Determine point of feed in field and complete wiring connections.

F. Install a chase nipple extension between outlet box on wall and raceway when raceway mounted to support channel for modular casework.

G. Maintain ground continuity throughout entire raceway length per requirements in Section 26 0526 – Grounding and Bonding for Electrical Systems.

H. Install appropriate backbox extension rings where raceway is mounted to steel slotted channel or by some other method, stood off from wall.

I. Raceway receptacle faceplates shall be labeled with adhesive labels in accordance with requirements in Section 26 0553 – Electrical Systems Identification, for 15A, 20A and 30A receptacles.

J. Reinforce each cover section for every 30A receptacle in raceway with two 4-40 Phillips counter-sunk steel screws attached to enclosure near top and bottom of receptacle.

K. Identify communication outlets per requirements in Section 27 0553 – Communications Systems Identification.

L. Raceway base shall be secured using screws. Securing with double-sided adhesive is not acceptable.

3.4 FIELD QUALITY CONTROL

A. Inspect surface raceways for physical damage and proper alignment.

B. Inspect components, wiring, connections, installation, and grounding.

3.5 REPAINTING

A. Remove paint splatters and other marks from surface of equipment.

B. Touch-up chips, scratches, or marred finishes to match original finish, using manufacturer-supplied paint kit. Leave remaining paint with Owner.

3.6 CLEANING

A. Vacuum dirt and construction debris from interior and exterior of equipment; do not use compressed air to assist in cleaning.

END OF SECTION

SECTION 26 0553 ELECTRICAL SYSTEMS IDENTIFICATION

PART 1 - GENERAL

1.1 RELATED WORK

A. Section 26 0519 – Low-Voltage Electrical Power Conductors and Cables

B. Section 26 0533 – Raceways and Boxes for Electrical Systems

C. Section 26 0543 – Underground Ducts and Raceways for Electrical Systems

D. Section 26 0923 – Lighting Control Devices

E. Section 26 2200 – Low-Voltage Transformers

F. Section 26 2300 – Low-Voltage Switchgear

G. Section 26 2413 – Switchboards

H. Section 26 2416.13 – Lighting and Appliance Panelboards

I. Section 26 2416.16 – Distribution Panelboards

J. Section 26 2500 – Enclosed Bus Assemblies

K. Section 26 2713 – Electrical Metering

L. Section 26 2726 – Wiring Devices

M. Section 26 2816 – Enclosed Switches and Circuit Breakers

N. Section 26 2913 – Enclosed Controllers

O. Section 26 3353.13 – Static Uninterruptible Power Supply

P. Section 26 3623 – Automatic Transfer Switches

Q. Section 28 3113 – Fire Detection and Alarm Systems

1.2 REFERENCE

A. Work under this Section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 - General Requirements.

1.3 DESCRIPTION

A. Section includes the following:
   1. Identification for raceways
   2. Identification for conductors and communication and control cable
   3. Equipment identification nameplates
   4. Wiring devices identification

B. Refer to the respective Division 26 Sections, and Sections in other Divisions that specify electrical components, for additional electrical identification requirements.

1.4 REFERENCE STANDARDS

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

B. ANSI C2 – National Electrical Safety Code

C. ANSI Z535.4 1998 – National Standards for Product Safety Signs and Labels

D. 29 CFR – Labor, Part 1910 – Occupational Safety and Health Standards, Section 1910.145 – Specifications for Accident Prevention Signs and Tags

E. NFPA 70 – National Electrical Code

F. UL-510 - Polyvinyl Chloride, Polyethylene, and Rubber Insulating Tape

1.5 SUBMITTALS

A. Product Data: For each electrical identification product indicated.

B. Nameplate Schedule: Prior to making nameplates, submit a complete schedule to Architect for approval indicating nameplate size, lettering size, color and actual nameplate information.

1.6 QUALITY ASSURANCE

A. Comply with ANSI A13.1 and ANSI C2.

B. Comply with ANSI Z535.4-1998

C. Comply with NFPA 70.

D. Comply with 29 CFR 1910.145.

1.7 COORDINATION

A. Coordinate identification names, abbreviations, colors, and other features with requirements in Contract Documents, Shop Drawings, manufacturer's wiring diagrams, and Operation and Maintenance Manual, and with those required by codes, standards, and 29 CFR 1910.145. Use consistent designations throughout project.

B. Coordinate installation of identifying devices with completion of covering and painting 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 before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.1 RACEWAY IDENTIFICATION

A. Fire Alarm Conduit

1. Material: Refer to Section 26 0533 – Raceways and Boxes for Electrical Systems and Section 28 3113 – Fire Detection and Alarm Systems
2. Identification: Raceways are to be factory applied permanent red in color for entire length and circumference.
3. Junction box covers are to be factory or field applied permanent red paint.

B. Raceways and Armored Cable over 600V
1. Paint "DANGER HIGH VOLTAGE [12,470 or 4160 VOLTS]" with permanent red paint on black background.
2. Paint is to be water and corrosion resistant for indoor and outdoor applications.
3. Letters are to be 2" high for 4-5" raceways, 1" high for 3" raceways.

2.2 CONDUCTOR AND COMMUNICATION- AND CONTROL-CABLE IDENTIFICATION MATERIALS

A. Comply with ANSI A13.1 for minimum size of letters for legend.

B. Lettered ID Marking Tape Manufacturers: Brady USA, Ideal, Marking Services, Inc. (MRI), Seton, or approved equal.

C. Color-Coding Electrical Conductor Tape: Colored, self-adhesive vinyl tape not less than 3 mils thick by 1" to 2" wide.
1. UL-510 listed, self adhesive, vinyl electrical tape

D. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.

2.3 WARNING LABELS AND SIGNS

A. Comply with NFPA 70 and 29 CFR 1910.145.

B. Self-Adhesive Warning Labels: Factory printed, multicolor, pressure-sensitive adhesive labels, configured for display on front cover, door, or other access to equipment, unless otherwise indicated.

C. Self-Adhesive Arc Flash Warning Labels: Industrial grade, made of durable polyester with over-laminate to withstand harsh environments (UV rays, scratches and most chemicals).
1. Manufacturer: Seton or approved equal

D. Baked-Enamel Warning Signs for Interior Use: Preprinted aluminum signs, punched or drilled for fasteners, with colors, legend, and size required for application. Nominal size, 7" x 10".

E. Warning label and sign shall include, but are not limited to, the following legends:
1. Multiple Power Source Warning: "DANGER – ELECTRICAL SHOCK HAZARD – EQUIPMENT HAS MULTIPLE POWER SOURCES."
2. Workspace Clearance Warning: "WARNING – OSHA REGULATION – AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES."
3. Emergency System Warning: "WARNING – EMERGENCY SYSTEM – DO NOT LEAVE SWITCH IN THE "OFF" POSITION."
4. Automatic Start Warning: "WARNING – EQUIPMENT MAY START AT ANY TIME."
5. Arc Flash Labels: Per ANSI Z535.4 and NFPA 70 ART 110.16, the signal word WARNING appearing in black letters on an orange background, with second line below (Arc Flash and

Shock Hazard) in black letters on white background and third line below (Appropriate PPE Required) in black letters on white background. Include the following information on the label:

a. Equipment name
b. Available bolted current
c. Flash protection boundary distance
d. Incident energy level at 18" expressed in cal/cm^2
e. Personnel protective equipment (PPE) class
f. Voltage shock hazard
g. Limited shock approach boundary
h. Restricted shock approach boundary
i. Prohibited shock approach boundary

2.4 INSTRUCTION SIGNS AND POSTED DRAWINGS

A. Instruction Signs: Engraved, laminated acrylic or melamine plastic, minimum 1/16" thick for signs up to 20 sq in and 1/8" thick for larger sizes.
   1. Engraved legend with black letters on white face.
   2. Punched or drilled for mechanical fasteners.

B. Posted Drawings: Print electrical riser diagrams on 20 lb bond paper. Reduce drawings to approximately 1/2 size. Contact Engineer to obtain updated original plans for printing.

2.5 EQUIPMENT IDENTIFICATION NAMEPLATES

A. Indoor
   1. Engraved, Three-layer, Laminated Acrylic or Melamine Nameplate: Self adhesive backed. White letters on a black background, except emergency power equipment nameplates are to have white letters on a red background. Minimum letter height shall be 3/8" unless noted otherwise.

B. Outdoor
   1. Engraved, Three-layer, Laminated UV Resistant Acrylic or Melamine Nameplate: Attached with non corrosive mechanical fastener or other permanent method to maintain compliance with NEMA rating of enclosure. White letters on a black background, except emergency power equipment nameplates are to have white letters on a red background. Minimum letter height shall be 1/2" unless noted otherwise.

2.6 WIRING DEVICES IDENTIFICATION

A. Refer to Section 26 2726 – Wiring Devices for requirements.

PART 3 - EXECUTION

3.1 APPLICATION

A. Accessible Raceways and Metal-Clad Cables More Than 600 V: Identify with "DANGER – HIGH VOLTAGE 12,470 or 4160 VOLTS" in permanent paint red letters on black background at least 2" high on 4-5" conduit, 1" high letters on metal clad cable and 3" conduit. Repeat identification at 10 ft maximum intervals and at each termination.

1. Identify covers of exposed junction and pull boxes with red paint. Stencil the legend “DANGER – HIGH VOLTAGE 12,470 or 4160 VOLTS” in red letters 2” high.
2. Print identification so it can be seen from all exposed sides of raceway and cable.

B. Power-Circuit Conductor Identification: For conductors #8AWG and larger, use UL-510 vinyl color-coding conductor tape indicating voltage and phase. Smaller conductors are to utilize factory colored insulation only.

C. Branch Circuit Conductors: Identify conductor source and circuit number at load terminations, and junction boxes using cloth tape and permanent ink. Identify circuit number only at source termination using pre-printed wrap-around identification tape.

D. Equipment Grounding and Bonding Conductor Identification: For conductors #1/0 and larger, use green UL-510 vinyl conductor tape. Smaller conductors are to utilize factory colored insulation only.

E. Isolated Ground Conductor: All conductors are to have factory green insulation with yellow stripe. Field applied color coded tape identification is not allowed.

F. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, signal, sound, intercommunications, voice, and data connections.
1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.
2. Use system of marker tape designations that is uniform and consistent with system used by manufacturer for factory-installed connections.
3. Coordinate identification with project drawings, manufacturer’s wiring diagrams, and Operation and Maintenance Manual.

G. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Comply with 29 CFR 1910.145 and apply self-adhesive warning labels. Identify system voltage with black letters on an orange background. Apply to exterior of door, cover, or other access to equipment.
1. Equipment with Multiple Power or Control Sources: Apply to door or cover of equipment including, but not limited to, the following:
   a. Automatic Transfer Switches
   b. Double Ended Equipment
   c. Generator Distribution Equipment
   d. Fire Pump Disconnects
2. Equipment Requiring Workspace Clearance According to NFPA 70: Unless otherwise indicated, apply to door or cover of equipment but not on flush panelboards and similar equipment in finished spaces.
3. Arc Flash Warning Labels: install per NFPA 70E for each switchgear, switchboard, panelboard, motor control center, industrial control panel (every enclosure that may contain energized conductors or components). Locate labels so they are visible to the personnel before examination, adjustment, servicing, or maintenance of the equipment.
4. Available Fault Current Labels: install per NFPA 70 for each piece of service entrance equipment. Locate labels so they are visible to the personnel before examination, adjustment, servicing or maintenance of the equipment.

H. Instruction Signs and Posted Drawings:

1. Operating Instructions: Install instruction signs to facilitate proper operation and maintenance of electrical systems and items to which they connect. Install instruction signs with approved legend printed in all capital letters of 12 pt size minimum where instructions are needed for system or equipment operation.
2. Emergency Operating Instructions: Install instruction signs with white legend on a red background with minimum 3/8" high letters for emergency instructions at equipment used for bypass operations, load shedding, manual throw over, etc.

I. Equipment Identification Nameplates: On each unit of equipment, install unique designation nameplate that is consistent with wiring diagrams, schedules, and Operation and Maintenance Manual. Apply nameplates to disconnect switches and protection equipment, central or master units, control panels, control stations, terminal cabinets, and racks of each system. Systems include power, lighting, control, communication, signal, monitoring, and alarm systems unless equipment is provided with its own identification.
   1. Nameplate Instructions:
      a. Indoor Equipment: Engraved, laminated acrylic self adhesive backed. Unless otherwise indicated, provide a single line of text with 3/8" high letters on 1-1/2" high nameplate; where 2 lines of text are required, use nameplates sized 2" high.
      b. Outdoor Equipment: Engraved, laminated UV resistant acrylic nameplates with 1/2" high letters. Outdoor equipment labels are to be factory applied with non-corrosive mechanical fasteners or other permanent method to maintain compliance with NEMA rating of enclosure.
      c. Elevated Components: Increase sizes of labels and letters to those appropriate for viewing from the floor.
      d. Any label that belongs to equipment within the emergency power subsystem shall be RED with white lettering. All other labels shall be BLACK with white lettering. Additionally, all labels will have at least two lines—one designating the component name and the other designating the component's power source. In the case of a component with multiple feeds, there shall be separate line for each power source component name.
   2. Install nameplates for equipment including, but not limited to, the following:
      a. Panelboards, electrical cabinets, and enclosures
      b. Access doors and panels for concealed electrical items
      c. Electrical switchgear, distribution panelboards, and switchboards, including each device within the equipment enclosures.
      d. Transformers
      e. Electrical substations
      f. Emergency system boxes and enclosures
      g. Disconnect switches
      h. Enclosed circuit breakers
      i. Motor controllers
      j. Pushbutton stations
      k. Automatic Transfer Switches
      l. Contactors
      m. Remote-controlled switches, dimmer modules, and control devices
      n. Voice and data cable terminal equipment
      o. Fire alarm control panel and annunciators

p. Security and intrusion-detection control stations, control panels, terminal cabinets, and racks
q. Monitoring and control equipment
r. Uninterruptible power supply equipment
s. Terminals, racks, and patch panels for voice and data communication and for signal and control functions
t. Non-concealed junction box covers of auxiliary electrical systems

J. Nameplates shall indicate equipment identification and shall be same as indicated on contract documents. Voltages shall be shown on panelboard nameplates.

3.2 INSTALLATION

A. Verify identity of each item before installing identification products.

B. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.

C. Apply identification devices to surfaces that require finish after completing finish work.

D. Self-Adhesive Identification Products: Clean surfaces before application, using materials and methods recommended by manufacturer of identification device.

E. Posted Drawings and Operating Instructions: Mount drawings and operating procedures on the wall immediately adjacent to the piece of equipment for which the instructions apply. If sufficient wall space is available, mount directly to one of the sheet metal panels of the equipment. Cover document with clear plexi-glass and aluminum frame. Mount frame to wall in a manner that will allow removal to update document.

F. Warning Signs: Install warning signs where there is hazardous exposure or danger associated with access to or operation of electrical facilities. Provide text of sufficient clarity and lettering of sufficient size to convey adequate information at each location; mount permanently in an appropriate and effective location. Comply with ANSI A13.1 standard color and design.
1. Operational Tags: Where needed for proper and adequate information on operation and maintenance of electrical systems, provide tags of plasticized card stock, either preprinted or hand printed to convey the message; example: “DO NOT OPEN THIS SWITCH WHEN BREAKER IS CLOSED.”

G. System Identification Color Banding for Conductors: Each color band shall completely encircle conductor. Locate bands at source and load terminations and at all junction and tap boxes.

H. Color coding for Phase and Voltage Level Identification, 600 V or Less: Use colors listed below for ungrounded conductors.
1. Colors for 208/120 V Circuits:
a. Phase A (left bus in panelboard): Black
b. Phase B (center bus in panelboard): Red
c. Phase C (right bus in panelboard): Blue
d. Neutral: White
e. Equipment Ground: Green
f. Isolated Ground: Green with yellow stripe

2. Colors for 480/277 V Circuits:
   a. Phase A (left bus in panelboard): Brown
   b. Phase B (center bus in panelboard): Orange
   c. Phase C (right bus in panelboard): Yellow
   d. Neutral: Gray
   e. Equipment Ground: Green
   f. Isolated Ground: Green with yellow stripe

3. Field-applied, Color-Coding Conductor Tape: Apply no more than 2" wide using multiple turns. Apply last two runs of tape with no tension to prevent possible unwinding. Locate bands to avoid obscuring factory cable markings where possible.

I. Painted Identification: Prepare surface and apply paint according to paint manufacturer's instructions. Do not use cleaning solvents that will harm surface to be painted.

END OF SECTION

SECTION 26 0573 OVERCURRENT PROTECTIVE DEVICE COORDINATION AND ARC FLASH STUDY

PART 1 - GENERAL

1.1 RELATED WORK

A. Section 26 0553 – Electrical Systems Identification

B. Section 26 0812 – Power Distribution Acceptance Tests

C. Section 26 0813 – Power Distribution Acceptance Test Tables

D. Section 26 1113 – Primary Unit Substations

E. Section 26 1216 – Dry-Type, Medium-Voltage Transformers

F. Section 26 1316 – Medium-Voltage Fusible Interrupter Switchgear

G. Section 26 1318 – Medium-Voltage Vacuum Interrupter Switchgear

H. Section 26 1323 – Medium-Voltage Pad-Mounted Switchgear

I. Section 26 2200 – Low-Voltage Transformers

J. Section 26 2300 – Low-Voltage Switchgear

K. Section 26 2413 – Switchboards

L. Section 26 2416.13 – Lighting and Appliance Panelboards

M. Section 26 2416.16 – Distribution Panelboards

N. Section 26 2419 – Motor Control Centers

O. Section 26 2813 – Fuses

P. Section 26 2816 – Enclosed Switches and Circuit Breakers

Q. Section 26 2913 – Enclosed Controllers

R. Section 26 3623 – Automatic Transfer Switches

1.2 REFERENCE

A. Work under this Section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.

1.3 DESCRIPTION

A. Section includes computer based, fault current, arc flash, and overcurrent protective device coordination studies for an electrical distribution system, based on actual equipment supplied. Set protective devices based on results of the protective device coordination study.

1. Coordination of series-rated devices is permitted only where indicated on drawings.

B. Furnish field information and data needed for the studies.

C. Available fault current and electrical equipment interrupting capacity indicated on drawings are based on the short circuit study performed during design as part of the construction documents.

D. Provide studies and reports prior to manufacture of the electrical distribution equipment.

E. Equipment submittal will not be approved until the coordination study is complete and the equipment submittals indicate compliance with the study recommendations.

1.4 REFERENCE STANDARDS

A. ANSI C57.12.10 – American National Standard for Transformers-230 kV and Below 833/958-8333/10 417 kVA, Single-Phase, and 750/862-60 000/80 000/100 000 kVA, Three-Phase, w/o Load Tap Changing; and 3750/4687-60 000/80 000 kVA with Load Tap Changing-Safety Requirements

B. ANSI C57.12.22 – American National Standard for Transformers-Pad-Mounted, Compartmental-Type, Self-Cooled, Three-Phase Distribution Transformers with High-Voltage Bushings, 2500 kVA & Smaller: High-Voltage, 34 500 GrdY/19 920 V & Below; Low Voltage, 480 V & Below-Requirements

C. ANSI C57.12.40 – American National Standard for Secondary Network Transformers-Subway and Vault Types (Liquid Immersed)-Requirements

D. ANSI C57.12.90 – General Requirements for Liquid-Immersed Distribution Power and Regulating Transformers

E. ANSI C57.96 – Distribution and Power Transformers, Guide for Loading Dry-Type (Appendix to ANSI C57.12 Standards)

F. IEEE 141 – Recommended Practice for Electric Power Distribution for Industrial Plants

G. IEEE 241 – Recommended Practice for Electric Power Systems in Commercial Buildings

H. IEEE 242 – Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems

I. IEEE 399 – Recommended Practice for Power System Analysis

J. IEEE 620 – Guide for the Presentation of Thermal Limit Curves for Squirrel Cage Induction Machines

K. IEEE 1015 – Recommended Practice for Applying Low-Voltage Circuit Breakers Used in Industrial and Commercial Power Systems

L. IEEE 1584 – Guide for Performing Arc-Flash Hazard Calculations

M. IEEE C37.010 – Application Guide for AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis

N. IEEE C37.20.1 – IEEE Standard for Metal-Enclosed, Low-Voltage Power Circuit Breaker Switchgear

O. IEEE 37.46 – American National Standard Specifications for Power Fuses and Fuse-Disconnecting Switches

P. IEEE C57.12 – General Requirements for Liquid-Immersed Distribution, Power and Regulating Transformers

Q. IEEE C57.96 – IEEE Guide for Loading Dry-Type Distribution and Power Transformers

R. ICEA P-32-382 – Short-Circuit Characteristics of Insulated Cable

S. ICEA P-45-482 – Short-Circuit Performance of Metallic Shielding and Sheaths of Insulated Cable

T. NEMA MG 1 – Motors and Generators

U. NFPA 70 – National Electrical Code (NEC)

V. NFPA 70C – Hazardous Locations Classification

W. NFPA 70E – Standard for Electrical Safety in Workplace

X. UK Standard – 260576S01 Power System Analysis and Arc Flash Study

1.5 SUBMITTALS

A. Product Data: Computer software program to be used for studies.

B. Product Certificates:
   1. Coordination-study and fault-current-study computer software programs, certifying compliance with IEEE 399.
   2. Arc flash calculations computer software programs, certifying compliance with IEEE 1584.

C. Qualification Data: For coordination study specialist.
   1. Submit qualifications of the organization proposed for performing the study. Include description of the equipment and computer-based computation methods or programs used and the names and experience histories of the personnel who will perform the study.

D. Other Action Submittals: Subsequent to having approval for system protective devices submit the following in digital format:
   1. Fault current study report
   2. Equipment evaluation report
   3. Coordination study input data, including completed computer program input data sheets
   4. Coordination Study Report
   5. Arc Flash Study and Report
   6. Arc Flash labels
   7. All software files to allow review and future use of files

1.6 QUALITY ASSURANCE

A. Perform studies using computer programs that are distributed nationally and are in wide use. Software algorithms shall comply with requirements of standards and guides specified in this Section. Manual calculations are not acceptable.

B. Coordination Study Specialist Qualifications: An organization experienced in the application of computer software used for studies, having performed successful studies of similar magnitude on electrical distribution systems using similar devices.
   1. Perform study under the direct supervision and control of a Registered Professional Electrical Engineer licensed in the State of Kentucky, with a minimum of 5 yrs recent experience in performing protective device coordination studies, arc flash calculations, and electrical system analysis.

C. Comply with IEEE 242 for short circuit currents and coordination time intervals.

D. Comply with IEEE 399 for general study procedures.

E. Comply with IEEE 1584 for arc flash calculations.

PART 2 - PRODUCTS

2.1 COMPUTER SOFTWARE DEVELOPERS

A. Computer Software Developers: Subject to compliance with requirements, provide products by one of the following:

B. Basis of Design Product:
   1. SKM Systems Analysis, Inc.
   2. EasyPower
   3. ETAP

2.2 COMPUTER SOFTWARE PROGRAM REQUIREMENTS

A. Comply with IEEE 399 and IEEE 1584.

B. Analytical features of fault current study computer software program shall include “mandatory,” “very desirable,” and “desirable” features as listed in IEEE 399 Table 7-4.

C. Computer software program shall be capable of plotting and diagramming time-current characteristic curves as part of its output. Computer software program reports device settings and ratings of all overcurrent protective devices and demonstrates selective coordination by computer-generated, time-current coordination plots.

D. Arc Flash Calculations: Software program capable of calculating Arc Flash Incident Energy (AFIE) levels and flash protection boundary distances.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine project overcurrent protective device submittals for compliance with electrical distribution system coordination requirements and other conditions affecting performance. Devices for coordination are indicated on drawings.

B. Proceed with coordination study only after relevant equipment submittals have been assembled. Overcurrent protective devices that have not been submitted and approved prior to coordination study may not be used in study.

C. Provide the study based on the actual electrical equipment supplied for the project.

3.2 POWER SYSTEM DATA

A. Gather and tabulate the following input data to support coordination study:
   1. Product Data for overcurrent protective devices specified in other Division 26 Sections and involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with power riser diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.
   2. Impedance of utility service entrance.
   3. Power Riser Diagrams: In hard copy and electronic copy formats, showing the following:
      a. Circuit breaker and fuse-current ratings and types
      b. Relays and associated power and current transformer ratings and ratios
      c. Transformer kilovolt amperes, primary and secondary voltages, connection type, impedance, and X/R ratios
      d. Generator kilovolt amperes, size, voltage, and source impedance
      e. Cables: Indicate conduit material, sizes of conductors, conductor material, insulation, and length
      f. Busway ampacity and impedance
      g. Motor horsepower and code letter designation according to NEMA MG 1
      h. Load current that is the basis for sizing continuous ratings of circuits for cables and equipment
      i. Use numbering scheme where each bus begins with a three-digit number followed by a description e.g. 102 MDPA or 103 ELEV DISC.
   4. Data sheets to supplement power riser diagrams, cross-referenced with tag numbers on diagrams, showing the following:
      a. Special load considerations, including starting inrush currents and frequent starting and stopping
      b. Transformer characteristics, including primary protective device, magnetic inrush current, and overload capability
      c. Motor full-load current, locked-rotor current, service factor, starting time, type of start, and thermal-damage curve
      d. Generator thermal-damage curve
      e. Ratings, types, and settings of utility company's overcurrent protective devices
      f. Special overcurrent protective device settings or types stipulated by utility company
      g. Time-current characteristic curves of devices indicated to be coordinated
      h. Manufacturer, frame size, interrupting rating in amperes rms symmetrical, ampere or current sensor rating, long-time adjustment range, short-time adjustment range, and instantaneous adjustment range for circuit breakers
      i. Manufacturer and type, ampere-tap adjustment range, time-delay adjustment range, instantaneous attachment adjustment range, and current transformer ratio for overcurrent relays
      j. Panelboards, switchboards, switchgear, and busways ampacity, and interrupting rating in amperes rms symmetrical

3.3 FAULT CURRENT STUDY

A. Calculate maximum available short circuit current in amperes rms symmetrical at circuit breaker positions of electrical power distribution system. Provide calculation for a current immediately after initiation and for a three-phase bolted short circuit at the following:
   1. Switchgear and switchboard bus
   2. Distribution panelboard
   3. Branch circuit panelboard
   4. Disconnect switches

B. Study electrical distribution system from normal and alternate power sources throughout electrical distribution system for project. Include studies of system switching configurations and alternate operations that could result in maximum fault conditions.
   1. Model the entire electrical distribution system from utility company point of connection to circuit breakers in 208 V distribution panels at secondary side of distribution transformers. Include mechanical HVAC equipment, motor driven equipment feeder circuits, and elevator feeder circuits.
   2. Model shall include components of the distribution system which would be exposed to fault current levels of 10,000 A symmetrical on a calculated basis.
   3. Study shall include automatic transfer switches and main-tie-main switchgear and worst-case short circuit rating shall be included in analysis for each piece of equipment as defined above.

C. Calculate momentary and interrupting duties on basis of maximum available fault current.

D. Perform calculations to verify interrupting ratings of overcurrent protective devices in compliance with IEEE 241 and IEEE 242.
   1. Transformers:
      a. ANSI C57.12.10
      b. ANSI C57.12.22
      c. ANSI C57.12.40
      d. IEEE C57.12.00
      e. IEEE C57.96
   2. Medium-Voltage Circuit Breakers: IEEE C37.010
   3. Low-Voltage Circuit Breakers: IEEE 1015 and IEEE C37.20.1
   4. Low-Voltage Fuses: IEEE C37.46

E. Study Report:
   1. Show calculated X/R ratios and equipment interrupting rating (5-cycle) fault currents on power riser diagrams in report. List other output values from computer analyses, including momentary (1/2-cycle), interrupting (5-cycle), and 30-cycle fault current values for 3-phase, 2-phase, and phase-to-ground faults.
   2. Show interrupting (5-cycle) and time-delayed currents (6 cycles and above) on medium-voltage circuit breakers to set relays and assess the sensitivity of overcurrent relays.

F. Equipment Evaluation Report:
   1. Prepare report on adequacy of overcurrent protective devices and conductors by comparing fault current ratings of devices with calculated fault current momentary and interrupting duties.

2. For 600V overcurrent protective devices, ensure interrupting ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.
3. For devices and equipment rated for asymmetrical fault current, apply multiplication factors listed in standards to 1/2-cycle symmetrical fault current.
4. Verify adequacy of phase conductors at maximum 3-phase bolted fault currents; verify adequacy of equipment grounding conductors and grounding electrode conductors at maximum ground-fault currents. Ensure short circuit withstand ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.
5. Notify Owner/Engineer promptly of discrepancies, problem areas, or inadequacies and provide recommendations for problem resolution.

3.4 COORDINATION STUDY

A. Perform coordination study using approved computer software program. Prepare a written report using results of fault current study. Comply with IEEE 399.
   1. Calculate maximum and minimum 1/2-cycle short circuit currents.
   2. Calculate maximum and minimum interrupting duty (5 cycles to 2 seconds) short circuit currents.
   3. Calculate maximum and minimum ground-fault currents.

B. Comply with NFPA 70 for overcurrent protection of circuit elements and devices.

C. Comply with IEEE 242 recommendations for fault currents and time intervals.

D. Transformer Primary Overcurrent Protective Devices:
   1. Devices non-operational in response to the following:
      a. Inrush current when first energized
      b. Self-cooled, full-load current or forced-air-cooled, full-load current, whichever is specified for that transformer.
      c. Permissible transformer overloads according to IEEE C57.96 if required by unusual loading or emergency conditions.
   2. Protect transformers according to IEEE C57.12.00, for fault currents by device settings.

E. Protect motors served by voltages more than 600 V according to IEEE 620.

F. Conductor Protection: Protect cables against damage from fault currents according to ICEA P-32-382, ICEA P-45-482, and conductor melting curves in IEEE 242. Demonstrate equipment withstands the maximum short circuit current for a time equivalent to tripping time of primary relay protection or total clearing time of fuse. To determine temperatures that damage insulation, use curves from cable manufacturers or from listed standards indicating conductor size and short circuit current. Verify adequacy of phase conductors at maximum three-phase bolted fault currents, equipment grounding conductors, and grounding electrode conductors at maximum ground-fault currents.

G. Include voltage classes of equipment from utility's incoming line protective device down to and including each panelboard. The phase and ground overcurrent protection shall be included as well as settings for other adjustable protective devices.

H. Selective Coordination: Overcurrent devices installed upstream and downstream of automatic transfer switches and/or associated with NEC Article 700 Emergency and 701 Legally Required loads shall be selectively coordinated from source of supply (both normal and emergency sources)

through final device. Change specific circuit breakers (type, frame, trip-unit, etc.) and equipment bus rating as necessary to meet this requirement.

I. Coordination Study Report: Prepare a written report indicating results of coordination study:
   1. Tabular Format of Settings Selected for Overcurrent Protective Devices:
      a. Device tag
      b. Relay-current transformer ratios; and tap, time-dial, and instantaneous-pickup values
      c. Circuit breaker sensor rating; and long-time, short-time, and instantaneous settings
      d. Fuse-current rating and type
      e. Ground-fault relay-pickup and time-delay settings
      f. Manufacturer and type of device
      g. Range of adjustments and recommended settings
   2. Coordination Curves: Determine settings of overcurrent protective devices to achieve selective coordination. Graphically illustrate adequate time separation exists between devices installed in series, drawn to show the boundaries of device operation on log-log scale graphs, including power utility company's upstream devices. Where time current curves do not explicitly illustrate selective coordination but breakers have been tested and documented as being selectively coordinated, submit manufacturer's literature to substantiate device coordination. Include on curve sheet a title and legend identifying portion of the system covered. Prepare separate sets of curves for the switching schemes and for emergency periods where the power source is local generation. Show the following information:
      a. Device tag
      b. Voltage and current ratio for curves
      c. Three-phase and single-phase damage points for each transformer
      d. No damage, melting, and clearing curves for fuses
      e. Cable damage curves
      f. Transformer inrush points
      g. Maximum fault current cutoff point
   3. Plot characteristics where applicable:
      a. Medium- and low- voltage fuses including minimum melt, total clearing and damage bands
      b. Low-voltage circuit breaker trip devices
      c. Transformer full-load current, magnetizing inrush current, and ANSI transformer withstand parameters
      d. Ground-fault protective devices
      e. Motor starting characteristics and motor damage points
      f. Generator short circuit decrement curve and generator damage point
      g. Conductor damage curves
      h. Electric utility's protective devices
      i. Medium-voltage equipment relays
   4. Notify Owner/Engineer promptly of discrepancies, problem areas, or inadequacies and provide recommendations for problem resolution. Propose approaches to effectively protect the underrated equipment. Present technical evaluation with discussion of logical compromises for best coordination.

J. Completed data sheets for setting of overcurrent protective devices.

3.5 ARC FLASH STUDY

A. Perform arc flash calculations for Arc Flash Incident Energy (AFIE) levels and flash protection boundary distances. Utilize short circuit rating of equipment identified in fault current study.

B. Model worst-case arc flash conditions**,** including various operational configurations of the electrical system as described in Section 3.3.B.3.
   1. Equipment with PPE rating greater than 2 shall be investigated. Investigation shall include adjustment of upstream overcurrent device settings to determine if PPE rating can be reduced with minimal compromise to coordination with other overcurrent devices.

C. Arc Flash Study Report: Provide study results in tabular form and include:
   1. Device or bus name
   2. Bolted fault and arcing fault current levels
   3. Arc Flash Incident Energy (AFIE) level at 455 mm expressed in cal/cm^2
   4. Flash protection boundary distances including:
      a. Limited shock approach boundary
      b. Restricted shock approach boundary
      c. Prohibited shock approach boundary
   5. Personal protective equipment class (PPE)

D. Provide recommendation for reducing AFIE levels and enhancing worker safety.

3.6 FIELD QUALITY CONTROL

A. Inspect, set, test, and calibrate the protective relays, circuit breakers, fuses, and other applicable devices per requirements in Section 26 0812 – Power Distribution Acceptance Tests and Section 26 0813 – Power Distribution Acceptance Test Tables.

B. Upon final approval of study, provide weatherproof vinyl or polyester arc flash label for all electrical equipment defined above. Label shall include calculated flash protection boundary, incident energy at working distance of 455 mm, required PPE level, limited approach, restricted approach, and prohibited approach boundaries, equipment name, and date label was produced.

3.7 ADJUSTING

A. Make modifications to equipment, as required, to accomplish conformance with equipment evaluation study.

B. Adjust relay and overcurrent protective device settings according to recommended settings table provided by overcurrent protective device coordination study.

C. Notify Owner/Engineer in writing of any required major modifications.

3.8 INSTALLATION

A. Install PPE labels on each piece of equipment prior to energizing equipment.

B. PPE labels shall be protected by clear plastic cover, weatherproof type material, or laminated and mounted on front of equipment. Taping of PPE label to front of equipment is unacceptable.

C. PPE label shall be clearly visible upon approach to equipment.

D. For large pieces of equipment, label shall be placed near main overcurrent device or incoming feeder to equipment.

E. Label shall be mounted at a minimum of 42” to bottom and maximum 66” to top above finished floor.

END OF SECTION

SECTION 26 0593 ELECTRICAL SYSTEMS FIRESTOPPING

PART 1 - GENERAL

1.1 RELATED WORK

A. Section 26 0533 – Raceways and Boxes for Electrical Systems

B. See Architectural Specification sections for additional firestopping requirements.

1.2 REFERENCE

A. Work under this Section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 - General Requirements.

1.3 DESCRIPTION

A. Section includes through-penetration firestop systems for penetrations through fire-resistance-rated constructions (walls, partitions, floors, and ceilings) including both empty openings and openings containing electrical penetrating items, including but not limited to raceways, cables, cable trays, busways, and wireways.

1.4 REFERENCE STANDARDS

A. ASTM E-814 – Standard Test Method for Fire Tests of Through-Penetration Firestops

B. UL 1479 - Fire Tests of Through-Penetration Firestops

C. UL 2079 - Tests For Fire Resistance of Building Joint Systems

1.5 PERFORMANCE REQUIREMENTS

A. Provide firestop system to resist spread of fire, resist passage of smoke and other gases, and maintain original fire-resistance rating of construction penetrated.

B. Firestop systems shall be UL Classified for the application and correspond to those indicated by reference to designations listed by UL Fire Resistance Directory.

C. Conform to applicable Code requirements of Authority Having Jurisdiction.

D. For through-penetration firestop systems exposed to view, traffic, moisture, and physical damage, provide products that, after curing, do not deteriorate when exposed to these conditions.

1.6 SUBMITTALS

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

B. Shop Drawings: For each through-penetration firestop system, show each type of construction condition penetrated, relationships to adjoining construction and type of penetrating item. Include firestop design designation of qualified testing and inspecting agency that evidences compliance with requirements for each condition indicated.

1. Submit documentation, including illustrations, from a qualified testing and inspecting agency that is applicable to each through-penetration firestop system configuration for construction and penetration items, including documentation of UL certification for firestop systems.

C. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

D. Material Safety Data Sheets provided with product delivered to job site.

E. Certification of compliance with Building Codes of Project location.

F. Inspection reports

1.7 QUALITY ASSURANCE

A. Installer Qualifications: A firm experienced in installing through-penetration firestop systems similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful performance.

B. Firestopping tests shall be performed by a qualified testing and inspecting agency, or another agency performing testing and follow-up inspection services for firestop systems acceptable to Authorities Having Jurisdiction.

C. Manufacturer's representative shall be on-site during initial installation of firestop systems to train appropriate Contractor personnel in proper selection and installation procedures.

1.8 DELIVERY, STORAGE AND HANDLING

A. Deliver through-penetration firestop system products to Project site in original, unopened containers or packages with intact and legible manufacturers' labels identifying product, type and manufacturer, and UL Label where applicable.

B. Store and handle materials for through-penetration firestop systems to prevent their deterioration or damage due to moisture, temperature changes, contaminants, or other causes.

C. Handle in accordance with recommended procedures, precautions, or remedies described in material safety data sheets as applicable.

1.9 PROJECT CONDITIONS

A. Do not install through-penetration firestop systems when ambient or substrate temperatures are outside limits permitted by through-penetration firestop systems' manufacturers or when substrates are wet due to rain, frost, condensation, or other causes.

B. Ventilate through-penetration firestop systems per manufacturers' written instructions by natural means or, where this is inadequate, forced-air circulation.

1.10 COORDINATION

A. Coordinate construction of openings and penetrating items to ensure that through-penetration firestop systems are installed according to specified requirements.

B. Coordinate sizing of sleeves, openings, core-drilled holes, or cut openings to accommodate through-penetration firestop systems.

C. Notify Owner's inspecting agency at least 7 days in advance of through-penetration firestop system installations; confirm dates and times on days preceding each series of installations.

D. Do not cover up through-penetration firestop system installations that will become concealed behind other construction until each installation has been examined by building inspector, if required by Authorities Having Jurisdiction.

1.11 SEQUENCING

A. Sequence work to avoid interferences with building finishes and installation of other products.

1.12 WARRANTY

A. Refer to Division 01 and Section 26 0000 – General Electrical Requirements for general warranty requirements.

B. Manufacturer shall provide standard 1 yr warranty against defects in materials and workmanship for products specified in this Section. Warranty period shall begin on date of substantial completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. 3M (Fire Protection Products Division), Hilti Inc, Tremco (Sealant/Weatherproofing Division), Nelson Firestop Products, Specified Technologies Inc, RectorSeal Corporation, approved equal.

B. Pyrophobic Systems, Ltd - Intumescent Technologies FireBlok fire suppression gasket for use in 4" X 4" X 2-1/8" boxes.

2.2 MATERIALS

A. Firestop Products: UL 1479, ASTM E-814 tested for specific fire-rated construction conditions conforming to construction assembly type, penetrating item type, annular space requirements and fire-rating involved for each separate instance; materials shall not contain flammable solvents.

B. Firestop Systems: Produced by the same manufacturer.

C. Fire Suppression Gaskets: Single piece gasket for use in 4" X 4" X 2-1/8" or smaller recessed electrical boxes in walls rated up to 2 hr.

D. Accessories: Components for each through-penetration firestop system that are needed to install fill materials and to comply with Part 1 "Performance Requirements" Article. Accessories include the following items:
   1. Permanent forming/damming/backing materials
   2. Temporary forming materials
   3. Substrate primers
   4. Collars
   5. Steel sleeves

E. Fill Materials: Including the following:

1. Firestop putty, caulk sealant, intumescent wrap strips, intumescent firestop collars, firestop mortars, pillows/bags, or a combination of these products to provide a UL-listed system for each application required for this Project; mineral wool backing where specified in manufacturer's application detail.

F. Mixing

1. For those products requiring mixing before application, comply with through-penetration firestop system manufacturer's written instructions for accurate proportioning of materials, water (if required), type of mixing equipment, selection of mixer speeds, mixing containers, mixing time, and other items or procedures needed to produce products of uniform quality with optimum performance characteristics for application indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions for compliance with requirements for opening configurations, penetrating items and other conditions affecting performance of firestopping.

B. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Clean out openings immediately prior to installing through-penetration firestop system to comply with firestop system manufacturer's written instructions.

B. Provide masking and temporary covering to prevent soiling of adjacent surfaces by firestopping materials.

C. Comply with manufacturer's recommendations for temperature and humidity conditions before, during and after installation of firestopping.

D. Install fire suppression gaskets inside electrical boxes before conductors are pulled. Install per manufacturer's requirements.

3.3 INSTALLATION

A. Comply with "System Performance Requirements" Article in Part 1 and with firestop system manufacturer's written installation instructions and drawings for products and applications indicated.

B. Install forming/damming/backing materials and other accessories of types required to support fill materials during application as required. After installing fill materials and allowing them to fully cure, remove combustible forming materials and other accessories not indicated as permanent components of firestop systems.

C. Avoid multiple penetrations of common fire barrier opening. Seal each penetration in accordance with manufacturer's UL installation details. When multiple penetrations are unavoidable, seal openings with appropriate UL Classified firestopping systems.

D. Adhere fire suppression gaskets to inside, rear of electrical box with attached adhesive strips.

3.4 IDENTIFICATION

A. Identify through-penetration firestop systems with pressure-sensitive, self-adhesive, preprinted vinyl labels. Attach labels permanently to surfaces of penetrated construction on both sides of each firestop system installation where labels will be visible to anyone seeking to remove penetrating items or firestop systems. Include the following information on labels:
   1. The words: “Warning—Through-Penetration Firestop System—Do Not Disturb. Notify Building Management of Any Damage.”
   2. Contractor’s name, address, and phone number
   3. Through-penetration firestop system designation of applicable testing and inspecting agency
   4. Date of installation
   5. Through-penetration firestop system manufacturer’s name
   6. Installer’s name

3.5 FIELD QUALITY CONTROL

A. Inspecting Agency: Owner will engage a qualified independent inspecting agency to inspect through-penetration firestop systems and to prepare test reports.
   1. Inspecting agency will state in each report whether inspected through-penetration firestop systems comply with or deviate from requirements.

B. Provide certification by Installer that all through-penetration firestop systems have been firestopped in accordance with applicable Building Codes of Project location.

C. Proceed with enclosing through-penetration firestop systems with other construction only after inspection reports are issued and firestop installations comply with requirements.

D. Where deficiencies are found, repair or replace through-penetration firestop systems so they comply with specifications.

3.6 CLEANING

A. Clean surfaces adjacent to sealed holes and joints to be free of excess firestop materials and soiling as work progresses.

END OF SECTION

SECTION 26 0812 POWER DISTRIBUTION ACCEPTANCE TESTS

PART 1 - GENERAL

1.1 RELATED WORK

A. Section 26 0513.16 – Medium-Voltage, Single- and Multi-Conductor Cables

B. Section 26 0519 – Low-Voltage Electrical Power Conductors and Cables

C. Section 26 0526 – Grounding and Bonding for Electrical Systems

D. Section 26 0813 – Power Distribution Acceptance Test Tables

E. Section 26 1216 – Dry-Type, Medium Voltage Transformers

F. Section 26 1316 – Medium Voltage Fusible Interrupter Switchgear

G. Section 26 2200 – Low-Voltage Transformers

H. Section 26 2300 – Low-Voltage Switchgear

I. Section 26 2413 – Switchboards

J. Section 26 2500 – Enclosed Bus Assemblies

K. Section 26 2713 – Electrical Metering

L. Section 26 2816 – Enclosed Switches and Circuit Breakers

M. Section 26 2913 – Enclosed Controllers

N. Section 26 3623 – Automatic Transfer Switches

1.2 REFERENCE

A. Work under this section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions and sections under Division 01 General Requirements.

1.3 DESCRIPTION

A. Section includes acceptance testing requirements for assessing the suitability for service and reliability of the power distribution system.

B. It is the purpose of this specification to assure all tested electrical equipment, both contractor and Owner supplied, is operational and within industry and manufacturer's tolerances and is installed in accordance with design specifications.

C. Tests and inspections shall be performed after installation.

D. Tests and inspections shall determine suitability for energization.

E. Electrical systems shall pass tests prior to substantial completion or Owner occupancy.

F. This specification requires contractor to engage services of NETA certified testing agency.

G. All tests tables referenced in this specification provided in Section 26 0813 – Power Distribution Acceptance Test Tables.

H. Items to be tested and inspected as follows:
1. 600-volt conductors and cables
2. Electrical metering
3. Dry type transformers
4. Medium-voltage fusible switchgear
5. Low-voltage switchgear
6. Switchboard
7. Low-voltage insulated-case/molded-case circuit breakers
8. Low-voltage disconnect switches
9. Automatic transfer switches
10. Motor controllers
11. Metal-enclosed busways
12. Ground fault protection systems
13. Grounding systems
14. Thermographic survey

1.4 REFERENCE STANDARDS

A. ANSI/IEEE C2 – National Electrical Safety Code

B. ANSI/IEEE C37 – Guides and Standards for Circuit Breakers, Switchgear, Relays, Substations, and Fuses

C. ANSI/IEEE C57 – Distribution, Power, and Regulating Transformers

D. ANSI/IEEE C62 – Surge Protection

E. ANSI/IEEE Std. 43 – IEEE Recommended Practice for Testing Insulation Resistance of Rotating Machinery

F. ANSI/IEEE Std. 81 – Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System

G. ANSI/IEEE Std. 141 – IEEE Recommended Practice for Electrical/Power Distribution for Industrial Plants (IEEE Red Book)

H. ANSI/IEEE Std. 142 – IEEE Recommended Practice for Grounding of Industrial and Commercial Power Systems (IEEE Green Book)

I. ANSI/IEEE Std. 241 – IEEE Recommended Practice for Electrical Power Systems in Commercial Buildings (IEEE Gray Book)

J. ANSI/IEEE Std. 242 – IEEE Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems (IEEE Buff Book)

K. ANSI/IEEE Std. 399 – IEEE Recommended Practice for Power Systems Analysis (IEEE Brown Book)

L. ANSI/IEEE Std. 446 – IEEE Recommended Practice for Emergency and Standby Power Systems for Industrial and Commercial Applications (IEEE Orange Book)

M. ANSI/IEEE Std. 493 – IEEE Recommended Practice for the Design of Reliable Industrial and Commercial Power Systems (IEEE Gold Book)

N. ANSI/IEEE Std. 1100 – IEEE Recommended Practice for Powering and Grounding Sensitive Electronic Equipment (IEEE Emerald Book)

O. NETA – Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems

P. NEMA AB 4 – Guidelines for Inspection and Preventive Maintenance of Molded-Case Circuit Breakers Used in Commercial and Industrial Applications

Q. NEMA MG1 – Motors and Generators

R. NFPA 70 – National Electrical Code

S. NFPA 70B – Recommended Practice for Electrical Equipment Maintenance

T. NFPA 70E – Electrical Safety Requirements for Employee Workplaces

U. NFPA 101 – Life Safety Code

V. NFPA 110 – Emergency and Standby Power Systems

W. NIST – National Institute of Standards and Technology

X. OSHA – Part 1910 – Subpart S – 1910.308 – Special Systems

1.5 SUBMITTALS

A. Test Reports: Include the following:
   1. Summary of project
   2. Description of equipment tested
   3. Equipment used to conduct the test
   4. Description of test
   5. Test results, as compared to manufacturers' or industry accepted standards and tolerances
   6. Conclusions and recommendations
   7. Signature of responsible test organization authority

B. List of equipment used to perform tests. Identify the following:
   1. Type
   2. Manufacturer
   3. Model number
   4. Serial number
   5. Date of last calibration

6. Documentation of calibration leading to NIST standards

1.6 QUALITY ASSURANCE

A. Qualifications of Testing Agency:
   1. Testing firm shall be a corporately and financially independent testing organization that can function as an unbiased testing authority, professionally independent of the manufacturer, supplier, and installers of equipment or system evaluated by the testing firm.
   2. Testing firm shall be regularly engaged in testing of electrical equipment, devices, installations and systems.
   3. Testing firm shall meet Federal Occupational Safety and Health Administration (OSHA) requirements for accreditation of independent testing laboratories.
   4. On-site technical person shall be currently certified by the InterNational Electrical Testing Association in electrical power distribution system testing.
   5. Testing firm shall use technicians who are regularly employed by the firm for testing services.
   6. Testing firm shall submit proof of above qualifications with bid documents when requested.

PART 2 - PRODUCTS

2.1 **Not applicable to this Section**.

PART 3 - EXECUTION

3.1 PREPARATION

A. Documentation: Deliver the following to testing firm, minimum two weeks prior to commencement of testing:
   1. Complete set of electrical plans and specifications, with available short circuit indicated on power riser diagrams.
   2. Approved submittals and shop drawings of equipment being tested.
   3. Pertinent change orders.
   4. Evaluation, overcurrent protective device coordination and arc flash studies provided by Engineer.

B. Schedule: Notify Owner and Engineer 10 working days prior to performance of any tests.

C. Coordination: Coordinate with Construction Manager/Owner/Engineer the testing schedule and availability of equipment ready for testing.

D. Test Power: Provide test power (including specialized) for equipment testing before and after service energizing.

3.2 FIELD QUALITY CONTROL

A. Inspection and Test Procedures: Comply with NETA.
   1. 600 V Conductors and Cables:
      a. Visual and Mechanical Inspection:
         1) Compare cable data with drawing and specifications.
         2) Inspect exposed sections of cables for physical damage.

3) Verify tightness of accessible bolted electrical connections by calibrated torque wrench in accordance with manufacturer's published data or Table 12.
4) Perform thermographic survey of bolted electrical connections in accordance with paragraph "Thermographic Survey."
5) Inspect compression-applied connectors for correct cable match and indentation.
6) Verify visible cable bends meet or exceed ICEA and manufacturer's minimum allowable bending radius.
7) For cables are terminated through window-type current transformers, provide an inspection to verify neutral and ground conductors are correctly placed for operation of protective devices.
8) Inspect for correct identification and arrangements.
9) Inspect jacket and insulation condition.

b. Electrical Tests:
1) Perform insulation-resistance test using megohm meter. Applied potential to be 1000 VDC. Individually test each conductor with other conductors grounded. Test duration shall be one minute.
2) Perform continuity tests to insure correct cable connection.

c. Test Values:
1) Insulation-resistance values should not be less than 50 megohms.

2. Electrical Metering:
a. Visual and Mechanical Inspection:
1) Compare equipment nameplate data with drawings and specifications.
2) Inspect physical and mechanical condition.
3) Verify tightness of electrical connections.
4) Inspect cover gasket, cover glass, condition of spiral spring, disc clearance, contacts, and case-shorting contacts, as applicable.
5) Verify freedom of movement, correct travel and alignment, and tightness of mounting hardware.

b. Electrical Tests:
1) Check calibration of meters at cardinal points.
2) Calibrate watt-hour meters according to manufacturer's published data.
3) Verify instrument multipliers.
4) Electrically confirm current transformer and voltage transformer secondary circuits are intact.

3. Dry Type Transformers:
a. Visual and Mechanical Inspection:
1) Compare equipment nameplate data with drawings and specifications.
2) Inspect physical and mechanical condition.
3) Inspect anchorage, alignment, and grounding.
4) Verify that resilient mounts are free and that any shipping brackets have been removed.
5) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or Table 12.

6) Perform thermographic survey of bolted electrical connections, in accordance with paragraph “Thermographic Survey.”
7) Verify that as-lift tap connections are as specified.

b. Electrical Tests:
1) Perform insulation-resistance tests winding-to-winding and each winding-to-ground with test voltage in accordance with Table 5. Calculate dielectric absorption ratio or polarization index.

c. Test Values:
1) Bolt-torque levels should be in accordance with Table 12, unless otherwise specified by manufacturer.
2) Insulation-resistance test values at one minute should be in accordance with Table 5.
3) The dielectric absorption or polarization index shall be greater than 1.0 and shall be recorded for future reference.

4. Low-Voltage Switchgear and Switchboard Assemblies:
a. Visual and Mechanical Inspection:
1) Compare equipment nameplate data with drawings and specifications.
2) Inspect physical and mechanical condition.
3) Confirm correct application of manufacturer’s recommended lubricants.
4) Verify appropriate anchorage, required area clearances, grounding and correct alignment.
5) Inspect doors, panels, and sections for paint, dents, scratches, fit, and missing hardware.
6) Verify fuse and/or circuit breaker sizes and types correspond to drawings and coordination study as well as to circuit breaker’s address for microprocessor-communication packages.
7) Verify that current and potential transformer ratios correspond to drawings.
8) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench. Refer to manufacturer’s published data or Table 12 for proper torque values.
9) Perform thermographic survey of bolted electrical connections in accordance with paragraph “Thermographic Survey.”
10) Confirm correct operation and sequencing of electrical and mechanical interlock systems.
a) Attempt closure on locked-open devices. Attempt to open locked-closed devices.
b) Make key exchange with devices operated in off-normal positions.
11) Inspect insulators for evidence of physical damage or contaminated surfaces.
12) Verify correct barrier and shutter installation and operation.
13) Exercise active components.
14) Inspect mechanical indicating devices for correct operation.
15) Verify filters are in place and/or vents are clear.
16) Perform visual and mechanical inspection of instrument transformers, in accordance with paragraph “Instrument Transformers.”

17) Inspect control power transformers.
    a) Inspect physical damage, cracked insulation, broken leads, tightness of connections, defective wiring, and overall general condition.
    b) Verify that primary and secondary fuse ratings or circuit breakers match drawings.
    c) Verify correct functioning of draw-out disconnecting and grounding contacts and interlocks.

b. Electrical Tests:
    1) Perform tests on all instrument transformers in accordance with paragraph “Instrument Transformers.”
    2) Perform resistance tests through bus joints with low-resistance ohmmeter. Joints that cannot be directly measured due to permanently installed insulation wrap shall be indirectly measured from closest accessible connection.
    3) Perform insulation-resistance tests in each bus section, phase-to-phase and phase-to-ground for one minute in accordance with Table 1.
    4) Perform over-potential test on each bus section, each phase-to-ground with phases not under test grounded, in accordance with manufacturer’s published data. In the absence of any published data, Table 2 shall apply. Test voltage shall be applied for one minute.
    5) Perform insulation-resistance tests at 1000 VDC on control wiring. Test duration shall be one minute. Do not perform this test on wiring connected to solid-state components. Follow manufacturer’s recommendation.
    6) Perform current injection tests on the entire current circuit in each section of switchgear.
        a) Perform current tests by primary injection, where possible, with magnitudes such that minimum of 1.0 amp flows in secondary circuit.
        b) Where primary injection is impractical, utilize secondary injection with minimum current of 1.0 amp.
        c) Test current at each device.
    7) Determine accuracy of meters and calibrate watt-hour meters in accordance with paragraph “Electrical Metering.” Verify multipliers.
    8) Perform phasing check on double-ended switchboard/switchgear to insure correct bus phasing from each source.
    9) Perform the following tests on control power transformers:
        a) Perform insulation-resistance tests. Perform measurements from winding-to-winding and each winding-to-ground. Test voltages shall be in accordance with Table 1 unless otherwise specified by manufacturer.
        b) Perform secondary wiring integrity test. Disconnect transformer at secondary terminals and connect secondary wiring to correct secondary voltage. Confirm potential at all devices.
        c) Verify correct secondary voltage by energizing primary winding with system voltage. Measure secondary voltage with secondary wiring disconnected.
        d) Verify correct function of control transfer relays located in switchboard/switchgear with multiple control power sources.
    10) Potential Transformer Circuits:

a) Perform insulation-resistance tests. Perform measurements from winding-to-winding and each winding-to-ground. Test voltages shall be in accordance with Table 1, unless otherwise specified by manufacturer.

b) Perform secondary wiring integrity test. Disconnect transformer at secondary terminals and connect secondary wiring to correct secondary voltage.

c) Verify secondary voltage by energizing primary winding with system voltage. Measure secondary voltage with secondary wiring disconnected.

11) Verify operation of switchgear/switchboard space heaters.

c. Test Values:

1) Bolt-torque levels shall be in accordance with Table 12, unless otherwise specified by manufacturer.

2) Compare bus connection resistances to values of similar connections.

3) Insulation-resistance values for bus, control wiring, and control power transformers shall be in accordance with manufacturer's published data. In the absence of manufacturer's published data, use Table 1. Values of insulation resistance less than this table or manufacturer's minimum should be investigated. Over-potential tests should not proceed until insulation-resistance levels are raised above minimum values.

4) Bus insulation shall withstand the over-potential test voltage applied.

5) Contact resistance values shall not exceed high limit of normal range as indicated in manufacturer's published data. If manufacturer's data is not available, investigate values that deviate from similar bus by more than 50% of lowest value.

5. Low-Voltage Insulated-Case/Molded-Case Circuit Breakers, 225A and Larger:

a. Visual and Mechanical Inspection:

1) Compare nameplate date with drawings and specifications.

2) Inspect circuit breaker for correct mounting.

3) Check cell fit, element alignment and racking mechanism for draw-out breakers.

4) Operate circuit breaker to insure smooth operation.

5) Inspect case for cracks or other defects.

6) Verify tightness of accessible bolted electrical connections and/or cable connections by calibrated torque-wrench method in accordance with manufacturer's published data or Table 12.

7) Inspect mechanism contacts and arc chutes in unsealed units.

b. Electrical Tests:

1) Perform a contact-resistance test.

2) Perform insulation-resistance test at 1000 VDC from pole-to-pole and from each pole-to-ground with breaker closed and across open contacts of each phase. Test duration shall be one minute. Use a minimum test voltage in accordance with Table 1 or manufacturer's published data.

3) Perform insulation-resistance test at 1000 VDC on all control wiring. Test duration shall be one minute. Do not perform the test on wiring connected to solid-state components. Follow manufacturer's recommendation.

4) Perform adjustments for final trip settings in accordance with overcurrent protective device coordination study.

5) Perform long-time delay time-current characteristic tests by passing 300% rated current through each pole separately, unless series testing is required to defeat ground fault functions.
6) Determine short-time pickup and delay by primary current injection.
7) Determine ground-fault pickup and time delay by primary current injection.
8) Determine instantaneous pickup current by primary injection using run-up or pulse method.
9) Verify correct operation of auxiliary features such as trip and pickup indicators, zone interlocking, electrical close and trip operation, trip-free, and anti-pump function.
10) Verify trip unit calibrations by secondary injection.
11) Determine minimum operation voltage on shunt trip and close coils in accordance with Table 20.
12) Check charging mechanism.

c. Test Values:
1) Bolt-torque levels shall be in accordance with Table 12, unless otherwise specified by manufacturer.
2) Compare microhm or millivolt drop values to adjacent poles or similar breakers. Investigate deviations of more than 50% of lowest value. Investigate any value exceeding manufacturer's recommendations.
3) Circuit breaker insulation-resistance shall be in accordance with Table 1.
4) Control wiring insulation-resistance shall comply with manufacturer's published data. In the absence of manufacturer's published data, use Table 1. Values of insulation resistance less than this table or manufacturer's minimum shall be investigated.
5) Trip characteristic of breakers shall fall within manufacturer's published time-current characteristic tolerance band, including adjustment factors. If manufacturer's curves are not available, trip times shall not exceed the value shown in Table 7. Circuit breakers exceeding specified trip time at 300% of pickup shall be tagged defective.
6) For molded-case circuit breakers, instantaneous pickup values shall be within manufacturer's published data or tolerances shown in Table 8.
7) Minimum operation voltages on shunt trip and close coils shall be in accordance with manufacturer's published data. In the absence of manufacturer's data, refer to Table 20.

6. Low-Voltage Disconnect Switches:
a. Visual and Mechanical Inspection:
1) Compare equipment nameplate data with drawings and specifications.
2) Inspect physical and mechanical condition.
3) Inspect anchorage, alignment, grounding, and required clearances.
4) Verify correct blade alignment, blade penetration, travel stops, and mechanical operation.
5) Verify that fuse sizes and types are in accordance with drawings, short-circuit and overcurrent protective device coordination studies.
6) Verify that each fuse has adequate mechanical support and contact integrity.
7) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or Table 12.
8) Perform thermographic survey of accessible bolted electrical connection in accordance with paragraph "Thermographic Survey."

9) Verify operation and sequencing of interlocking systems.
10) Verify correct phase barrier installation.
11) Verify correct operation of all indicating and control devices.
12) Confirm correct application of manufacturer's recommended lubricants.

b. Electrical Tests:
1) Measure contact resistance across each switchblade and fuseholder.
2) Perform insulation-resistance test at 1000 VDC from pole-to-pole and from each pole-to-ground. Test duration shall be one minute. Use a minimum test voltage in accordance with Table 1 or manufacturer's published data.
3) Measure fuse resistance.
4) Perform ground fault test, if applicable.

c. Test Values:
1) Compare bolted connection resistances to values of similar connections.
2) Bolt-torque levels should be in accordance with Table 12, unless otherwise specified by the manufacturer.
3) Compare microhm or millivolt drop values to adjacent poles or similar switches. Investigate deviations of more than 50% of lowest value. Investigate any value exceeding manufacturer's recommendations.
4) Minimum insulation-resistance shall be in accordance with manufacturer's published data or Table 1.
5) Investigate fuse-resistance values that deviate from each other by more than 15%.

7. Automatic Transfer Switches:
a. Visual and Mechanical Inspection:
1) Compare equipment nameplate data with drawings and specifications.
2) Inspect physical and mechanical condition.
3) Confirm correct application of manufacturer's recommended lubricants.
4) Verify manual transfer warnings are attached and visible.
5) Verify tightness of control connections.
6) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or Table 12.
7) Perform thermographic survey of accessible bolted electrical connections in accordance with paragraph "Thermographic Survey."
8) Perform manual transfer operation.
9) Verify positive mechanical interlocking between normal and alternative sources.
10) Inspect anchorage, alignment, grounding and required clearances.

b. Electrical Tests:
1) Measure contact resistance.
2) Perform insulation-resistance tests, phase-to-phase and phase-to-ground, with switch in both source positions. Test duration shall be one minute. Use a test voltage in accordance with Table 1 or manufacturer's published data. For control devices that cannot tolerate test voltage, follow manufacturer's recommendation.
3) Verify settings and operation of control devices.
4) Calibrate and set relays and timers in accordance with paragraph "Protective Relays."

5) Verify phase rotation, phasing and synchronized operation as required by the application.
6) Perform automatic transfer tests:
   a) Simulate loss of normal power.
   b) Return to normal power.
   c) Simulate loss of emergency power.
   d) Simulate all forms of single-phase conditions.
7) Verify correct operation and timing of following functions:
   a) Normal source voltage-sensing relays.
   b) Engine start sequence.
   c) Time delay upon transfer.
   d) Alternate source voltage-sensing relays.
   e) Automatic transfer operation.
   f) Interlocks and limit switch function.
   g) Time delay and retransfer upon normal power restoration.
   h) Engine cool down and shutdown feature.

c. Test Values:
   1) Bolt-torque levels shall be in accordance with Table 12, unless otherwise specified by manufacturer.
   2) Insulation-resistance test voltage and minimum values shall be in accordance with Table 1.
   3) Compare microhm values to adjacent poles or similar switches. Investigate deviations of more than 50% of lowest value. Investigate any value exceeding manufacturer's recommendations.

8. Motor Controllers:
   a. Visual and Mechanical Inspection:
      1) Compare equipment nameplate data with drawings and specifications.
      2) Inspect physical and mechanical condition.
      3) Inspect anchorage, alignment and grounding.
      4) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or Table 12.
      5) Verify controller mechanical operations. Inspect gap, wipe, alignment, and pressure are in accordance with manufacturer's published data.
      6) Verify motor running protection installed and properly sized.
      7) Confirm correct application of manufacturer's recommended lubricants.
   b. Electrical Tests:
      1) Perform resistance tests through all bus joints with low-resistance ohmmeter. Any joints that cannot be directly measured due to permanently installed insulation wrap shall be indirectly measured from closest accessible connection.
      2) Perform insulation-resistance tests on each bus section, phase-to-phase and phase-to-ground with controller closed and across each open pole. Test duration shall be one minute. Use a test voltage in accordance with Table 1 or manufacturer's published data. For control devices that cannot tolerate test voltage, follow manufacturer's recommendations.

3) Perform insulation-resistance tests at 1000 VDC on control wiring. Test duration shall be one minute. Do not perform this test on wiring connected to solid-state components. Follow manufacturer's recommendations.
4) Test motor protection devices in accordance with manufacturer's published data. In the absence of manufacturer's data, use paragraph "Protective Relays."
5) Test circuit breakers in accordance with paragraph "Low-Voltage Insulated-Case/Molded-Case Circuit Breakers."
6) Perform operational tests by initiating control devices.

c. Test Values:
1) Bolt-torque levels shall be in accordance with Table 12, unless otherwise specified by manufacturer.
2) Compare bus connection resistances to values of similar connections.
3) Insulation-resistance values for bus, control wiring, and control power transformers shall be in accordance with manufacturer's published data. In the absence of manufacturer's published data, use Table 1. Values of insulation-resistance less than this table or manufacturer's minimum should be investigated.
4) Motor protection parameters shall be in accordance with manufacturer's published data.

9. Ground Fault Protection Systems:
a. Visual and Mechanical Inspection:
1) Compare equipment nameplate data with drawings and specifications.
2) Visually inspect components for damage and errors in polarity or conductor routing:
a) Verify ground connection is made ahead of neutral disconnect link and on line side of any ground fault sensor.
b) Verify neutral sensors are connected with correct polarity on both primary and secondary.
c) Verify all phase conductors and neutral pass through sensor in same direction for zero sequence systems.
d) Verify grounding conductors do not pass through zero sequence sensors.
e) Verify grounded conductor is solidly grounded.
3) Verify tightness of accessible bolted electrical connections, including control circuits, by calibrated torque-wrench method in accordance with manufacturer's published data or Table 12.
4) Verify correct operation of self-test panel.
5) Set pickup and time-delay settings in accordance with settings provided on drawings and in specifications. Record operation and test sequences as required by NFPA 70.
6) Verify the control power transformer has adequate capacity for the system.

b. Electrical Tests:
1) Measure system neutral-to-ground insulation resistance with neutral disconnect link temporarily removed. Replace neutral disconnect link after testing.
2) Perform insulation-resistance test of control wiring at 1000 VDC for one minute. Do not perform this test on wiring connected to solid-state components. Follow manufacturer's recommendations.
3) Perform the following pickup tests using primary injection:

a) Verify relay does not operate at 90% of pickup setting.
b) Verify pickup is less than 125% of setting or 1200 amp, whichever is smaller.

4) For summation type systems using phase-neutral current transformers, verify correct polarities by applying current to each phase-neutral current transformer pair. This test also applies to molded-case breakers using external neutral current transformer.
   a) Relay should operate when current direction is the same relative to polarity marks in the two current transformers.
   b) Relay should not operate when current direction is opposite relative to polarity marks in the two current transformers.
5) Measure time delay of the relay at 150% or greater of pickup.
6) Verify reduced voltage tripping capability: 55% for AC systems and 80% for DC systems.

c. Test Values:
   1) System neutral-to-ground insulation shall be minimum of one megohm.
   2) Insulation resistance values shall be in accordance with Table 1.
   3) Relay timing shall be in accordance with manufacturer's specifications but must also be no longer than one second at 3000 amp.
   4) Bus bolt-torque levels shall be in accordance with Table 12, unless otherwise specified by manufacturer.

10. Grounding Systems:
    a. Visual and Mechanical Inspection:
       1) Verify ground system is in compliance with drawings, specifications, and NFPA 70.
       2) Inspect physical and mechanical condition.
       3) Inspect anchorage.
    b. Electrical Tests:
       1) Perform fall-of-potential or alternative test in accordance with ANSI/IEEE 81 on the main grounding electrode or system.
       2) Perform point-to-point tests to determine the resistance between the main grounding system and all major electrical equipment frames, system neutral, and/or derived neutral points.
       3) Make resistance measurements in dry weather not earlier than 48 hours after rainfall.
    c. Test Values:
       1) The resistance between the main grounding electrode and ground should be no greater than five ohms. (Reference ANSI/IEEE 142.) Investigate any values above five ohms and notify Engineer immediately for further instructions.
       2) Investigate point-to-point resistance values that exceed 0.5 ohm.
11. Thermographic Survey:
    a. Visual and Mechanical Inspection:
       1) Inspect physical, electrical, and mechanical conditions.
       2) Remove all necessary covers prior to thermographic inspection.
       3) Equipment to be inspected shall include all current-carrying devices. Provide report including the following:
          a) Discrepancies.

b) Temperature difference between area of concern and reference area.
c) Cause of temperature difference.
d) Areas inspected. Identify inaccessible and unobservable areas and equipment.
e) Identify load conditions at time of inspection.
f) Provide photographs and thermogram of deficient area.

b. Test Parameters:
1) Inspect distribution systems with imaging equipment capable of detecting minimum temperature difference of 1°C at 30°C.
2) Equipment shall detect emitted radiation and convert detected radiation to visual signal.
3) Thermographic surveys should be performed during periods of maximum possible loading but not less than 40% of rated load of the electrical equipment being inspected. Refer to NFPA 70B, Section 20.17 (Infrared Inspection).

c. Test Results:
1) Temperature differences of 1°C to 3°C indicate possible deficiency and warrant investigation.
2) Temperature differences of 4°C to 15°C indicate deficiency; repair as time permits.
3) Temperature differences of 16°C and above indicate major deficiency; repair immediately.
4) Suggested actions based on temperature rise can be found in Table 18.

B. Test Reports:
1. Testing firm shall do the following:
a. Prepare test report, including description of equipment tested, description of test, test results, conclusions and recommendations, retesting results, list of test equipment used and calibration date.
b. Show test results in comparison to industry and manufacturer's values and tolerances.
c. Interpret test results in writing and give recommendations for acceptance or rejection upon consultation with Engineer and prior to energizing equipment.
d. Assure electrical equipment is operational and within industry and manufacturer's tolerances, and is installed in accordance with contract documents.
e. Assure suitability of energization.
f. Report to the Owner and Engineer any system, material, or workmanship that is found defective on the basis of acceptance tests.
g. Retest equipment when required.
h. Maintain written record of tests.
i. Utilize safety practices during the tests in accordance with:
1) Acceptable state and local safety operating procedures
2) Owner's safety practices
3) OSHA
4) NFPA 70E
j. Perform tests with apparatus de-energized and grounded, except where otherwise specifically required ungrounded by test procedures.
k. Assemble and certify final test report.

l. Provide 4 copies of complete test report.

m. Attach label to all tested equipment with indication of date tested and testing firm name.

2. Contractor shall do the following:

a. Investigate, replace, or repair any fault in material or in any part of the installation revealed by the tests.

b. Deliver one copy of each test report directly to Engineer within 30 days after completion of testing, unless directed otherwise. Insert a copy of each test report in the equipment operation and maintenance manuals.

C. Test Equipment:

1. Test Instrument Calibration:

a. Testing firm shall have calibration program that assures test instruments are maintained with rated accuracy.

b. Instruments shall be calibrated in accordance with the following frequency schedule:

1) Field instruments: Analog, 6 months maximum; Digital, 12 months maximum

2) Laboratory instruments: 12 months

3) Leased specialty equipment: 12 months where accuracy is guaranteed by lessor

c. Dated calibration labels shall be visible on test equipment.

d. Records, which show date and results of instruments calibrated or tested, must be kept up-to-date.

e. Up-to-date instrument calibration instructions and procedures shall be maintained for test instrument.

f. Equipment used for field testing shall be more accurate than instrument being tested.

g. Calibrating standard applied to testing equipment shall be of higher accuracy than instrument tested.

END OF SECTION

SECTION 26 0813 POWER DISTRIBUTION ACCEPTANCE TEST TABLES

TABLE 1
Insulation Resistance Test Values
Electrical Apparatus And Systems

Voltage Rating	Minimum DC Test Voltage	Recommended Minimum Insulation Resistance In Megohms
250	500	25
600	1,000	100
1,000	1,000	100
2,500	1,000	500
5,000	2,500	1,000
8,000	2,500	2,000
15,000	2,500	5,000
25,000	5,000	20,000
34,500 and above	15,000	100,000

See Table 14 for temperature correction factors.

TABLE 2
Switchgear Low-Frequency Withstand Test Voltages

Type of Switchgear	Rated kV	Maximum Test Voltage kV	
		AC	DC
Low-Voltage Power Circuit Breaker Switchgear	.254	1.6	2.3
	.508	1.6	2.3
	.635	1.6	2.3
MC (Metal-Clad Switchgear)	4.76	14.0	20.0
	8.25	27.0	37.0
	15.0	27.0	37.0
	27.0	45.0	+
	38.0	60.0	+
SC (Station-Type Cubicle Switchgear)	15.5	37.0	+
	38.0	60.0	+
	72.5	*120*.0	+
MEI (Metal-Enclosed Interrupter Switchgear)	4.76	14.0	20.0
	8.25	19.0	27.0
	15.0	27.0	37.0
	15.5	37.0	52.0
	25.8	45.0	+
	38.0	60.0	+

Derived from ANSI/IEEE C37.20.2-1993, Paragraph 5.5, *Metal-Clad and Station-Type Cubicle Switchgear* and C37.20.3-1993, Paragraph 5.5, *Metal-Enclosed Interrupter Switchgear*, and includes 0.75 multiplier with fraction rounded down.

The column headed “DC, Maximum Test Voltage kV” is given as a reference only for those using DC tests to verify the integrity of connected cable installations without disconnecting the cables from the switchgear. It represents values believed to be appropriate and approximately equivalent to the corresponding power frequency withstand test values specified for voltage rating of switchgear. The presence of this column in no way implies any requirement for a DC withstand test on AC equipment or that a DC withstand test represents an acceptable alternative to the low-frequency withstand tests specified in this specification, either for design tests, production tests, conformance tests, or field tests. When making DC tests, the voltage should be raised to the test value in discrete steps and held for a period of one minute.

Because of the variable voltage distribution encountered when making DC withstand tests, the manufacturer should be contacted for recommendations before applying DC withstand tests to the switchgear. Voltage transformers above 34.5kV should be disconnected when testing with DC. Refer to ANSI/IEEE C57-13-1993 (*IEEE Standard Requirements for Instrument Transformers*) paragraph 8.8.2.
+ Consult Manufacturer

TABLE 3
Recommended Dissipation Factor/Power Factor at 20°C
Liquid Filled Transformers, Regulators, and Reactors
Acceptance Test Values

Oil, Silicone, and Less-Flammable Hydrocarbon Maximum Value (Percent)	
New Power Transformers and Reactors	0.5%
New Distribution Transformers and Regulators	1.0%
Remanufactured Power Transformers and Reactors	1.0%
Remanufactured Distribution Transformers and Regulators	1.5%

TABLE 4
Insulating Fluid Limits

Table 4.1 Test Limits for New Insulating Oil Received in New Equipment		
Mineral Oil		
Test	**ASTM Method**	**# 69 kV and Below**
Dielectric breakdown, kV minimum	D877	30
Dielectric breakdown, kV minimum @ 1 mm(0.04”) gap	D1816	25
Dielectric breakdown, kV minimum @ 2 mm(0.08”) gap	D1816	45
Interfacial tension mN/m minimum	D971 or D2285	38
Neutralization number, mg KOH/g maximum	D974	0.015
Water content, (ppm) maximum	D1533	20
Power factor at 25°C, %	D924	0.05
Power factor at 100°C, %	D924	0.40
Color	D1500	1.0
Visual condition	D1524	Bright and clear

ANSI/IEEE C57.106-2002, *Guide for Acceptance and Maintenance of Insulating Oil in Equipment,* Tables 1, 2, and 3.

Table 4.2 Test Limits for Silicone Insulating Liquid in New Transformers		
Test	**ASTM Method**	**Acceptable Values**
Dielectric breakdown, kV minimum	D877	30
Visual	D2129	clear, free of particles
Water content, (ppm) maximum	D1533	50
Dissipation/power factor, 60 Hz, % max. @ 25°C	D924	0.1
Viscosity, cSt @ 25°C	D445	47.5 – 52.5
Fire point, °C, minimum	D92	340
Neutralization number, mg KOH/g max.	D974	0.01

ANSI/IEEE C57.111-1989 (R1995), *Guide for Acceptance of Silicone Insulating Fluid and Its Maintenance in Transformers,* Table 2.

TABLE 4 (CONT.)
Insulating Fluid Limits

Table 4.3
Typical Values for Less-Flammable Hydrocarbon Insulating Liquid Received in New Equipment

ASTM Method	Test	Results		
		Minimum		Maximum
D1816	Dielectric breakdown voltage for 2 mm(0.08") gap, kV	40	34.5 kV class and below	---
		60	Desirable	
D1816	Dielectric breakdown voltage for 1 mm(0.04") gap, kV	20	34.5 kV class and below	---
		30	Desirable	
D974	Neutralization number, mg KOH/g	----		0.03
D877	Dielectric breakdown voltage kV	30		----
D924	AC loss characteristic (dissipation factor), % 25°C 100°C	 ---- ----		 0.1 1
D1533B	Water content, (ppm)	----		25
D1524	Condition-visual	Clear		
D92	Flash point (°C)	275		----
D92	Fire point (°C)	300[a]		----
D971	Interfacial tension, mN/m, 25°C	38		----
D445	Kinematic viscosity, mm^2/s. (cSt), 40°C	1.0 X 10^2(100)		1.3 X 10^2(130)
D1500	Color	----		L2.5

ANSI/IEEE C57.121-1998, *IEEE Guide for Acceptance and Maintenance of Less-Flammable Hydrocarbon Fluid in Transformers,* Table 3.

The test limits shown in this table apply to less-flammable hydrocarbon fluids as a class. Specific typical values for each brand of fluid should be obtained from each fluid manufacturer.

a. If the purpose of the HMWH installation is to comply with the NFPA 70 *National Electrical Code*, this value is the minimum for compliance with NEC Article 450.23.

TABLE 5

Transformer Insulation-Resistance
Acceptance Test Voltage and Minimum Results

Transformer Coil Rating Type in Volts	Minimum DC Test Voltage	Recommended Minimum Insulation Resistance in Megohms	
		Liquid Filled	Dry
0 - 600	1000	100	500
601 - 5000	2500	1000	5000
5001 - 15000	5000	5000	25000

See Table 14 for Temperature Correction Factors.

NOTE: Since insulation resistance depends on insulation rating (kV) and winding capacity (kVA), values obtained should be compared to manufacturer's test data.

TABLE 6
Medium-Voltage Cables
Acceptance Test Values

Table 6.1
DC Test Voltages

Rated Voltage Phase-to-Phase kV	Conductor Sizes AWG or kcmil (mm)	Nominal Insulation Thickness mils (mm)		Maximum DC Field Test Voltages, kV During/After Installation	
		100% Insulation Level	133% Insulation Level	100% Insulation Level	133% Insulation Level
5	8-1000 (8.4-507) Above 1000 (507)	90 (2.29) 140 (3.56)	115 (2.92) 140 (3.56)	28 28	36 36
8	6-1000 (13.3-507) Above 1000 (507)	115 (2.92) 175 (4.45)	140 (3.56) 175 (4.45)	36 36	44 44
15	2-1000 (33.6-507) Above 1000 (507)	175 (4.45) 220 (5.59)	220 (5.59) 220 (5.59)	56 56	64 64
25	1-2000 (42.4-1013)	260 (6.60)	320 (8.13)	80	96
28	1-2000 (42.4-1013)	280 (7.11)	345 (8.76)	84	100
35	1/0-2000 (53.5-1013)	345 (8.76)	420 (10.7)	100	124

Tables derived from ANSI/ICEA S-93-639/NEMA WC 74-2000, *5-46 kV Shielded Power Cable for Use in the Transmission and Distribution of Electric Energy;* ANSI/ICEA S-94-649-2000, *Standard for Concentric Neutral Cables Rated 5,000 – 46,000 Volts*; ANSI/ICEA S-97-682-2000, *Standard for Utility Shielded Power Cables Rated 5,000 – 46,000 Volts*; and The Okonite Company, *High-Voltage Proof Testing.*

The DC field test voltages listed above are intended for cable designed in accordance with ICEA specifications. When older cables or other types/classes of cables or accessories are connected to the system, voltages lower than those shown may be necessary. Consult the manufacturers of the cables and/or accessories before applying the test voltage.

TABLE 6 (CONT.)
Medium-Voltage Cables
Acceptance Test Values

Table 6.2
AC Test Voltages

Rated Voltage Phase-to-Phase kV	Conductor Sizes AWG or kcmil (mm)	Nominal Insulation Thickness mils (mm)		AC Test Voltage, kV	
		100% Insulation Level	133% Insulation Level	100% Insulation Level	133% Insulation Level
5 KV	8-1000 1001-3000	90 (2.29) 140 (3.56)	115 (2.92) 140 (3.56)	18 28	23 28
8 kV	6-1000 1001-3000	115 (2.92) 175 (4.45)	140 (3.56) 175 (4.45)	23 35	28 35
15 kV	2-1000 1001-3000	175 (4.45) 220 (5.59)	220 (5.59) 220 (5.59)	35 44	44 44
25 kV	1-3000	260 (6.60)	320 (8.13)	52	64
28 kV	1-3000	280 (7.11)	345 (8.76)	56	69
35 kV	1/0-3000	345 (8.76)	420 (10.7)	69	84

Tables derived from ANSI/ICEA S-93-639/NEMA WC 74-2000, *5-46 kV Shielded Power Cable for Use in the Transmission and Distribution of Electric Energy;* ANSI/ICEA S-94-649-2000, *Standard for Concentric Neutral Cables Rated 5,000 – 46,000 Volts*; ANSI/ICEA S-97-682-2000, *Standard for Utility Shielded Power Cables Rated 5,000 – 46,000 Volts.*

All AC voltages are RMS values.

TABLE 6 (CONT.)
Medium-Voltage Cables
Acceptance Test Values

Table 6.3 **Partial Discharge Requirements** **for Semiconducting Coating and Tape Designs Only**		
Rated Circuit Voltage Phase-to-Phase Volts	**Minimum Partial Discharge Extinction Level, kV**	
	100% Insulation Level	**133% Insulation Level**
2001-5000	4	5
5001-8000	6	8
8001-15000	11	15

ANSI/ICEA S-93-639/NEMA WC 74-2000, *5-56 kV Shielded Power Cable for Use in the Transmission and Distribution of Electric Energy.*

Table 6.4 **Very Low Frequency Testing Levels** **0.1 Hz Test Voltage (RMS)**	
System Voltage Phase-to-Phase (kV) (RMS)	**Proof Phase-to-Ground (kV) (RMS)**
5	10
15	22
25	33
35	47

TABLE 7
Molded-Case Circuit Breakers
Values for Inverse Time Trip Test

(At 300% of Rated Continuous Current of Circuit Breaker)

Range of Rated Continuous Current Amperes	Maximum Trip Time in Seconds For Each Maximum Frame Rating[1]	
	250V	251 - 600V
0-30	50	70
31-50	80	100
51-100	140	160
101-150	200	250
151-225	230	275
226-400	300	350
401-600	----------	450
601-800	----------	500
801-1000	----------	600
1001-1200	----------	700
1201-1600	----------	775
1601-2000	----------	800
2001-2500	----------	850
2501-5000	----------	900

Reproduction of Table 5-3 from NEMA Standard AB4-1996.

[1] For integrally-fused circuit breakers, trip times may be substantially longer if tested with the fuses replaced by solid links (shorting bars).

TABLE 8
Instantaneous Trip Setting Tolerances for Field Testing
of Marked Adjustable Trip Circuit Breakers

	Tolerances of High and Low Settings	
Ampere Rating	**High**	**Low**
Adjustable	+40%	-30%
Non-adjustable	+25%	-25%

Reproduction of Table 5-4 from NEMA publication AB4-1996.

For circuit breakers with nonadjustable instantaneous trips, tolerances apply to the manufacturer's published trip range, i.e., +40% on high side, -30% on low side.

TABLE 9
Instrument Transformer Dielectric Tests
Field Acceptance

Nominal System (kV)	BIL (kV)	Applied Potential Tests Field Test Voltage (kV)	
		AC	DC[1]
0.6	10	3	4
1.2	30	7.5	10
2.4	45	11.25	15
5.0	60	14.25	19
8.7	75	19.5	26
15	95	25.5	34
15	110	25.5	34
25	125	30	40
25	150	37.5	50
34.5	150	37.5	50
34.5	200	52.5	70

Derived from Paragraph 8.8.2 and Tables 2 and 7 of ANSI/IEEE C57.13-1993 (Standard Requirements for Instrument Transformers).

[1] DC potential tests are not recommended for transformers rated higher than 200 kV BIL. DC tests may prove beneficial as a reference for future testing. In such cases the test direct voltage should not exceed the original factory test RMS alternating voltages.

TABLE 10
Maximum Allowable Vibration Amplitude

RPM @ 60 Hz	Velocity in/s peak	Velocity mm/s	RPM @ 60 Hz	Velocity in/s peak	Velocity mm/s
3600	0.15	3.8	3000	0.15	3.8
1800	0.15	3.8	1500	0.15	3.8
1200	0.15	3.8	1000	0.13	3.3
900	0.12	3.0	750	0.10	2.5
720	0.09	2.3	600	0.08	2.0
600	0.08	2.0	500	0.07	1.7

Derived from NEMA publication MG 1-1998, Section 7.8.1, Table 7-1. Table is unfiltered vibration limits for resiliently mounted machines. For machines with rigid mounting, multiply the limiting values by 0.8.

TABLE 11
Overpotential Test Voltages for Electrical Apparatus Other than Inductive Equipment

Nominal System (Line) Voltage[1] (kV)	Insulation Class	AC Factory Test (kV)	Maximum Field Applied AC Test (kV)	Maximum Field Applied DC Test (kV)
1.2	1.2	10	6.0	8.5
2.4	2.5	15	9.0	12.7
4.8	5.0	19	11.4	16.1
8.3	8.7	26	15.6	22.1
14.4	15.0	34	20.4	28.8
18.0	18.0	40	4.0	33.9
25.0	25.0	50	30.0	42.4
34.5	35.0	70	42.0	59.4
46.0	46.0	95	57.0	80.6
69.0	69.0	140	84.0	118.8

[1] Intermediate voltage ratings are placed in the next higher insulation class.

TABLE 12

U.S. Standard
Bolt Torques for Bus Connections
Heat-Treated Steel – Cadmium or Zinc Plated

Grade	SAE 1 & 2	SAE 5	SAE 7	SAE 8
Minimum Tensile (psi)	64K	105K	133K	150K
Bolt Diameter In Inches	Torque (Foot Pounds)			
1/4	4	6	8	8
5/16	7	11	15	18
3/8	12	20	27	30
7/16	19	32	44	48
1/2	30	48	68	74
9/16	42	70	96	105
5/8	59	96	135	145
3/4	96	160	225	235
7/8	150	240	350	380
1.0	225	370	530	570

Bolt Torques for Bus Connections
Silicon Bronze Fasteners[1]
Torque (Foot Pounds)

Bolt Diameter in (Inches)	Nonlubricated	Lubricated
5/16	15	10
3/8	20	14
1/2	40	25
5/8	55	40
3/4	70	60

[1] Bronze alloy bolts shall have a minimum tensile strength of 70,000 psi.

TABLE 12 (CONT.)

Bolt Torques for Bus Connections
Aluminum Alloy Fasteners[2]
Torque (Foot Pounds)

Bolt Diameter in Inches	Lubricated
5/16	8.0
3/8	11.2
1/2	20.0
5/8	32.0
3/4	48.0

[2] Aluminum alloy bolts shall have a minimum tensile strength of 55,000 psi.

Bolt Torques for Bus Connections
Stainless Steel Fasteners[3]
Torque (Foot Pounds)

Bolt Diameter in Inches	Uncoated
5/16	14
3/8	25
1/2	45
5/8	60
3/4	90

[3] Bolts, cap screws, nuts, flat washers, locknuts: 18-8 alloy.
Belleville washers: 302 alloy.

TABLE 13
SF_6 Gas Tests

Test	Method	Serviceability Limits[a]
Moisture	Hygrometer	Per manufacturer or 200 ppm[b]
SF_6 decomposition byproducts	ASTM D 2685	500 ppm
Air	ASTM D 2685	5000 ppm[c]
Dielectric breakdown Hemispherical contents	0.10" gap at atmospheric pressure	11.5 – 13.5 kV[d]

a. In the absence of consensus standards dealing with SF_6 gas tests, the NETA Standards Review Council suggests the above representative values.
b. According to some manufacturers.
c. Dominelli, N. and Wylie, L., *Analysis of SF_6 Gas as a Diagnostic Technique for GIS*, Electric Power Research Institute, Substation Equipment Diagnostics Conference IV, February 1996.
d. Per Even, F.E., and Mani, G. Sulfur Fluorides, Kirk, *Othmer Encyclopedia of Chemical Technology*, 4th ed., 11,428, 1994.

Reference: IEC 61634 High-Voltage Switchgear and Controlgear – *Use and Handling of Sulfur Hexafluoride (SF_6) in High-Voltage Switchgear and Controlgear.*

TABLE 14
Insulation Resistance Conversion Factors For Conversion of Test Temperature to 20°C

Temperature		Multiplier	
°C	**°F**	**Apparatus Containing Immersed Oil Insulations**	**Apparatus Containing Solid Insulations**
0	32	0.25	0.40
5	41	0.36	0.45
10	50	0.50	0.50
15	59	0.75	0.75
20	68	1.00	1.00
25	77	1.40	1.25
30	86	1.98	1.58
35	95	2.80	2.00
40	104	3.95	2.50
45	113	5.60	3.15
50	122	7.85	3.98
55	131	11.20	5.00
60	140	15.85	6.30
65	149	22.40	7.90
70	158	31.75	10.00
75	167	44.70	12.60
80	176	63.50	15.80

TABLE 15 (not used)
High-Potential Test Voltage
Automatic Circuit Reclosers

Nominal Voltage Class, kV	Maximum Voltage, kV	Rated Impulse Withstand Voltage, kV	Maximum Field Test Voltage, kV, AC
14.4	15.0	95	35
14.4	15.5	110	50
24.9	27.0	150	60
34.5	38.0	150	70
46.0	48.3	250	105
69.0	72.5	350	160

Derived from ANSI/IEEE C37.61-1973(R1992), *Standard Guide for the Application, Operation, and Maintenance of Automatic Circuit Reclosers* and from C37.60-1981(R1992), *Standard Requirements for Overhead, Pad-Mounted, Dry-Vault, and Submersible Automatic Circuit Reclosers and Fault Interrupters for AC Systems.*

TABLE 16 (not used)
High-Potential Test Voltage
for Acceptance Test of Line Sectionalizers

Nominal Voltage Class, kV	Maximum Voltage, kV	Rated Impulse Withstand Voltage, kV	Maximum Field Test Voltage, kV, AC	DC 15 Minute Withstand (kV)
14.4 (1 ∅)	15.0	95	35	53
14.4 (1 ∅)	15.0	125	42	53
14.4 (3 ∅)	15.5	110	50	53
24.9 (1 ∅)	27.0	125	60	78
34.5 (3 ∅)	38.0	150	70	103

Derived from ANSI/IEEE C37.63-1984(R1990) Table 2 (*Standard Requirements for Overhead, Pad-Mounted, Dry-Vault, and Submersible Automatic Line Sectionalizers of AC Systems*).

NOTE: Values of AC voltage given are dry test one-minute factory test values.

TABLE 17
Dielectric Withstand Test Voltages
Metal-Enclosed Bus

Type of Bus	Rated kV	Maximum Test Voltage, kV	
		AC	DC
Isolated Phase for Generator Leads	24.5	37.0	52.0
	29.5	45.0	--
	34.5	60.0	--
Isolated Phase for Other than Generator Leads	15.5	37.0	52.0
	25.8	45.0	--
	38.0	60.0	--
Nonsegregated Phase	0.635	1.6	2.3
	4.76	14.2	20.0
	15.0	27.0	37.0
	25.8	45.0	63.0
	38.0	60.0	--
Segregated Phase	15.5	37.0	52.0
	25.8	45.0	63.0
	38.0	60.0	--
DC Bus Duct	0.3	1.6	2.3
	0.8	2.7	3.9
	1.2	3.4	4.8
	1.6	4.0	5.7
	3.2	6.6	9.3

Derived from ANSI/IEEE C37.23-1987, Tables 3A, 3B, 3C, 3D, and paragraph 6.4.2. The table includes a 0.75 multiplier with fractions rounded down.

NOTE:

The presence of the column headed “DC” does not imply any requirement for a DC withstand test on AC equipment. This column is given as a reference only for those using DC tests and represents values believed to be appropriate and approximately equivalent to the corresponding power frequency withstand test values specified for each class of bus.

Direct current withstand tests are recommended for flexible bus to avoid the loss of insulation life that may result from the dielectric heating that occurs with rated frequency withstand testing.

Because of the variable voltage distribution encountered when making DC withstand tests and variances in leakage currents associated with various insulation systems, the manufacturer should be consulted for recommendations before applying DC withstand tests to this equipment.

TABLE 18
Thermographic Survey
Suggested Actions Based on Temperature Rise

Temperature difference (TD) based on comparisons between similar components under similar loading	Temperature difference (TD) based upon comparisons between component and ambient air temperatures	Recommended action
1°C to 3°C	1°C to 10°C	Possible deficiency; warrants investigation
4°C to 15°C	11°C to 20°C	Indicates probably deficiency; repair as time permits
-- -- --	21°C to 40°C	Monitor until corrective measures can be accomplished
>15°C	>40°C	Major discrepancy; repair immediately

Temperature specifications vary depending on the exact type of equipment. Even in the same class of equipment (i.e., cables) there are various temperature ratings. Heating is generally related to the square of the current; therefore, the load current will have a major impact on)T. In the absence of consensus standards for TD, the values in this table will provide reasonable guidelines.

An alternative method of evaluation is the standards-based temperature rating system as discussed in Chapter 8.9.2, Conducting an IR Thermographic Inspection, *Electrical Power Systems Maintenance and Testing*, by Paul Gill, PE, 1998.

It is a necessary and valid requirement that the person performing the electrical inspection be thoroughly trained and experienced concerning the apparatus and systems being evaluated as well as knowledgeable of thermographic methodology.

TABLE 19
Overpotential Test Voltages
Electrical Apparatus Other than Inductive Equipment

Nominal System (Line) Voltage[a] (kV)	Insulation Class	AC Factory Test (kV)	Maximum Field Applied AC Test (kV)	Maximum Field Applied DC Test (kV)
1.2	1.2	10	6.0	8.5
2.4	2.5	15	9.0	12.7
4.8	5.0	19	11.4	16.1
8.3	8.7	26	15.6	22.1
14.4	15.0	34	20.4	28.8
18.0	18.0	40	24.0	33.9
25.0	25.0	50	30.0	42.4
34.5	35.0	70	42.0	59.4

a. Intermediate voltage ratings are placed in the next higher insulation class.

TABLE 20
Rated Control Voltages and their Ranges
for Circuit Breakers

The maximum voltage is measured at the point of user connection to the circuit breaker [see Notes (9) (10)] with no operating current flowing, and the minimum voltage is measured with maximum operating current flowing.

Rated Control Voltages and their Ranges for Circuit Breakers					
RATED CONTROL VOLTAGE (8)	**Direct Current Voltage Ranges (1)(2) Volts, DC**		**OPENING FUNCTIONS ALL TYPES**	**RATED CONTROL VOLTAGE (60 Hz)**	**ALTERNATING CURRENT (1)(2)(3)(5) CLOSING, TRIPPING, AND AUXILIARY FUNCTIONS**
	CLOSING AND AUXILIARY FUNCTIONS				
	INDOOR CIRCUIT BREAKERS	**OUTDOOR CIRCUIT BREAKERS**		**SINGLE PHASE**	**SINGLE PHASE**
24	---	---	14-28	120	104-127 (4)
48	38-56	36-56	28-56	240	208-254 (4)
125	100-140	90-140	70-140	Polyphase	Polyphase
250	200-280	180-280	140-280		
---	---	---	---	208Y/120	180Y/104-
---	---	---	---	240	220Y/127
					208-254

Derived from Table 8, ANSI C37.06-2000, *AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis – Preferred Ratings and Related Required Capabilities.*

RATED CONTROL VOLTAGES AND THEIR RANGES FOR CIRCUIT BREAKERS Solenoid-Operated Devices	
RATED VOLTAGE	**Closing Voltage Ranges for Power Supply**
125 DC	90 – 115 or 105 – 130
250 DC	180 – 230 or 210 – 260
230 AC	190 – 230 or 210 - 260

Notes:

(1) Electrically operated motors, contactors, solenoids, valves, and the like need not carry a nameplate voltage rating that corresponds to the control voltage rating shown in the table as long as these components perform the intended duty cycle (usually intermittent) in the voltage range specified.

(2) Relays, motors, or other auxiliary equipment that function as a part of the control for a device shall be subject to the voltage limits imposed by this standard, whether mounted at the device or at a remote location.

(3) Includes supply for pump or compressor motors. Note that rated voltages for motors and their operating ranges are covered by ANSI/NEA MG-1-1978.

(4) Includes heater circuits.

(5) Voltage ranges apply to all closing and auxiliary devices when cold. Breakers using standard auxiliary relays for control functions may not comply at lower extremes of voltage ranges when relay coils are hot, as after repeated or continuous operation.

(6) Direct current control voltage sources, such as those derived from rectified alternating current, may contain sufficient inherent ripple to modify the operation of control devices to the extent that they may not function over the entire specified voltage ranges.

(7) This table also applies for circuit breakers in gas-insulation substation installations.

(8) In cases where other operational ratings are a function of the specific control voltage applied, tests in C37.09 may refer to the "Rated Control Voltage." In these cases, tests shall be performed at the levels in this column.

(9) For an outdoor circuit breaker, the point of user connection to the circuit breaker is the secondary terminal block point at which the wires from the circuit breaker operating mechanism components are connected to the user's control circuit wiring.

(10) For an indoor circuit breaker, the point of user connection to the circuit breaker is either the secondary disconnecting contact (where the control power is connected from the stationary housing to the removable circuit breaker), or the terminal block point in the housing nearest to the secondary disconnecting contact.

(11) Some solenoid operating mechanisms are not capable of satisfactory performance over the range of voltage specified in the standard; moreover, two ranges of voltage may be required for such mechanisms to achieve an acceptable standard of performance.

(12) The preferred method of obtaining the double range of closing voltage is by use of tapped coils. Otherwise, it will be necessary to designate one of the two closing voltage ranges listed above as representing the condition existing at the device location due to battery or lead voltage drop or control power transformer regulation. Also, caution should be exercised to ensure that the maximum voltage of the range used is not exceeded.

END OF SECTION

SECTION 260923 - LIGHTING CONTROL DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. General use toggle switches.
2. Switchbox – mounted stand-along dimmers.
3. Indoor occupancy and vacancy sensors.
4. Switchbox-mounted occupancy sensors.
5. Emergency shunt relays.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings:

1. Show installation details for the following:

    a. Occupancy sensors.
    b. Vacancy sensors.

2. Interconnection diagrams showing field-installed wiring.
3. Include diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plan(s) and elevations, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Suspended ceiling components.
2. Structural members to which equipment will be attached.
3. Items penetrating finished ceiling, including the following:

    a. Luminaires.
    b. Air outlets and inlets.
    c. Speakers.
    d. Sprinklers.
    e. Access panels.

f. Control modules.

B. Field quality-control reports.

C. Sample Warranty: For manufacturer's warranties.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For each type of lighting control device to include in operation and maintenance manuals.

1.6 WARRANTY

A. Manufacturer's Warranty: Manufacturer and Installer agree to repair or replace lighting control devices that fail(s) in materials or workmanship within specified warranty period.

1. Warranty Period: Two year(s) from date of Substantial Completion.

1.7 COMMISSIONING

A. An independent third party Commissioning Agent will document completion of the building Lighting Control Systems. The Lighting Control System Subcontractors are members of the Commissioning Team and will facilitate completion of the Commissioning process. Refer to section 019113 Building Systems Commissioning for the project Commissioning requirements and roles and responsibilities of each member of the Commissioning Team.

PART 2 - PRODUCTS

2.1 GENERAL USE TOGGLE SWITCHES

A. Industrial Grade (1221 Style)
1. 20 Amp, 120/277 Volt, Toggle Single-Pole AC Quiet Switch, Extra Heavy Duty Spec Grade, Self Grounding, Back & Side Wired

B. Standards and Certifications
1. NEMA: WD-1 and WD-6
2. UL Fed Spec WS896E: File #E7458
3. UL Standard: UL 20
4. RoHS: Compliant
5. Warranty: 10 Year Limited

C. Electrical Specifications
1. Amperage: 20 Amp
2. Voltage: 120/277 VAC
3. Grounding: Self-Grounding
4. Dielectric Voltage: Withstands 1500V for 1 minute
5. Overload UL20 Test: 100 cycles of OL at 4.8 times rated current
6. Temperature Rise: Maximum 30 degrees C rise
7. Endurance: 50,000 cycles minimum

D. Material Specifications
   1. Strap Material: .048” Thick Galvanized Steel
   2. Base Material: Thermoplastic
   3. Toggle: Polycarbonate
   4. Cover Material: Thermoplastic
   5. Contact Material: Silver Alloy
   6. Terminal Screws: Brass 8-32
   7. Grounding Screw: Brass 8-32
   8. Ground Clips: Brass
   9. Color: Coordinate with Architect.

E. Mechanical Specifications
   1. Terminal ID: Brass-Hot Black-Hot White-Neutral Green-Gnd
   2. Terminal Accom: 14-#10 AWG back wired; #14-#12 AWG side wired
   3. Product ID: Ratings are permanently marked on device

F. Multiway Switches
   1. 3-Way: 1223 style
   2. 4-Way: 1224 style

2.2 SWITCHBOX-MOUNTED OCCUPANCY SENSORS

A. General Requirements for Sensors: Automatic-wall-switch occupancy sensor with manual on-off switch, suitable for mounting in a single gang switchbox, with provisions for connection to BAS using a separate dry contact hardwired connection.

   1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
   2. Occupancy Sensor Operation: Unless otherwise indicated, turn lights on when coverage area is occupied, and turn lights off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
   3. Operating Ambient Conditions: Dry interior conditions, 32 to 120 deg F (0 to 49 deg C).
   4. Switch Rating: Not less than 800-VA LED load at 120 V.

B. Wall-Switch Sensor:

   1. Standard Range: 180-degree field of view, field adjustable from 180 to 40 degrees; with a minimum coverage area of 900 sq. ft.
   2. Sensing Technology: Dual technology - PIR and ultrasonic.
   3. Switch Type: SP, field-selectable automatic "on," or manual "on," automatic "off."
   4. Capable of controlling load in three-way application.
   5. Voltage: 120 V.
   6. Ambient-Light Override: Concealed, field-adjustable, light-level sensor from 10 to 150 fc (108 to 1600 lux). The switch prevents the lights from turning on when the light level is higher than the set point of the sensor.
   7. Concealed, field-adjustable, "off" time-delay selector at up to 30 minutes.
   8. Color: Coordinate with Architect.
   9. Faceplate: Color matched to switch.

2.3 EMERGENCY RELAY

A. Description: NC, electrically held relay, arranged for wiring in parallel with manual or automatic switching contacts; complying with UL 924.

1. Coil Rating: 120 V.

2. Energize lighting indicated on any loss of utility power.

2.4 CONDUCTORS AND CABLES

A. Power Wiring to Supply Side of Remote-Control Power Sources: Not smaller than No. 12 AWG. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Classes 2 and 3 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 24 AWG. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

C. Class 1 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 18 AWG. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine lighting control devices before installation. Reject lighting control devices that are wet, moisture damaged, or mold damaged.

B. Examine walls and ceilings for suitable conditions where lighting control devices will be installed.

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

3.2 SENSOR INSTALLATION

A. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, smoke detectors, fire-suppression systems, and partition assemblies.

B. Install and aim sensors in locations to achieve not less than 90-percent coverage of areas indicated. Do not exceed coverage limits specified in manufacturer's written instructions.

3.3 DEVICE INSTALLATION

A. Install devices at heights scheduled, and as indicated on drawings. Centerline of switches is to be 48” AFF unless otherwise noted.

B. Install wall devices vertically on latch side of door within 6” of frame edge, unless otherwise noted.

C. Install switches with handle operating vertically, with “ON” position up.

D. Group adjacent switches under single, multigang wall plates.

E. Install ceiling devices as shown on drawings and as recommended by device manufacturer.

F. Ceiling mounted occupancy sensors shall be located minimum of 6 ft from supply air diffusers where possible.

G. Install devices plumb, level with finished surfaces and free from blemishes.

H. Verify device locations prior to rough in.

I. Control wiring shall be low voltage, Class II wiring, electrically isolated from power wiring by a Class II transformer.

J. Provide separate neutral conductor for each dimmer.

3.4 WIRING INSTALLATION

A. All wiring shall be installed in conduit. Low-voltage wiring shall not share a conduit with power wiring.
   1. Ceiling mounted sensors and other devices without means to mount on a standard electrical box or terminate conduit shall enter a conduit stubout within 18 inches of the device.
   2. Conduit stub-outs shall be provided with a plastic bushing.

B. Perform work in a neat and workmanlike manner in accordance with NECA 1 and, where applicable, NECA 130.

C. Wiring Method: Comply with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

D. Wiring within Enclosures: Separate power-limited and nonpower-limited conductors according to conductor manufacturer's written instructions.

E. Size conductors according to lighting control device manufacturer's written instructions unless otherwise indicated.

F. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

3.5 IDENTIFICATION

A. Identify components and power and control wiring according to Section 260553 "Electrical Systems Identification."

   1. Identify controlled circuits in lighting switchbox by means of permanent marker.
   2. Identify circuits or luminaires controlled by photoelectric and occupancy sensors at each sensor.
   3. Identify all junction boxes with circuits contained therein.
   4. Provide label to indicate panel and circuit number at bottom of cover plate.

3.6 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

B. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

1. Operational Test: After installing time switches and sensors, and after electrical circuitry has been energized, start units to confirm proper unit operation.
2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Lighting control devices will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.

3.7 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months from date of Substantial Completion, provide on-site assistance in adjusting lighting control devices to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

1. For occupancy and motion sensors, verify operation at outer limits of detector range. Set time delay to suit Owner's operations.

3.8 TRAINING

A. Train Owner's maintenance personnel to adjust, operate, and maintain lighting control devices.

3.9 COMMISSIONING

A. The 019113 Lighting Control System commissioning is separate from and in addition to any other required Lighting Control System testing, commissioning, demonstrations, and training required by this specification. Lighting Control System Subcontractors, Vendor Reps and Programmers will be required to make separate trips to complete the 019113 Lighting Control System Commissioning.

END OF SECTION

SECTION 260943 - NETWORK LIGHTING CONTROLS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Digital-network lighting control system and associated components:
   1. Network bridges.
   2. LED drivers.
   3. Power interfaces.
   4. Main units
   5. Lighting control modules
   6. Energy meter.
   7. Digital dimming ballast and switching modules
   8. BACnet controllers.
   9. Lighting management system software.
   10. Control stations.
   11. Low-voltage control interfaces.
   12. Wired sensors.
   13. Accessories.

1.02 RELATED REQUIREMENTS

A. Section 230901 Controls System Integration, for interface with lighting control system.
B. Section 260553 Identification products and requirements.
C. Section 260923 Lighting Control Devices
   1. Finish requirements for wall controls specified in this section.
   2. Accessory receptacles and wallplates, to match lighting controls specified in this section.
   3. Multizone wallbox dimmers.
D. Section 265113 Luminaires and associated components, for interface with lighting control system.
E. Division 27 for all Ethernet based communication infrastructure.
F. The Contractor shall familiarize himself with the published UK controls standards available at www.uky.edu/evpfa/facilities/CPMD and comply with requirements therein. All controls interfaces shall comply with Section 230900S03 “Instrumentation and Control for HVAC.” Where conflicts arise with any other contract requirement, the Contractor shall contact the Architect for resolution. The most restrictive requirement will apply.
G. System shall be an expansion of the existing UK RB#2 (BBSRB2) nLight system installed in Phase 1. All hardware and programming required to integrate the system shall be provided by the contractor. Contractor shall also reference other sections within this specification for work required to integrate the Level 1 Wet-Lab Fitup lighting controls with the medical center DDC.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate the placement of sensors and wall controls with millwork, furniture, equipment, etc. installed under other sections or by others.
   2. Coordinate the placement of wall controls with actual installed door swings.
   3. Coordinate the placement of daylight sensors with windows, skylights, and luminaires to achieve optimum operation. Coordinate placement with ductwork, piping, equipment, or other potential obstructions to light level measurement installed under other sections or by others.
   4. Where motorized window treatments are to be controlled by the lighting control system provided under this section, coordinate the work with other trades to provide compatible products.

5. Coordinate the work to provide luminaires and lamps compatible with the lighting controls to be installed.
6. Notify Architect of any conflicts or deviations from the contract documents to obtain direction prior to proceeding with work.

B. Preinstallation Meeting: Conduct on-site meeting with lighting control system manufacturer prior to commencing work as part of manufacturer's standard startup services. Manufacturer to review with installer:
1. Low voltage wiring requirements.
2. Separation of power and low voltage/data wiring.
3. Wire labeling.
4. BACnet controller locations and installation.
5. Sensor locations, in accordance with layout provided by lighting control manufacturer as part of sensor layout and tuning services specified in Part 2 under "DIGITAL-NETWORK LIGHTING CONTROL SYSTEM - GENERAL REQUIREMENTS". Lighting control manufacturer may direct Contractor regarding sensor relocation should conditions require a deviation from locations indicated.
6. Control locations.
7. Computer jack locations.
8. Load circuit wiring.
9. Network wiring requirements.
10. Connections to other equipment and other lighting equipment.
11. Installer responsibilities.
12. Power panel locations.

C. Sequencing:

1. Do not install sensors and wall controls until final surface finishes are complete.

1.04 SUBMITTALS

A. ACTION SUBMITTALS

1. Product Data: For each type of panelboard, switching and overcurrent protective device, transient voltage suppression device, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.

2. Shop Drawings: For each panelboard and related equipment.
   a. Include dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings.
   b. Detail enclosure types and details for types other than NEMA 250, Type 1.
   c. Detail bus configuration, current, and voltage ratings.
   d. Short-circuit current rating of panelboards and overcurrent protective devices.
   e. Include evidence of NRTL listing for series rating of installed devices.
   f. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
   g. Include wiring diagrams for power, signal, and control wiring.
   h. Include time-current coordination curves for each type and rating of overcurrent protective device included in panelboards. Submit on translucent log-log graft paper; include selectable ranges for each type of overcurrent protective device.

B. INFORMATIONAL SUBMITTALS

1. Field Quality-Control Reports:

   a. Test procedures used.
   b. Test results that comply with requirements.
   c. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

2. Panelboard Schedules: For installation in panelboards.

C. ACTION SUBMITTALS

1. Product Data: For each type of panel switching component, controller, software, suppression device, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.

2. Shop Drawings: For each panel and related equipment.

   a. Include dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings.
   b. Include evidence of NRTL listing for devices.
   c. Include wiring diagrams for power, signal, and control wiring.
   d. Include building specific layout plans showing all device locations, addressing and interconnecting wiring.

D. INFORMATIONAL SUBMITTALS

1. Field Quality-Control Reports:

   a. Test procedures used.
   b. Test results that comply with requirements.
   c. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

2. Schedules:

   a. All load schedules

   b. All device and controller addresses and locations.

E. CLOSEOUT SUBMITTALS

1. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01," include the following:

   a. Manufacturer's written instructions for testing and programming.
   b. Two copies of all programming on compact disk.

F. MAINTENANCE MATERIAL SUBMITTALS

1. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

   a. Keys: Two spares for each type of cabinet lock.
   b. Controls: One each of all electronic hardware such as cards, i/0 cards, etc.
   c. Devices: Five each of each type of switch, occupanccy sensor and 1 or 2 zone wall-box controller.

1.05 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.
B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.
C. Manufacturer Qualifications:
   1. Networked lighting system shall be manufactured by nLight.
   2. Native BACnet-based system. All building controllers, application controllers, and all input/output devices shall communicate using the protocols and network standards as defined by ANSI/ASHRAE Standard 135-2001, BACnet. This system shall communicate with the owner's existing BACnet head-end software using BACnet/IP at the tier 1 level. No gateways shall be used for communication to controllers installed under section. BACnet/MSTP or BACnet/IP shall be used for all other tiers of communication. Provide all necessary BACnet-based-compliant hardware and software to meet the system's functional specifications. Provide Protocol Implementation Conformance Statement (PICS) for Windows-based control software and every controller in system, including unitary controllers. These must be in compliance with Front End systems PICS and BIBBS and attached Tridium PICS and BIBBS. Provide all hardware and software to backup, restore, troubleshoot and install system.
D. Maintenance Contractor Qualifications: Manufacturer's authorized service representative.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Store products in a clean, dry space in original manufacturer's packaging in accordance with manufacturer's written instructions until ready for installation.

1.07 FIELD CONDITIONS

A. Maintain field conditions within manufacturer's required service conditions during and after installation.

   1. System Requirements, Unless Otherwise Indicated:
      a. Ambient Temperature:
         1) Lighting Control System Components, Except Those Listed Below: Between 32 and 104 degrees F (0 and 40 degrees C).
         2) Lighting Management System Computer: Between 50 and 90 degrees F (10 and 35 degrees C).
      b. Relative Humidity: Less than 90 percent, non-condensing.

1.08 WARRANTY

A. See Section 017800 - Closeout Submittals, for additional warranty requirements.
B. Manufacturer's Extended Warranty, With Manufacturer Start-Up:
   1. Lighting Control System Components

a. First Three Years:
   1) 100 percent replacement parts coverage, 100 percent manufacturer labor coverage to troubleshoot and diagnose a lighting issue.
   2) First-available on-site or remote response time.
b. First Ten Years:
   1) Telephone Technical Support: Available 24 hours per day, 7 days per week, excluding manufacturer holidays.

2. Ballasts and LED Drivers Modules: Five years 100 percent parts coverage, no manufacturer labor coverage.

1.09 COMMISSIONING

A. An independent third party Commissioning Agent will document completion of the building Lighting Control Systems. The Lighting Control System Subcontractors are members of the Commissioning Team and will facilitate completion of the Commissioning process. Refer to section 019113 Building Systems Commissioning for the project Commissioning requirements and roles and responsibilities of each member of the Commissioning Team.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Products by listed manufacturers are subject to compliance with specified requirements and prior approval of Engineer.
B. Substitutions:
   1. All proposed substitutions (clearly delineated as such) must be submitted in writing for approval by Architect a minimum of 10 working days prior to the bid date and must be made available to all bidders. Proposed substitutes must be accompanied by a review of the specification noting compliance on a line-by-line basis.
   2. By using pre-approved substitutions, Contractor accepts responsibility and associated costs for all required modifications to related equipment and wiring. Provide complete engineered shop drawings (including power wiring) with deviations from the original design highlighted in an alternate color for review and approval by Architect prior to rough-in.
C. Source Limitations: Furnish products produced by a single manufacturer and obtained from a single supplier.

2.02 DIGITAL-NETWORK LIGHTING CONTROL SYSTEM - GENERAL REQUIREMENTS

A. Include additional costs for manufacturer's sensor layout and tuning services
   .
   1. Lighting control manufacturer to design occupancy/vacancy and/or daylight sensor layout (wired) that provides adequate coverage and performs according to required sequence of operations.
   2. Lighting control manufacturer to visit site for pre-installation meeting and system startup; lighting control manufacturer may direct Contractor regarding sensor relocation should conditions require a deviation from locations indicated.
   3. Any additional sensors or hardware required to meet sequence of operations to be furnished by lighting control manufacturer at no additional cost.
   4. Lighting control manufacturer to provide up to two additional post-startup on-site service visits for fine-tuning of sensor calibration.

B. Provide products listed, classified, and labeled by Underwriter's Laboratories Inc. (UL); testing firm acceptable to authority having jurisdiction as suitable for the purpose indicated.

C. Unless specifically indicated to be excluded, provide all required equipment, conduit, boxes, wiring, connectors, hardware, supports, accessories, software, system programming, etc. as necessary for a complete operating system that provides the control intent indicated.
D. Shade Control Requirements:
   1. Capable of operating shades independently, without use of external group controllers.
   2. Capable of controlling shade speed for tracking within plus or minus 0.125 inch (3.17 mm) throughout entire travel.
   3. Provide 10 year power failure memory for preset stops, open and close limits, shade grouping and sub grouping and system configuration.
   4. Capable of synchronizing multiple shade electronic drive units of the same size to start, stop and move in unison.
   5. Capable of controlling any shade electronic drive unit via keypads and contact closure inputs without separate group controller.
   6. Capable of operating any group or sub group of shade electronic drive units within subsystem via keypads and interfaces.
   7. Capable of one-touch control of shades via keypad, lighting control, or handheld remote.
   8. Capable of stopping shades within accuracy of 0.125 inch (3.17 mm) at any point between open and close limits.
   9. Capable of storing up to 250 programmable stop points, including open, close, and any other position.
   10. Capable of recalling presets via keypad, contact closure input, infrared receiver, lighting management system software, or other lighting control system interface.
   11. Capable of controlling lights and shades from single wall control button.
E. Design lighting control equipment for 10 year operational life while operating continually at any temperature in an ambient temperature range of 32 degrees F (0 degrees C) to 104 degrees F (40 degrees C) and 90 percent non-condensing relative humidity.
F. Electrostatic Discharge Tolerance: Design and test equipment to withstand electrostatic discharges without impairment when tested according to IEC 61000-4-2.
G. Dimming and Switching (Relay) Equipment:
   1. Designed so that electrolytic capacitors operate at least 36 degrees F (20 degrees C) below the capacitor's maximum temperature rating when the device is under fully loaded conditions at maximum rated temperature.
   2. Inrush Tolerance:
      a. Utilize load-handling thyristors (SCRs and triacs), field effect transistors (FETs) and isolated gate bipolar transistors (IGBTs) with maximum current rating at least two times the rated operating current of the dimmer/relay.
      b. Capable of withstanding repetitive inrush current of 50 times the operating current without impacting lifetime of the dimmer/relay.
   3. Surge Tolerance:
      a. Panels: Designed and tested to withstand surges of 6,000 V, 3,000 amps according to IEEE C62.41.2 and IEC 61000-4-5 without impairment to performance.
      b. Other Power Handling Devices: Designed and tested to withstand surges of 6,000 V, 200 amps according to IEEE C62.41.2 without impairment to performance.
   4. Power Failure Recovery: When power is interrupted and subsequently restored, within 3 seconds lights to automatically return to same levels (dimmed setting, full on, or full off) as prior to power interruption.
   5. Dimming Requirements:
      a. Line Noise Tolerance: Provide real-time cycle-by-cycle compensation for incoming line voltage variations including changes in RMS voltage (plus or minus 2 percent change in RMS voltage per cycle), frequency shifts (plus or minus 2 Hz change in frequency per second), dynamic harmonics, and line noise.
         1) Systems not providing integral cycle-by-cycle compensation to include external power conditioning equipment as part of dimming system.
      b. Incorporate electronic "soft-start" default at initial turn-on that smoothly ramps lights up to the appropriate levels within 0.5 seconds.

c. Utilize air gap off to disconnect the load from line supply.
d. Control all light sources in smooth and continuous manner. Dimmers with visible steps are not acceptable.
e. Load Types:
1) Assign a load type to each dimmer that will provide a proper dimming curve for the specific light source to be controlled.
2) Provide capability of being field-configured to have load types assigned per circuit.
f. Minimum and Maximum Light Levels: User adjustable on a circuit-by-circuit basis.
g. Low Voltage Dimming Modules:
1) Coordination Between Low Voltage Dimming Module and Line Voltage Relay: Capable of being electronically linked to a single zone.
2) Single low voltage dimming module; capable of controlling the following light sources:
(a) 0-10V analog voltage signal.
(1) Provide Class 2 isolated 0-10V output signal conforming to IEC 60929.
(2) Sink current according to IEC 60929.
(3) Source current.
(b) 10-0V reverse analog voltage signal.
(c) DSI digital communication.
(d) DALI broadcast communication per IEC 60929:
(1) Logarithmic intensity values complying with IEC 60929.
(2) Linear intensity values for use with LED color intensity control.
(e) PWM per IEC 60929.

6. Switching Requirements:
a. Rated Life of Relays: Minimum of 1,000,000 cycles at fully rated current for all lighting loads.
b. Switch load in a manner that prevents arcing at mechanical contacts when power is applied to and removed from load circuits.
c. Provide output fully rated for continuous duty for inductive, capacitive, and resistive loads.

H. Device Finishes:
1. Wall Controls: <<Match finishes specified for wiring devices in Section 260923, unless otherwise indicated.
2. Color Variation in Same Product Family: Maximum delta E of 1, CIE L*a*b color units.
3. Visible Parts: Exhibit ultraviolet color stability when tested with multiple actinic light sources as defined in ASTM D4674. Provide proof of testing upon request.

I. Interface with Tridium Extended Architecture building automation system
1. The controls, graphics and all listed I/O points from this project shall communicate with the owners existing BACnet software head-end station using BACnet/IP over the campus Ethernet system. See attachment for minimum BACnet Points Lists.
2. Provide all necessary BACnet-based-compliant hardware, software (**including the latest version and shall include 2 software licenses of any required proprietary software**), and all required cables to meet the system's functional specifications. Provide Protocol Implementation Conformance Statement (PICS) for Window-based control software and every controller in system, including unitary controllers. These must be in compliance with Front End systems PICS and BIBBS and attached Tridium PICS and BIBBS. Provide all hardware and software to backup, restore, troubleshoot and install system.

The controls, graphics and all listed I/O points from this project shall communicate with the owner's existing BACnet software head-end station using BACnet/IP. All BACnet points shall be exposed to the owner's head-in station. See attachment for minimum "BACnet" points list. Graphics will be installed by owner on the head-end system. All pint and device names shall comply with the Medical Center standards and shall be approved before and included in the shop drawings submittal. Cooperate with the graphics provider to ensure that all specified points and alarms communicate and operate on the head-end system. All point and device names shall comply with the Medical Center standards (format listed below, consult PPDMC for the correct abbreviations) and shall be included in the shop drawings submittal for review

and approval. Point naming conventions and formats are listed further in this specification in the Direct Digital Controls Equipment section.

3. The control and monitoring system for this project shall be made up using standard materials, equipment and components regularly manufactured for systems of this type. The system shall be complete in every respect and shall be a functioning system.
4. Manufacturer: System shall be as described in Paragraph 1.05.C.1 and 1.05.C.2.
   a. Installing Contractor: Install controls contractors must comply with the following requirements:
      1) The Installing Contractor has been in the business of installed networked lighting controls for the last five (5) years minimum. In addition, the installed contractor needs to demonstrate with documentation that they have provide controls in a minimum of three (3) university projects of similar size and scope where they successfully integrated with a native BACnet system.
      2) The contractor shall procure factory startup sequence and network integration service. Factory staff shall have a minimum of 5 years of related installation experience and BACnet integration experience.
      3) Have experience with successful integrations of controls with Niagara Tridium systems.
      4) Contractor to have a minimum of 3 years of installation history with the brand of controls being bid.
      5) Must have a help desk operation or staff available for phone contact 24/7 for providing technical support to university staff. Call forward and emergency service numbers are not acceptable during normal business hours.
      6) Service technicians shall be stations regionally. Response time shall be guaranteed to be under 8 hours.

J. The building controller shall comply with Annex J of the BACnet specification for IP connections. This device shall use Ethernet to connect to the IP internet work. It must support interoperability on the campus area network and function as a BACnet Broadcast Management Device (BBMD) if required based on subnet. Vendor must work with PPDMC controls to obtain BACnet Instance Number. All BACnet/MSTP instance number shall be unique on the UK PPDMC Tridium Network.

2.03 POWER INTERFACES

A. Provide power interfaces as indicated or as required to control the loads as indicated.
B. General Requirements:
   1. Phase independent of control input.
   2. Rated for use in air-handling spaces as defined in UL 2043.
   3. Utilize air gap off to disconnect the load from line supply.
   4. Diagnostics and Service: Replacing power interface does not require re-programming of system or processor.
C. Product(s):
   1. Phase-Adaptive Power Module: Provides interface for phase control input to provide full 16 A circuit output of forward/reverse phase control for compatible loads.
   2. 3-Wire Fluorescent Power Module: Provides interface for phase control input to provide full 16 A circuit output for compatible line-voltage control fluorescent electronic dimming ballasts.
   3. Switching Power Module: Provides interface for phase control input to provide full 16 A circuit output of switching for compatible non-dim loads.
   4. Phase-Adaptive Power Module with 3-Wire Fluorescent Input: Provides interface for fluorescent ballast control input to provide full 16 A circuit output for compatible loads.
   5. Ten Volt Interface: Provides interface for phase control input to provide full 16 A circuit output of switching and 0-10 V low voltage control for compatible fluorescent electronic dimming ballasts.

6. Hi-Power Dimming Modules: Provides interface for phase control input to provide full 16 A circuit output of switching and forward phase control for compatible loads.

2.04 MAIN UNITS

A. Product: nLight, Wattstopper DLM or approved equal.
B. Provide main units with configuration and quantity of zones as indicated or as required to control the loads as indicated.
C. Connects to lighting control bridges via ethernet cabling.
D. Engrave units with button, zone, and scene descriptions
E. Preset Lighting Control with Zone Override:
   1. Intensity for each zone indicated by means of one illuminated bar graph per zone.
   2. User-programmable zone and scene names.
   3. Utilize air gap off to disconnect the load from line supply.
   4. Astronomical time clock and programmer interface provides access to:
      a. Scene selections.
      b. Fade zone to a level.
      c. Fine-tuning of preset levels with scene raise/lower.
      d. Lock out scenes and zones.
      e. Fine-tuning of light levels with individual zone raise/lower.
      f. Terminal block for wired infrared signal input.
      g. Enable/disable wall station.
   5. Light intensity with real time energy savings by digital display.
   6. Fade time indicated by digital display for current scene while fading.
   7. Integral wide angle infrared receiver.
   8. For temporary local overrides, individual raise/lower buttons to allow zones to be adjusted without altering scene values stored in memory.
   9. Direct Low-Voltage Control of Digital Ballasts and LED drivers (120V, 220/240V, 277V and/or 347V Lighting):
      a. Electronically link a digital fluorescent lighting ballast to a zone for both dimming and turning on/off.
      b. Electronically assign daylight sensors to digital ballasts and line voltage dimmers for proportional daylight harvesting.
      c. Single integral controller with Class 1 or Class 2 isolated digital output signal conforming to IEC 60929; capable of direct control without interface.
   10. Creates daylighting rows independent of control zones.
   11. Capable of re-zoning without re-wiring using programming display on unit.
   12. Zone raise/lower buttons capable of controlling local lighting loads connected to the main unit or remote lighting zones in the system
F. Preset Shade Control with Zone Override:
   1. Preset expandable shade control: Provide up to three columns of shade control.
   2. For temporary local overrides, individual raise/lower buttons to allow zones to be adjusted without altering scene values stored in memory.
G. Provides one direct-wired occupancy sensor connection without interface or powerpack.

2.05 LIGHTING CONTROL MODULES

A. Provide lighting control modules as indicated or as required to control the loads as indicated.
B. General Requirements:
   1. Listed to UL 508 as industrial control equipment.
   2. Delivered and installed as a listed factory-assembled panel.
   3. Passively cooled via free-convection, unaided by fans or other means.
   4. Mounting: Surface.
   5. Connection without interface to wired:
      a. Occupancy sensors.

b. Daylight sensors.
c. IR receivers for personal control.

6. Connects to lighting control bridges via ethernet cabling.
7. LED status indicators confirm communication with occupancy sensors, daylight sensors, and IR receivers.
8. Contact Closure Input:
   a. Directly accept contact closure input from a dry contact closure or sold-state output without interface to:
      1) Activate scenes.
         (a) Scene activation from momentary or maintained closure.
      2) Enable or disable after hours.
         (a) Automatic sweep to user-specified level after user-specified time has elapsed.
         (b) System will provide occupants a visual warning prior to sweeping lights to user-specified level.
         (c) Occupant can reset timeout by interacting with the lighting system.
      3) Activate or deactivate demand response (load shed).
         (a) Load shed event will reduce lighting load by user-specified amount.
9. Emergency Contact Closure Input:
   a. Turn all zones to full output during emergency state via direct contact closure input from UL 924 listed emergency lighting interface, security system or fire alarm system.
   b. Allow configurable zone response during emergency state.
   c. Disable control operation until emergency signal is cleared.
10. Supplies power for control link for keypads and control interfaces.
11. Distributes sensor data among multiple lighting control modules.

C. Switching Lighting Control Modules:
   1. Switching:
      a. Rated Life of Relay: Minimum of 1,000,000 cycles at fully rated current for all lighting loads.
      b. Load switched in manner that prevents arcing at mechanical contacts when power is applied to and removed from load circuits.
      c. Fully rated output continuous duty for inductive, capacitive, and resistive loads.
      d. Module to integrate up to four individually controlled zones, each with a capacity of up to 16 amps of high in-rush lighting load (magnetic fluorescent ballast, electronic fluorescent ballast, incandescent, magnetic low-voltage, electronic low-voltage, neon/cold cathode and motor loads).
      e. Utilize air gap off, activated when user selects "off" at any control to disconnect the load from line supply.

D. 0-10V Lighting Control Modules:
   1. Coordination Between Low Voltage Dimming Module and Line Voltage Relay: Capable of being electronically linked to single zone.
   2. Single low voltage dimming module; capable of controlling following light sources:
      a. 0-10V analog voltage signal.
         1) Provide Class 2 isolated 0-10V output signal conforming to IEC 60929.
         2) Sink current per IEC 60929.
      b. 10V-0V analog voltage signal.
         1) Provide Class 2 isolated 0-10V output signal conforming to IEC 60929.
         2) Sink current per IEC 60929.
   3. Switching:
      a. Rated Life of Relay: Minimum of 1,000,000 cycles at fully rated current for all lighting loads.
      b. Load switched in manner that prevents arcing at mechanical contacts when power is applied to and removed from load circuits.
      c. Fully rated output continuous duty for inductive, capacitive, and resistive loads.
      d. Module to integrate up to four individually controlled zones, each with a capacity of up to 16 amps of high in-rush lighting load (magnetic fluorescent ballast, electronic fluorescent

ballast, incandescent, magnetic low-voltage, electronic low-voltage, neon/cold cathode and motor loads).

e. Utilize air gap off, activated when user selects "off" at any control to disconnect the load from line supply.

E. Digital Fixture Lighting Control Modules:
1. Provide smart diagnostics for system verification.
2. Provide testing capability using manual override buttons.
3. Each low-voltage digital communication link to support up to 64 ballasts or LED drivers capable of NFPA 70 Class 1 or Class 2 installation.

F. Total Light Management Control Module (Digital Lighting and Shades Control):
1. Ten fused 30W (60W peak) 24V DC outputs provide power to compatible shades, drapery drive units, keypads, and accessories.
2. Provide power for 10 to 30 shades dependent on shade dimensions.
3. Provide smart diagnostics for system verification.
4. Provide testing capability using manual override buttons.
5. Each low-voltage digital communication link to support up to 64 ballasts capable of NFPA 70 Class 1 or Class 2 installation.

2.06 DIGITAL DIMMING BALLAST AND SWITCHING MODULES

A. Provide digital dimming ballast and switching modules as indicated or as required to control the loads as indicated.

B. General Requirements:
1. Provide continuous 3-wire signal dimming to compatible 3-wire electronic dimming ballasts.
2. Utilize air gap off to disconnect the load from line supply.
3. Connect without interface to:
a. Occupancy sensor.
b. Daylight sensor.
c. Personal control input (wall station or infrared receiver).
4. Generate digital communication commands to distribute ballast and sensor data on the digital bus.
5. If power is interrupted and subsequently restored, lights automatically return to the setting prior to power interruption.
6. Each ballast module responds independently to:
a. Up to 32 occupancy sensors.
b. Up to 64 personal control inputs.
c. Two daylight sensors.
7. Unique internal reference number visible displayed on module cover.
8. Averages two independent daylight harvesting inputs internally.
9. Responds to digital load shed command.
a. Sets high end trim.
b. Automatically scales light output proportional to load shed command. (Example: If light output is at 30 percent and a load shed command of 10 percent is received, the ballast to automatically set the maximum light output at 90 percent and lower current light output by 3 percent to 27 percent).
10. Provide integral fault protection to prevent ballast module failure in the event of a mis-wire.

C. Product(s):
1. 3-Wire Ballast Module, 2 Amp
a. Integrates up to 2 amps of 3-wire electronic dimming ballasts into digital control system as a single zone.

D. 3-Wire Ballast Module, 16 Amp:
a. Integrates up to 16 amps of 3-wire electronic dimming ballasts into digital control system as a single zone.
b. Integrates up to 16 amps of switched high intensity discharge (HID) lighting load into digital control system as a single zone.

E. Switching Power Module, 16 Amp:
    a. Integrates up to 16 amps of high in-rush lighting load (magnetic fluorescent ballast, electronic fluorescent ballast, HID, incandescent, magnetic low-voltage, electronic low-voltage, neon/cold cathode and motor loads) into digital control system as a single zone.

2.07 LIGHTING GATEWAYS

A. Provided in a pre-assembled NEMA listed enclosure with terminal blocks listed for field wiring.
B. Connects to controls and power panels via RS485.
C. Enables light management software to control and monitor compatible dimming ballasts and ballast modules, power panels, power modules, and window treatments.
    1. Utilizes Ethernet connectivity to light management computer utilizing one of the following methods:
        a. Dedicated network.
        b. Dedicated VLAN.
        c. Shared network with Building Management System (BMS).
        d. Corporate network where managed switches are configured to allow multicasting and use of IGMP.
D. Integrates control station devices, power panels, shades, preset lighting controls, and external inputs into a single customizable lighting control system with:
    1. Multiple Failsafe Mechanisms:
        a. Power failure detection via emergency lighting interface.
        b. Protection: Lights go to full on if ballast wires are shorted.
        c. Distributed architecture provides fault containment. Single bridge failure or loss of power does not compromise lights and shades connected to other lighting control bridges.
    2. Manual overrides.
    3. Automatic control.
    4. Central computer control and monitoring.
    5. Integration with the UK med center Tridium BMS via BACnet.
    6. Provide ability to send custom output strings over Ethernet.
E. Furnished with astronomical time clock.
F. Furnished with solar clock to track the position of the sun to control the shades to limit penetration of direct sunlight.
G. Maintains a backup of the programming in a non-volatile memory capable of lasting more than ten years without power.
H. BACnet Integration:
    1. Provide ability and system setup to communicate by means of native BACnet IP communication (does not require interface) to lighting control system from a user-supplied 10BASE-T or 100BASE-T Ethernet network.
    2. Requires only one network connection per system.
    3. Lighting control system to be BACnet Test Laboratory (BTL) listed.
    4. All devices shall follow the UK PPDMC naming convention. Refer to the Section 230901, Control System Integration for requirements.
    5. Basic BACnet integration:
        a. The BACnet integrator can command:
            1) Area light output.
            2) Area enable or disable after hours mode.
            3) Area load shed level.
            4) Area load shed enable/disable.
            5) Area shade group presets and levels
            6) Enable/Disable:
                (a) Automated solar adaptive shade control.
                (b) Cloudy day/Shadow override mode for automated shade control.
                (c) Brightness override mode for automated shade control
                (d) Area occupancy sensors.

(e) Area Daylighting
7) Daylighting level.
8) Area occupied and unoccupied level
9) Occupancy sensor timeouts.

b. The BACnet integrator can monitor:
1) Area on/off status.
2) Area occupancy status.
3) Area fault.
(a) Lamp failures.
(b) Control devices not responding.
4) Area load shed status.
5) Area instantaneous power usage and maximum potential power usage.
6) Area shade group presets and levels
7) Cloudy day and shadow sensor status.
8) Light levels from window mounted sensors
9) Enable/Disable:
(a) Status of Automated solar adaptive shade control.
(b) Status of cloudy/shadow override for automated shade control
(c) Status of brightness override for automated shade control
(d) Area occupancy sensors.
(e) Daylighting.
10) Daylighting level.
11) Light level from photo sensors and window sensors
12) Area occupied and unoccupied level.
13) Occupancy sensor timeouts.

c. Shade assignment and grouping to be discoverable with third party building management software.

2.08 LIGHTING MANAGEMENT SYSTEM COMPUTERS

A. System shall function without a stand alone server or pc-based software. The building automation system shall manage all timed events via BACNet interface.

2.09 CONTROL STATIONS

A. Provide control stations with configuration as indicated or as required to control the loads as indicated.
B. Wired Control Stations:
1. General Requirements:
a. Class 2 (low voltage).
b. UL listed.
c. Control stations can be replaced without reprogramming.
2. Product(s):
a. Multi-Scene Wired Control:
1) Allows control of any devices part of the lighting control system.
2) Utilize RS485 wiring for low-voltage communication.
3) Functionality:
(a) Upon button press, LEDs to immediately illuminate.
(b) LEDs to reflect the true system status. LEDs to remain illuminated if the button press was properly processed or LEDs to turn off if the button press was not processed.
(c) Allows for easy reprogramming without replacing unit.
(d) Replacement of units does not require reprogramming.
4) Provide faceplates with concealed mounting hardware.

5) Engrave wall stations with button, zone, and scene descriptions to be selected by Architect and owner.
6) Silk-screened borders, logos, and graduations to use graphic process that chemically bonds graphics to faceplate, resistant to removal by scratching and cleaning.
7) Software Configuration:
   (a) Customizable control station device button functionality:
      (1) Buttons can be programmed to perform single defined action.
      (2) Buttons can be programmed to perform defined action on press and defined action on release.
      (3) Buttons can be programmed using conditional logic off of a state variable such as time of day or partition status.
8) Control station device LEDs to support logic that defines when it is illuminated:
   (a) Scene logic (logic is true when all zones are at defined levels).
   (b) Room logic (logic is true when at least one zone is on).
   (c) Pathway (logic is true when at least one zone is on).
   (d) Last scene (logic is true when spaces are in defined scenes).
9) Contact Closure Interface: Accepts both momentary and maintained contact closures.

b. Single-Scene or Zoned Wired Control:
   1) Turn an individual fixture or group of fixtures on and off.
   2) Raise and lower light levels.
   3) Recall favorite light levels.

c. Four-Button Preset Wallstation:
   1) Recall four scenes plus all on or all off for one group of fixtures.
   2) Master raise/lower control for entire group of fixtures.
   3) Integral IR receiver for personal control.
   4) Immediate local LED response upon button activation to indicate that a system command has been requested.

d. Wired Keyswitch:
   1) Configuration:
      (a) Three position, momentary, center position key removal
   2) Allows control of any devices part of the lighting control system.
   3) Utilize RS485 wiring for low-voltage communication.
   4) Functionality:
      (a) Allows for easy reprogramming without replacing unit.
      (b) Requires key insertion to activate actions.
   5) Provide faceplates with concealed mounting hardware.
   6) Engrave wall stations with button, zone, and scene descriptions
   7) Silk-screened borders, logos, and graduations to use graphic process that chemically bonds graphics to faceplate, resistant to removal by scratching and cleaning.
   8) Software Configuration:
      (a) Customizable control station device button functionality:
         (1) Key positions can be programmed to perform single defined action.
         (2) Key positions can be programmed using conditional logic off of a state variable such as time of day or partition status.

e. Slider Control:
   1) Allows control of any lighting zone in the system via intuitive analog slider control
   2) Utilize RS485 wiring for low-voltage communication.
   3) Available in 1-16 zone configurations
   4) Available with or without a take switch to activate the slider scene
   5) Optional keypad gangning
   6) Slider zones can be chained in partitioned spaces
   7) Provide faceplates with concealed mounting hardware.
   8) Customizable engraving of faceplate to be selected by Architect and owner.

2.10 LOW-VOLTAGE CONTROL INTERFACES

A. Provide low-voltage control interfaces as indicated or as required to control the loads as indicated.
B. Connects to lighting control bridges via ethernet cabling.
C. UL listed.
D. Contact Closure Interface:
    1. The contact closure input device to accept both momentary and maintained contact closures.
    2. The contact closure output device can be configured for maintained or pulsed outputs.
    3. Contact closure can be programmed using conditional logic off of a state variable such as time of day or partition status.
E. Wallbox Input Closure Interface:
    1. Mounts in wallbox behind contact closure keypad to provide interface for up to eight contact closure inputs.
    2. The contact closure input device to accept both momentary and maintained contact closures.
F. RS232 and Ethernet Interface:
    1. Provide ability to communicate via Ethernet or RS232 to audiovisual equipment, touchscreens, etc.
    2. Provide control of:
        a. Light scene selections.
        b. Fine-tuning of light scene levels with raise/lower.
        c. Shade group presets.
        d. Fine-tuning of shade preset levels with raise/lower.
        e. Simulate system wall station button presses and releases.
    3. Provide status monitoring of:
        a. Light scene status.
        b. Shade group status.
        c. Wall station button presses and releases.
        d. Wall station LEDs.
G. DMX Interface:
    1. Provide ability to:
        a. Map a single zone intensity to a single DMX512 lighting channel.
        b. Map a single zone intensity to three DMX512 channels for RGB/CMY color control.
        c. Map a single zone intensity to a single DMX512 integration channel.
        d. Smoothly transition from one color to another in a cross fade.
        e. Automatically sequence through a variety of colors.
        f. Download, program, and customize a color wheel for each unit.
H. Sensor Modules:
    1. Products:
        a. Sensor module with wired inputs only
    2. Wired Modules:
        a. Provide wired inputs for:
            1) Occupancy sensors.
            2) Daylight sensors.
            3) IR receivers for personal control.
            4) Digital ballast wall stations.

2.11 WIRED SENSORS

A. Wired Occupancy Sensors:
    1. General Requirements:
        a. Connects directly to compatible ballasts and modules without the need of a power pack or other interface.
        b. Turns off or reduces lighting automatically after reasonable time delay when a room or area is vacated by the last person to occupy the space.

c. Accommodates all conditions of space utilization and all irregular work hours and habits.
d. Comply with UL 94.
e. Self-Adaptive: Continually adjusts sensitivity and timing to ensure optimal lighting control for any use of the space.
f. Furnished with field-adjustable controls for time delay and sensitivity to override any adaptive features.
g. Provide capability to:
    1) Add additional timeout system-wide without need to make local adjustment on sensor.
    2) Group multiple sensors.
h. Power Failure Memory: Settings and learned parameters to be saved in non-volatile memory and not lost should power be interrupted and subsequently restored.
i. Furnished with all necessary mounting hardware and instructions.
j. Class 2 devices.
k. Ceiling-Mounted Sensors: Indicate viewing directions on mounting bracket.
l. Wall-Mounted Sensors: Provide swivel-mount base.
m. Color: White.

2. Wired Passive Infrared Sensors:
    a. Utilize multiple segmented lens, with internal grooves to eliminate dust and residue build-up.
    b. Ceiling-Mounted Sensors: Provide customizable mask to block off unwanted viewing areas.
    c. Product(s):
        1) Ceiling-Mounted Passive Infrared Sensor, 450 square feet (42 sq m): Coverage of 450 square feet (42 sq m) with ceiling height of 8 to 12 feet (2.4 to 3.7 m); 360 degree field of view.
        2) Ceiling-Mounted Passive Infrared Sensor, 1500 square feet (140 sq m): Coverage of 1500 square feet (140 sq m) with ceiling height of 8 to 12 feet (2.4 to 3.7 m); 360 degree field of view.
        3) Wall-Mounted Passive Infrared Sensor: Coverage of 1600 square feet (149 sq m) with ceiling height of 8 to 12 feet (2.4 to 3.7 m); 110 degree field of view.
3. Wired Ultrasonic Sensors:
    a. Utilize an operating frequency of 32kHz or 40kHz, crystal-controlled to operate within plus/minus 0.005 percent tolerance.
    b. Product(s):
        1) Ceiling-Mounted Ultrasonic Sensor, 500 square feet (46 sq m): Coverage of 500 square feet (46 sq m) with ceiling height of 8 to 12 feet (2.6 to 3.7 m); 180 degree field of view.
        2) Ceiling-Mounted Ultrasonic Sensor, 1000 square feet (93 sq m): Coverage of 1,000 square feet (93 sq m) with ceiling height of 8 to 12 feet (2.6 to 3.7 m); 180 degree field of view.
        3) Ceiling-Mounted Ultrasonic Sensor, 2000 square feet (186 sq m): Coverage of 2000 square feet (186 sq m) with ceiling height of 8 to 12 feet (2.6 to 3.7 m); 360 degree field of view.
4. Wired Dual Technology Sensors:
    a. Passive Infrared: Utilize multiple segmented lens, with internal grooves to eliminate dust and residue build-up.
    b. Ultrasonic: Utilize an operating frequency of 32kHz or 40kHz, crystal-controlled to operate within plus/minus 0.005 percent tolerance.
    c. Ceiling-Mounted Sensors: Provide customizable mask to block off unwanted viewing areas.
    d. Isolated Relay: Provide an internal additional isolated relay with Normally Open, Normally Closed, and Common outputs for use with HVAC control, Data Logging and other control options where indicated.

e. Integral Photocell: Provide an integral photocell with adjustable sensitivity to prevent lights from turning on when there is sufficient natural light where indicated.
f. Product(s), Without Isolated Relay and Integral Photocell:
   1) Ceiling-Mounted Dual Technology Sensor, 500 square feet (46 sq m): Coverage of 500 square feet (46 sq m) with ceiling height of 8 to 12 feet (2.6 to 3.7 m); 180 degree field of view.
   2) Ceiling-Mounted Dual Technology Sensor, 1000 square feet (93 sq m): Coverage of 1000 square feet (93 sq m) with ceiling height of 8 to 12 feet (2.6 to 3.7 m); 180 degree field of view.
   3) Ceiling-Mounted Dual Technology Sensor, 2000 square feet (186 sq m): Coverage of 2000 square feet (186 sq m) with ceiling height of 8 to 12 feet (2.6 to 3.7 m); 360 degree field of view.
   4) Wall-Mounted Dual Technology Sensor: Coverage of 1600 square feet (149 sq m) with ceiling height of 8 to 12 feet (2.4 to 3.7 m); 110 degree field of view.
g. Product(s), With Isolated Relay and Integral Photocell:
   1) Ceiling-Mounted Dual Technology Sensor, 500 square feet (46 sq m): Coverage of 500 square feet (46 sq m) with ceiling height of 8 to 12 feet (2.6 to 3.7 m); 180 degree field of view; with isolated relay and integral photocell.
   2) Ceiling-Mounted Dual Technology Sensor, 1000 square feet (93 sq m): Coverage of 1000 square feet (93 sq m) with ceiling height of 8 to 12 feet (2.6 to 3.7 m); 180 degree field of view; with isolated relay and integral photocell.
   3) Ceiling-Mounted Dual Technology Sensor, 2000 square feet (186 sq m): Coverage of 2000 square feet (186 sq m) with ceiling height of 8 to 12 feet (2.6 to 3.7 m); 360 degree field of view; with isolated relay and integral photocell.
   4) Wall-Mounted Dual Technology Sensor: Coverage of 1600 square feet (149 sq m) with ceiling height of 8 to 12 feet (2.4 to 3.7 m); 110 degree field of view; with isolated relay and integral photocell.

B. Sensor Power Packs:
   1. Provide sensor power packs where required for power connection to sensors.
   2. For ease of mounting, installation and future service, power pack(s) to be able to mount through a 1/2 inch knockout in a standard electrical enclosure and be an integrated, self-contained unit consisting internally of an isolated load switching control relay and a transformer to provide low-voltage power. Transformer to provide power to a minimum of three sensors.
   3. Plenum-rated.
   4. Control Wiring Between Sensors and Control Units: Class 2, 18-24 AWG, stranded UL Classified, PVC insulated or TEFLON jacketed cable suitable for use in plenums, where applicable.
C. Wired Daylight Sensors:
   1. Digital Interior Daylight Sensor:
      a. Use Class 2 wiring for low voltage communication.
      b. Can be replaced without reprogramming.
      c. Open-loop basis for daylight sensor control scheme.
      d. Stable output over temperature from 32 degrees F (0 degrees C) to 104 degrees F (40 degrees C).
      e. Partially shielded for accurate detection of available daylight to prevent fixture lighting and horizontal light component from skewing sensor detection.
      f. Provide linear response from 0 to 500 footcandles.
      g. Integral IR receiver for personal control.
      h. Mountable on lighting fixtures or recessed acoustical ceiling tiles.
      i. Constructed via sonic welding.
      j. Color: White.
   2. Daylight Control Package:
      a. Controller:
         1) Automatically switches a dry contact according to changes in ambient light levels.

2) Fully adjustable separate high and low setpoints, with an adjustable dead band between set points to prevent unwanted cycling.
3) Input time delay to prevent unwanted cycling due to intermittent light level fluctuations.
4) Signal/setpoint and relay status indication.
5) Sensor calibration input.

b. Sensors:
1) Class 2, three-wire analog devices.
2) Provision for zero or offset based signal.
3) Indoor Photo Sensors: With fresnel lens and 60 degree cone of response; sensor range of 0 to 750 footcandles.
4) Outdoor Photo Sensors: Weatherproof, with hood over aperture to shield sensor from direct sunlight; sensor range of 0 to 750 footcandles.
5) Atrium Photo Sensors: With translucent dome and 180 degree field of view; sensor range of 2 to 2,500 footcandles.
6) Skylight Photo Sensors: With translucent dome and 180 degree field of view; sensor range of 10 to 7,500 footcandles.

D. Infrared Partition Sensors:
1. Provide contact closure based on status of the partition wall (open/close) enabling automatic linking of controls.

2.12 ACCESSORIES

A. Emergency Lighting Interface:
1. Provides total system listing to UL 924 when used with lighting control system.
2. Senses all three phases of building power.
3. Provides an output to power panels or digital ballast interfaces if power on any phase fails and sends all lights controlled by these devices to 100 percent intensity. Lights to return to their previous intensities when normal power is restored.
4. Accepts a contact closure input from a fire alarm control panel.

2.13 SOURCE QUALITY CONTROL

A. Factory Testing :
1. Perform full-function factory testing on all completed assemblies. Statistical sampling is not acceptable.
2. Perform full-function factory testing on 100 percent of all ballasts and LED drivers.
3. Perform factory audit burn-in of all dimming assemblies and panels at 104 degrees F (40 degrees C) at full load for two hours.
4. Perform factory burn-in of 100 percent of all ballasts at 104 degrees F (40 degrees C).

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as shown on the drawings.
B. Verify that ratings and configurations of system components are consistent with the indicated requirements.
C. Verify that mounting surfaces are ready to receive system components.
D. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

A. All wiring shall be installed in conduit. Low-voltage wiring shall not share a conduit with power wiring.
1. Ceiling mounted sensors and other devices without means to mount on a standard electrical box or terminate conduit shall enter a conduit stubout within 18 inches of the device.

2. Conduit stub-outs shall be provided with a plastic bushing.

B. Perform work in a neat and workmanlike manner in accordance with NECA 1 and, where applicable, NECA 130.
C. Install products in accordance with manufacturer's instructions.
D. Provide dedicated network between BACnet controllers and lighting control bridges.
E. Define each dimmer/relay load type, assign each load to a zone, and set control functions.
F. Sensor Locations: Locations indicated are diagrammatic and only intended to indicate which rooms or areas require devices. Provide quantity and locations as required for complete coverage of respective room or area based on manufacturer's recommendations for installed devices.
G. Mount exterior daylight sensors to point due north with constant view of daylight.
H. Ensure that daylight sensor placement minimizes sensor view of electric light sources. Locate ceiling-mounted and luminaire-mounted daylight sensors to avoid direct view of luminaires.
I. Lamp Burn-In: Operate lamps at full output for prescribed period per manufacturer's recommendations prior to use with any dimming controls. Replace lamps that fail prematurely due to improper lamp burn-in.
J. LED Light Engine/Array Lead Length: Do not exceed 10 feet (3.1 m).

3.03 FIELD QUALITY CONTROL

A. See article "SYSTEM STARTUP" below for requirements related to testing and inspection.
B. Correct defective work, adjust for proper operation, and retest until entire system complies with contract documents.

3.04 BACnet Integration

A. Contractor shall conform to all Medical Center building management system requirements, the owner’s naming convention, ID and addressing standards. Refer to Section 250200-Controls for requirements.

3.05 SYSTEM STARTUP

A. Provide services of a manufacturer's certified field service engineer to perform system startup.
B. Manufacturer's Startup Services:
    1. Manufacturer's certified field service engineer to conduct minimum of three site visits to ensure proper system installation and operation.
    2. Conduct first visit to review requirements with installer as specified in Part 1 under "Administrative Requirements".
    3. Conduct second site visit upon completion of lighting control system to perform system startup and verify proper operation:
        a. Verify sensor locations, in accordance with layout provided by lighting control manufacturer as part of sensor layout and tuning services specified in Part 2 under "DIGITAL-NETWORK LIGHTING CONTROL SYSTEM - GENERAL REQUIREMENTS"; lighting control manufacturer may direct Contractor regarding sensor relocation should conditions require a deviation from locations indicated.
        b. Verify connection of power wiring and load circuits.
        c. Verify connection and location of controls.
        d. Energize BACnet controllers and download system data program.
        e. Address devices.
        f. Verify proper connection of panel links (low voltage/data) and address panel.
        g. Download system panel data to dimming/switching panels.
        h. Check dimming panel load types and currents and supervise removal of by-pass jumpers.
        i. Verify system operation control by control.
        j. Verify proper operation of manufacturer's interfacing equipment.
        k. Verify proper operation of manufacturer's supplied PC and installed programs.

l. Configure initial groupings of ballast for wall controls, daylight sensors and occupancy sensors.
m. Provide initial rough calibration of sensors; fine-tuning of sensors is responsibility of Contractor unless provided by lighting control manufacturer as part of sensor layout and tuning services where specified in Part 2 under "DIGITAL-NETWORK LIGHTING CONTROL SYSTEM - GENERAL REQUIREMENTS".
n. Obtain sign-off on system functions.

4. Conduct third site visit to train Owner's representative on system capabilities, operation, and maintenance, as specified in Part 3 under "Closeout Activities".

3.06 COMMISSIONING

A. The 019113 Lighting Control System commissioning is separate from and in addition to any other required Lighting Control System testing, commissioning, demonstrations, and training required by this specification. Lighting Control System Subcontractors, Vendor Reps and Programmers will be required to make separate trips to complete the 019113 Lighting Control System Commissioning.

3.07 CLOSEOUT ACTIVITIES

A. Training:
1. Include services of manufacturer's certified field service engineer to perform on-site training of Owner's personnel on operation, adjustment, and maintenance of lighting control system as part of standard system start-up services.
a. Include training on software to be provided:
1) Configuration software used to make system programming and configuration changes.
2) Control and monitor.

3.08 PROTECTION

A. Protect installed products from subsequent construction operations.

3.09 MAINTENANCE

A. System Optimization Visit: Include additional costs for lighting control system manufacturer to visit site six months after system start-up to evaluate system usage and discuss opportunities to make efficiency improvements that will fit with the current use of the facility.

END OF SECTION

SECTION 26 2200 LOW-VOLTAGE TRANSFORMERS

PART 1 - GENERAL

1.1 RELATED WORK

A. Section 26 0519 – Low-Voltage Electrical Power Conductors and Cables

B. Section 26 0526 – Grounding and Bonding for Electrical Systems

C. Section 26 0529 – Hangers and Supports for Electrical Systems

D. Section 25 0533 – Raceway and Boxes for Electrical Systems

E. Section 26 0553 – Electrical Systems Identification

F. Section 26 0812 – Power Distribution Acceptance Tests

G. Section 26 0813 – Power Distribution Acceptance Test Tables

1.2 REFERENCE

A. Work under this Section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.

1.3 DESCRIPTION

A. Section includes dry type distribution and buck-boost transformers rated 600V and less, with capacities up to 500 kVA.

1.4 REFERENCE STANDARDS

A. ANSI/NECA 1 – Standard Practices for Good Workmanship in Electrical Contracting

B. IEE C57.12.91 – Test Code for Dry Type Distribution and Power Transformers

C. NEMA 250 – Enclosures for Electrical Equipment (1000 Volts Maximum)

D. NEMA ST 1 – Specialty Transformers (except General Purpose Type)

E. NEMA ST 20 – Dry-Type Transformers for General Applications

F. NFPA 70 – National Electrical Code

G. UL 506 – Specialty Transformers

H. UL 1561 – Dry-Type General Purpose and Power Transformers

I. 10 CFR 431.192 – DOE Efficiency Standard for Distribution Transformers

1.5 SUBMITTALS

A. Product Data:

1. Include rated nameplate data, capacities, minimum clearances, installed devices and features, and performance for each type and size of transformer indicated.

B. Shop Drawings:
   1. For each transformer size and type:
      a. Physical dimensions, including bolting templates, weight, and center of gravity
      b. Winding and termination material
      c. Loads, method of field assembly, components, and location and size of each field connection
      d. Wiring Diagrams: Power, signal, and control wiring
      e. kVA rating
      f. Primary taps
      g. Insulation class and temperature rise
      h. Efficiency values measured at 0, 25, 50, 75, and 100% load
      i. Impedance value – X/R and %Z
      j. Sound level
      k. “K” factor listing, where applicable

C. Submit 1/4” scale electrical room floor plans with transformer locations.

D. Manufacturer’s Installation Instructions:
   1. Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product.

E. Test Reports: Indicate field test and inspection procedures and interpret test results and corrective action taken for compliance with specification requirements.

F. Output Settings Report: Record output voltages and tap settings.

G. Closeout Submittals:
   1. Project Record Documents:
      a. Record actual locations of transformers.
   2. Operation and Maintenance Data:
      a. Include manufacturer’s recommended operating instructions, maintenance procedures and intervals, and preventive maintenance instructions.
      b. Include spare parts data listing, source, and current prices of replacement parts and supplies.
      c. Include in emergency, operation and maintenance manuals.
      d. Include manufacturer’s Seismic Qualification Certification, Installation Seismic Qualification Certification, manufacturer’s Ultra Quiet Transformers Sound Level Certification, where applicable, and Output Settings Report.

1.6 QUALITY ASSURANCE

A. Obtain transformers from one source and by single manufacturer.

B. Regulatory Requirements:

1. Comply with NFPA 70 for components and installation.
2. Furnish products listed and classified by Underwriters Laboratories, Inc., as suitable for purpose specified and indicated.
3. Comply with 10 CFR 431.192 for minimum efficiency standards.

C. Certifications:
1. Furnish Engineer with manufacturer's Ultra Quiet Transformers Sound Level Certification, where applicable: Submit certification that ultra quiet transformers have sound level not exceeding 35 dB. Submit for each ultra quiet transformer. Include the following:
a. Basis for Certification: Indicate whether certification is based on actual test of assembled components or on calculations.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Store in clean, dry space. Maintain factory wrapping or provide additional canvas or plastic cover to protect from dirt, water, construction debris, and traffic.

B. Temporary Heating: Apply temporary heat according to manufacturer's written instructions within the enclosure of each ventilated-type unit, throughout periods during which equipment is not energized and when transformer is not in a space that is continuously under normal control of temperature and humidity.

1.8 WARRANTY

A. Refer to Division 01 and Section 26 0000 – General Electrical Requirements for general warranty requirements.

B. Manufacturer shall provide standard 1 yr written warranty against defects in materials and workmanship for products specified in this Section. Warranty period shall begin on date of substantial completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acme Electric

B. Eaton

C. General Electric

D. Olsun Electrics Corporation

E. Powersmiths

F. Square D

G. Siemens

2.2 DISTRIBUTION TRANSFORMERS

A. Fabrication:
1. NEMA ST 20, UL 1561

2. Factory assembled and tested
3. Air-cooled, for 60 Hz service
4. Two winding dry type
5. Coils:
   a. Continuous wound construction and impregnated with non-hydroscopic, thermosetting varnish.
   b. Conductors: Continuous windings without splices, except for taps, and encapsulated wire resin compound to seal out moisture and air.
   c. Winding Materials: Copper
   d. Separate primary and secondary
   e. Internal Connections: Braised or pressure type
6. Cores: High-grade silicon steel, non-aging, with high magnetic permeability, low eddy current losses and low hysteresis. Magnetic flux densities below saturation point. Core laminations clamped with steel members, one leg per phase.
7. Rubber vibration absorbing mounts to isolate base of enclosure from core and coil assembly.
8. Transformer neutral visibly grounded to enclosures with flexible grounding conductor.

B. Enclosure:
   1. NEMA 250
   2. Type 2, unless otherwise indicated to comply with environmental conditions at installed location.
   3. Code-gauge steel panel over core and coil.
   4. Ventilated (air-cooled).
   5. Cooling and terminal chamber access with both sides and rear obstructed.
   6. Manufacturer's lifting eyes or brackets.
   7. Finish: Manufacturer's standard gray enamel over prime coat after being degreased, cleaned, and phosphatized.

C. Ratings:
   1. KVA Rating: 500 kVA maximum
   2. Primary Voltage: As indicated on drawings.
   3. Secondary Voltage: As indicated on drawings.
   4. Insulation Class and Winding Temperature Rise:
      a. Transformers 15kVA and smaller: Class 220°C with 150°C temperature rise above 40°C ambient temperature.
      b. Transformers 25kVA – 112.5kVA: Class 220°C, with 115°C temperature rise above 40°C ambient temperature.
      c. Transformers above 112.5kVA: Class 220°C, with 80°C temperature rise above 40°C ambient temperature.
   5. Top of Enclosure Temperature: Maximum 35°C above 40°C ambient temperature at warmest point at full load.
   6. K-Factor Rating: UL 1561, as indicated on drawings.

D. Primary Taps:
   1. Transformers rated less than 3kVA: None.

2. Transformers rated 3kVA - 15kVA: One 5% above and one 5% below normal full capacity.
3. Transformers rated 15kVA and larger: Two 2.5% above and two 2.5% below normal full capacity, minimum of four taps.

E. Energy Efficiency:
1. NEMA Standard TP-1-2002

F. Sound Levels:
1. NEMA ST 20, maximum average sound levels as follows:
a. 45 dB for general-purpose transformer sizes less than 51kVA.
b. 50 dB for general-purpose transformer sizes 51-150kVA.
c. 55 dB for general-purpose transformer sizes 151-500kVA.

2.3 LUGS

A. Manufacturer's primary and secondary bolted lugs: labeled for 75°C copper and aluminum conductors for ventilated enclosures.

B. Connections at sides near bottom, accessible from front of cabinet.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine conditions for compliance with enclosure and ambient temperature requirements for each transformer.

B. Examine areas and surface to receive transformers for compliance with requirements, installation tolerances, and other conditions affecting performance. Proceed with installation only after unsatisfactory conditions have been corrected.

C. Verify space indicated for transformers' mounting meets code-required working clearances.

D. Notify Architect/Engineer of any discrepancies prior to submittal of product data and shop drawings.

E. Verify that ground connections are in place and requirements in Section 26 0526 – Grounding and Bonding for Electrical Systems have been met.

F. Purchase manufacturer's "touch-up" paint kit for repainting.

3.2 INSTALLATION

A. Install transformers in accordance with ANSI/NECA 1.

B. Install level and plumb within 1/2 degree, and at least 6" from the adjacent wall or structure to insure proper ventilation, in accordance with manufacturer's written instruction, and in compliance with recognized industry practices.

C. Transformer mounting:
1. Mount transformers as indicated on plans.
2. Floor mounting:

a. Secure to floor via isolation pads between floor brackets (fabricated by manufacturer) and transformer.
b. Mount on vibration dampening laminated rubber/cork pad.

3. Wall mounting:
   a. Secure to concrete-and-block wall via isolation pads between wall brackets (fabricated by manufacturer) and transformer.
   b. Secure to gypsum walls with independent steel slotted channel supports, secured to floor via isolation pads between wall brackets (fabricated by manufacturer) and transformer.
   c. Mount on vibration dampening laminated rubber/cork pad.
4. Suspended mounting:
   a. Suspend transformer enclosures designed for floor mounting, where suspended from structural ceiling, via trapeze constructed of steel slotted channel support system hung via 1/2" minimum steel threaded hanger rods attached to structural members or inserts in structural slab. Each rod to contain spring isolator ceiling hanger. Use locking type nuts in assembly.
   b. Anchor and fasten transformers and their supports to building structural elements by the methods described in Section 26 0529 – Hangers and Supports for Electrical Systems.

D. Install engraved plastic nameplates under provisions of Section 26 0553 – Electrical Systems Identification. Attach nameplate to transformer using small, corrosion-resistant metal screws or rivets with methods and location not to violate the rating of the enclosure. Do not use contact adhesive.
   1. Indicate kVA rating, voltage/phase rating for primary and secondary.
   2. Identify source and load.

E. Connect each transformer to rigid conduit system with maximum 36" of flexible liquid-tight metal conduit. Install conduit per requirements in Section 26 0533 – Raceway and Boxes for Electrical Systems.

F. Install transformer in dedicated electrical space per NFPA 70 and as shown on drawings. Coordinate with miscellaneous trades for equipment foreign to the electrical installation to be outside of dedicated electrical space.

3.3 CONNECTIONS

A. Ground transformers according to Section 26 0526 – Grounding and Bonding for Electrical Systems.

B. Connect wiring according to Section 26 0519 – Low-Voltage Electrical Power Conductors and Cables.

3.4 FIELD QUALITY CONTROL

A. Inspect transformers for physical damage, proper alignment, anchorage, grounding, connections, and installation.

B. Test transformers per requirements in Sections 26 0812 – Power Distribution Acceptance Tests and 26 0813 – Power Distribution Acceptance Test Tables.

C. Interpret test results in writing and submit to Engineer.

D. Output Settings Report: Prepare a written report recording output voltages and tap settings and submit to Engineer.

3.5 REPAINTING

A. Remove paint splatters and other marks from surface of equipment.

B. Touch-up chips, scratches, or marred finishes to match original finish, using manufacturer-supplied paint kit. Leave remaining paint with Owner.

3.6 ADJUSTING

A. Record transformer secondary voltage at each unit for at least 48 h of typical occupancy period. Adjust transformer taps to provide optimum voltage conditions at secondary terminals. Optimum is defined as not exceeding nameplate voltage plus 10% and not being lower than nameplate voltage minus 3% at maximum load conditions.

3.7 CLEANING

A. Vacuum dirt and construction debris from interior and exterior of equipment; do not use compressed air to assist in cleaning.

END OF SECTION

SECTION 26 2416.13 LIGHTING AND APPLIANCE PANELBOARDS

PART 1 - GENERAL

1.1 RELATED WORK

A. Section 26 0519 – Low-Voltage Electrical Power Conductors and Cables

B. Section 26 0526 – Grounding and Bonding for Electrical Systems

C. Section 26 0529 – Hangers and Supports for Electrical Systems

D. Section 26 0533 – Raceway and Boxes for Electrical Systems

E. Section 26 0553 – Electrical Systems Identification

F. Section 26 0812 – Power Distribution Acceptance Tests

G. Section 26 0813 – Power Distribution Acceptance Test Tables

1.2 REFERENCE

A. Work under this section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.

1.3 DESCRIPTION

A. Section includes circuit breaker type lighting and appliance branch circuit panelboards as shown on drawings and as scheduled.

1.4 REFERENCE STANDARDS

A. NECA 407 - Recommended Practice for Installing and Maintaining Panelboards

B. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum)

C. NEMA AB 1 - Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit Breaker Enclosures

D. NEMA PB 1 - Panelboards

E. NEMA PB 1.1 - General Instructions for Proper Installation, Operation, and Maintenance of Panelboards Rated 600 Volts or Less

F. NFPA 70 - National Electrical Code

G. UL 50 - Enclosures for Electrical Equipment

H. UL 67 - Panelboards

I. UL 486A-486B - Wire Connectors

J. UL 489 - Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit Breaker Enclosures

K. UL 869A - Reference Standard for Service Equipment

1.5 SUBMITTALS

A. Product Data:
   1. Submit catalog data showing specified features of standard products. Eliminate extraneous catalog data.

B. Shop Drawings:
   1. Submit for review prior to manufacture. Include complete description, front view, dimensions, voltage, main bus ampacity, circuit breaker arrangement and sizes, short circuit current rating, and factory settings of individual protective devices.
   2. Submit 1/4” scale electrical room floor plans with panelboard locations.

C. Partial Submittals:
   1. Panelboards shall be submitted for review together. Partial submittals of panelboards are not acceptable and will be rejected.

D. Manufacturer’s Installation Instructions:
   1. Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product.

E. Test Reports:
   1. Indicate field test and inspection procedures and interpret test results and corrective action taken for compliance with specification requirements.

F. Closeout Submittals:
   1. Project Record Documents:
      a. Record actual locations of panelboards and record actual circuiting arrangements.
   2. Operation and Maintenance Data:
      a. Include manufacturer’s recommended operating instructions, maintenance procedures and intervals, and preventive maintenance instructions.
      b. Include manufacturer’s written instructions for testing and adjusting overcurrent protective devices.
      c. Include time-current curves and selectable ranges for each type of overcurrent protective device.
      d. Include spare parts data listing, source, and current prices of replacement parts and supplies.

1.6 QUALITY ASSURANCE

A. Obtain panelboards, overcurrent protective devices, components, and accessories from one source and by single manufacturer.

B. Regulatory Requirements:
   1. Comply with NFPA 70.
   2. Furnish products listed and classified by Underwriters Laboratories, Inc., as suitable for purpose specified and indicated.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Store in clean, dry space. Maintain factory wrapping or provide additional canvas or plastic cover to protect from dirt, water, construction debris, and traffic.

B. Comply with NEMA PB 1.1 and manufacturer's written instructions.

1.8 WARRANTY

A. Refer to Division 01 and Section 26 0000 – General Electrical Requirements for general warranty requirements.

B. Manufacturer shall provide standard 1 yr written warranty against defects in materials and workmanship for products specified in this Section. Warranty period shall begin on date of substantial completion.

1.9 MAINTENANCE

A. Extra Materials:
   1. Furnish Owner with two keys per panelboard.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Square D

B. General Electric

C. Cutler Hammer

D. Siemens

2.2 LIGHTING AND APPLIANCE BRANCH CIRCUIT PANELBOARDS

A. NEMA PB 1, UL 67

B. Fabrication:
   1. Factory assembled.
   2. With locking door.
   3. Incoming feeder lugs: copper conductors.
   4. Multiple lugs to match number of conductors per phase.
   5. Sub-feed (double) lugs, or feed-through lugs where indicated.
   6. Filler plates.
   7. Wiring terminals for field installed conductors: Pressure wire connectors, except wire-binding screws for #10 AWG or smaller conductors.
   8. Hinged panel trim.

C. Panelboard Buses:
   1. Copper
   2. Ampere rating as scheduled

3. Ground bus: uninsulated, bonded to panelboard cabinet
4. Insulated neutral bus: 100% of phase bus rating

D. Molded-Case Circuit Breakers:
1. NEMA AB 1, UL 489
2. Bolt-on type, labeled for 75°C copper and aluminum conductors
3. Quick-make, quick-break, with thermal-magnetic trip.
4. Common internal trip on multi-pole breakers. Handle-ties are not permitted.
5. Ampere rating as scheduled
6. Listed as Type SWD for lighting circuits
7. Listed as Type HACR for air conditioning equipment circuits
8. Bussing, device mounting hardware, and steel knockouts in dead front where “space” is indicated
9. Tandem circuit breakers are not acceptable
10. Locks on trip handles where indicated
11. Main breakers with shunt trip in laboratory branch circuit panels, where indicated
12. Ground fault equipment protection (GFEP), rated 30 mA trip, to provide equipment protection for branch circuits feeding electrical heat tracing, where indicated
13. Ground fault circuit interrupter (GFCI), rated at 4-6 mA trip for protection of personnel, where indicated

E. Cabinet
1. NEMA 250, UL 50
2. NEMA Type 1 enclosure.
3. Front (trim) flush and surface mounted with door in front with concealed self-adjusting trim clamps, and complete with cylinder-type lock and catch.
4. Same height matching trim, where two cabinets are mounted adjacent to one another in finished areas.
5. All sections of panelboards have the same size, where oversize cabinets are required for one section of multi-section panelboard.
6. Boxes and fronts made of code-gauge galvanized steel.
7. Manufacturer’s standard gray enamel finish over prime coat.

2.3 SHORT CIRCUIT CURRENT RATING

A. Each panelboard with minimum short circuit current rating as indicated on drawings.

B. Panelboards marked with their maximum short circuit current rating at supply voltage.

C. Panelboards: Fully rated. Series-rated panelboards are not acceptable.

2.4 SPARE CONDUITS

A. Spare conduits per requirements in Section 26 0533 – Raceway and Boxes for Electrical Systems.

PART 3 - EXECUTION

3.1 COORDINATION WITH MANUFACTURER

A. For all electrical panels, top fed panels are to be fed from the top and bottom fed from the bottom so no feeder cables are in the side gutters of the panels.

B. Instruct manufacturer about the location of main lugs or main circuit breaker (i.e., top or bottom feed based on incoming feeder entrance location).

C. Instruct manufacturer to provide multiple lugs where conductors in parallel or sub-feed (double) lugs or feed-through lugs are indicated.

D. Instruct manufacturer on the size of cross-connection cables for panelboards fed via sub-feed (double) lugs or feed-through lugs. Make cable size with ampacity equal to incoming feeder.

E. Verify that “touch-up” paint kit is available for repainting.

3.2 EXAMINATION

A. Verify that space indicated for panelboard mounting meets code-required working clearances and dedicated equipment space.

B. Notify Architect/Engineer of any discrepancies prior to submittal of product data and shop drawings.

3.3 INSTALLATION

A. Install panelboards in accordance with NECA 407 and NEMA PB 1.1.

B. Install panelboards plumb and rigid without distortion of box, in accordance with manufacturer's written instructions, and in compliance with recognized industry practices.

C. Panelboard mounting:
   1. Fasten panelboards firmly to walls and structural surfaces, ensuring they are permanently and mechanically anchored.
   2. Anchor and fasten panelboards and their supports to building structural elements (wood, concrete, masonry, hollow walls and nonstructural building surfaces) by the methods described in Section 26 0529 – Hangers and Supports for Electrical Systems.
   3. Install two rows of steel slotted channel, with a minimum of 4 attachment points, for each panelboard section.
   4. When not located directly on wall, provide support frame of steel slotted channel anchored to floor and ceiling structure.

D. Install top breaker handle a maximum of 6’-6” above finished floor or working platform with handle in its highest position.

E. Tighten electrical connectors and terminals according to equipment manufacturer's published torque-tightening values. Where manufacturer’s torque values are not indicated, use those specified in UL 486A – 486B.

F. Install as-built typewritten circuit directory in directory frame (to indicate installed circuit loads) mounted inside each panelboard door. Include description of connected loads, room number,

room name, area, or item served for each branch circuit. Indicate motor names and horsepower as applicable. Cover circuit directory with colorless plastic. Coordinator with Owner and Architect to ensure that room numbers used in panel directory are final numbers assigned by Owner.

G. Install engraved plastic nameplates under provisions of Section 26 0553 – Electrical Systems Identification. Attach nameplate to exterior of each panelboard using small metal screws or rivets. Do not use contact adhesive.
   1. Include panelboard name, amperage, voltage, phase, and number of wires.

H. Label spare circuits as SPARE. Leave spare breakers in OFF position.

I. Room numbers used shall be those used by Owner except as otherwise directed by Architect.

J. Install panelboard in dedicated electrical space per NFPA 70 and as shown on drawings. Coordinate with miscellaneous trades for equipment foreign to the electrical installation to be outside of dedicated electrical space.

K. Install filler plates in unused spaces.

L. Install three 3/4" spare conduits stubbed into accessible ceiling space or space designated to be ceiling space in the future for all flush-mounted panelboards. Install conduits in accordance with requirements in Section 26 0533 – Raceway and Boxes for Electrical Systems.

3.4 CONNECTIONS

A. Ground panelboards according to Section 26 0526 – Grounding and Bonding for Electrical Systems.

B. Connect wiring according to Section 26 0519 – Low-Voltage Electrical Power Conductors and Cables.

3.5 FIELD QUALITY CONTROL

A. Inspect for physical damage, proper alignment, anchorage, and grounding.

B. Maintain proper phasing for multi-wire circuits.

C. Test main circuit breakers in accordance with requirements in Sections 26 0812 – Power Distribution Acceptance Tests and 26 0813 – Power Distribution Acceptance Test Tables.

D. Interpret test results in writing and submit to Engineer.

E. Check phase-to-phase and phase-to-ground insulation resistance levels prior to energization of panelboards.

F. Check panelboards for electrical continuity of circuits and for short-circuits prior to energization.

3.6 REPAINTING

A. Remove paint splatters or other marks from surface of panelboards.

B. Touch-up chips, scratches, or marred finishes to match original finish, using manufacturer-supplied paint kit. Leave remaining paint with Owner.

3.7 ADJUSTING

A. Adjust fronts, covers, hinges, and locks.

3.8 CLEANING

A. Clean panelboard interiors and exteriors prior to final inspection. Remove paint splatters and other spots, dirt and debris.

END OF SECTION

SECTION 26 2416.16 DISTRIBUTION PANELBOARDS

PART 1 - GENERAL

1.1 RELATED WORK

A. Section 26 0519 – Low-Voltage Electrical Power Conductors and Cables

B. Section 26 0526 – Grounding and Bonding for Electrical Systems

C. Section 26 0529 – Hangers and Supports for Electrical Systems

D. Section 26 0553 – Electrical Systems Identification

E. Section 26 0812 – Power Distribution Acceptance Tests

F. Section 26 0813 – Power Distribution Acceptance Test Tables

G. Section 26 2813 – Fuses

1.2 REFERENCE

A. Work under this Section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.

1.3 DESCRIPTION

A. Section includes circuit breaker type and fusible switch type power distribution panelboards as shown on drawings and as scheduled.

1.4 REFERENCE STANDARDS

A. NECA 407 - Recommended Practice for Installing and Maintaining Panelboards

B. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum)

C. NEMA AB 1 - Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit Breaker Enclosures

D. NEMA FU 1 - Low-Voltage Cartridge Fuses

E. NEMA KS 1 - Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum)

F. NEMA PB 1 - Panelboards

G. NEMA PB 1.1 - General Instructions for Proper Installation, Operation, and Maintenance of Panelboards Rated 600 Volts or Less

H. NFPA 70 - National Electrical Code

I. UL 50 - Enclosures for Electrical Equipment

J. UL 67 - Panelboards

K. UL 486A – 486B - Wire Connectors

L. UL 489 - Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit Breaker Enclosures

M. UL 4248 - Fuseholders

N. UL 869A - Reference Standard for Service Equipment

1.5 SUBMITTALS

A. Product Data:
   1. Submit catalog data showing specified features of standard products. Eliminate extraneous catalog data.

B. Shop Drawings:
   1. Submit for review prior to manufacture. Include complete description, front view, dimensions, voltage, main bus ampacity, circuit breaker and fusible switch arrangement and sizes, short circuit current rating, and factory settings of individual protective devices.
   2. Submit 1/4” scale electrical room floor plans with panelboard locations.
   3. Submit features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
   4. Panelboards shall be submitted for review together. Partial submittals of panelboards are not acceptable and will be rejected.

C. Manufacturer’s Installation Instructions:
   1. Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product.

D. Test Report:
   1. Indicate field test and inspection procedures and interpret test results and corrective action taken for compliance with specification requirements.

E. Closeout Submittals:
   1. Project Record Documents:
      a. Record actual locations of panelboards and record actual circuiting arrangements.
   2. Operation and Maintenance Data:
      a. Include manufacturer’s recommended operating instructions, maintenance procedures and intervals, and preventive maintenance instructions.
      b. Include manufacturer’s written instructions for testing and adjusting overcurrent protective devices.
      c. Include time-current curves and selectable ranges for each type of overcurrent protective device.
      d. Include spare parts data listing, source, and current prices of replacement parts and supplies.

1.6 QUALITY ASSURANCE

A. Obtain panelboards, overcurrent protective devices, components, and accessories from one source and by a single manufacturer.

B. Regulatory Requirements:
   1. Comply with NFPA 70.
   2. Furnish products listed and classified by Underwriters Laboratories, Inc., as suitable for purpose specified and indicated.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Store in clean, dry space. Maintain factory wrapping or provide additional canvas or plastic cover to protect from dirt, water, construction debris, and traffic.

B. Comply with NEMA PB 1.1 and manufacturer's written instructions.

1.8 WARRANTY

A. Refer to Division 01 and Section 26 0000 – General Electrical Requirements for general warranty requirements.

B. Manufacturer shall provide standard 1 yr written warranty against defects in materials and workmanship for products specified in this Section. Warranty period shall begin on date of substantial completion.

1.9 MAINTENANCE

A. Extra Materials:
   1. Furnish Owner with two keys per panelboard.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Square D

B. General Electric

C. Cutler Hammer

D. Siemens

2.2 POWER DISTRIBUTION PANELBOARDS

A. NEMA PB 1, UL 67.

B. Fabrication:
   1. Factory assembled
   2. Individualized breaker and fusible switch dead-front cover door-in-door construction
   3. Incoming feeder lugs: copper conductors
   4. Multiple lugs to match number of conductors per phase
   5. Sub-feed (double) lugs, or feed-through lugs where indicated
   6. Filler plates
   7. Wiring terminals for field installed conductors: Pressure wire connectors, except wire-binding screws for #10 AWG or smaller conductors.

8. Hinged panel trim.

C. Panelboard Buses:
   1. Copper
   2. Ampere rating as scheduled
   3. Ground bus: uninsulated, bonded to panelboard cabinet
   4. Insulated neutral bus where applicable: 100% of phase bus rating

D. Molded-Case Circuit Breakers:
   1. NEMA AB 1, UL 489
   2. Bolt-on or I-line type, labeled for 75°C copper and aluminum conductors
   3. Quick-make, quick-break, with thermal-magnetic trip and electronic (solid-state microprocessor-based) trip.
   4. Equipped with individually insulated, braced, and protected connectors
   5. Common internal trip on multi-pole breakers. Handle-ties are not permitted.
   6. Ampere rating as scheduled
   7. Front face flush with each other
   8. Large, permanent, individual circuit numbers affixed to each breaker in uniform position
   9. Tripped indication clearly shown by breaker handle taking position between “ON” and “OFF.”
   10. Listed as Type HACR for air conditioning equipment circuits
   11. Bussing, device mounting hardware, and steel knockouts in dead front where “space” is indicated
   12. For 225A frame size and below: thermal-magnetic trip
   13. For 250A frame size and above: electronic trip units interchangeable in the field within the frame size and field-adjustable long time pick-up, long time delay, short time pick-up, short time delay, and instantaneous current settings. Each adjustment shall have discrete settings and shall be independent of all other adjustments.
   14. Locks on trip handles where indicated

E. Fusible Switches:
   1. NEMA KS1, NEMA FU1, UL 512
   2. Labeled for 75°C conductors
   3. Quick-make quick-break with visible blades, externally operable handle and dual horsepower ratings.
   4. Handles to physically indicate “ON” and “OFF” position.
   5. Lockable only in “OFF” position and accept three industrial type heavy-duty padlocks.
   6. Covers and handles be interlocked to prevent opening in “ON” position, with means to permit release of interlock.
   7. Large permanent individual circuit numbers affixed to each fusible switch in uniform position.
   8. Rejection clips for Class R fuses specified.
   9. Provisions for Class J or Class L fuses, as applicable.
   10. Fuses: Per requirements in Section 26 2813 – Fuses.

F. Cabinet
   1. NEMA 250, UL 50

2. NEMA Type 1 enclosure.
3. Four-piece front (trim) surface mounted with door over the front, with concealed self-adjusting trim clamps, and complete with cylinder-type lock and catch except omit door in fusible switch panelboard.
4. Same height matching trim, where two cabinets are mounted adjacent to one another in finished areas.
5. All sections of panelboards have the same size, where oversize cabinets are required for one section of multi-section panelboard.
6. Boxes and fronts made of code-gauge galvanized steel
7. Manufacturer's standard gray enamel finish over prime coat

2.3 SHORT CIRCUIT CURRENT RATING

A. Each panelboard with minimum short circuit current rating as indicated on drawings.

B. Panelboards marked with their maximum short circuit current rating at supply voltage.

C. Panelboards: Fully rated. Series-rated panelboards are not acceptable.

PART 3 - EXECUTION

3.1 COORDINATION WITH MANUFACTURER

A. Instruct manufacturer about the location of additional wiring gutter space when required, i.e. top, bottom, or combination. Do not install conduits into the side of panelboards.

B. Instruct manufacturer about the location of main lugs or main circuit breaker (i.e., top or bottom feed based on incoming feeder entrance location).

C. Instruct manufacturer to provide multiple lugs where conductors in parallel or sub-feed (double) lugs or feed-through lugs are indicated.

D. Instruct manufacturer on the size of cross-connection cables for panelboards fed via sub-feed (double) lugs or feed-through lugs. Make cable size with ampacity equal to incoming feeder.

E. Verify that "touch-up" paint kit is available for repainting.

3.2 EXAMINATION

A. Verify that space indicated for panelboard mounting meets code-required working clearances and dedicated equipment space.

B. Notify Architect/Engineer of any discrepancies prior to submittal of product data and shop drawings.

3.3 INSTALLATION

A. Install panelboards in accordance with NECA 407 and NEMA PB 1.1.

B. Install panelboards plumb and rigid without distortion of box, in accordance with manufacturer's written instructions, and in compliance with recognized industry practices.

C. Panelboard mounting:

1. Fasten panelboards firmly to walls and structural surfaces, ensuring they are permanently and mechanically anchored.
2. Anchor and fasten panelboards and their supports to building structural elements (wood, concrete, masonry, hollow walls and nonstructural building surfaces) by the methods described in Section 26 0529 – Hangers and Supports for Electrical Systems.
3. Install two rows of steel slotted channel, with a minimum of four attachment points, for each panelboard section.
4. When not located directly on wall, provide support frame of steel slotted channel anchored to floor and ceiling structure.

D. Install top breaker handle a maximum of 6'-6" above finished floor or working platform, with handle in its highest position.

E. Tighten electrical connectors and terminals according to equipment manufacturer's published torque tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A –486B.

F. Install as-built typewritten circuit directory in directory frame (to indicate installed circuit loads before completing load balancing) mounted inside each panelboard door. Include description of connected loads, room number, room name, area, or item served for each branch circuit. Indicate motor names and horsepower as applicable. Cover circuit directory with colorless plastic. Coordinate with Owner and Architect to ensure that room numbers used in panel directory are final numbers assigned by Owner.

G. Install engraved plastic nameplates under provisions of Section 26 0553 – Electrical Systems Identification. Attach nameplate to exterior of each panelboard using small, corrosion-resistant metal screws or rivets. Do not use contact adhesive.
   1. Indicate panelboard name, amperage, voltage, phase, and number of wires.

H. Label spare circuits as SPARE. Leave spare breakers in OFF position.

I. Room numbers used shall be those used by Owner except as otherwise directed by Architect.

J. Install panelboard in dedicated electrical space per NFPA 70 and as shown on drawings. Coordinate with miscellaneous trades for equipment foreign to the electrical installation to be outside of dedicated electrical space.

K. Install filler plates in unused spaces.

L. Install fuses in fusible switches, per requirements in Section 26 2813 – Fuses.

3.4 CONNECTIONS

A. Ground panelboards according to Section 26 0526 – Grounding and Bonding for Electrical Systems.

B. Connect wiring according to Section 26 0519 – Low-Voltage Electrical Power Conductors and Cables.

3.5 FIELD QUALITY CONTROL

A. Inspect for physical damage, proper alignment, anchorage, and grounding.

B. Test circuit breakers per requirements in Sections 26 0812 – Power Distribution Acceptance Tests and 26 0813 – Power Distribution Acceptance Test Tables.

C. Interpret test results in writing and submit to Engineer.

D. Check phase-to-phase and phase-to-ground insulation resistance levels prior to energizing panelboards.

E. Check panelboards for electrical continuity of circuits and for short-circuits prior to energizing.

3.6 REPAINTING

A. Remove paint splatters or other marks from surface of panelboards.

B. Touch-up chips, scratches, or marred finishes to match original finish, using manufacturer-supplied paint kit. Leave remaining paint to Owner.

3.7 ADJUSTING

A. Adjust fronts, covers, hinges, and locks.

B. Circuit Breakers: Set field-adjustable trip settings or change the trip settings, as provided by engineer.

3.8 CLEANING

A. Clean panelboard interiors and exteriors prior to final inspection. Remove paint splatters and other spots, dirt and debris.

END OF SECTION

SECTION 26 2726 WIRING DEVICES

PART 1 - GENERAL

1.1 RELATED WORK

A. Section 26 0526 - Grounding and Bonding for Electrical Systems

B. Section 26 0553 - Electrical Systems Identification

1.2 REFERENCE

A. Work under this Section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.

1.3 DESCRIPTION

A. Section includes receptacles, hazardous (classified) location receptacles and device cover plates.

1.4 REFERENCE STANDARDS

A. ASHRAE 90.1 – Energy Standard for Buildings Except Low-Rise Residential Buildings

B. IEEE C62.41.2 – Characterization of Surges in Low-Voltage (1000V and less) AC Power Circuits

C. IEEE C62.45 – Surge Testing for Equipment Connected to Low-Voltage (1000V and less) AC Power Circuits

D. NECA 1 – Good Workmanship in Electrical Contracting

E. NFPA 70 – National Electrical Code

F. NEMA WD-1 – General Color Requirements for Wiring Devices

G. NEMA WD-6 – Wiring Devices - Dimensional Requirements

H. NEMA 250 – Enclosures for Electrical Equipment (1000 Volts Maximum)

I. UL 498 – Attachment Plugs and Receptacles

J. UL 943 – Ground-Fault Circuit-Interrupters

K. UL 1310 – Class II Power Units

L. UL 1436 – Outlet Circuit Testers and Similar Indicating Devices

1.5 SUBMITTALS

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

B. Shop Drawings: List of legends and description of materials and process used for premarking wall plates.

C. Manufacturer’s Installation Instructions:

1. Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product.

D. Test Reports: Indicate field test and inspection procedures and interpret test results and corrective action taken for compliance with specification requirements.

E. Closeout Submittals:
   1. Project Record Documents:
      a. Record actual locations and ratings of wiring devices.
   2. Operation and Maintenance Data:
      a. Include in manufacturers' packing label warnings and instruction manuals with labeling conditions.
      b. Include source and current prices of replacement parts and supplies.

1.6 QUALITY ASSURANCE

A. Obtain wiring devices from one source and by single manufacturer.

B. Regulatory Requirements:
   1. Comply with NFPA 70 for components and installation.
   2. Furnish products listed and classified by Underwriters Laboratories, Inc., as suitable for purpose specified and indicated.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Store in clean, dry space. Maintain factory unopened packaging until ready for installation.

1.8 WARRANTY

A. Refer to Division 01 and Section 26 0000 – General Electrical Requirements for general warranty requirements.

B. Manufacturer shall provide standard 1 yr warranty against defects in materials and workmanship for products specified in this Section. Warranty period shall begin on date of substantial completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Cooper Wiring Devices; a division of Cooper Industries, Inc.

B. Hubbell Incorporated; Wiring Device-Kellems

C. Pass & Seymour/Legrand; Wiring Devices & Accessories

2.2 RECEPTACLES

A. Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, and UL 498.

B. Receptacles: 125 V, 20A, heavy-duty (specification grade); side wired; flush mounted; straight blade; 2 pole, 3 wire grounding; thermoplastic body; duplex configuration unless otherwise noted. Provide hospital grade receptacles in wetlabs.
   1. Ground Fault Circuit Interrupter (GFCI):
      a. Additional compliance with UL 943 Class A.
      b. Leakage current trip level: 4 to 6 mA.
      c. Trip time: .025 seconds nominal.
      d. Feed-through type
      e. Reverse line-load function to prevent GFCI from functioning if wired incorrectly.
      f. Indicator Light: Lighted when device is tripped.
   2. Isolated Ground (IG):
      a. Ground strap isolated from mounting strap.
      b. Ground screw connected directly to ground contacts.
   3. USB Charging:
      a. UL-498 and UL-1310 listed
      b. Two USB 2.1 Amp or 3.0 Amp, 5VDC charging ports in addition to two 120V, 20A NEMA 5-20R outlets in one single gang device.
      c. LED indicator for notification of USB port connection.
      d. Auto-grounding connection type.
   4. Tamper Resistant (TR):
      a. Requires insertion of object in both left and right contacts to energize.
      b. 2- or 3-prong plug.
   5. Twist-locking:
      a. NEMA WD 6 configuration as indicated on drawings.
   6. Switched: Upper half switched and lower half not switched.
   7. Dedicated: Labeled “Dedicated.”
   8. Special Purpose Receptacles: Specification grade, rated for voltage, amperage and NEMA configuration as noted on drawings.

2.3 DEVICE COVER PLATES

A. Single and combination types to match corresponding wiring devices:
   1. Attachment: Metal screws with head color to match plate finish.
   2. Material for Finished Spaces: satin-finished stainless steel.
   3. Material for Unfinished Spaces: Galvanized steel.
   4. Material for Damp Locations: Cast aluminum with while-in-use hinged cover, and listed and labeled for use in “wet locations.”

B. Weatherproof Cover Plates (Indoor Flush):
   1. Vertical Receptacles: Hubbell HBL5221 or approved equal.
   2. Horizontal Receptacles: Hubbell HBL5206WO or approved equal.

C. Weatherproof Cover Plates (Outdoor): NEMA 250, complying with type 3R weather-resistant, die-cast aluminum with weatherproof while-in-use hinged cover with tab for locking with padlock.

D. Tamper Resistant (TR):
   1. Slide cover over receptacle.

2.4 FINISHES

A. Color:
   1. Receptacle faceplates, and device cover plates:
      a. Receptacle faceplates connected to Emergency Power System: Red.
      b. UPS Receptacles: Gray

PART 3 - EXECUTION

3.1 COORDINATION

A. Special Purpose Receptacles: Coordinate final selections of NEMA configuration (locking, straight, blade, etc.) with configuration of plug on utilization equipment.

B. Receptacles for Owner-furnished equipment and equipment furnished under other divisions of specifications: Match plug configurations.

C. Coordination with Other Trades:
   1. Take steps to insure that devices and their boxes are protected. Do not place wall finish materials over device boxes and do not cut holes for boxes with routers guided by riding against outside of the boxes.
   2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
   3. Install device boxes in brick or block walls so that the device cover plate does not cross a joint
   4. Install wiring devices after all wall preparation, excluding painting, is complete. Install device cover plates after painting is complete.

3.2 EXAMINATION

A. Verify location of wiring devices with architectural interior elevation drawings, prior to rough-in.

B. Verify outlet boxes are installed at proper height.

C. Verify wall openings are neatly cut and completely covered by wall plates.

D. Verify branch circuit wiring installation is completed, tested, and ready for connection to wiring devices.

3.3 PREPARATION

A. Clean debris from outlet boxes.

3.4 INSTALLATION

A. Comply with NECA 1, including the mounting heights listed in that standard, unless otherwise scheduled or indicated on drawings. Indicated dimensions are to center of device.

B. Conductors:

1. Do not strip insulation from conductors until just before they are spliced or terminated on devices.
2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
3. Length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300, without pigtails.
4. Do not place bare stranded conductors directly under device screws. Use crimp on fork terminals for device terminations.

C. Device Installation:
1. Replace all devices that have been in temporary use during construction or show signs of installation prior to completion of building finishing operations.
2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
3. Do not remove surface protection, such as plastic film and smudge covers, until last possible moment.
4. Connect devices to branch circuits using pigtails that are not less than 6” in length.
5. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, 2/3 to 3/4 of the way around terminal screw.
6. Use a torque screwdriver when a torque is recommended or required by the manufacturer.
7. When conductors larger than #10 AWG are installed on 20A circuits, splice #12 AWG pigtails for device connections.
8. Tighten unused terminal screws on the device.
9. When mounting into metal boxes, remove fiber or plastic washers used to hold device mounting screws in yokes, allowing metal-to-metal contact.
10. Install devices plumb, level with finished surfaces and free from blemishes.
11. Install devices above counters, 2” to the bottom of device above countertop or backsplash. Install all devices at same height above any one counter or fixed cabinet.
12. Install special purpose receptacles according to shop and rough-in drawings furnished by trade(s) producing such equipment. Verify locations prior to rough-in.
13. Install weatherproof GFCI receptacles:
    a. Within 25’-0” of roof-mounted mechanical equipment
    b. Outdoors
    c. As indicated on drawings
14. Connect wiring device grounding terminal to outlet box with bonding jumper and branch circuit equipment grounding conductor. Ground per requirements in Section 26 0526 – Grounding and Bonding for Electrical Systems.

D. Installation Orientations:
1. Install ground pin of vertically mounted receptacles up, and on horizontally mounted receptacles to the left.
2. Unless otherwise indicated or where space problem occurs, mount devices flush, with long dimension vertical.

E. Device Cover Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.

3.5 IDENTIFICATION

A. Comply with Section 26 0553 – Electrical Systems Identification.

1. Receptacles (20A, 120V): Use hot, stamped or engraved machine printing with black-filled lettering on white background on face of cover plate, and durable wire markers or tags inside outlet boxes. Indicate source panel identification and circuit number.
    a. Receptacles for computers and printers shall be provided with engraved cover plates identifying their specific use.
2. Receptacles (other than 20A,120V): Use hot, stamped or engraved machine printing with black-filled lettering on white background on face of cover plate, and durable wire markers or tags inside outlet boxes. Indicate source panel identification, circuit number, voltage, phase, and amperage.
3. Emergency Power Receptacles: In addition to above indicate “Emergency”.
4. Engrave cover plates on all Owner-furnished equipment and equipment furnished under other divisions of these specifications with source panel identification, circuit number (where applicable) as specified in this section.
5. Provide factory embossed or field-applied label to automatically switched receptacle face or cover plates to comply with ASHRAE 90.1 and NEC 406.3(E). Label is to include symbol indicated below. Use Hubbell CL60 label or equal for field applied labels.
    a. Switched receptacle symbol:

3.6 FIELD QUALITY CONTROL

A. Inspect wiring devices for defects.

B. Verify receptacle device is energized.

C. Perform tests and prepare test reports:

1. Test receptacle devices for proper polarity:
    a. Test every receptacle with receptacle circuit tester. Tester shall test for open ground, reverse polarity, open hot, open neutral, hot and ground reversed, hot or neutral and hot open. Rewire receptacles with faults and retest.
2. Test each GFCI receptacle device for proper operation:
    a. Perform testing using an instrument specifically designed and manufactured for testing ground-fault circuit interrupters. Apply the test to the receptacle. “TEST” button operation will not be acceptable as a substitute for this test. Replace receptacles that do not shut off power with 5/1000 A within 1/40 second and retest.
3. Test Instruments: Use instruments that comply with UL 1436.
4. Test Instrument for Convenience Receptacles: Digital wiring analyzer with digital readout or illuminated LED indicators of measurement.

D. Tests for Convenience Receptacles:

1. Line Voltage: Acceptable range is 105 V to 132 V.
2. USB Voltage: Acceptable range is 4.8VDC to 5.5VDC.
3. Percent Voltage Drop under 15A Load: A value of 5% or higher is not acceptable.

4. Ground Impedance: Values of up to 2 ohms are acceptable.
5. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.
6. Using the test plug, verify that the device and its outlet box are securely mounted.
7. The tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault current path, defective devices, or similar problems. Correct circuit conditions, remove malfunctioning units and replace with new ones, and retest as specified above.

E. Operational Tests: Demonstrate the operation of each switch with the systems fully energized and operating. Each switch shall be demonstrated three times.

F. Interpret test results in writing and submit to Engineer.

3.7 ADJUSTING

A. Adjust devices and wall plates to be flush and level.

3.8 CLEANING

A. Remove excess plaster from interior of outlet boxes.

B. Clean devices and cover plates after painting is complete. Replace stained or improperly painted devices and cover plates.

END OF SECTION

SECTION 26 2813 FUSES

PART 1 - GENERAL

1.1 RELATED WORK

A. Section 26 2413 - Switchboards

B. Section 26 2416.16 - Distribution Panelboards

C. Section 26 2816 - Enclosed Switches and Circuit Breakers

D. Section 26 2913 - Enclosed Controllers

1.2 REFERENCE

A. Work under this Section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and section under Division 01 General Requirements.

1.3 DESCRIPTION

A. Section includes nonrenewable cartridge fuses, rated 600V and less, for use in low-voltage power distribution system and spare fuse cabinet.

1.4 REFERENCE STANDARDS

A. NEMA FU 1 - Low Voltage Cartridge Fuses

B. UL 248-1 - Low Voltage Fuses - Part 1: General Requirements

C. UL 248-4 - Low-Voltage Fuses - Part 4: Class CC Fuses

D. UL 248-5 - Low-Voltage Fuses - Part 5: Class G Fuses

E. UL 248-8 - Low-Voltage Fuses - Part 8: Class J Fuses

F. UL 248-10 - Low-Voltage Fuses - Part 10: Class L Fuses

G. UL 248-12 - Low-Voltage Fuses - Part 12: Class R Fuses

H. UL 248-15 - Low-Voltage Fuses - Part 15: Class T Fuses

I. UL 248-17 – Low-Voltage Fuses – Part 17: Class CF Fuses

J. UL 4248 - Fuseholders

1.5 SUBMITTALS

A. Product Data:
   1. Submit the following for each fuse type and size indicated:
      a. Manufacturer's technical data on features, performance, electrical characteristics, ratings, and dimensions.

b. Time-current curves, selective coordination charts and tables, and related data.
c. Let-through current curves for fuses with current-limiting characteristics.
d. Fuse size for each elevator disconnect switch.

B. Closeout Submittals:
1. Project Record Documents:
a. Record actual class, size, and location of fuses.

1.6 QUALITY ASSURANCE

A. Obtain fuses from one source and by single manufacturer.

B. Comply with NFPA 70 for components and installation.

1.7 MAINTENANCE

A. Extra Materials:
1. Furnish to the Owner a quantity of spare fuses equal to 10% of the total quantity of each fuse class and size installed, minimum of 3 of each fuse class and size.
2. Furnish 2 fuse pullers for each size fuse.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Eaton Cooper Bussmann

B. Mersen

C. Littelfuse

2.2 CARTRIDGE FUSES

A. NEMA FU 1, UL 248-1.

B. Characteristics: nonrenewable current-limiting cartridge fuse; current rating and class, as specified or indicated, and voltage rating consistent with circuit voltage.

C. Miscellaneous data:

UL Standard	Class	Volts	Amperage	Interrupting Rating (Amp RMS Sym.)
248-4	CC	600	0-30	200,000
248-5	G	600	0-20	100,000
248-5	G	480	25-60	100,000
248-8	J	600	0-600	200,000
248-10	L	600	601-6000	200,000

UL Standard	Class	Volts	Amperage	Interrupting Rating (Amp RMS Sym.)
248-11	Plug	125	15-30	10,000
248-12	RK1	250 or 600	0-600	200,000
248-12	RK5	250 or 600	0-600	200,000
248-15	T	300	0-1200	200,000
248-15	T	600	0-800	200,000
248-17	CF	600	1-100	200,000

2.3 FUSEBLOCKS

A. UL 4248

B. Thermoplastic base with UL flammability 94VO

C. Clip reinforcing springs – 100A and above

D. 200,000 A RMS Sym short-circuit current rating

E. Copper or aluminum connections

2.4 FINGER SAFE FUSEHOLDERS

A. UL 4248

B. Thermoplastic base with UL flammability 94VO

C. Cover over fuses

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine utilization equipment nameplates and installation instructions. Install fuses of sizes and with characteristics appropriate for each piece of equipment.

3.2 INSTALLATION

A. Verify proper fuse locations, sizes, and characteristics.

B. Install fuses in fusible devices specified in other sections at job site.

C. Arrange fuses so manufacturer, class, and size are readable without removing fuse.

D. Install typewritten labels on inside door of each fused device, indicating fuse replacement information.

3.3 APPLICATION

A. Main Service: Class L

B. Main Feeders: Class L, Class J, or Class RK1 as indicated by Engineer

C. Motor Branch Circuits: Class J or Class RK1, dual element time delay

D. Transformer Primary Protection: Class J or Class RK1 dual element time delay

E. Other Branch Circuits: Class J or Class RK1, fast acting, current limiting or as indicated by Engineer

F. Lighting and Appliance Panelboard 208/120V, 1A-100A branch circuits: Class CF, Class CC or Plug

G. Lighting and Appliance Panelboard 480/277V, 1A-100A branch circuits: Class CF or Class CC

3.4 CLEANING

A. Clean fuses and tighten connections prior to energizing of equipment.

END OF SECTION

SECTION 26 2816 ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 RELATED WORK

A. Section 26 0519 – Low-Voltage Electrical Power Conductors and Cables

B. Section 26 0526 – Grounding and Bonding for Electrical Systems

C. Section 26 0529 – Hangers and Supports for Electrical Systems

D. Section 26 0553 – Electrical Systems Identification

E. Section 26 0812 – Power Distribution Acceptance Tests

F. Section 26 0813 – Power Distribution Acceptance Test Tables

G. Section 26 2813 – Fuses

1.2 REFERENCE

A. Work under this Section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.

1.3 DESCRIPTION

A. Section includes fusible and non-fusible disconnect switches and circuit breakers in individual enclosures.

1.4 REFERENCE STANDARDS

A. ANSI//NECA 1 - Standard Practices for Good Workmanship in Electrical Contracting

B. NEMA AB 1 - Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit Breakers Enclosures

C. NEMA KS 1 - Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum)

D. NFPA 70 - National Electrical Code

E. UL 98 - Enclosed and Dead Front Switches

F. UL 486A - 468B - Wire Connectors

G. UL 489 - Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit Breaker Enclosures

H. UL 869A - Reference Standard for Service Equipment

1.5 SUBMITTALS

A. Product Data:

1. Submit catalog cut sheet indicating voltage, amperage, HP ratings, enclosure type, and dimension, fuse clip features, terminal lugs and all accessories including interlock devices, short circuit current ampere rating and factory settings of individual protective devices.

B. Manufacturer's Installation Instructions:
   1. Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product.

C. Test Reports:
   1. Indicate field test and inspection procedures and interpret test results and corrective action taken for compliance with specification requirements.

D. Closeout Submittals:
   1. Project Record Documents:
      a. Record actual locations of disconnect switches and ratings of installed fuses.
      b. Record actual locations and continuous current ratings of enclosed circuit breakers.
   2. Operation and Maintenance Data:
      a. Include manufacturer's recommended operating instructions, maintenance procedures and intervals, and preventive maintenance instructions.
      b. Include spare parts data listing, source, and current prices of replacement parts and supplies.

1.6 QUALITY ASSURANCE

A. Obtain disconnect switches and enclosed circuit breakers from one source and by single manufacturer.

B. Regulatory Requirements:
   1. Comply with NFPA 70 for components and installation.
   2. Furnish products listed and classified by Underwriters Laboratories, Inc., as suitable for purpose specified and indicated.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Store in clean, dry space. Maintain factory wrapping or provide additional canvas or plastic cover to protect from dirt, water, construction debris, and traffic.

B. Comply with manufacturer's written instructions.

1.8 WARRANTY

A. Refer to Division 01 and Section 26 0000 – General Electrical Requirements for general warranty requirements.

B. Manufacturer shall provide standard 1 yr written warranty against defects in materials and workmanship for products specified in this Section. Warranty period shall begin on date of substantial completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Square D

B. General Electric

C. Cutler-Hammer

D. Siemens

E. Erickson Electric Company

2.2 DISCONNECT SWITCHES

A. NEMA KS 1, UL 98

B. Load interrupter enclosed knife switch, heavy-duty type.

C. Fusible or non-fusible type as indicated.

D. Switch Interiors:
   1. Switch blades that are visible in "OFF" position when switch door is open.
   2. Plated current carrying parts.
   3. Removable arc suppressors to permit easy access to line side lugs.

E. Switch Mechanism:
   1. Quick-make, quick-break, with visible blades and externally operable handle.
   2. Lockable only in “OFF” position and accept three industrial type, heavy-duty padlocks.
   3. Dual cover interlock to prevent unauthorized opening of switch door when handle is in "ON" position, and to prevent closing of switch mechanism with door open.
   4. Defeater mechanism to bypass interlock.
   5. Operating handle integral part of enclosure.
   6. Handle to physically indicate "ON" and "OFF" position.

F. Ratings:
   1. Ampacity as indicated on drawings.
   2. Minimum 10kA withstand rating for non-fusible switches
   3. Minimum 100kA withstand rating for fusible switches
   4. Horsepower rated.

G. Fusible Switches:
   1. Rejection clips for Class R fuses specified.
   2. Provisions for Class J or Class L fuses, as applicable.
   3. Fuses: Per requirements in Section 26 2813 – Fuses.

2.3 ENCLOSED CIRCUIT BREAKERS

A. NEMA AB 1, UL 489.

B. Enclosed molded-case circuit breakers:
   1. Tripped indication clearly shown on breaker handle taking position between “ON” and “OFF”.
   2. 225A frame size and below: thermal-magnetic trip.
   3. 250A frame size and above: electronic (solid-state microprocessor-based) trip units interchangeable in the field within the frame size and field-adjustable long time pick-up, long time delay, short time pick-up, short time delay, and instantaneous current settings. Each adjustment shall have discrete settings and shall be independent of other adjustments.
   4. Locking tabs on cover to allow breaker handle to be locked in the open or closed position. When locked cover is not allowed to be removed.

C. Breaker Mechanism:
   1. Quick-make, quick-break.

D. Ratings:
   1. Ampacity as indicated on drawings.
   2. Listed as Type HACR for air conditioning equipment circuits.
   3. Listed as Type SWD for lighting circuits.
   4. Interrupting rating as indicated on drawings. Minimum ratings unless otherwise noted:
      a. 208/120V: 22kA
      b. 480/277V: 42kA

2.4 LUGS

A. Front removable lugs.

B. Labeled for 75°C copper and aluminum conductors.

C. Multiple lugs to match number of conductors per phase.

D. Termination of field installed conductors: Pressure wire connectors, except wire-binding screws for #10 AWG or smaller conductors.

2.5 ACCESSORIES:

A. Solid neutral assembly, where required.

B. Equipment ground kit.

C. One set of normally open (NO) auxiliary contacts, where disconnect switch is installed at a remote motor served by any type of motor controller including full and reduced voltage starters, solid state soft starters and variable frequency drives.

2.6 ENCLOSURES

A. NEMA KS 1, NEMA AB 1, UL 98, UL 489, as applicable.

B. NEMA Type 1 (dry indoor locations)
   1. Code-gauge galvanized steel
   2. Manufacturer’s standard gray enamel finish over prime coat

C. NEMA Type 3R (intermittently wet indoor or outdoor locations)
   1. Code-gauge galvanized steel
   2. Manufacturer's standard gray enamel finish over prime coat

D. NEMA Type 4X (continuously wet or corrosive locations to include cooling towers)
   1. Code-gauge Type 316 stainless steel

E. Surface-mounted

2.7 SHORT CIRCUIT CURRENT RATING

A. Each circuit breaker shall have minimum short circuit current rating as indicated on drawings.

PART 3 - EXECUTION

3.1 COORDINATION WITH MANUFACTURER

A. Instruct manufacturer about the location of incoming lugs, i.e., top or bottom feed based on incoming feeder entrance location.

B. Verify that "touch-up" paint kit is available for repainting.

C. Provide watertight bolt-on hubs for top entry NEMA-3R and NEMA-4X enclosures.

3.2 EXAMINATION

A. Examine areas and surface to receive disconnect switches and enclosed circuit breakers for compliance with requirements, installation tolerances, and other conditions affecting performance. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Verify that space indicated for disconnect switches and enclosed circuit breakers mounting meets code-required working clearances.

C. Notify Architect/Engineer of any discrepancies prior to submittal of product data and shop drawings.

3.3 INSTALLATION

A. Install disconnect switches and/or enclosed circuit breakers in accordance with ANSI/NECA 1.

B. Install disconnect switches and/or enclosed circuit breakers level and plumb, in accordance with manufacturer's written instruction.

C. Disconnect switches and enclosed circuit breakers mounting:
   1. Fasten disconnect switches and enclosed circuit breakers firmly to walls and structural surfaces, ensuring they are permanently and mechanically anchored.
   2. Anchor and fasten disconnect switches and enclosed circuit breakers and their supports to building structural elements (wood, concrete, masonry, hollow walls and nonstructural building surfaces) by the methods described in Section 26 0529 – Hangers and Supports for Electrical Systems.
   3. Install two rows of steel slotted channel, with a minimum of four attachment points, for each disconnect switch and enclosed circuit breaker.

4. When not located directly on wall, install support frame of steel slotted channel anchored to floor and ceiling structure.

D. Do not support disconnect switches and/or enclosed circuit breakers by raceway.

E. Install top disconnect switch and/or enclosed circuit breaker handle a maximum of 6'-6" above finished floor.

F. Tighten electrical connectors and terminals according to equipment manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A - 486B.

G. Install engraved plastic nameplates under provisions of Section 26 0553 – Electrical Systems Identification. Attach nameplate to exterior of each switch and/or enclosed circuit breaker using small corrosion-resistant metal screws or rivets. Do not use contact adhesive.

1. Include switch and/or enclosed circuit breaker name, amperage, voltage, phase, and number of wires.

H. Install fuses in fusible switches at job site per requirements in Section 26 2813 – Fuses.

3.4 CONNECTIONS

A. Ground equipment according to Section 26 0526 – Grounding and Bonding for Electrical Systems.

B. Connect wiring according to Section 26 0519 – Low-Voltage Electrical Power Conductors and Cables.

3.5 FIELD QUALITY CONTROL

A. Inspect for physical damage, proper alignment connections, anchorage, and grounding.

B. Correct malfunctioning units on-site and retest to demonstrate compliance. Remove and replace with new units and retest.

C. Test disconnect switches and/or enclosed circuit breakers per requirements in Sections 26 0812 – Power Distribution Acceptance Tests and 26 0813 – Power Distribution Acceptance Test Tables.

D. Interpret test results in writing and submit to Engineer.

3.6 REPAINTING

A. Remove paint splatters and other marks from surface of equipment.

B. Touch-up chips, scratches, or marred finishes to match original finish, using manufacturer-supplied paint kit. Leave remaining paint with Owner.

3.7 ADJUSTING

A. Circuit Breakers: Set field-adjustable trip settings or change the trip settings, as provided by Engineer.

3.8 CLEANING

A. Vacuum dirt and construction debris from interior and exterior of equipment; do not use compressed air to assist in cleaning.

END OF SECTION

SECTION 26 2913 ENCLOSED CONTROLLERS

PART 1 - GENERAL

1.1 RELATED WORK

A. Section 26 0519 – Low-Voltage Electrical Power Conductors and Cables

B. Section 26 0526 – Grounding and Bonding for Electrical Systems

C. Section 26 0529 – Hangers and Supports for Electrical Systems

D. Section 26 0533 – Raceway and Boxes for Electrical Systems

E. Section 26 0553 – Electrical Systems Identification

F. Section 26 0812 – Power Distribution Acceptance Tests

G. Section 26 0813 – Power Distribution Acceptance Test Tables

H. Section 26 2813 – Fuses

1.2 DESCRIPTION

A. Section includes enclosed manual and magnetic motor controllers and enclosed contactors.

B. Motors shown on the drawings or specified in other Divisions of these specifications shall be provided with motorized equipment and connected under this section. Provide motor controllers and power circuit disconnect devices for all motors, unless shown or specified to be furnished with motorized equipment under other Divisions of these specifications, and/or by others, for installation by this contract.

C. Variable-frequency controllers furnished by Division 20 for installation by Division 26.

D. Motor Voltage Information:

1. Voltages available are: 120V single phase and 460 V, 3-phase. Circuits are designed for motors with voltage ratings as follows:
    a. Smaller than 1/2 hp motors: 115 V, single phase.
    b. 1/2 hp motors and larger: 460 V, 3-phase.

1.3 REFERENCE STANDARDS

A. ANSI/NECA 1 – Standard Practices for Good Workmanship in Electrical Contracting

B. NEMA AB 1 – Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit Breakers Enclosures

C. NEMA 250 – Enclosures for Electrical Equipment (1000 V Maximum)

D. NEMA ICS 2 – Industrial Control and Systems: Controllers, Contactors and Overload Relays, Rated Not More Than 2000 VAC or 750 VDC

E. NEMA ICS 4 – Industrial Control and Systems: Terminal Blocks

F. NEMA ICS 5 – Industrial Control and Systems: Control Circuit and Pilot Devices

G. NEMA ICS 6 – Industrial Control and Systems: Enclosures

H. NEMA KS 1 – Enclosed and Miscellaneous Distribution Equipment Switches (600 V Maximum)

I. NEMA MG 1 – Motors and Generators

J. NFPA 70 – National Electrical Code

K. UL 98 – Enclosed and Dead Front Switches

L. UL 486A-486B – Wire Connectors

M. UL 489 – Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit Breakers Enclosures

N. UL 508 – Industrial Control Equipment

1.4 SUBMITTALS

A. Product Data:
   1. Motor controllers: Submit catalog cut sheets showing voltage, size, rating and size of switching and overcurrent protective devices, dimensions, and enclosure details.
   2. Contactors: Submit catalog cut sheets showing voltage, size, current rating, dimensions, and enclosure details.
   3. Factory settings and time-current curves of individual protective devices.
   4. Confirm motor sizes and voltages with submittals of other Divisions of specifications, and/or by others, prior to Section submittals.

B. Manufacturer's Installation Instructions:
   1. Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and/or starting of product.

C. Test Reports: Indicate field test and inspection procedures and interpret test results and corrective action taken for compliance with specification requirements.

D. Closeout Submittals:
   1. Project Record Documents:
      a. Record actual locations and ratings of enclosed motor controllers and enclosed contactors.
   2. Operation and Maintenance Data:
      a. Include manufacturer's recommended operating instructions, maintenance procedures and intervals, and preventive maintenance instructions.
      b. Include spare parts data listing, source, and current prices of replacement parts and supplies.

1.5 QUALITY ASSURANCE

A. Obtain motor controllers, and contactors from one source and by single manufacturer.

B. Regulatory Requirements:
   1. Comply with NFPA 70 for components and installation.
   2. Furnish products listed and classified by Underwriters Laboratories, Inc., as suitable for purpose specified and indicated.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Store in clean, dry space. Maintain factory wrapping or provide additional canvas or plastic cover to protect units from dirt, water, construction debris, and traffic.

1.7 WARRANTY

A. Refer to Division 01 and Section 26 0000 – General Electrical Requirements for general warranty requirements.

B. Manufacturer shall provide standard 1 yr warranty against defects in materials and workmanship for products specified in this Section. Warranty period shall begin on date of substantial completion.

1.8 MAINTENANCE

A. Extra Materials: Furnish extra materials described below that match product installed, are packaged with protective covering for storage, and are identified with labels describing contents.
   1. Spare pilot lights: Furnish 1 spare lamp for every 5 installed units, but not less than 1 set of 3 of each kind.
   2. Spare Fuses: Furnish 6 spare fuses for each size installed.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Square D

B. General Electric

C. Cutler-Hammer

D. Siemens

E. Allen Bradley

2.2 MANUAL MOTOR CONTROLLERS

A. Description: NEMA ICS 2, AC general-purpose, Class A, manually operated, full-voltage controller for small motors, with bimetal type overload relay and pushbutton operator.

2.3 FULL-VOLTAGE NON-REVERSING MAGNETIC MOTOR CONTROLLERS

A. Description: NEMA ICS 2, AC general-purpose, Class A, magnetic controller for induction motors rated in horsepower, three-phase and single-phase, as scheduled, except where single-phase motors scheduled to be provided with built-in overload elements:
   1. Size 1 minimum

2. Control Voltage: 24VAC, 60 Hz
3. Overload Relays: NEMA ICS 2, solid-state:
    a. Solid-state type:
        1) Class 10, 20 selectable inverse-time tripping characteristics.
        2) Non-volatile operating memory.
        3) 3:1 current adjustment range.
        4) Phase loss/phase unbalance protection.
        5) Ambient temperature insensitive.
        6) Self-powered.
        7) Manual reset. Automatic reset not acceptable.
        8) Manual trip.
        9) Visible trip indication.
4. Features:
    a. Auxiliary Contacts: NEMA ICS 2, 2 each field-convertible contacts in addition to seal-in contact.
    b. Red mushroom type E-Stop button
    c. Pilot Lights NEMA ICS 5: push-to-test LED incandescent or LED type. Red for running, green for off.
    d. Hand-Off-Auto (H-O-A) Selector Switches: Rotary type.
    e. Control Power Transformers: 120V secondary, adequate capacity to operate connected pilot, indicating and control devices, plus 100% spare capacity in each motor controller, but not less than 150VA. Fused primary and secondary, and unfused leg of secondary bonded to enclosure.
    f. Terminals: NEMA ICS 4.
    g. Other accessories detailed or required by drawings.

2.4 COMBINATION CONTROLLERS

A. Factory-assembled motor controllers with externally operable disconnect, fusible switch type, in common enclosure; means for locking disconnect handle and means for defeating cover interlock.
    1. Fusible Switch: NEMA KS 1 and UL 98; enclosed knife switch, heavy-duty type, external operable handle, clips or pads to accommodate specified fuses:
        a. Rejection clips for Class R fuses.
        b. Provisions for Class J type fuses.

2.5 MOTOR CONTROLLER ACCESSORIES

A. Factory installed devices in controller enclosure, unless otherwise indicated, as follows:
    1. 24 VAC control circuits and pilot light, unless noted otherwise.
    2. Red pilot light to indicate motor operation.
    3. Green pilot light to indicate motor stopped.
    4. Minimum wire size for control circuits: #14 AWG.
    5. Stop and Lockout Pushbutton Station: Momentary-break pushbutton station with a factory-applied hasp arranged so a padlock can be used to lock pushbutton in depressed position with control circuit open, where indicated.

B. Control services: As scheduled on motor schedule or indicated.

2.6 LUGS

A. Labeled for 75°C copper and aluminum conductors.

B. Multiple lugs to match number of conductors per phase.

C. Termination of field installed conductors: Pressure wire connectors, except wire-binding screws for #10 AWG or smaller conductors.

D. For equipment specified in this section and for equipment furnished under other Divisions of this specification and/or by others.

2.7 MOTOR CONTROLLERS AND CONTACTOR ENCLOSURES

A. NEMA 250, NEMA 1CS 6.

B. NEMA Type 1, Type 3R (outdoor locations) enclosure.

C. NEMA-4X for corrosive environments including cooling towers.

D. Code-gauge galvanized steel.

E. NEMA-4X enclosure is to be Type 316 Stainless Steel.

F. Manufacturer's standard gray enamel finish over prime coat.

G. Surface-mounted.

PART 3 - EXECUTION

3.1 COORDINATION

A. Coordinate motor control wiring with Division 23 of these specifications.

B. Coordinate motor sizes and voltages with submittals of other Divisions of these specifications and/or by others.

C. Verify with manufacturer that "touch-up" paint kit is available for repainting.

3.2 EXAMINATION

A. Examine areas and surface to receive motor controllers and contactors for compliance with requirements, installation tolerances, and other conditions affecting performance. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Verify that space indicated for motor controllers and contactors mounting meets code-required working clearances.

C. Notify Architect/Engineer of any discrepancies prior to submittal of product data.

3.3 INSTALLATION

A. Install motor controllers and contactors in accordance with ANSI/NECA 1.

B. Install level and plumb, in accordance with manufacturer's written instruction.

C. Motor controllers and contactors mounting and seismic restraints:
   1. Install motor controllers and contactors anchorage devices and seismic restraints based on design by an Engineer registered and licensed in the State of Illinois and to comply with Section 26 0548 – Vibration and Seismic Controls for Electrical Systems for seismic criteria.
   2. Fasten motor controllers and contractors firmly to walls and structural surfaces, ensuring they are permanently and mechanically anchored.
   3. Anchor and fasten motor controllers and contactors and their supports to building structural elements (wood, concrete, masonry, hollow walls and nonstructural building surfaces) by the methods described in Section 26 0529 – Hangers and Supports for Electrical Systems.
   4. Install two rows of steel slotted channel, with minimum of four attachment points, for each motor controller and contactor.
   5. When not located directly on wall, install support frame of steel slotted channel anchored to floor and ceiling structure.
   6. Do not support motor controllers and contactors only by raceway.

D. Tighten electrical connectors and terminals according to equipment manufacturer's published torque-tightening valves. Where manufacturer's torque valves are not indicated, use those specified in UL 486A-486B.

E. Install engraved plastic nameplates under provisions of Section 26 0553 – Electrical Systems Identification. Attach nameplate to exterior of each motor controller and contactor, using small corrosion resistant metal screws or rivets. Do not use contact adhesive:
   1. Indicate motor served, nameplate horsepower, full load amperes, code letter, service factor, voltage/phase rating, and fuse size and type, when applicable.

F. Connect each motor terminal box to rigid conduit system with maximum 18" of flexible liquid-tight metal conduit. Install conduit per requirements in Section 26 0533 – Raceway and Boxes for Electrical Systems.

G. Check for proper rotation and phase relationship of each motor.

H. Install fuses in fusible switch at job site pre requirements in Section 26 2813 – Fuses.

I. Control Wiring Installation:
   1. Install wiring between motor control devices according to Section 26 0519 – Low-Voltage Electrical Power Conductors and Cables.
   2. Install motor control wiring in accordance with control wiring diagrams and in raceways where indicated or required by contract drawings.
   3. Bundle, train, and support wiring in enclosures.
   4. Connect hand-off-automatic switch and other automatic-control devices where applicable.
      a. Connect selector switches to bypass only manual- and automatic-control devices that have no safety functions when switch is in hand position.
      b. Connect selector switches with motor-control circuit in both hand and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor overload protectors.

3.4 APPLICATION

A. Select features of each motor controller to coordinate with ratings and characteristics of supply circuit and motor; required control sequence; duty cycle of motor, and configuration of pilot device and control circuit affecting controller functions.

3.5 CONNECTIONS

A. Provide green wire ground through flexible conduit to interconnect motor frame and rigid conduit system.

B. Ground and bond motor controller and contactor enclosures according to Section 26 0526 – Grounding and Bonding for Electrical Systems.

C. Connect power and control wiring according to Section 26 0519 – Low-Voltage Electrical Power Conductors and Cables.

D. Connect control wiring for operation, control and supervision of motorized equipment as shown on drawings and/or specified in this and other Divisions of these specifications.

3.6 FIELD QUALITY CONTROL

A. Inspect motor controllers and contactors for physical damage, proper alignment, connections, anchorage, seismic restraints and grounding.

B. Correct malfunctioning motor controllers and contactors on-site and retest to demonstrate compliance. Remove and replace with new units and retest.

C. Test continuity of each circuit.

D. Test motor controllers per requirements in Sections 26 0812 – Power Distribution Acceptance Tests and 26 0813 – Power Distribution Acceptance Test Tables.

E. Interpret test results in writing and submit to Engineer.

3.7 REPAINTING

A. Remove paint splatters and other marks from surface of equipment.

B. Touch-up chips, scratches or marred finishes to match original finish, using manufacturer-supplied paint kit. Leave remaining paint with Owner.

3.8 ADJUSTING

A. Set field-adjustable circuit breakers trip settings or change the trip settings as indicated on drawings.

B. Adjust motor circuit protectors.

3.9 CLEANING

A. Vacuum dirt and construction debris from interior and exterior of equipment; do not use compressed air to assist in cleaning.

END OF SECTION

SECTION 265113 - LIGHTING FIXTURES AND LAMPS

1. GENERAL

A. Furnish and install all lighting fixtures, as herein specified, complete with accessories for safe and effective operation. All fixtures shall be installed and left in an operable condition with no broken, damaged or soiled parts.

B. All items furnished shall comply with the latest standards applicable such as U.L., NEMA, etc., and shall bear labels accordingly. All fixtures shall be the color specified or as selected by the Architect. Wherever fixtures have evident damage, they shall be restored to new condition or shall be replaced. Likewise, fixtures showing dirt, dust or fingerprints shall be restored to new condition or shall be replaced.

C. A PDF copy of light fixture factory shop drawings and cuts, showing fixture dimensions, photometric data, installation data and, if applicable, air handling data, shall be submitted to the Engineer for written approval 30 days after bid date. (Submission shall be made via the University's online project management system.)

D. Locate pendant, surface mounted or chain-hung industrial fixtures in mechanical rooms and similar spaces to avoid ductwork and piping. Locate around and between equipment to maximize the available light. Request a layout from the Engineer if uncertain about an installation.

E. Alternate fixtures may be substituted for types specified by name or catalog number. Proposed substitutions must be submitted to the Engineer ten working days prior to bid date for written approval to bid. This written approval will only be issued in addendum form.

F. Where emergency battery packs are provided with fixtures (if any), they shall be connected to an unswitched power line and wired in accord with the manufacturer's recommendations. Test buttons and indicator lamps shall be visible and accessible with fixture door open, or shall be remotely flush mounted in the ceiling adjacent to the fixture.

G. Where remote emergency lighting transfer relays are provided, they shall be flush mounted in the ceiling adjacent to a controlled fixture. They shall be connected to an unswitched power line and installed in accord with the manufacturer's recommendations. Test buttons and indicator lamps shall be visible and accessible without removing ceiling tiles or access panels.

H. All reflecting surfaces, glass or plastic lenses, downlighting cones and specular reflectors shall be handled with care during installation to avoid fingerprints or dirt deposits. It is preferred that louvers be shipped and installed with clear plastic bags to protect louvers. At close of project, and after construction air filters are changed, remove bags. Any louver or cone showing dirt or fingerprints shall be cleaned with solvent recommended by the manufacturer to a like-new condition, or replaced as necessary in order to turn over to the Owner new fixtures at beneficial occupancy.

I. Refer to architectural details as applicable for recessed soffit fixtures or wherever fixture installations depend upon work of other trades. Coordinate all installations with other trades. Verify dimensions of spaces for fixtures, and if necessary, adjust lengths to assure proper fit and illumination of diffuser and/or area below.

J. Warranty shall start at Project Substantial Completion.

2. VOLTAGE

A. All lighting fixtures will be rated 120 volts.

3. LED FIXTURES

A. LED SOURCES

1. LED's shall be manufactured by a manufacturer who has produced commercial LEDs for a minimum of five (5) years.

2. Lumen Output – minimum initial delivered lumen output of the luminaire shall be as follows for the lumens exiting the luminaire in the 0-360 degree zone - as measured by IESNA Standard LM-79-08 in an accredited lab. Exact tested lumen output shall be clearly noted on the shop drawings.

3. Lumen output shall not decrease by more than 20% over the minimum operational life of 50,000 hours at the rated ambient operating temperature.

4. Individual LEDs shall be connected such that a catastrophic loss or the failure of one LED will not result in the loss of the entire luminaire.

5. LED Boards shall be suitable for field maintenance and have with plug-in connectors. LED boards shall be upgradable

6. Light Color/Quality:
   a) Correlated Color temperature (CCT) range as per specification, between 3000K, 3500K and 4000K shall be correlated to chromaticity as defined by the absolute (X,Y) coordinates on the 2-D CIE chromaticity chart.
   b) Color shift over 6,000 hours shall be <0.007 change in u' v' as demonstrated in IES LM80 report.
   c) The color rendition index (CRI) shall be 80 or greater
   d) LED boards to be tested for color consistency and shall be within a space of 2.5 MacAdam ellipses on the CIE chromaticity chart.

B. LED DRIVERS

1. Driver: Acceptable manufacturer: eldoLED, Sylvania, or Philips that meet or exceed the criteria herein.

2. Ten-year expected life while operating at maximum case temperature and 90 percent non-condensing relative humidity.

3. Driver should be UL Recognized under the component program and shall be modular for simple field replacement.

4. Electrical characteristics: 120 volt, UL Listed, CSA Certified, Sound Rated A+. Driver shall be > 80% efficient at full load across all input voltages. Input wires shall be 18AWG solid copper minimum.

5. Dimming: Driver shall be suitable for full-range dimming. The luminaire shall be capable of continuous dimming without perceivable flicker over a range of 100 percent to 0.1 percent of rated lumen output with a smooth shut off function unless specifically scheduled otherwise.

6. Dimming shall be controlled by a 0-10V signal unless specifically scheduled.

7. Driver shall include ability to provide no light output when the control signal drops below 0.5 V, and shall consume 0.5 watts or less in this standby.

8. Driver shall be capable of configuring a linear or logarithmic dimming curve.

9. Drivers shall track evenly across multiple fixtures at all light levels, and shall have an input signal to output light level that allows smooth adjustment over the entire dimming range regardless of the controller type

10. Flicker: Driver and luminaire electronics shall deliver illumination that is free from objectionable flicker as measured by flicker index (ANSI/IES RP-16-10). At all points within the dimming range from 100-0.1 percent luminaire shall have: Less than 1 percent flicker index at frequencies below 120 Hz and less than 12 percent flicker index at 120 Hz, and shall not increase at greater than 0.1 percent per Hz to a maximum of 80 percent flicker index at 800Hz

11. Driver disconnect shall be provided where required to comply with codes.

C. LED ELECTRICAL

1. THD: Total harmonic distortion (current and voltage) induced into an AC power line by a luminaire shall not exceed 20 percent at any standard input voltage and meet ANSI C82.11 maximum allowable THD requirements.

2. Surge Suppression: The luminaire shall include surge protection to withstand high repetition noise and other interference. Withstand up to a 1,000 volt surge without impairment of performance as defined by ANSI C62.41 Category A. To reduce false circuit breaker tripping due to turn on inrush, the following statement ensures that electronic dimming driver will meet NEMA inrush recommendations.

3. Rush Current: Meet or exceed NEMA 410 driver inrush standard of 430 Amps per 10 Amps load with a maximum of 370 Amps2 – seconds.

4. RF Interference: The luminaire and associated on-board circuitry must meet Class A emission limits referred in Federal Communications Commission (FCC) Title 47, Subpart B, Section 15 Non-Consumer requirements for EMI/RFI emissions

5. Driver must support automatic adaptation, allowing for future luminaire upgrades and enhancements and deliver improved performance.

6. Power Factor: The luminaire shall have a power factor of 90% or greater at all standard operating voltages and full luminaire output.

4. LIGHT FIXTURE GENERAL REQUIREMENTS

A. Recessed Lighting Fixtures - General Requirements

1. The following are minimum requirements for recessed fixtures for lay-in grid, gypsum board, plaster and concealed spline ceilings. Surface-mounted fixture requirements shall be similar.

2. Housings shall be a minimum of 4" depth, premium grade, constructed of a minimum 22 gauge die embossed or stiffened cold rolled pre-treated rust-resistant steel.

3. All parts shall be finished with polyester powder or white baked enamel (85% minimum reflectance) painted after fabrication. All wiring shall be type TFN, or THWN and shall be covered by the steel driver cover or wiring channel. Exposed wiring is not acceptable. Connection wiring shall be accessible thru a hinged access plate above driver channel in top of unit.

4. The complete light fixture unit shall be UL listed and labeled. Other agency listings may be acceptable with written approval from the Engineer.

5. Fixture lens doors shall be reversible, hinged, painted after fabrication, with spring-loaded or other mechanically stable positive action latches.

6. Lens shall be as specified for each fixture type. If a specific manufacturer and series number of lens is listed, the substitute shall be of the exact specification (thickness, prism configurations, transparency, efficiency, photometric distribution, hardness, vandal-resistance, etc.). Minimum average thickness of any prismatic lens shall be .125".

7. Fixture trim and/or flanges shall conform with ceiling constructions as required. Verify all types prior to submission of shop drawings and indicate any special types on submittals. Fixtures installed in drywall or plaster ceilings to be provided with flange, screed and swing gate anchoring system.

8. All fixtures shall be furnished with hold down clips to meet applicable seismic codes, four clips per fixture minimum or the equivalent thereof in the installation trim. Verify thickness of drywall or plaster ceilings prior to submission of shop drawings, to allow for proper trim adjustment.

9. Support fixtures with one hanger wire at each end. Hanger wires shall be installed within 15° of plumb, maximum or additional support shall be provided. Wires shall be attached to the fixture body and to the building structure - not to the supports of other work or equipment.

10. Each type of lay-in fixture shall be furnished with the proper housing flange or lip to suit the type of lay-in grid(s) being utilized on the project. The Contractor is to verify if narrow or standard grid members are being furnished and provide the proper type of light fixture trim. Indicate any special trims on shop drawing submittals.

B. Industrial and Striplight Fixtures - General Requirements

1. Units shall have die-formed heavy gauge cold rolled steel channels and die-embossed reflectors.

2. Finishes to be coated with a gloss powder paint or baked enamel finish with a minimum 85% reflectance.

3. Units to have aligner clips where required for a continuous row appearance. Where continuous rows exceed twelve feet in length, provide a "unistrut" channel or similarly adequate mounting to stiffen and align row.

4. Units to have captive latches for all covers and wire guards where specified. Wire guards shall be heavy-duty #14 wire gauge minimum with corrosion-resistant plated or vinyl finish.

5. Units to be UL listed.

6. Mounting brackets and hanging mechanisms shall be as specified in fixture descriptions, or as required. Allow a generous safety margin with all support systems, as recommended by the manufacturer.

C. Recessed Downlight - General Requirements

1. Fixture to have an extruded or die-cast aluminum housing. Retaining mechanism shall provide easy access to LED array and driver box.

2. Unit to have a corrosion-resistant steel junction box with hinged access covers and thermal protector.

3. Mounting/plaster frame to be heavy gauge steel with finishing trim friction support springs, for the required ceiling thickness. Trim to be of color as selected by the Architect.

4. Optical system to consist of a sealed LED module with diffuser.

5. Provide telescoping channel bar hangers that adjust vertically and horizontally.

6. Fixtures to be UL listed for thru-branch circuit wiring, recessed, and damp locations. Where installed in plaster or drywall or other inaccessible ceiling type, they shall be U.L. listed for bottom access.

D. Exit Lights - General Requirements

1. Housings and canopies shall be die-cast aluminum or corrosion resistant steel. Edge-lit clear acrylic panel shall be provided where scheduled. Mountings shall be wall or ceiling, universal type, to suit the installation conditions.

2. Provide with stencil face, lettering color red, of sizes in accord with code, or as otherwise specified.

3. Provide single or double face as scheduled, indicated on plans or as required by the local authority having jurisdiction. Adjust installation position if required for clear visibility, in accord with applicable codes.

4. Complete unit to be finished in color as selected by the Architect.Provide directional arrows as indicated on plans, as scheduled to suit the means of egress or as required by the local authority having jurisdiction.

5. All exit signs shall be long life LED type.

6. Where emergency backup battery packs are provided with exit lights, they shall have capacities for continuous operation per applicable codes. They shall have reserve battery capacity to operate remote lamps where indicated.

5. LIGHTING FIXTURE SCHEDULE

A. Refer to the contract drawings for Lighting Fixture Schedule

6. CONTROLS

A. Refer to Specification 260923-Lighting Control Devices.
B. Refer to Specification 260943-Network Lighting Controls.

END OF SECTION

SECTION 27 0000 GENERAL COMMUNICATIONS REQUIREMENTS

PART 1 - GENERAL

1.1 REFERENCE

A. The Work under this Section and related sections is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 1 General Requirements.

B. This section specifies a system or a component of a system being commissioned as defined in Section 01 91 00 Commissioning. Testing of these systems is required, in cooperation with the Owner and the Commissioning Authority. Refer to Section 01 91 00 Commissioning for detailed commissioning requirements.

1.2 DESCRIPTION

A. Intent of drawings and specifications is to obtain complete systems tested, adjusted, and ready for operation.

B. Except as otherwise defined in greater detail, terms "provide", "furnish" and "install" as used in Division 27 contract documents shall have the following meanings:

1. "Provide" or "provided" shall mean "furnish and install".
2. "Furnish" or "furnished" does not include installation.
3. "Install" or "installed" does not include furnishing.

C. Include incidental details not usually shown or specified, but necessary for proper installation and operation.

D. Division 26 contractor is responsible for all cable tray, conduits, back boxes, and pull boxes required for Division 27 scope.

E. Check, verify and coordinate work with drawings and specifications prepared for other trades. Include modifications, relocations or adjustments necessary to complete work or to avoid interference with other trades.

F. Included in this contract are connections to equipment provided by others. Refer to Architectural, Electrical, Integrated Automation, Mechanical, Security and final shop drawings for equipment being furnished under other sections for exact locations of outlets and various connections required.

G. Information given herein and on drawings is as exact as could be secured but is not guaranteed. Do not scale drawings for exact dimensions.

H. Where architectural features govern location of work, refer to architectural drawings.

I. All work shall be performed in "neat and workmanlike" manner as defined in ANSI/NECA 1 "Standard Practices for Good Workmanship in Electrical Contracting".

1.3 RELATED WORK

A. Related Division 27 Sections include:

1. Section 27-0526 - Grounding and Bonding for Communications Systems
2. Section 27-0528.29 - Hangers and Supports for Communications Systems
3. Section 27 0528.33 - Raceway and Boxes for Communications Systems
4. Section 27-0528.36 - Cable Tray for Communications Systems
5. Section 27 0537 Communications System Firestopping
6. Section 27-0553 - Communications Systems Identification
7. Section 27-1100 - Communications Equipment Room Fittings
8. Section 27-1500 - Communications Horizontal Cabling

B. Related sections in other Divisions of Work:
   1. Section 26 0000 – General Electrical Requirements
   2. Section 26-0529 - Hangers and Supports for Electrical Systems
   3. Section 26 0533 – Raceway and Boxes for Electrical Systems
   4. Section 26-0536 - Cable Trays for Electrical Systems
   5. Section 26 0593 – Electrical Systems Firestopping
   6. Also see individual technical sections identified above.

C. Temporary Services:
   1. Refer to Division 01 - Temporary Facilities and Controls.

D. Continuity of Service:
   1. No service shall be interrupted or changed without permission from Architect and Owner. Obtain written permission before work is started.
   2. When interruption of services is required, persons concerned shall be notified and shall agree upon a time.

E. Cleaning and Repair:
   1. Clean and repair existing materials and equipment that remain or is to be reused.

F. Demolition:
   1. Division 01 - Selective Demolition.
      a. Not applicable to this Division of work.
   2. Division 02 - Building Demolition
      a. Not applicable to this Division of work.
   3. Perform demolition as shown on drawings to accomplish new work (if applicable).
      a. Remove abandoned wiring to source of supply.
         1). Coordinate with Owner for disconnecting wiring at associated cross-connect.
      b. Disconnect outlets and remove devices as shown on drawings.
      c. Remove abandoned outlets if conduit servicing them is abandoned and removed.
      d. Provide blank cover for abandoned boxes that are not removed.
      e. Disconnect communications systems in walls, floors, and ceilings scheduled for removal.
   4. Accomplish work in neat workmanlike manner to minimize interference; annoyance or inconvenience such work might impose on Owner or other contractors.
   5. Unless otherwise noted, remove from premises materials and equipment removed in demolition work.

a. Equipment noted to be removed and turned over to Owner shall be delivered to Owner at place and time Owner designates.

b. Where materials are to be turned over to Owner or reused and installed by Contractor, it shall be Contractor's responsibility to maintain condition of materials and equipment equal to that existing before work began. Repair or replace damaged materials or equipment at no additional cost to Owner.

6. Where demolition work interferes with Owner's use of premises, schedule work through Architect, Owner and with other contractors to minimize inconvenience to Owner. Architect must approve schedule before Contractor begins such work.

1.4 REQUIREMENTS OF REGULATORY AGENCIES

A. Rules and regulations of Federal, State and local authorities and utility companies, in force at time of execution of contract shall become part of this specification.

1.5 REFERENCES AND STANDARDS

A. Design, cable and component selection, and installation practices shall conform with following:
   1. ANSI/NFPA 70 - National Electrical Code
   2. Local Electrical Code
   3. Country, state and local health, safety and building codes
   4. UL 444 - Communications Cables
   5. University of Kentucky - Communications and Network Systems – Telecommunications Standards (latest version)
   6. BICSI Telecommunications Distribution Methods Manual (TDMM)

B. Agencies or publications referenced herein refer to the following:
   1. ANSI American National Standards Institute
   2. ASME American Society of Mechanical Engineers
   3. ASTM American Society for Testing and Materials
   4. BICSI Building Industry Consulting Services International
   5. EIA Electronic Industries Alliance
   6. FIPS Federal Information Processing Standards
   7. FCC Federal Communications Commission
   8. ICEA Insulated Cable Engineers Association
   9. IEEE Institute of Electrical and Electronics Engineers
   10. JCAHO Joint Commission on Accreditation of Healthcare Organizations
   11. NEC National Electrical Code
   12. NECA National Electrical Contractors Association
   13. NEMA National Electrical Manufacturers Association
   14. NESC National Electrical Safety Code
   15. NETA National Electrical Testing Association
   16. NFPA National Fire Protection Association
   17. NIST National Institute of Standards and Technology
   18. OSHA Occupational Safety and Health Administration
   19. TIA Telecommunications Industry Association

20. UL Underwriters Laboratories, Inc.

C. Work shall be in accordance with latest edition of codes, standards or specifications unless noted otherwise.

1.6 DEFINITIONS

A. The following definitions are applicable to communications environments and shall apply to this document and its companion sections for clarification and direction.
   1. Entrance facility - an entrance to building for both public and private network service cables and/or wireless services including entrance point of building and continuing to Entrance Room.
   2. Entrance Room - room where both public and private network service cables and/or wireless services are terminated. Service provider(s) point-of-demarcation (DEMARC) is typically located here.
   3. Equipment Room (Telecom): an environmentally controlled centralized space for telecommunications equipment that usually houses main or intermediate cross-connect. Backbone cabling, cabling to Building Entrance and horizontal cabling may be terminated here.
   4. Equipment Intermediate Distribution Facility – Centralized space for security, building automation, fire alarm and/or other low-Voltage equipment.
   5. Guarantee - promise or an assurance that attests to quality or durability of product or service or that task will be performed in specified manner. Used interchangeably with "Warranty" in these documents.
   6. Intra-building - within single building.
   7. Inter-building - between 2 or more buildings.
   8. IP Telephony – Use of Internet Protocol (IP) for two-way transmission of conversations. Sometimes referred to as “Voice over Internet Protocol (VoIP)”.
   9. Rack Unit - standard measurement of vertical mounting space on an equipment rack. Each Rack Unit is 1-3/4” high.
   10. Voice over Internet Protocol – See IP Telephony.

B. Typical NEMA Enclosures and Usage
   1. Refer to Section 26 0000 – General Electrical Requirements.
   2. NEMA 1 - Indoors. Falling dirt
   3. NEMA 2 - Indoors. Falling dirt. Falling liquids. Light splashing
   4. NEMA 3 - Outdoors. Sleet, snow, rain. Windblown dust
   5. NEMA 3X - Same as NEMA 3 plus corrosion resistant
   6. NEMA 3S - Same as NEMA 3 plus mechanism operable when ice covered
   7. NEMA 3SX - Same as NEMA 3S plus corrosion resistant
   8. NEMA 3R - Outdoors. Rain, snow, sleet
   9. NEMA 3RX - Same as NEMA 3R plus corrosion resistant
   10. NEMA 4:
      a. Indoors - Falling dirt. Falling and light splashing liquids. Flying dust, lint and fibers. Hose down
      b. Outdoors - Rain, sleet, snow. Wind blown dust. Hose down
   11. NEMA 4X - Same as NEMA 4 plus corrosion resistant
   12. NEMA 5 - Indoors. Falling Dirt. Falling Liquids. Settling dust, lint and fibers

13. NEMA 6:
    a. Indoors - Falling dirt. Falling and light splashing liquids. Flying dust, lint and fibers. Hose down. Temporary submersion.
    b. Outdoors - Rain, snow, sleet. Windblown dust. Hose down. Temporary submersion.
14. NEMA 6P:
    a. Indoors - Same as NEMA 6 / Indoors plus corrosion resistant. Prolonged submersion.
    b. Outdoors - NEMA 6 /Outdoors plus corrosion resistant. Prolonged Submersion.
15. NEMA 7 - Indoors. Class I, Division 1 or 2, Groups A, B, C or D. (Flammable gas).
16. NEMA 9 - Indoors. Class II, Division 1 or 2. Groups E, R, or G. (Combustible dust).
17. NEMA 12 - Indoors. Falling Dirt. Falling liquids. Flying dust, lint and fibers. Oil or coolant seepage.
18. NEMA 13 - Same as NEMA 12 plus oil or coolant spraying or splashing.]

1.7 ABBREVIATIONS AND ACRONYMS

A. The following abbreviations and acronyms shall apply to this document and its companion sections for clarification and direction.

1.	AC	Access Control
2.	AFF	Above Finished Floor
3.	AP	Wireless Access Point
4.	ATM	Asynchronous Transfer Mode
5.	AWG	American Wire Gauge
6.	BAS	Building Automation Systems
7.	BDF	Building Distribution Facility
8.	BEF	Building Entrance Facility
9.	BTU	British Thermal Unit
10.	CATV	Community Antenna Television
11.	CCTV	Closed-Circuit Television
12.	CFOI	Contractor Furnished, Owner Installed
13.	CDDI	Copper Distributed Data Interface (Cisco Systems trade name for TP-PMD)
14.	cm	centimeters
15.	CNS	UK- Communications and Network Systems
16.	°C	degrees Celsius
17.	°F	degrees Fahrenheit
18.	DTMF	Dual Tone Multi Frequency
19.	EIA	Electronic Industries Alliance
20.	EBDF	Equipment Building Distribution Facility
21.	EIDF	Equipment Intermediate Distribution Facility
22.	EMT	Electrical Metallic Tubing
23.	FDDI	Fiber Distributed Data Interface
24.	ft	feet
25.	FTP	Foiled Twisted Pair
26.	GbE	Gigabit Ethernet

27. 10GbE 10 Gigabit Ethernet
28. HCP Horizontal Connection Point
29. Hz Frequency in Hertz (k = kilo, M = Mega, G = Giga)
30. ID Inside Diameter
31. IDF Intermediate Distribution Facility
32. in inch
33. kg kilogram
34. lbs pounds
35. LAN Local Area Network
36. MATV Master Antenna Television
37. MC Main Cross-connect
38. m meters
39. mm millimeters
40. Mbps Megabits per second
41. µm micrometer (10^{-6} meter)
42. OD Outside Diameter
43. PBX Private Branch Exchange (Telephone Switch)
44. pF pico-Farad (10^{-12} Farad)
45. PVC Polyvinyl Chloride
46. RGC Rigid Galvanized Conduit
47. RU Rack Unit
48. SCS Structured Cable System
49. sq ft square feet (area)
50. TGB Telecommunications Grounding Busbar
51. TMGB Telecommunications Main Grounding Busbar
52. TP-PMD Twisted Pair Physical Layer Medium
53. UTP Unshielded Twisted Pair
54. WAN Wide Area Network
55. WAO Work Area Outlet
56. WLAN Wireless Local Area Network
57. VoIP Voice over Internet Protocol

B. Refer also to technical sections for additional terminology.

1.8 WORK BY OWNER

A. Owner will:
   1. Furnish active LAN electronics for interface with building voice and data cabling systems.
   2. Provide and install owner-furnished patch cords within IDF rooms, or distribute owner-furnished patch cords to appropriate vendors for installation.
   3. Coordinate all third-party vendor equipment and installation not included in Division 27 Specifications and drawings

1.9 LISTING

A. Refer to technical sections of this Division of work for listing requirements.

1.10 SUBMITTALS

A. Submit shop drawings for equipment provided under this Section:
   1. Refer to Division 01 - Submittal Procedures.
   2. Submit shop drawings for equipment and systems as requested in respective specification sections. Submittals which are not requested may not be reviewed.
   3. Mark general catalog sheets and drawings to indicate specific items submitted.
   4. Include proper identification of equipment by name and/or number, as indicated in specification and shown on drawings.
   5. When manufacturer's reference numbers are different from those specified, provide correct cross-reference number for each item. Submittals shall be clearly marked and noted accordingly.
   6. Submittals should be grouped to include complete documentation of related systems, products and accessories in single submittal. Where applicable, dimensions shall be marked in units to match those specified.
   7. Submittals shall be in electronic form (ADOBE *Acrobat* PDF) or on paper.
      a. Paper documents shall be original catalog sheets or photocopies thereof.
      b. Facsimile (fax) sheets will not be accepted.
      c. When multiple products are shown on a page, clearly indicate what item is proposed for use.
   8. When equipment and items specified include accessories, parts and additional items under one designation, submittals shall be complete and include required components.
   9. Include wiring diagrams for electrically powered or controlled equipment.
   10. Submit equipment room layouts drawn to scale, including equipment, raceways, accessories and clearance for maintenance.
   11. Where submittals cover products containing potentially hazardous non-metallic materials, include "Material Safety Data Sheet" (MSDS) from manufacturer stating physical and chemical properties of components and precautionary considerations required.
   12. "Coordination Drawings", shall be specifically prepared for Divisions 20, 21, 22 and 23 (all trades) to facilitate installation of new work. Refer to Division 1 for additional requirements.
   13. Submit shop drawings or product data as soon as practicable after signing contracts. Submittals must be approved before installation of materials and equipment.
   14. Submittals, which are not complete, not permanent, or not properly checked by Contractor, will be returned without review.

B. Certificates and Inspections:
   1. Obtain and pay for inspections required by authorities having jurisdiction and deliver certificates approving installations to Owner unless otherwise directed.

C. Operation and Maintenance Manuals:
   1. Refer to Division 01 - Closeout Procedures.
   2. Upon completion of work but before final acceptance of system, submit to Architect for approval, 3 copies of operation and maintenance manuals in loose-leaf binders. If "one copy"

is larger than 2" thick or consists of multiple volumes, submit only one set initially for review. After securing approval, submit 3 copies to Owner.

3. Manuals shall be organized by specification section number and shall have table of contents and tabs for each piece of equipment or system.
4. Manuals shall include the following:
   a. Copies of shop drawings
   b. Manufacturer's operating and maintenance instructions. Include parts lists of items or equipment. Where manufacturer's data includes several types or models, applicable type or model shall be designated.
   c. CD ROM's of O&M data with exploded parts lists where available
   d. Phone numbers and addresses of local parts suppliers and service companies
   e. Internet/WEB page addresses where applicable
   f. Wiring diagrams
   g. Start up and shut down procedure
   h. Factory and field test records
   i. Additional information, diagrams or explanations as designated under respective equipment or systems specification section
5. Instruct Owner's representative in operation and maintenance of equipment. Instruction shall include complete operating cycle on all apparatus.
6. O&M manuals and instructions to Owner shall be provided prior to request for final payment.

D. Record Documents:
   1. Refer to General Conditions of Contract, and Division 01 - Closeout Procedures. Prepare complete set of record drawings in accordance with Division 01.

1.11 QUALITY ASSURANCE

A. General:
   1. Refer to Division 1 for general Guarantee (Warranty) requirements.
   2. Cable and Equipment Manufacturer(s) shall be company specializing in communications equipment, cable, accessories and/or equipment with minimum of 5 years documented experience in producing products similar to those specified herein.

B. Refer to technical sections for Guarantee requirement for each system.
   1. Where no guarantee requirements are called out, guarantee as called out in Division 1 equipment, materials, and workmanship to be free from defect.

C. Repair, replace or alter systems or parts of systems found defective at no extra cost to Owner.

D. Contractor Qualifications:
   1. Qualified personnel utilizing state-of-the-art equipment and techniques shall complete system installation.
   2. Contractor shall have been in communications business for minimum of 5 years and shall provide references to 2 successfully completed projects equal to 50% of magnitude specified in the following sections.
   3. Contractor shall have minimum 1 RCDD (Registered Communications Distribution Designer) on permanent staff both at bidding and throughout the entire construction schedule.

4. Minimum 50% of contractor technicians shall be certified under BICSI (Building Industry Consulting Services International) installation certification program.
5. Contractor must provide a complete material listing at bid date with manufacturers, part numbers, and quantities prior to bid acceptance.
6. Contractor project manager and technicians on site shall be manufacturer-trained to install shielded (F/UTP) copper cabling prior to F/UTP component installation.

1.12 JOB CONDITIONS

A. Building Access:
   1. Arrange for necessary openings in building to allow for admittance of all apparatus.

B. Cutting and Patching:
   1. Refer to General Conditions of Contract, and Division 01 - Cutting and Patching.
   2. Perform cutting and patching required for complete installation of systems unless otherwise noted. Patch and restore work cut or damaged, to original condition. This includes openings remaining from removal or relocation of existing system components.
   3. Provide materials required for patching unless otherwise noted.
   4. Do not pierce beams or columns without permission of Architect and then only as directed. If openings are required through walls or floors where no sleeve has been provided, hole shall be core drilled to avoid unnecessary damage and structural weakening.
   5. Where alterations disturb lawns, paving, walks, etc., replace, repair or refinish surfaces to condition existing prior to commencement of work. This may include areas beyond construction limits.

C. Housekeeping and Cleanup:
   1. Refer to Division 01 - Closeout Procedures.
   2. Periodically as work progresses and/or as directed by Architect, remove waste materials from building and leave area of work broom clean. Upon completion of work, remove tools, scaffolding, broken and waste materials, etc. from site.

1.13 GUARANTEE

A. General:
   1. Refer to Division 01 for general Guarantee (Warranty) requirements.
   2. Cable and Equipment Manufacturer(s) shall be company specializing in communications equipment, cable, accessories and/or equipment with minimum of 5 years documented experience in producing products similar to those specified herein.

B. Refer to technical sections for Guarantee requirement for each system.
   1. Where no guarantee requirements are called out, guarantee as called out in Division 1 equipment, materials, and workmanship to be free from defect.

C. Repair, replace or alter systems or parts of systems found defective at no extra cost to Owner.

D. In any case, wherein fulfilling requirements of any guarantee, if Contractor disturbs any work guaranteed under another contract, restore such disturbed work to condition satisfactory to Architect and guarantee such restored work to same extent as it was guaranteed under such other contract.

E. Guarantees shall include labor, material and travel time.

PART 2 - PRODUCTS

2.1 PRODUCT SUBSTITUTIONS

A. Product substitutions are not allowed without written approval from owner.

PART 3 - EXECUTION

3.1 GENERAL

A. Verify elevations and measurements prior to installation of materials.

B. Contractor shall coordinate with owner & engineer on final raceway counts, conduit quantities, and equipment room fitting quantities.

C. Division 26 Contractor shall provide all Division 27 pathway infrastructure as specified and shown on plans, including back boxes, conduits, pull boxes, cable trays, surface raceways, and floor boxes.

D. Division 26 Contractor shall provide all grounding and bonding infrastructure as specified and shown on plans, including but not exclusive to Communications grounding backbone, Communications ground bars, and interconnecting grounding and bonding conductors.
   1. Division 26 Contractor shall provide all Telecommunications Grounding Busbars (TGBs).
   2. Division 26 Contractor shall provide and terminate grounding conductors from Division 26-provided infrastructure to the closest Communications Grounding Busbar located in each of the BDF and IDF rooms

3.2 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to site under provisions of Division 01.

B. Store and protect products under provisions of Division 01.

C. Store in clean, dry space.

D. Maintain factory wrapping or provide cover to protect units from dirt, water, construction debris, and traffic.

E. Handle in accordance with manufacturer's written instructions.

F. Handle carefully to avoid damage to components, enclosure, and finish. Lift only with lugs provided for the purpose.

3.3 FLOOR, WALL, ROOF AND CEILING OPENINGS

A. Coordinate location of openings, chases, furred spaces, etc. with appropriate Contractors. Provide during progress of construction sleeves and inserts that are to be built into structure.

B. Temporary sleeves, if used to form wall openings, shall be removed prior to installation of permanent materials. Permanent sleeves for wall penetrations shall be minimum 24 ga galvanized sheet metal unless otherwise noted.

C. Steel sleeves, when required, shall be Schedule 40 carbon steel pipe with integral water stop.

D. For core drilled holes, size and location shall be reviewed and approved by Structural Engineer prior to execution.

E. Submit product data and installation details for penetrations of building structure. Submittal shall include schedule indicating penetrating materials, (including steel conduit, PVC conduit, cables, cable tray), sizes of each, opening sizes and sealant products intended for use.

F. Where penetrations of fire-rated assemblies are involved, seal penetrations with appropriate firestopping systems as specified in Division 26.

G. Submit complete penetration layout drawings showing openings in building structural members including floor slabs, bearing walls, shear walls. Indicate and locate, by dimension, required openings including those sleeved, formed or core drilled. Drawings shall be approved by the structural engineer prior to preparing openings in structural member.

H. Openings for penetrations shall be minimum 1/2” larger on all sides than outside dimensions of raceways or cables. However, where fire resistant penetrations are required, size openings in accordance with recommendations of firestopping systems manufacturer.

I. Seal non fire-rated floor penetrations with non-shrink grout equal to Embeco by Master Builders, or urethane caulk, as appropriate.

J. Seal non-rated wall openings with urethane caulk.

K. Where penetrations occur through exterior walls into building spaces, use steel sleeves with integral water stop, similar to type "WS" wall sleeves by Thunderline Corporation. Seal annular space between sleeves and pipe with "Link-Seal" modular wall and casing seals by Thunderline Corporation, or sealing system by another manufacturer approved as equal by Architect. Sealing system shall utilize Type 316 stainless steel bolts, washers and nuts.

L. Finish and trim penetrations as shown on details and as specified hereinafter.

M. Provide chrome or nickel plated escutcheons where raceways pass through walls, floors or ceilings and are exposed in finished areas. Size escutcheons to fit raceways for finished appearance. Finished areas shall not include mechanical/electrical rooms, janitor’s closets, storage rooms, etc., unless suspended ceilings are specified.

3.4 EQUIPMENT ACCESS

A. Install raceways, junction and pull boxes, and accessories to permit access to equipment for maintenance. Relocation of raceways, or accessories as required to provide access, shall be provided at no additional cost to Owner.

B. Install equipment with ample space allowed for removal, repair or changes to equipment. Provide ready accessibility to equipment and wiring without moving other equipment, which is to be installed or which is already in place.

C. Access doors in walls, chases, or inaccessible ceilings will be provided under Division 08 - Access Doors and Frames, unless otherwise indicated. Access doors shall be for purpose of providing access where equipment requiring servicing, repairs or maintenance is located in walls, chases or above inaccessible ceilings.

D. Locate communications outlets and equipment to fit details, panels, decorating or finish at space. Architect reserves right to make minor position changes of outlet locations before work has been installed.

E. Verify room door swings before installing wall-mounted communications outlets and install boxes on latch side of door unless noted otherwise.

3.5 EQUIPMENT SUPPORTS

A. Provide supporting steel not indicated on drawings as required for installation of equipment and materials including angles, channels, beams, hangers.

B. Concrete anchors, used for attachment to concrete, shall be steel shell with plug type. Plastic, rawhide or anchors utilizing lead are not allowed.

C. Do not support equipment or cable pathways from metal roof decking.

3.6 SUPPORT PROTECTION

A. In occupied areas, mechanical rooms and areas requiring normal maintenance access, certain equipment must be guarded to protect personnel from injury.

B. Provide minimum 1/2” thick Armstrong Armaflex insulation or similar product applied with Armstrong 520 adhesive on lower edges of equipment, including bus duct, cable tray, pull boxes and electrical supporting devices suspended less than 7 ft above floors, platforms or catwalks in these areas.

C. Threaded rod or bolts shall not extend beyond supporting element and shall be protected as described above.

3.7 ACTIVE ELECTRONICS

A. Contractor shall:
   1. Unpack and install Owner-furnished 802.11 wireless access point units at the locations of the type-C data outlets noted on the drawings.
      a. Quantity: refer to drawings.
      b. Connect each unit to local data outlet with owner furnished yellow patch cord.
      c. Record each unit’s MAC # and install Owner-furnished label.

B. Coordinate with owner exact device locations prior to beginning work.

3.8 HOUSEKEEPING PADS

A. Not applicable to this Division of work.

3.9 LEAD SHIELDING

A. Wherever installation of this Contractor's equipment destroys radiological integrity of wall, floor, or ceiling, this Contractor shall be responsible to provide suitable lead shielding to maintain that integrity. Coordinate these requirements with Trade Contractor.

3.10 ACCEPTANCE TESTING

A. Prior to testing, submit to owner (or owners representative) and Engineer, proposed schedule for acceptance testing.
   1. This notification shall be minimum of ten (10) working days in advance to allow for participation by Owner and/or Engineer.

B. Prior to testing, submit written description of intended test procedures and submit sample test forms to Engineer.
   1. Submitted information shall include proposed file naming format to be used in identifying cable, pair or optical fiber which is subject of test record.
   2. Failure to provide above information shall be grounds for Engineer or Owner to reject any Documentation of related testing and to require repeat of affected test.

C. Conduct tests during course of construction when identifiable portion(s) of installation is complete.
   1. Alternatively, testing can be conducted after entire installation is complete if this does not delay project schedule.

D. Provide equipment and personnel necessary to conduct acceptance tests.

E. Testing shall be completed and accepted by Owner and Engineer before Owner furnished equipment and cross connects are installed.

F. Document tests.

G. When equipment or systems fail to meet minimum test requirements, replace or repair defective work or materials as necessary and repeat inspection and test. This shall be at no additional cost to the owner. Replacement materials shall be new.

H. This Contractor is responsible for certifying, in writing, equipment and system test results. Certification shall include identification of portion of system tested, date, time, test criteria and name and title of person signing test certification documents.

I. Maintain copies of certified test results, including those for failed tests, at project site. At completion of project, include copies of test records and certifications in O&M Manuals.

J. System functional performance testing is part of the Commissioning Process as specified in Section 01 91 00. Functional performance testing shall be performed by the contractor and witnessed and documented by the Commissioning Authority.

3.11 START-UP

A. All systems and equipment shall be started, tested, adjusted and turned over to Owner ready for operation.
   1. This includes "Owner-Furnished, Contractor-Installed" (OFCI) and "Contractor-Furnished, Contractor-Installed" (CFCI) systems and equipment.

B. Follow manufacturer's pre-start-up checkout, start-up, trouble shooting and adjustment procedures.

C. Contractor shall provide services of technician/installer knowledgeable in start-up and checkout of types of systems and equipment on project.

D. Provide start-up services, by manufacturer's representative where specified or where Contractor does not have qualified personnel.

E. Coordinate start-up with trades.

F. Major equipment and system startup and operational tests shall be scheduled and documented in accordance with Section 01 91 00 Commissioning.

3.12 DOCUMENTATION

A. Upon completion of installation, Contractor shall provide System Documentation. Documentation shall include:
   1. Acceptance Test Results
   2. Record Drawings
   3. All Approved Submittals
   4. Manufacturer’s Warranty Documents

B. Submit System Documentation in accordance with Division 01 "Project Record Documents".

C. Submit documentation within ten (10) working days of the completion of installation of system.
   1. Draft drawings may include mark-ups done by hand.
   2. Machine generated (final) copies of Record Drawings shall be submitted within 30 working days of completion of each testing phase.

D. Submit Acceptance Test Results in electronic form for review and distribution.
   1. Interim documentation of Test Results (if applicable) may be submitted via email or on CD-ROM.
   2. Final documentation of Test Results shall be submitted on CD-ROM.
   3. Test results shall be submitted in format(s) native to test instrument(s) used in performing testing.
   4. Where unique software (other than an MS-Word™ compatible Word Processor or MS-Excel™ spreadsheet) is required for viewing of test results, Contractor shall provide along with above documentation, one licensed copy of such software. Software shall run on MICROSOFT Windows-based personal computer.

E. Acceptance Test results shall include description of sub-system tested, equipment/cable/outlet I.D., reference and test setup, test equipment type/model and serial number(s), equipment location and direction of test (if applicable), test frequencies/wavelengths, date and operator name(s).

F. Engineer or Owner may request that 10% random re-test be conducted on cable system - at no additional cost - to verify documented findings. Tests shall be a repeat of those defined above and in technical sections.
   1. Owner may also perform independent testing to verify results.
   2. If findings contradict documentation submitted by Contractor, additional testing can be requested to extent determined necessary by Engineer or Owner, including 100% re-test. This re-test shall be at no additional cost to Owner.

G. Documentation - including hard copy and electronic forms of Test Data and Record Drawings - shall become property of Owner.
   1. Refer also to Technical Sections for requirements specific to covered subsystems

H. Documentation - including hard copy of Record Drawings - shall become property of Owner.

I. Refer also to Technical Sections for requirements specific to covered subsystems.

3.13 CLEANING

A. After installation is complete, Contractor shall clean all systems.

B. Vacuum debris from system components, enclosures, junction boxes and pull boxes prior to testing and again prior to completion.

C. Thoroughly clean equipment of stains, paint spots, dirt and dust. Remove temporary labels not used for instruction or operation.

END OF SECTION

SECTION 27 0526 - GROUNDING AND BONDING FOR COMMUNICATIONS SYSTEMS

PART 1 GENERAL

1.1 SCOPE

A. This section details product and execution requirements for Communications Grounding and Bonding.

1.2 RELATED WORK

A. Related Division 27 Sections include:

1. Section 27-0000 - General Communications Requirements
2. Section 27-0528.29 - Hangers and Supports for Communications Systems
3. Section 27-0528.33 - Raceway and Boxes for Communications Systems
4. Section 27-0528.36 - Cable Tray for Communications Systems
5. Section 27-0553 - Communications Systems Identification
6. Section 27-1100 - Communications Equipment Room Fittings
7. Section 27-1500 - Communications Horizontal Cabling

B. Related sections in other Divisions of Work:

1. Section 26-0526 - Grounding and Bonding for Electrical Systems

1.3 REFERENCES AND STANDARDS

A. Refer to Section 27-0000 - General Communications Requirements that identifies pertinent References and Standards.

B. In addition, the following apply:

1. IEEE/ANSI 142 - Recommended Practice for Grounding of Industrial and Commercial Power Systems.
2. UL 467 Electrical Grounding and Bonding Equipment
3. ANSI J-STD-607-B - Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications
4. NEC Article 250 – Grounding
5. NEC Article 800 – Communications Circuits
6. NFPA 78 – Lightning Protection

1.4 DEFINITIONS AND ABBREVIATIONS

A. Refer to Section 27-0000 - General Communications Requirements which provides information on Definitions and Abbreviations used in this and related sections.

B. Additional definitions (per referenced standards):

1. Telecommunications Main Grounding Busbar (TMGB): Busbar placed in convenient and accessible location and bonded by means of bonding conductor for telecommunications to

building service equipment (power) ground. For the UK-RB2 project, the Main Grounding Busbar (MGB) in the basement level BDF room shall serve as the TMGB.

2. Telecommunications Grounding Busbar (TGB): interface to building telecommunications grounding system generally located in telecommunications room. Common point of connection for telecommunications system and equipment bonding to ground, and located in telecommunications room or equipment room.
3. Telecommunications Bonding Conductor: conductor that interconnects telecommunications bonding infrastructure to building's service equipment (power) ground.
4. Telecommunications Bonding Backbone (TBB): conductor that interconnects tele-communications main grounding busbar (TMGB) to telecommunications grounding busbar (TGB).
5. Grounding Equalizer (GE): conductor that interconnects elements of telecommunications grounding infrastructure.
6. Exothermic Weld: method of permanently bonding two metals together by controlled heat reaction resulting in molecular bond.
7. Irreversible Compression: permanent mechanical bond between conductors or conductor and connector using mechanical or hydraulic tool.

1.5 WORK BY OWNER

A. Refer to Section 27-0000 - Structured Cabling which identifies Work by Owner affecting sub-system(s) covered by this section.

1.6 SUBMITTALS

A. Refer to Section 27-0000 - General Communications Requirements which provides general guidelines for product or installation information to be submitted by Contractor.

B. Refer to Section 26-0526 – Grounding and Bonding for Electrical systems which provides submittal guidelines for Division 26-provided components.

1.7 QUALITY ASSURANCE

A. Refer to Section 27-0000 - General Communications Requirements which identifies general quality assurance requirements for the Project.

1.8 GUARANTEE

A. Refer to Division 01, General Conditions, and General Requirements - Guarantee Documents for general warranty requirements.

PART 2 PRODUCTS

2.1 TELECOMMUNICATIONS GROUNDING BUSBARS

A. Material: Copper (aluminum not permitted)
   1. 1/4" thick

B. Pre-drilled
   1. 3/8" Diameter
   2. Hole spacing per ANSI Joint Standard J-STD-607-B

3. Hole pattern shall accommodate two-hole lugs

C. Insulators and stand-off brackets shall electrically isolate busbar from wall or other mounting surface.

D. Busbars shall be listed by nationally recognized testing laboratory.

E. Size:
   1. Telecommunications Main Ground Busbar (TMGB) - 24" x 4" (minimum)
   2. Telecommunications Grounding Busbar (TGB) - 12" x 2" (minimum)

2.2 CONDUCTORS

A. Material: Stranded copper (aluminum not permitted)

B. Bonding Conductors shall be insulated.
   1. Green Jacket or Black Jacket marked with Green Tape or Green adhesive labels per NEC Guidelines

C. Size:
   1. Telecommunications Bonding Conductor (TMGB to Grounding Electrode):
      a. Refer to drawings.
   2. Telecommunications Bonding Backbone (TBB; TMGB to TGB):
      a. Refer to drawings.
   3. Grounding Equalizer (GE):
      a. Refer to drawings.

2.3 CONNECTIONS

A. Mechanical Connectors
   1. Connector Body shall:
      a. Be high-strength, high-conductivity cast copper alloy
      b. Be 2 bolt type
   2. Bolts, nuts, washers and lock-washers: Silicon Bronze
      a. Shall be supplied as part of connector body
      b. Split bolt connector types are not allowed
   3. Connector shall:
      a. Meet or exceed UL 467
      b. Be clearly marked with catalog number, conductor size and manufacturer.

B. Compression Connectors
   1. Connector Body: pure wrought copper.
      a. Conductivity shall be no less than 99% by IACS standards.
   2. Connector shall:
      a. Meet or exceed performance requirements of IEEE 837, latest revision
      b. Be factory filled with an oxide-inhibiting compound

c. Be clearly marked with manufacturer, catalog number, conductor size and required compression tool settings

3. Connection shall be irreversible.

C. Exothermic connections are not allowed on Communications grounding and bonding components.

PART 3 EXECUTION

3.1 GENERAL

A. Division 26 Contractor shall provide Telecommunications grounding and bonding infrastructure as specified and shown on plans, including Telecommunications grounding backbone, Telecommunications ground bars, and interconnecting grounding and bonding conductors.

1. Division 26 Contractor shall provide and terminate grounding conductors from Division 26-provided infrastructure to the closest Telecommunications Grounding Busbar located in each of the BDF and IDF rooms.

B. Division 27 Contractor shall provide and terminate Telecommunications grounding conductors from Division 27-provided equipment to the closest Telecommunications Grounding Busbar located in each of the BDF, MDF, and IDF rooms.

3.2 SEQUENCING AND SCHEDULING

A. Permanently attach all Telecommunications grounds prior to energizing communications equipment.

3.3 INSTALLATION

A. Provide required elements and miscellaneous hardware necessary to establish Telecommunication Grounding infrastructure as specified.

B. Install Products in accordance with manufacturer's instructions.

1. Install Compression Connectors with compression, tool and die system, as recommended by manufacturer of connectors.

C. Grounding connections shall be tight and shall be made with UL listed grounding devices, fittings, bushings, etc.

D. On the Telecommunications Bonding Conductor, Telecommunications Bonding Backbone (TBB) and Grounding Equalizer (GE) all connections shall be Compression type.

E. Locate TGBs and TMGB per drawings.

F. Telecommunications Bonding Backbone (TBB) shall be continuous and not interrupted by Telecommunications Grounding Busbars (TGB).

1. TGBs shall be bonded to TBB via tap off of TBB.
   a. Exception is "last" TGB on TBB (e.g. furthest from TMGB).
2. Grounding Equalizer(s) (GE) shall connect to TGBs to be interconnected.

G. Insulate Busbars from their support.

H. Connections shall be bare metal to bare metal contact.
   1. Clean surfaces of paint, dirt, oil, etc.

I. Connections shall be exposed and visible for inspection at all times.
   1. Do not install insulation over ground connections.

J. Terminate each grounding conductor on its own terminal lug.
   1. Multiple conductors on single lug not permitted.

3.4 FIELD QUALITY CONTROL

A. Inspect grounding and bonding system conductors and connections for tightness and proper installation.

3.5 DOCUMENTATION

A. Accurately record actual locations of grounding electrode(s), busbars and backbone grounding conductors.

END OF SECTION

SECTION 27 0528.29 - HANGERS AND SUPPORTS FOR COMMUNICATIONS SYSTEMS

PART 1 GENERAL

1.1 DESCRIPTION

A. Unless noted otherwise, all hangers and supports shall be provided by the Division 26 Contractor.

B. This section includes product and execution requirements for items unique to communications and not included in Division 26 sections.

1.2 RELATED WORK

A. Related Division 27 Sections include:
1. Section 27-0000 - General Communications Requirements
2. Section 27-0526 - Grounding and Bonding for Communications Systems
3. Section 27-0528.33 - Raceway and Boxes for Communications Systems
4. Section 27-0528.36 - Cable Tray for Communications Systems
5. Section 27-0553 - Communications Systems Identification
6. Section 27-1100 - Communications Equipment Room Fittings
7. Section 27-1500 - Communications Horizontal Cabling

B. Related sections in other Divisions of Work:
1. Section 26-0529 - Hangers and Supports for Electrical Systems

1.3 REFERENCE

A. The Work under this Section is subject to requirements of the Contract Documents including the General Conditions, Supplementary Conditions, and section sunder Division 01 General Requirements.

PART 2 PRODUCTS

2.1 PRODUCTS COMMON WITH ELECTRICAL SYSTEMS

A. Refer to Section 26 0529 - Hangers and Supports for Electrical Systems - Part 2 for all products identified in Part 1.

PART 3 EXECUTION

3.1 GENERAL

A. Division 26 Contractor shall provide all Division 27 hangers, supports, and related devices as specified and shown on drawings.

3.2 PRODUCTS COMMON WITH ELECTRICAL SYSTEMS

A. Refer to Section 26-0529 - Hangers and Supports for Electrical Systems - Part 3 for all products identified in Part 1.

END OF SECTION

SECTION 27 0528.33 RACEWAY AND BOXES FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Unless otherwise noted, all raceway and boxes shall be provided by the Division 26 Contractor.

B. This section includes product and execution requirements for items unique to communications and not included in Division 26 sections.

C. Refer to Section 26 0533 - Raceway and Boxes for Electrical Systems - Part 1 for requirements for Standards, Submittals, Quality Assurance, Delivery/Storage/Handling, and Guarantee for:
   1. Outlet Boxes
   2. Pull and Junction Boxes
   3. Raceways and Wireways (including sleeves, expansion fittings, penetrations, and seals)
   4. Indoor Service Poles
   5. Poke-through Fittings
   6. Floor Boxes
   7. Cable Supports

1.2 RELATED WORK

A. Related Division 27 Sections include:
   1. Section 27 0000 - General Communications Requirements
   2. Section 27-0526 - Grounding and Bonding for Communications Systems
   3. Section 27-0528.29 - Hangers and Supports for Communications Systems
   4. Section 27-0528.36 - Cable Tray for Communications Systems
   5. Section 27-0553 - Communications Systems Identification
   6. Section 27-1100 - Communications Equipment Room Fittings
   7. Section 27-1300 - Communications Backbone Cabling

B. Related sections in other Divisions of Work:
   1. Section 26 0533 - Raceway and Boxes for Electrical Systems

1.3 REFERENCES

A. Work under this section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.

PART 2 - PRODUCTS

2.1 PRODUCTS COMMON WITH ELECTRICAL SYSTEMS

A. Refer to Section 26 0533 - Raceway and Boxes for Electrical Systems - Part 2 for Pull and Junctions Boxes for Communications, Raceways for Communications, and other products identified in Part 1.

2.2 OPTICAL FIBER/COMMUNICATIONS CABLE RACEWAY

A. Manufacturers: Carlon, Pyramid, or approved equal.

B. Size innerduct for maximum 40% fill (cable vs. innerduct I.D.). Minimum innerduct duct size shall be 1-1/4" inch (I.D.) unless otherwise noted on drawings.

C. Indoor Innerduct shall be:
   1. Corrugated
   2. Riser rated.

D. Innerduct Color shall be as follows:
   1. Riser: ORANGE

PART 3 - EXECUTION

3.1 GENERAL

A. Division 26 Contractor shall provide all Division 27 grounding and bonding infrastructure as specified and shown on plans, including but not exclusive to Communications grounding backbone, Communications ground bars, and interconnecting ground cables.

B. Division 27 Contractor shall provide and terminate grounding conductors from Division 27-provided infrastructure to the closest Communications Grounding Busbar located in each of the BDF and IDF rooms

3.2 PRODUCTS COMMON WITH ELECTRICAL SYSTEMS

A. Refer to Section 26 0533 - Raceway and Boxes for Electrical Systems - Part 3 for Pull and Junctions Boxes for Communications, Raceways for Communications, and other products identified in Part 2.

3.3 OPTICAL FIBER/COMMUNICATIONS CABLE RACEWAY (INNERDUCT)

A. Flexible Non-metallic Innerduct (e.g. "Innerduct") shall be provided as follows:
   1. As protection to backbone fiber optic cables installed in conduits, cable tray or cable support hooks
   2. As protection to fiber optic cable(s) within telecommunications equipment rooms

B. Extend innerduct to termination and/or cable storage enclosure.

C. Provide couplings designed for innerduct size and type where innerduct enters a termination or storage enclosure.

D. Where not installed in a continuous length, splice innerduct segments using couplings designed for that purpose.

E. Provide nylon pull cord in empty innerduct and cap innerduct at both ends.

F. Label innerduct where entering and exiting all junction boxes, pull boxes, and enclosures, and at 10 ft intervals where exposed with tags indicating cable type and cables contained therein.

END OF SECTION

SECTION 27 0528.36 - CABLE TRAYS FOR COMMUNICATIONS SYSTEMS

PART 1 GENERAL

1.1 SCOPE

A. Unless noted otherwise, all cable tray shall be provided by the Division 26 Contractor.

B. This section includes product and execution requirements for items unique to communications and not included in Division 26 sections.

C. Cable tray system is intended to support Division 27-provided cable only.

1. A/C power wiring and fire alarm system cabling are not allowed in cable tray.

2. All D/C power wiring shall be approved by the Engineer prior to installation.

a. Four-pair copper Communications cables utilizing IEEE 802.af Power over Ethernet (PoE) are exempt from this requirement.

1.2 RELATED WORK

A. Related Division 27 Sections include:

1. Section 27-0000 - General Communications Requirements.

2. Section 27-0526 - Grounding and Bonding for Communications Systems

3. Section 27-0528.29 - Hangers and Supports for Communications Systems

4. Section 27-0528.33 - Raceway and Boxes for Communications Systems

5. Section 27-0553 - Communications Systems Identification

6. Section 27-1100 - Communications Equipment Room Fittings

7. Section 27-1500 - Communications Horizontal Cabling

B. Related sections in other Divisions of Work:

1. Section 26-0529 - Hangers and Supports for Electrical Systems

2. Section 26-0536 - Cable Trays for Electrical Systems

1.3 REFERENCE

A. The Work under this Section is subject to requirements of the Contract Documents including the General Conditions, Supplementary Conditions, and section sunder Division 01 General Requirements.

PART 2 PRODUCTS

2.1 PRODUCTS COMMON WITH ELECTRICAL SYSTEMS

A. Refer to Section 26-0529 - Hanger and Supports for Electrical Systems - Part 2 for products identified in Part 1.

B. Refer to Section 26-0536 - Cable Trays for Electrical Systems - Part 2 for products identified in Part 1.

PART 3 EXECUTION

3.1 GENERAL

A. Division 26 Contractor shall provide all Division 27 pathway infrastructure as specified and shown on plans, including but not exclusive to back boxes, conduits, pull boxes, cable trays, surface raceways, and floor boxes.

3.2 PRODUCTS COMMON WITH ELECTRICAL SYSTEMS

A. Refer to Section 26-0529 – Hangers and Supports for Electrical Systems - Part 3 for products identified in Part 1.

B. Refer to Section 26-0536 - Cable Trays for Electrical Systems - Part 3 for products identified in Part 1.

END OF SECTION

SECTION 27 0537 -COMMUNICATIONS SYSTEM FIRESTOPPING

PART 1 GENERAL

1.1 SCOPE

A. This Section details product and execution requirements for Communications System Firestopping.

1.2 DESCRIPTION

A. Furnish and install work under this Section including the following:
   1. Post-cable installation penetrations within Communications raceways through fire-resistance-rated floor, roof, walls, and partitions including openings containing conduits, cables, cable bundles, cable tray and other penetrating items.
   2. Firestopping systems and installation shall provide fire rating equal to that of construction being penetrated.
   3. Proposed firestop materials and methods shall conform to applicable code requirements of authority having jurisdiction.

1.3 RELATED WORK

A. The Work under this Section is subject to requirements of the Contract Documents including the General Conditions, Supplementary Conditions, and sections under Division 01 - General Requirements.

B. Related Division 27 Sections include:
   1. Section 27-0000 - General Communications Requirements
   2. Section 27-0528.33 - Raceway and Boxes for Communications Systems
   3. Section 27-0528.36 - Cable Trays for Communications Systems
   4. Section 27-1100 - Communications Equipment Room Fittings
   5. Section 27-1300 - Communications Backbone Cabling

C. Related sections in other Divisions of Work:
   1. Section 26-0000 - General Electrical Requirements
   2. Section 26-0533 - Raceway and Boxes for Electrical Systems
   3. Section 26-0536 - Cable Trays for Electrical Systems
   4. Section 26-0593 - Electrical System Firestopping

1.4 REFERENCE

A. Refer to Section 27-0000 - General Communications Requirements which identifies related specification sections in this and other Divisions (if applicable).

1.5 REFERENCE STANDARDS

A. UL 1479 - Fire Tests For Through-Penetration Firestops

B. UL 2079 - Tests For Fire Resistance of Building Joint Systems

1.6 SUBMITTALS

A. Submit shop drawings for equipment provided under this Section.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: Engage an experienced installer who has completed firestopping systems that are similar in material, design, and extent to that indicated for this Project and that have performed successfully.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. 3M, Hilti, Tremco, Nelson Firestop Products, Specified Technologies, Inc, or Rectorseal Corp.

2.2 MATERIALS

A. Use only firestop products that have been UL tested for specific fire-rated construction conditions conforming to construction assembly type, penetrating item type, annular space requirements and fire-rating involved for each separate instance.

B. Materials shall not contain flammable solvents.

C. Use removable pillow type fire stop material with cable tray.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions for compliance with requirements for opening configurations, penetrating items and other conditions affecting performance of firestopping.

B. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 PROJECT CONDITIONS

A. Do not install firestopping when ambient or substrate temperatures are outside limits permitted by firestopping manufacturer or when substrates are wet due to rain, frost, condensation, or other causes.

B. Ventilate firestopping per manufacturers' instructions by natural means or, where this is inadequate, forced air circulation.

3.3 DELIVERY AND HANDLING

A. Deliver products to Project site in original, unopened containers or packages with intact and legible manufacturers' labels identifying product, type and UL label where applicable.

B. Handle with recommended procedures, precautions or remedies described in material safety data sheets as applicable.

3.4 PREPARATION

A. Confirm cable installation is complete prior to beginning work.

B. Clean out openings immediately prior to installing firestopping to comply with recommendations of firestopping manufacturer.

C. Provide masking and temporary covering to prevent soiling of adjacent surfaces by firestopping materials.

D. Comply with manufacturer's recommendations for temperature and humidity conditions before, during and after installation of firestopping.

3.5 INSTALLATION

A. Comply with manufacturer's installation instructions and drawings.

B. Install forming/backing materials and other accessories of types required to support fill materials during application as required. After installing fill materials, remove forming materials and other accessories not indicated as permanent components of firestop systems.

C. Avoid multiple penetrations of common fire barrier opening. When possible, seal each penetration in accordance with project details.

D. Firestopping devices and equipment shall be red in color.

3.6 SEQUENCING AND SCHEDULING

A. Do not cover up firestopping installations that will become concealed behind other construction until authorities having jurisdiction, if required, have examined each installation.

B. Where deficiencies are found, repair or replace firestopping so that it complies with requirements.

3.7 CLEANING

A. Clean surfaces adjacent to sealed holes and joints free of excess firestop materials and soiling as work progresses.

END OF SECTION

SECTION 27 0553 - COMMUNICATIONS SYSTEMS IDENTIFICATION

PART 1 GENERAL

1.1 SCOPE

A. This Section details product and execution requirements for labeling of communications cabling, termination components, pathways, and spaces.

B. All components shall be clearly labeled to identify them as unique throughout the Project.

1.2 RELATED WORK

A. Related Division 27 Sections include:

1. Section 27-0000 - General Communications Requirements
2. Section 27-0526 - Grounding and Bonding for Communications Systems
3. Section 27-0528.29 - Hangers and Supports for Communications Systems
4. Section 27-0528.33 - Raceway and Boxes for Communications Systems
5. Section 27-0528.36 - Cable Trays for Communications Systems
6. Section 27-1100 - Communications Equipment Room Fittings
7. Section 27-1500 - Communications Horizontal Cabling

B. Related sections in other Divisions of Work:

1. See individual technical sections identified above (if applicable).

1.3 REFERENCES AND STANDARDS

A. Refer to Section 27-0000 - General Communications Requirements which identifies pertinent References and Standards.

B. Other applicable references and standards include:

1. TIA/EIA-606-B - Administration Standard for Commercial Telecommunications Infrastructure.

1.4 DEFINITIONS AND ABBREVIATIONS

A. Refer to Section 27-0000 - General Communications Requirements which provide information on Definitions and Abbreviations used in this and related sections.

1.5 SUBMITTALS

A. Refer to Section 27-0000 - General Communications Requirements which provide general guidelines for product and/or installation information to be submitted by Contractor.

B. Prior to installation, provide samples of label types planned for the Project.

1. Samples shall include examples of lettering to be used and shall follow standards detailed below.

1.6 QUALITY ASSURANCE

A. Refer to Section 27-0000 - General Communications Requirements which identifies general quality assurance requirements for the Project.

PART 2 PRODUCTS

2.1 GENERAL

A. Labels and markings shall be physically and chemically resistant to damage that would make label unreadable.

B. Cable labels shall be self-laminating, White/Transparent Vinyl and incorporate an integrated clear lamination which, when label is wrapped around cable, covers printed part of label.

1. Labels shall be of adequate size to accommodate circumference of cable(s) being marked and properly self-laminate over full extent of printed area of label.

2. Labels on larger cables (e.g. Copper Backbone) may be wrapped with clear non-removable tape.

PART 3 EXECUTION

3.1 GENERAL

A. Coordinate labeling requirements with University of Kentucky CNS Department.

B. All patch panels, connecting blocks, optical fiber panels, and grounding busbars must be properly labeled per TIA/EIA 606 and BICSI TDMM.

C. Labeling shall be by mechanical means.

1. Hand lettered designations are not allowed.

D. Tags shall be non-removable.

1. Exceptions:
   a. Telecommunications Ground tags secured with cable ties.
   b. Innerduct Tags secured with cable ties.

E. Characters shall be Black Ink and printed on background of contrasting color.

F. Labels shall match hardware layout and design.

G. Labels shall be as large as practicable while fitting properly.

H. No lettering shall be smaller than 10-point.

I. Label cables with tag which is wrapped around cable sheath.
1. Clean cable sheath thoroughly before applying label.
2. Position label as to be visible and not obscured by termination hardware.

3.2 ROOM IDENTIFICATION

A. BDF and IDF room number shall match architectural room numbers as shown on drawings.

3.3 EQUIPMENT RACK IDENTIFICATION

A. All racks and distribution frames must be properly labeled per TIA/EIA 606 and BICSI TDMM.

3.4 TELECOMMUNICATIONS OUTLET

A. Label each telecommunications outlet port with unique identifying code.

1. Top Label of Outlet:
    a. Room Number of Outlet Location
    b. Location in room going clockwise starting at corridor door (1,2,3…)
        1). Example: In room AO6112, the top of the first faceplate going clockwise in the room shall be labeled:

AO6112-1

2. Bottom Label of Outlet:
    a. Room Number of source IDF/EIDF Room
    b. Patch panel ID
    c. Patch panel port number (1, 2, 3…)
        1). Example: In room AO6112, the bottom of the first faceplate going clockwise in the room shall be labeled:

AO6C002-A-1,2

3.5 WIRELESS ACCESS POINT OUTLET

A. Label each wireless access point outlet port with unique identifying code.

1. Top Label of Outlet:
    a. Room Number of Outlet Location
    b. AP
    c. Location in room/space going clockwise (1,2,3…)
        1). Example: In room AO6112, the top of the first wireless access point faceplate going clockwise in the room/space shall be labeled:

AO6112-AP-1

2. Bottom Label of Outlet:
    a. Room Number of source IDF/EIDF Room
    b. Patch panel ID
    c. Patch panel port number (1, 2, 3…)
        1). Example: In room AO6112, the bottom of the first faceplate going clockwise in the room shall be labeled:

AO6C002-A-1, 2

3.6 MODULAR PATCH PANEL

A. All patch panels, connecting blocks, optical fiber panels, and grounding busbars must be properly labeled per TIA/EIA 606 and BICSI TDMM.

B. Label each patch panel in each rack in alphabetical order (A,B,C…) starting at the top of each rack. Labels shall be unique within each room.

C. Label each patch panel port:

1. Faceplate ID

2. Jack ID

a. Example: In for the data jack 1 in the faceplate 1 within room AO6112:

AO6112-1-1

D. Coordinate and confirm labeling requirements with University of Kentucky CNS Department.

3.7 COAXIAL PATCH PANEL

A. Label each patch panel in each rack in alphabetical order (A,B,C…) starting at the top.

B. Label each patch panel port:

1. Faceplate ID

a. Example: In for the coaxial jack 1 in the patch panel 1 within room AO6112:

AO6112-1-1

3.8 FIBER OPTIC PATCH PANEL

A. All patch panels, connecting blocks, optical fiber panels, and grounding busbars must be properly labeled per TIA/EIA 606 and BICSI TDMM.

B. Label each patch panel in each rack in alphabetical order (A, B, C…) starting at the top of each rack.

C. Label each patch panel port:

1. Faceplate ID

2. Jack ID

a. Example: For the data jack 1 in the faceplate 1 within room AO6112:

AO6112-1 D1

3.9 HORIZONTAL CABLING

A. Label each horizontal cable at both ends at termination point with unique identifying code.

B. Label each end of horizontal cable to match patch panel label.

3.10 BACKBONE COPPER CABLE

A. Label each backbone cable at both ends at termination point with unique identifying code.

B. Label cable sheath:

1. At point where sheath ends

2. At point on cable where viewing of label is not obscured by termination blocks or other visual barrier.

C. Label shall be on plastic tag tie-wrapped to cable sheath, or placed on adhesive labels adhered to cable sheath.

1. If adhesive labels are used, cable sheath shall be cleaned thoroughly before applying label. Clear cellophane tape covering shall be placed over label to protect it and maintain adhesion to sheath.

D. Label Intra-building cables with:

1. From and To locations,

2. Pair Count,

3. Date installed.

4. Example 100-pair copper twisted pair cable from BDFAOB211 to IDFAO6015:

BDFAOB211- IDFAO6015
001-100
10/2019

E. Label Inter-building (between buildings) cables with:

1. Coordinate labeling requirements with University of Kentucky CNS Department.

3.11 TERMINATION BLOCKS

A. Termination Blocks shall be labeled with color-coded designation strips.

B. Label termination positions in horizontal row with position identifier.

C. Place termination block labels above or below termination.

D. IDF 110-style Cabling Blocks shall incorporate BLUE Designation Strips and shall be labeled consistent to patch panels.

E. Intra-Building (within building) 110-style Backbone Cabling Blocks shall incorporate WHITE Designation Strips and shall identify:

1. Cable Origin & Destination
   a. Repeat on every designation strip.

2. Pair #.
   a. Label 1st and 25th Positions on each row (e.g. 001 & 025, 026 & 050, etc.).
      1). Example BDFAOB211 to IDFAO6015:

001	BDFAOB211-IDFAO6015 025
026	BDFAOB211-IDFAO6015 050

F. Inter-Building (between buildings) Backbone Cabling Blocks shall incorporate BROWN Designation Strips and shall identify:

1. Cable Origin & Destination
   a. Repeat on every designation strip.

2. Pair #
   a. Label 1st and 25th Positions on each row (e.g. 001 and 025, 026 and 050, etc.).
      1). Example cable linking Building XXXXXX and PCF BDFA0B211:

001	XXXXXX- BDFAOB211	025
026	XXXXXX- BDFAOB211	050

3.12 BACKBONE FIBER OPTIC CABLING

A. Label each backbone cable at both ends at termination point with unique identifying code.

B. Label shall be placed on adhesive labels adhered to cable sheath.
   1. Cable sheath shall be cleaned thoroughly before applying label.

C. Label Intra-building cables with:
   1. From and To locations,
   2. Fiber type (core/cladding diameter)
   3. Fiber count
   4. Date installed.
   5. Example 36-fiber cable from BDFAOB211 to IDFAO6015:

BDFAOB211-
IDFAO6015
50/125 001-036
10/2019

D. Label Inter-building cables with:
   1. From and To locations,
   2. Fiber type (core/cladding diameter)
   3. Fiber count
      a. Where multiple cables are installed between same end-points, labeling shall indicate sequential fiber numbering.
         1). For example 144-fibers provided as two 72-fiber cables would be labeled "001-072" and "073-144".
   4. Date installed.
   5. Example 72-fiber cable from Building GSH to PCF BDFA0B211:

GSH- BDFA0B211
50/125 001-072
10/2019

3.13 FIBER OPTIC PATCH PANELS

A. All patch panels, connecting blocks, optical fiber panels, and grounding busbars must be properly labeled per TIA/EIA 606 and BICSI TDMM.

B. Patch panel port labeling shall be consistent with Telecommunications Outlet and Horizontal Cabling labeling.

C. Coordinate labeling requirements with University of Kentucky CNS Department.

3.14 INNERDUCT

A. Innerduct containing fiber optic cable installed under this project shall be labeled where exposed.

1. Includes areas where innerduct is installed in trays and in equipment rooms.

B. Label innerduct with durable Yellow Polyethylene tag that reads "CAUTION FIBER OPTIC CABLE"

1. Tag shall provide blank spaces for adding fiber count and cable destination information.

C. Label Tag to include:

1. Identifier(s) of cable(s) contained therein.
   a. Use Backbone Cable labeling formats as described above.

D. Hand lettering is acceptable on tag

1. Use an indelible type ink.

E. Tag shall be secured to Innerduct using self-locking ties.

3.15 TELECOMMUNICATIONS GROUNDS

A. Label Grounds as close as practicable to point of termination.

B. Labels shall be non-metallic and include the following:

WARNING IF THIS CONNECTOR OR CABLE IS LOOSE OR MUST BE REMOVED, PLEASE CALL UK-CNS.

END OF SECTION

SECTION 27 1100 - COMMUNICATIONS EQUIPMENT ROOM FITTINGS

PART 1 GENERAL

1.1 SCOPE

A. This Section details product and execution requirements for Communications Equipment Room Fittings.

1.2 DESCRIPTION

A. Communication Equipment Room Fittings include:
   1. Cabinets, Racks, Frames, and Enclosures
   2. Cable and Wire Management
      a. Horizontal Cable Managers
   3. Cable Runway
   4. Termination Blocks
   5. Patch Panels

B. Refer to Project Drawings for Equipment Room layout and equipment placement.

1.3 RELATED WORK

A. The Work under this Section is subject to requirements of the Contract Documents including the General Conditions, Supplementary Conditions, and sections under Division 1 General Requirements.

B. Related Division 27 Sections include:

   1. Section 27-0000 - General Communications Requirements
   2. Section 27-0526 - Grounding and Bonding for Communications Systems
   3. Section 27-0528.29 - Hangers and Supports for Communications Systems
   4. Section 27-0528.33 - Raceway and Boxes for Communications Systems
   5. Section 27-0528.36 - Cable Tray for Communications Systems
   6. Section 27-0553 - Communications Systems Identification

C. Related sections in other Divisions of Work:

   1. Section 26-0526 Grounding and Bonding for Electrical Systems
   2. Section 26-0529 Hangers and Supports for Electrical Systems
   3. Section 26-0553 - Raceway and Boxes for Electrical Systems
   4. Section 26-0536 - Cable Trays for Electrical System

1.4 REFERENCES AND STANDARDS

A. Refer to Section 27-0000 - General Communications Requirements which identifies related specification sections in this and other Divisions (if applicable).

1.5 DEFINITIONS AND ABBREVIATIONS

A. Refer to Section 27-0000 -General Communications Requirements which provide information on Definitions and Abbreviations used in this and related sections.

1.6 WORK BY OWNER

A. Refer to Section 27-0000 - General Communications Requirements which identifies Work by Owner affecting sub-system(s) covered by this Section.

1.7 SUBMITTALS

A. Refer to Section 27-0000 - General Communications Requirements which provide general guidelines for product or installation information to be submitted by Contractor.

1.8 QUALITY ASSURANCE

A. Refer to Section 27-0000 - General Communications Requirements which identify general quality assurance requirements for the Project.

1.9 GUARANTEE

A. Refer to Division 01, General Conditions, and General Requirements - Guarantee Documents for general warranty requirements.

PART 2 PRODUCTS

2.1 GENERAL

A. Patch Cables and Termination hardware shall be technically compliant with and installed in accordance with referenced TIA Documents.

B. Cables shall be Underwriters Laboratory (UL) listed, comply with Article 800 (Communications Circuits) of National Electrical Code and shall meet specifications of NEMA (low loss), UL 444, and ICEA (where applicable).

C. Horizontal (Station) Cable and Termination Components (Jack, Patch Panel) are specified to function as System.

1. Where required for warranty purposes, manufacturers of cabling and termination components used (if more than one) shall recognize each other in their Certification Programs.

2.2 CABINETS, RACKS, FRAMES AND ENCLOSURES

A. Manufacturers: Ortronics
   1. Ortronics part # OR-MM6716

B. Cable Management Racks shall:
   1. Be painted steel
      a. Color: Black
   2. Be 7’ high (45RU)
   3. Be 16.25” channel depth

2.3 CABLE MANAGEMENT

A. Manufacturers: Panduit
   1. Horizontal Cable Management Panel
      a. Ortronics part # OR-60400057

B. Horizontal Cable Management Panels shall:
   1. Be painted steel.
   2. Be 3.5" (2 RU) high
   3. Have minimum of 5 distribution rings (3.75" x 3.75" minimum dimension)
      a. Distribution rings shall be painted steel.

2.4 CABLE RUNWAY

A. Manufacturer: MonoSystems, Inc.
   1. UL Compliance: Products are UL classified and labeled

B. Cable Runway shall:
   1. Refer to Section 26 0536 - Cable Trays for Electrical Systems - Part 2 for products.
   2. Be listed by Underwriters Laboratories as an equipment grounding conductor.
   3. Comply with NEMA Standard VE1-2
   4. Comply with NEC Article 392
   5. Comply with NFPA 70B
   6. Be 4” deep sides
   7. Be minimum 18” wide. Refer to Project Drawings for sizing.

2.5 4-PAIR COPPER MODULAR PATCH PANELS

A. Manufacturers:
   1. Category 6A F/UTP: Commscope/Uniprise part # CPPA-SDDM-SL-2U-48
   2. Category 6 UTP: Commscope/Uniprise part # CPP-UDDM-SL-1U-24

2.6 COAXIAL PATCH PANELS

A. Manufacturers: Commscope part #1479450-1 or University of Kentucky ITS approved equal

2.7 TERMINATION BLOCKS

A. Manufacturers: Commscope/TE
   1. Rackmount 100-Pair 110 Block
      a. Commscope/TE part # 558635-1
   2. 300-Pair 110 Block Kit w/legs
      a. Commscope/TE part # 569446-1
   3. 100-Pair 110 Block Kit w/legs
      a. Commscope/TE part # 569440-1

B. Blocks shall be 110-style high-density cross-connect blocks.

C. Blocks shall meet or exceed TIA Category 5e performance criteria.

2.8 FIBER OPTIC PATCH PANELS

A. Manufacturers:
   1. Housing: Corning part # CCH-04U Coupling Panel:
      a. Backbone Coupling Panel, 8.3 micron Singlemode: Corning part # CCH-CP12-59
      b. Backbone Coupling Panel, 50 micron Multimode: Corning part # CCH-CP12-G7

B. Patch Panels shall:
   1. Be enclosed assemblies
   2. Incorporate hinged or retractable front cover
   3. Be rack mountable on standard TIA 19" equipment racks
   4. Provide for strain relief of incoming cables
   5. Incorporate radius control mechanisms to limit bending of fiber to manufacturer's recommended minimums of 1.2", whichever is larger
   6. Provide protection to both "facilities" and "user" sides of couplings.
   7. Be configured to require only front access when patching
   8. Incorporate patch cable routing space internal to patch panel housing.
      a. Routing space shall be front-accessible.
   9. Include provisions for permanent labeling of fiber optic cables.
      a. Labeling shall be accessible from front of patch panel and shall not require disassembly of patch panel housing or removal of front cover.
   10. Coupling panels shall be provided with alignment sleeve.

C. Access to inside of panel housing during installation shall be from front and rear.
   1. Panels that require disassembly of housing to gain entry will not be accepted.

D. Incoming cables shall not be accessible from patching area of panel.
   1. Housing shall provide physical barrier to access of such cables.
   2. Where factory-terminated cable assemblies ("pigtails") are spliced to cable, Housing shall incorporate hardware for securing of splice tray and required cable, buffer tube and pigtail slack.

PART 3 EXECUTION

3.1 GENERAL

A. Division 26 Contractor shall provide all Division 27 pathway infrastructure as specified and shown on plans, including back boxes, conduits, pull boxes, cable trays, surface raceways, and floor boxes.

B. Contractor shall provide necessary assistance to allow Owner or Carrier personnel to establish service on new cable system.

1. Includes general wiring overview, cable pair identification, and cross connect documentation (if applicable).

3.2 CABLE MANAGEMENT

A. Provide horizontal cable management in equipment racks as follows:

1. Provide one 2RU horizontal cable manager below every group of three horizontal patch panels in equipment racks.

3.3 MODULAR PATCH PANELS

A. Provide panels as needed to accommodate new horizontal link cables.

B. Mount patch panels in existing 19" equipment racks.

C. Position cables in sequence of:

1. Telecommunications Outlet ID for horizontal cabling

2. Pair number for backbone cabling

D. Provide minimum of 4 screws to secure each patch panel onto rack.

3.4 FIBER OPTIC PATCH PANELS

A. Provide Fiber Optic Patch Panel housings and coupling panels as required per backbone and horizontal cable counts.

B. Provide patch panels and horizontal cable management in existing 19" equipment racks.

C. Provide coupling panels and mount in patch panel housings.

D. Position fibers consecutively - starting with lowest number - and mapped "position for position" between patch panels.

1. There shall be no transpositions in cabling per TIA T568C.

E. Provide blank covers for unused coupling assembly spaces in panels.

F. Clean couplings with foam swab and isopropyl alcohol prior to connector insertion. Blow dry with canned compressed air.

G. Provide dust caps for couplings.

H. Provide minimum of 4 screws to secure each patch panel onto rack.

END OF SECTION

SECTION 27-1500 COMMUNICATIONS HORIZONTAL CABLING

PART 1 GENERAL

1.1 SCOPE

A. This Section details product and execution requirements for Horizontal (Station) Cabling subsystem.

B. Horizontal cabling subsystem is portion of communication link that connects horizontal or intermediate cross-connect (typically at IDF room) and Communications Outlet.

1.2 DESCRIPTION

A. Communications Horizontal Cabling includes:

1. 4-Pair Cable
    a. Category 6A F/UTP
2. Coaxial Cable
3. Communications Faceplate
4. 4-Pair Modular Jack
5. Coaxial Connector

1.3 RELATED WORK

A. Related Division 27 Sections include:

1. Section 27-0000 - General Communications Requirements
2. Section 27-0526 - Grounding and Bonding for Communications Systems
3. Section 27-0528.33 - Raceway and Boxes for Communications Systems
4. Section 27-0528.36 - Cable Trays for Communication Systems
5. Section 27-0528-39 - Surface Raceways for Communication Systems
6. Section 27-0553 - Communications Systems Identification
7. Section 27-1100 - Communications Equipment Room Fittings
8. Section 27-1300 - Communications Backbone Cabling

B. Related sections in other Divisions of Work:

1. See individual technical sections identified above (if applicable).

1.4 REFERENCES AND STANDARDS

A. Refer to Section 27-0000 - General Communications Requirements which identifies pertinent References and Standards and other published documents that are applicable to this scope of work.

1.5 DEFINITIONS AND ABBREVIATIONS

A. Refer to Section 27-0000 - General Communications Requirements which provide information on Definitions and Abbreviations used in this and related Sections.

B. In this Section, "Communications Outlet" is considered to consist of Frame / Faceplate into which Modular Jacks or other couplings snap, Modular Jacks, blank for unused jack positions, and labeling/identification components.

1.6 WORK BY OWNER

A. Refer to Section 27-0000 - Structured Cabling which identifies Work by Owner affecting sub-system(s) covered by this Section.

1.7 SUBMITTALS

A. Refer to Section 27-0000 - General Communications Requirements which provide general guidelines for product or installation information to be submitted by Contractor.

B. Submit:

1. Samples of each Communications Outlet faceplate to confirm color and material.
2. Samples of each Communications jack to confirm color & material.
3. One 3-foot section of each cable type from cable reels sent to site for Engineer's final approval.
    a. Section shall have manufacturer's cable markings visible.
4. Nominal Velocity of Propagation (NVP) for 4-pair Horizontal Copper Cable.

1.8 QUALITY ASSURANCE

A. Refer to Section 27-0000 - General Communications Requirements which identify general quality assurance requirements for the Project.

1.9 GUARANTEE

A. Refer to Division 1, General Conditions, and General Requirements - Guarantee Documents for general warranty requirements.

B. Refer to Section 27 1000 - Structured Cabling for particular Warranty requirements for Structured Cabling. Those requirements apply to all cable and components covered in this section.

PART 2 PRODUCTS

2.1 GENERAL

A. Cables and Termination hardware shall be technically compliant with and installed in accordance with referenced TIA/EIA Documents.

B. Cables shall be Underwriters Laboratory (UL) listed, comply with Article 800 (Communications Circuits) of National Electrical Code and shall meet specifications of NEMA (low loss), UL 444, and ICEA (where applicable).

C. Horizontal (Station) Cable and Termination Components (Jack, Patch Panel) are specified to function as System.

1. Where required for warranty purposes, manufacturers of cabling and termination components used (if more than one) shall recognize each other in their Certification Programs.

D. Horizontal Cable types include:

1. 4-pair copper Foiled Twisted Pair (F/UTP)
2. Coaxial

2.2 4-PAIR HORIZONTAL 4-PAIR COPPER CABLE

A. Manufacturers: Commscope/Uniprise
1. Category 6A F/UTP Green: Commscope/Uniprise part # UN884029304/10 CS44R series
2. Category 6 UTP: Commscope/Uniprise part # UN88402#### (#### identifies jacket color and packaging) CS37R series

B. Cables shall be suitable for installation in environment defined

C. Cabling shall be packaged to minimize tangling and kinking of cable during installation.

D. Configuration:
1. Number of Pairs: 4 twisted pair
a. Pair twists of any pair shall not be same as any other pair within each cable.
b. Pair twist lengths shall be selected by manufacturer to ensure compliance with crosstalk requirements of TIA/EIA 568-B.2
2. Conductors: insulated solid annealed copper pairs
a. Category 6A F/UTP: 23 AWG
b. Category 6 UTP: 23 AWG
3. Jacket Type: PVC
4. Drain Wire
a. F/UTP: Yes
b. UTP: No
5. Cable Rating: NEC Article 800 Type CMR, UL listed

E. Pairs of 4-pair cables shall be identified by banded color code in which conductor insulation is marked with dominant color and banded with contrasting color.
1. By pair number, pair colors or dominant band shall meet TIA 568B configuration:
a. Pair 1: Tip - White/Blue; Ring - Blue (or Blue/White)
b. Pair 2: Tip - White/Orange; Ring - Orange (or Orange/White)
c. Pair 3: Tip - White/Green; Ring - Green (or Green/White)
d. Pair 4: Tip - White/Brown; Ring - Brown (or Brown/White)

F. Horizontal cable shall:
1. Category 6A F/UTP:
a. Meet or exceed TIA Category 6A 10-Gigabit F/UTPperformance requirements.
b. Incorporate an overall shield.
c. Have Green jacket.
2. Category 6 UTP:
a. Meet or exceed TIA Category 6 performance requirements.

2.3 HORIZONTAL COAXIAL CABLE

A. Manufacturers: CommScope, Belden, Superior Essex.

B. Cables shall be suitable for installation in environment defined and shall meet CATV rating (or permitted substitute as defined by NEC).

C. Station Coaxial Cable shall be RG-6 type, Quad-shield

D. Coaxial cable shall be sweep tested 5 MHz to 2.25 GHz.

E. RG-6 Type (Quad-shield)

1. Center Conductor: 18 AWG solid bare copper.
2. Dielectric: Gas expanded (foamed) polyethylene.
3. First shield: Aluminum-polypropylene-aluminum laminated tape with overlap bonded to dielectric.
4. Second shield: 34 AWG aluminum braid wire (60% coverage).
5. Third shield: Non-bonded foil shield.
6. Fourth shield: 34 AWG aluminum braid wire (60% coverage).
7. Jacket: Flame retardant PVC. Jacket shall contain carbon black to ensure UV stability
8. Impedance: 75 ± 3 ohms
9. Velocity of Propagation: 83% nominal
10. Maximum Attenuation @ 68°F:
    a. 55 MHz: 1.60 dB/100 ft
    b. 750 MHz: 5.65 dB/100 ft
    c. 1 GHz: 6.1 dB/100 ft
    d. Serial 10 Gigabit Ethernet at 850-nm window: 33 m

2.4 COMMUNICATIONS FACEPLATE

A. Manufacturers:
1. Single-gang: Commscope/ Uniprise
2. Double-gang: Commscope/ Uniprise
3. Split grommeted faceplate at monitor locations: Semtron, Midlite, DataPro
4. Floor box locations:
    a. Coordinate requirements with manufacturer of selected floor box
5. Audio Visual locations:
    a. Coordinate requirements with manufacturer of selected AV box

B. Modular Jacks and coaxial connectors (if applicable) shall snap into mounting frame, which shall mount into faceplate.

1. Jacks and connectors may be mounted directly into faceplate.

C. Wall-mount Telephone Faceplate

1. Faceplates intended to be used in locations where wall mounted telephone set is required shall:
    a. Be stainless steel construction.
    b. Accommodate 1 8-position modular data jack.
        1). Modular jack shall be positioned to mate with wall-mounted telephone.
    c. Mount on standard single gang outlet box.
    d. Include mating lugs for mounting wall-mounted telephone.

D. Work Area Outlet Faceplate
1. Wall-mounted faceplates intended to be used in general work areas shall:
    a. Accommodate minimum of 4 modular jacks and connectors.
    b. Be a 4 port single gang plate for all outlets requiring 1 to 4 cables. For outlets of 5 or more cables, 9 port double gang faceplates shall be provided.
    c. Be constructed of high impact plastic (except where otherwise noted).
    d. Incorporate recessed designation strips at top and bottom of frame for identifying labels.
        1). Designation strips shall be fitted with clear plastic covers.
        2). Designation strips and covers shall be positioned over faceplate mounting screws.
2. Power pole faceplates shall incorporate a faceplate extender of sufficient size to accommodate horizontal cable minimum bend radius.
3. Faceplate color shall match other trades.

E. Modular Furniture Outlet Faceplate
1. Confirm opening size with furniture supplier.
2. Coordinate faceplate color with owner.

2.5 4-PAIR MODULAR JACK

A. Manufacturers:
1. Category 6A F/UTP SL Series, Green Icon: Commscope/Uniprise part # 760237683 USL10G-SHLD
2. Category 6 UTP SL Series: Commscope/Uniprise part # 7602376## (## identifies outlet color) USL 600 series

2.6 COAXIAL CONNECTOR/INSERT

A. Manufacturers: Commscope/TE Connectivity part # 1499855-# (# indicates color of insert)

B. Coaxial Connectors shall be threaded male F-type.

C. Male F-connectors shall:
1. Be matched to cable type(s) used.
2. Be single piece connector.
3. Incorporate 1/2" crimp ring using hex crimp.

D. Use female/female feed-through couplings for coaxial outlets and patch panels (if applicable).

PART 3 EXECUTION

3.1 GENERAL

A. Refer to project Drawings for outlet locations.

B. Provide Modular Jacks, Coaxial Connectors (if applicable) and Fiber Optic couplings in faceplates as shown on Project Documents.

1. Provide 1 faceplate per Communications Outlet symbol shown on Project Documents.

C. 4-pair Category-rated horizontal cable length shall not exceed 295 ft measured from horizontal cross-connect and Communications Outlet.

1. Includes slack required for installation and termination.
2. Contractor is responsible for installing station cable to avoid unnecessarily long runs.
3. Any area that cannot be reached within above constraints shall be identified and reported to Engineer prior to installation.
4. Unless otherwise noted, terminate horizontal cabling at IDF room on same floor as outlet.

D. Follow manufacturer’s recommended termination practices.

3.2 CABLE INSTALLATION AND TERMINATION

A. General

1. Refer to Section 27-0000 - General Communications Requirements for general cable installation requirements.
2. Total length of 4-pair Category-rated horizontal cable shall not exceed 295-ft.
3. Provide "service slack" for every Horizontal Cable in cable tray
    a. Slack length shall provide 18” of cable slack for accessing rear of faceplate.
    b. Slack shall be installed in an ‘S’ or ‘figure 8’ configuration; coiled loops are not allowed.
    c. Total length of 4-pair Category-rated horizontal cable including slack shall not exceed 295 ft.
4. Minimum bend radius shall be 4x cable diameter for F/UTP cable.
5. Minimum bend radius shall be 6x cable diameter for coaxial cable
6. During installation, minimum bend radius shall be ten times outside diameter of F/UTP cables.
7. All Communications cabling shall be in conduit from the wall box to the cable tray.
8. Bundling, tie-wrapping, or lashing of cables not allowed.
9. Cables located within vendor booms shall be:
    a. Provided to the boom by Division 27.
    b. Pulled through the boom by the boom vendor.

c. Tested and terminated by Division 27.

1). Any boom cables failing link testing shall be inspected for jacket and/or cable damage through the boom. If damage is evident, cable shall be replaced via the specified protocol, at no cost to Division 27 or Owner.

B. Horizontal Copper Twisted-Pair Cabling

1. Provide horizontal copper twisted pair cable between horizontal cross connect (typically at IDF Room) and Communications Outlet.

2. At Communications Outlet, terminate each 4-pair Horizontal Cable on 8P8C Modular Jack specified herein.

a. Terminating one cable on more than one jack is not allowed.

b. When applicable, ensure proper bonding of overall shielded is accomplished.

3. At horizontal cross-connect, terminate:

a. For F/UTP cables:

1). Ensure proper bonding of overall shielded is accomplished.

2). Terminate Modular Jack in Patch Panel.

4. Terminate cables using 568B wiring standard.

5. Cable shield and jacket shall be continuous to within 1/2" of termination.

6. Preserve pair twists to point of termination.

7. Refer to Section 27-1100 - Communications Equipment Room Fittings for termination instructions for Modular Patch Panel and Termination Block.

C. Horizontal Coaxial Cable

1. Provide horizontal coaxial cable between Telecommunications Room(s) and coaxial workstation outlets.

2. At Telecommunications Room(s):

a. Terminate each end of cables to F-type connector.

1). Prepare cables per manufacturers recommendations for connector type used.

2). Insure proper center conductor length as specified by manufacturer.

b. Terminate cable to wall-mounted patch panel as specified.

3.3 COMMUNICATIONS OUTLET

A. Faceplates shall be configured to provide connectivity as required by location. Refer to drawings.

B. Mount modular jacks and connectors into faceplates and secure faceplates to outlet box or modular furniture.

C. Allow for minimum 50% future jack growth within each faceplate.

D. Ensure back box space allows for minimum cable bend radii behind each faceplate.

E. Use faceplate extender if required to provide adequate clearance between jack and furniture panel to maintain minimum cable bend radius.

F. Confirm BAS Gateway locations with BAS Contractor prior to beginning work.

1. Provide one (1) single-jack BAS Gateway outlet for every twelve (12) BAS controllers.
2. Confirm each outlet location is centered with twelve-controller cluster, to minimize serial cable lengths from the BAS Contractor-provided gateway.

3.4 FIELD TESTING

A. Refer to Section 27-0000 - General Communications Requirements for general guidelines regarding requirements for scheduling and performance of compliance testing.

1. In addition, refer to sub-sections below for cable type under test.

B. Cabling shall be 100% fault free unless otherwise noted. If any cable is found to be outside specification defined herein, replace that cable and associated termination(s). Then repeat applicable tests.

C. Final test results shall be on installation after jacks are installed in faceplates and faceplates are mounted in final configuration.

D. 4-Pair Horizontal Copper Cable

1. Test from Jack at Communications Outlet to Patch Panel on which cables are terminated at horizontal cross-connect serving that location.
2. Testing shall be per TIA/EIA-568 (-B1.1 through -B3.1) Permanent Link test configurations.
3. Maximum length of station cable shall not exceed 295 feet.
4. Cables shall be free of shorts within pairs, and be verified for Continuity, Pair Validity and Polarity, and Wire Map (Conductor Position on Modular Jack).
    a. Identify and correct defective, split or mis-positioned pairs.
5. In addition to above, Performance Testing shall be performed on all cables.
    a. Category 6A F/UTP Cables:
        1). Test to frequency of 500 MHz maximum. Testing of Transmission Performance shall include the following:
            a). Length
            b). Attenuation
            c). Pair to Pair NEXT Loss (new limits)
            d). PSNEXT Loss
            e). Return Loss
            f). Pair to Pair ELFEXT Loss (Equal Level Far End Cross-talk)
            g). PSEFEXT Loss
            h). Propagation Delay
            i). Delay Skew
            j). ANEXT (Alien Near-End Cross-Talk)
            k). Alien FEXT
            l). PSANEXT
            m). PSAELFEXT (PS AARC-F per TIA and SIO)
            n). Must pass the link test as directed in ANSI/TIA/EIA 568B.2-10.
6. Test cables to maximum frequency defined by standards covering specified performance category.

7. Perform Transmission Performance Testing using test instrument designed for testing to specified frequencies.
    a. Test records shall verify "PASS" on each cable and display specified parameters - comparing test values with standards based "templates" integral to unit.
8. Nominal Velocity of Propagation (NVP) used for cable type under test shall be traceable to manufacturers' product data.
    a. Test results obtained using an incorrect NVP will be rejected.

E. Horizontal Coax Cable
1. All cables shall be tested using Wire Test Instrument to:
    a. Locate breaks/faults/incorrect terminations
    b. Verify length
    c. Verify impedance
    d. Return Loss (5-MHz to 1-GHz)
    e. Signal strength: Verify signal level at outlet is nominal 10 dBmV +/- 5 dBmV.
2. Terminate cable - as required by individual tests - with its characteristic impedance.

3.5 DOCUMENTATION

A. Refer to Section 27-0000 - General Communications Requirements for general guidelines regarding documentation requirements.

B. Test results shall include record of:
1. test frequencies
2. cable type
3. conductor pair and cable (or Outlet) I.D.
4. measurement direction
5. coaxial signal levels
6. test equipment type, model and serial number
7. date
8. reference setup
9. crew member name(s).

C. Information added by Contractor to Record Drawings relating to Horizontal Cabling shall include cable routes, outlet locations and numbering and other detail necessary to document cable installation.

END OF SECTION

SECTION 281643 - PERIMETER SECURITY SAFETY

PART 1 - GENERAL

1.1 SCOPE

A. This section details product and execution requirements for Security Management System (SMS) for the project.

B. Work includes furnishing all labor, materials, tools and equipment, and documentation required for a complete turnkey working system as specified in this Section. SMS shall consist of but not be limited to Door Controllers, Card Readers, Sensors, Switches, Conduit, Boxes, Cable and Wired Devices. Programming and cardholder enrolling are also considered as part of installation as well as coordination with UKPD.

C. Unless noted otherwise, "Contractor" shall refer to SMS Integrator & Installer.

Communications routing from SMS to door controllers shall be via Owner LAN.

1.2 RELATED WORK

A. Related Division 28 Sections include:

282300 - VIDEO SURVEILLANCE

B. Related Sections in other divisions of Work:

087100 – DOOR HARDWARE
260000 - ELECTRIC
270000 - COMMUNICATIONS

1.3 REFERENCES AND STANDARDS

A. Work under this Section is subject to requirements of Division 1 General Requirements.

B. Other applicable standards are as follows:

UL 294 - Access Control System Units.
UL 1076 - Proprietary Burglar Alarm Units and Systems.
FCC Rules and Regulations Part 15, Radio Frequency Devices

C. All work and materials shall conform in every detail to rules and requirements of National Fire Protection Association, Kentucky Electrical Code, University of Kentucky Standards and University of Kentucky CNS Standards. UKCNS standards can be found online at the following link: https://www.uky.edu/cpmd/design-standards/divisions-20---29---facility-services-subgroup and click on Division 270000 to find the latest version.

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

1.4 DEFINITIONS AND ABBREVIATIONS

A. SMS – Security Management System

1.5 WORK BY OWNER

A. Owner shall:

Provide list of cardholders for initial SMS programming by Contractor.
Provide scheduling of each door, including:

a. Alarm activations and distribution.
b. Door lock and unlock.
c. Cardholder validation by day and time.
d. Delay time of door open alarm.
e. Duration of lock activation upon credential authorization.

1.6 SUBMITTALS

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

B. System Design drawings with cable routing, device location and labeling.

C. Operation statements for all SMS doors.

D. Communication Closet layout drawings.

E. Certifications for BICSI as required by UKCNS per Division 27.

F. Owner Operation Manuals for all installed equipment as well as documentation of all programing.

G. As built drawings showing cable pathways and routing. As built drawings to also show any changes made to original ESS drawings.

1.7 QUALITY ASSURANCE

A. Security Management System Contractor shall:

Have successfully completed two (2) Security Systems projects in equal magnitude of the system specified in following sections. Contractor shall be a Lenel Authorized VAR in good standing. Proper proof of certifications will be submitted at time of Bid. Be responsible for complete turnkey system up to but not including SMS programing, programing cost will be included in BID with Programing work being done by UKPD's Lenel VAR of Record. Be responsible to coordinate with UKPD's Lenel VAR of Record to complete system installation. Comply with all certification requirements set out in Division 27 as it related to the installation of DATA cabling. Specifically, contractor will comply with the requirement of all DATA cabling being installed by BICSI certified installers and installation supervised by a registered in good standing RCDD in the full-time employee of the project contractor.

1.8 GUARANTEE

A. Warranty requirements for Security Management System (SMS) shall be five (5) years on all parts and labor commencing on Date of Substantial Completion. Those requirements apply to all components covered in this section

PART 2 - PRODUCTS

2.1 GENERAL

A. Security Management System shall provide ability to:

Unlock electrified door locks upon authentication of submitted credential to local card readers.
Monitor door alarms and remotely unlock.
Lock doors on an automated schedule from central system.
Unlock doors as required by code via fire alarm relays.

Annunciate intrusion alarms from remote sensors.
Unlock individual doors manually via operator interface.
Lock doors from central Operations Center.

B. System must support the Campus Central One Card ID Badge.

2.2 NETWORK SMS

A. Manufacturer: Lenel Security Systems

2.3 SYSTEM CONTROLLER

A. Manufacturer: Mercury Systems LNL-2220. Controllers will include all power supplies, Life Safety FPO250 or Mercury Systems approved equal and Battery Back Up Units. All parts and pieces needed for a complete UL listed working turnkey system. All Lenel Licensing required for UK Campus Enterprise System shall be included Contractors Bid.

2.4 MULTI-DOOR DOOR CONTROLLER

A. Manufacturer: Mercury Systems LNL-1320.

Controller shall accommodate minimum two card readers and associated inputs/outputs.

2.5 MULTI-INPUT / OUTPUT CONTROLLER

A. Manufacturer: Mercury Systems LNL-1100 / LNL-1200.

Controller shall accommodate 16 programmable inputs; 2 programmable relay outputs

2.6 PROXIMITY CARD READERS

A. Manufacturer: HID.

Wall-mount: Model RP40 (6125C) iClass Standard Reader.
Mullion-mount Reader RP15 (6145C) multiCLASS.

B. General

Reader(s) shall:

a. Be furnished in Wiegand output model and shall be sealed in a polycarbonate enclosure designed to withstand harsh environments.
b. Unless otherwise specified, reader covers shall be furnished in “black” color – Classic design.
c. Recognize 125 kHz and iClass 13.56 MHz signals
d. Contain an indicator to indicate valid and invalid card
e. Be designed for ambient operating environment.
f. Be powered remotely using centralized power supplies.
g. Read iClass Corporate 1000 sector information
h. Include Near Field / Bluetooth capabilities.

2.6 BIOMETRIC READERS (Eye Scanners)

Manufacturer: EyeLock

Wall-mount Model: nano NXT

Scanner(s) shall:

a. Be mounted at 54” AFF typically
b. Be mounted above card reader.
c. Always be installed in conjunction with a Card Reader
d. Be installed with DATA cable connected to POE Network Switch port.
e. Be installed with 12-24 Volt DC Power via dedicated Life Safety Power Supply located in nearest UKCNS Data Closet. Each Scanner Unit shall be fused at the power supply individually.

2.7 DOOR CONTACTS (DPS / Monitor Points when not included in Door Hardware)

A. Steel Door contacts.

Manufacturers: GE Interlogix 1078 Series or approved equal.

2.8 REQUEST-TO-EXIT MOTIONS SENSORS (When not included in Door Hardware)

A. Manufacturers: GE, Honeywell, or approved equivalent.

1. Provide door header mounted request to exit motion sensors as indicated on Drawings.

2. Minimum Specifications

a. Detection technology Passive infrared
b. Detection pattern Narrow beam 35-degree cone
c. Output contact normally open contact is closed when sensing zone is entered or exited
d. Power requirements 12 – 24 VDC
e. Mounting: Door header

2.9 POWER SUPPLIES

A. As required to support Card Reader(s), Door Controller(s), Strike(s), Sensor(s), Eye Scanners and other components for fully operational turnkey system. Each component connected to power supplies shall be independently fused with rated fuses to match the manufacturer requirements for each specific device. Power supply cabinets shall have door locks included and keys shall be turned over to UKPD at substantial completion.

B. Electrified Door hardware power supplies shall be specified by Division 8. Each component connected to power supplies shall be independently fused with rated fuses to match the manufacturer requirements for each specific device.

2.10 CABLING

A. General

Cable shall be:

a. Plenum Rated.

B. Reader Cable

Construction:

a. 18 AWG stranded or as recommended by system manufacturer.
b. Aluminum/Mylar shield with drain wire applied over assembled conductors.

C. Door Lock Power Cable

Provide and install as required for door hardware. Refer to Architectural Door Schedule and Door Hardware documents.

D. Door Contact / Signal Cable

Door Contact/Signal Cable used for monitoring purposes.
Construction:

a. 22 AWG twisted, stranded or as recommended by system manufacturer.
b. Aluminum/Mylar shield with drain wire applied over assembled conductors.

E. Request-to-Exit Motion Detector Signal Cable

Motion Detector Signal Cable used for monitoring purposes.
Construction:

a. 20 AWG stranded or as recommended by system manufacturer.
b. Aluminum/Mylar shield with drain wire applied over assembled conductors.

F. Door Controller Cable

Provide all LAN patch cables, jacks, and faceplates

PART 3 - EXECUTION

3.1 PRE-INSTALLATION COORDINATION

A. Coordinate with Electrical Contractor (Division 260000) that:

Section 280000 provided pathways and equipment back boxes are completed and are coordinated with no conflicts for system installation.
Adequate power has been provided and properly located for security system equipment.
Code-complying fire alarm relays will be installed for cable termination. Fire Alarm contractor will provide relay contacts in Com Closet for connection to Access control panels. Contractor is responsible for coordination with Fire Alarm Contractor. Access control Contractor shall provide all parts and pieces including all cabling from Access control panel to Fire Alarm Contact point.
Coordinate scheduling of work to make sure there are no conflicts.

B. Coordinate with Door Frame supplier (Division 8):

Doors and door frames are properly prepared for electric locking hardware and door position switches are furnished by door type.
Locations of all devices prior to installation.
Electric door power supply locations and connections requirements.

C. Coordinate with the Communications Contractor (Division 27):

Locations of all LAN-connected devices with no conflicts.
Coordinate scheduling of work.

D. At a minimum, coordinate the following with Owner:

VLAN/or network partitioning for SMS system.
Owner-provided IP addresses for SMS devices.
Network infrastructure requirements at SMS head-end
Initial database programming.
Planned system downtime.
Programming and training for new system.

E. Coordinate with Construction Manager as required providing a fully functioning turnkey Security system.

F. Coordinate with all trades on the operation and installation of ADA entrance doors with relation to Long Range Card Readers and interconnection with door actuator plates, motor units, Fire Alarm and Smoke Evacuation System. Contractor will supply any and all associated timer boards or additional parts required for complete operating doors system.

G. Coordination Meetings shall be scheduled and conducted beginning within 60 days of contract award and continuing till project conclusion inclusive with the A/E team and Commissioning Agent.

3.2 INSTALLATION

A. General

Verify acceptance of each type of specified request-to-exit hardware for each application with local life safety code officials.
Provide tamper proof fasteners for all equipment in public areas. Fastener finish shall match equipment finish.
Maintain minimum three feet of access in front of class 1 electrical equipment.

B. Delivery, Storage, and Handling

Deliver products to and receive products at site under provisions of General Requirements.
Materials shall be stored according to manufacturer's recommendations at minimum.

C. Equipment

Provide equipment as indicated on Drawings and specified herein. Additional specific installation requirements are as follows:

Door Controllers

a. Provide Door Controllers in Data Closets as shown on Drawings.
b. Provide connection to 120 VAC via hardwire conduit. Coordination with Division 260000.
c. Separate 24 VDC and 120 VAC, wire, cable, and devices by 12” minimum space.
d. Enclose wire and cable in wire ways or bundle with wire exiting wire ways to terminal strips or panel mounted devices.
e. Space controllers according to manufacturer’s requirements. Ensure adequate space is allowed for device heat dissipation.
f. Do not place controller or control devices on enclosure sides.

Card Readers

g. Provide card readers and card reader devices as shown on Drawings.
h. Wire card reader LEDs to indicate valid and invalid card reads, and door locked and unlocked conditions. All card reader LED indicators shall operate identically throughout Project. LED shall be red in normal, secured state, and shall be green on valid card read and while door is unlocked.

Electric Locking Mechanics

i. Interface with electric locking mechanics as required by the door hardware.
j. Provide lock control of electrified locking mechanics through output contacts activated by Door Controller.

Electrified Panic Devices

k. Interface with electrified panic devices as indicated on Drawings. Provide all low-voltage wire and connections between SMS power transfer device and electric locking mechanics.

l. Provide lock control of electrified panic devices through output contacts activated by Door Controller.

m. Provide all 120VAC if required for Device operation per hardware specifications. Provide connection to Fire Alarm connection points as required by Code. Fire Alarm Contractor to provide relay contacts in Com closets for this purpose. Contractor is responsible for all parts and pieces including cable from Access control panel to the Fire Alarm relay contract. Contractor is responsible for coordination with Fire Alarm contractor.

Door Position Switches

n. Install as shown on drawings.

o. Coordinate pathways.

Request-to-Exit Motion Sensors

p. Provide as shown on drawings.

q. Coordinate pathways.

Fire Alarm Interface

r. Connect (hard wire) door controller to building fire alarm system for fail-safe release upon any fire alarm.

s. Interface with low voltage / low current normally closed dry contact from fire alarm system provided by fire alarm Contractor (verify exact location in Data Closet for connection with FA). Contact shall open on any fire alarm condition.

t. Provide all additional UL listed fail-safe relays and power supplies necessary to interface to this contact and unlock all fail-secure doors.

u. Coordination Meetings with Fire Alarm Contractor shall be scheduled and conducted beginning within 60 days of contract award and continuing till project conclusion inclusive with the A/E team and Commissioning Agent.

Cable Installation

v. Visually inspect all wire and cable for faulty insulation prior to installation.

w. Furnish and install all specified wire and cable as required for functioning SMS system.

x. Neatly lace, dress and support cabling.

y. Pull cables in accordance with cable manufacturer's recommendations University of Kentucky CNS and ANSI/EEE C2 Standards.

1) Do not exceed manufacturer's recommended pulling tensions.
2) Do not install bruised, kinked, scored, deformed, or abraded cable.
3) Do not splice cable between indicated termination, tap, or junction points.
4) Remove and discard cable where damaged during installation and replace it with new cable.
5) Pull all cable by hand unless installation conditions require mechanical assistance.

z. Run all wire and cable continuous from device location to final point of termination. No mid-run cable splices shall be allowed.

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

bb. Cable shall never be laid directly on a ceiling grid or attached in any manner to ceiling grid wires.

cc. Furnish and install all cable such that ample slack is supplied at device terminating end of cable to compensate for any final field modifications at install locations.

1) Loosely coil slack in “Figure-eight” in a manner that prevents kinking.
2) Loop radius shall be at least 4X minimum bend radius for cable.
3) Slack length of cable shall be 4 feet (minimum).

dd. Provide code-compliant fire proofing techniques for all penetrations of fire rated partitions and slabs, where penetrations are made by or used for installation of SMS System.

ee. Coordinate routing of wire and cable requiring isolation from power, radio frequency (RF), electromagnetic interference (EMI), telephone, etc. with General Contractor.

ff. At no time, shall any cable be subjected to a bend less than manufacturer’s specified minimum radius and UK CNS Standards.

gg. Provide grommets and strain relief material where necessary to avoid abrasion of wire and excess tension on Wire and Cable.

hh. Make connections with solder-less devices, mechanically and electrically secured in accordance with manufacturers’ recommendations. Wire nuts shall not be an acceptable means of connecting wire and cable.

ii. Utilize conduit and cable trays and or pathways to route SMS cables from each door or device to Door Controller. Follow University of Kentucky CNS standards for low voltage cabling.

jj. No A/C current-carrying conductors are allowed in same pathway as signal or low-voltage power cables.

kk. Wire and cable within Door Controllers, enclosures and or other security enclosures shall be neatly installed, completely terminated, pulled tight with slack removed and routed in such a way as to allow direct, unimpeded access to equipment within enclosure. All wire and cable shall be bundled and tied. Ties shall be similar to T&B TyRap cable ties.

ll. Use of electrical tape for splices and connections shall not be acceptable.

mm. Make connections with solder less devices, mechanically and electrically secured in accordance with manufacturers’ recommendations. Wire nuts shall not be an acceptable means of connecting wire and cable.

nn. All system cabling within vertical risers (as required) shall be bundled, wrapped and tied to structure at three-meter intervals in order to isolate it from other wire and cable within riser. Additionally, all wire and cable within shaft shall be supported at least every two floors using Greenlee Slack Grips (Split Mesh Lace Closing) or approved equal. Provide all personnel and equipment necessary to install and support cable. All equipment shall be UL listed for application.

D. System Programming and Data Entry

Collect all data required to make the Security Management System operational. Deliver data to Owner on data entry forms, utilizing data from Contract Documents, Contractor's field surveys and all or pertinent information in Contractor's possession required for complete installation database. Identify and request from Owner any additional data needed to make SMS System fully operational and integrated. Completed forms shall be delivered to Owner for review and approval at least 30 days prior to Contractor's scheduled needed date. Contractor will coordinate with University of Kentucky Police Department Campus Security System Lenel VAR of Record (Stanley Security) for database and Campus Cloud Services programming and Integration. Contractor shall provide Door Counts, Panel Counts and locations, Reader Counts and input, output counts. Contractor shall also supply any special devices or operations that may require special programing. Examples would be Elevators, Biometric readers and others.

Contractor shall request a quote for this programing work, two (2) Client Workstation Licenses and any other Lenel Licenses required from Stanley Security. Stanley Security Group Contact person is Vicky Daugherty (912-246-9466) Vicky.Daugherty@sbdinc.com. This and any fees associated with the Lenel programing shall be included in Contractor's Bid. Contractors Bid shall be for a complete turn key total functional system. Contractor shall provide time in Bid to coordinate and participate with Stanley Security during their testing and programing.

Provide all initial system information for SMS setup including, but not limited to following:

a. SMS Card Reader Information

1) Coordinate all card reader values and text, including descriptors, alarm messages, map call up and identification with Owner.

b. Input and output points for SMS. Coordinate all input and output priorities and text, including descriptors, alarm messages, Video Camera call up, and map call up and identification with Engineer.

c. Initial system users, including levels of access. This shall include designation of Owner's representative at "Super User" level immediately upon SMS initialization.

d. Provide Elevator access per cardholder by cab and floor.

E. Furnish and install all SMS wire and cable including LAN cabling.

F. Provide code-compliant fire proofing techniques for all penetrations of fire rated partitions and slabs, where penetrations are made by or used for installation of SMS.

G. 120 VAC power dedicated to security system shall be on provided Emergency Generator Power. Gateways shall be on properly sized UPS units on Emergency Generator backup circuits. UPS units are provided by UKCNS. Contractor shall coordinate with UKCNS to provide power requirements for all equipment. A meeting with UKCNS to coordinate this and other IT related issues will be scheduled within 60 days of Contract award and be inclusive of A / E Team, UKCNS and Commissioning Agent.

H. Connect to AC power with provided UL listed power supplies and transformers to distribute low voltage power to system components as required.

I. Provide hinged cover UL listed terminal cabinets with tamper switches for all power supplies, transformers and power distribution terminal strips. Provide all conduit and wiring from AC power facilities to terminal cabinets.

J. Provide protection against spikes, surges, noise, and or line problems for all system equipment and components.

K. Provide protection on all exterior, control, power, signal cables and conductors against power surges. Each surge protector shall be UL Listed.

L. In no instance, shall any UL labeled door or frame be drilled, cut, penetrated, or modified in any way.

M. Contractor shall be responsible for replacing any labeled door or frame that is modified without written approval from project Engineer.

N. Label all controls as necessary to agree with their function.

O. Label all Wire and Cable in common at both ends using a permanent method such as self-laminating cable marking tape.

Tags shall be attached to wire and cable nylon cable ties in an accessible location so that they can easily be read.

Tags shall be installed when wire and cables are installed.

Labeling shall be consistent with existing cable labeling system and agree with Record Documentation.

P. Place wire identification numbers at each end of conductor involved by using sleeve type, heat shrinkable markers. Markers shall be installed so as to be readable from left to right or top to bottom.

Q. Mark all connectors with common designations for mating connectors. Connector designations shall be indicated on record drawings.

R. Coil all spare conductors in device back box, panel wire way, or top of panel where wire way is not provided. Conductors shall be neatly bundled and tagged.

S. Install integrated security and communication system in accordance with manufacturer's instructions at locations indicated on the Drawings.

T. Mount equipment plumb, level, square, and secure. For video entrance stations and video door stations, comply with manufacturer's design requirements to provide optimum picture quality of station monitoring.

3.3 DEMONSTRATION AND TRAINING

A. Coordinate with Owner and UKPD to establish required training.

B. Contractor shall be on call during Warranty period to answer any questions Owner might have. The Owner reserves the right to use any excess training hours, not used by time of system completion, for future training as requested by Owner until total number of training hours has been used.

C. Demonstration:

Demonstrate that integrated security and communication system functions properly.
Perform demonstration at final system inspection by qualified representative of manufacturer working with UK Lenel VAR of Record.

3.4 SYSTEM START-UP

A. Start-up includes all Contractor-Furnished, Contractor-Installed (CFCI) systems and equipment.

B. Work shall be complete and ready to operate prior to final acceptance.

C. All database programming for systems up to inaugural day of beneficial use of Security System shall be coordinated thru UKPD and UK Lenel VAR of Record.

D. Adjust integrated security and communication system for proper operation in accordance with manufacturer’s instructions.

3.5 SYSTEM ACCEPTANCE

A. Final acceptance testing of Work will be coordinated and observed by owner representatives and UKPD in coordination with Stanley Security Solutions.

B. Prior to testing, Contractor shall submit two sets of preliminary (draft) Record Drawings to owner and UKPD. Preliminary Record Drawings are to be used by owner and UKPD to conduct system final test.

C. At completion of Work, remove all waste materials, rubbish, Contractor's and subcontractors' tools, construction equipment, machinery and all surplus materials.

3.6 PROTECTION

A. Protect installed integrated security and communication system from damage during construction.

END OF SECTION

SECTION 282300 - VIDEO SURVEILLANCE

PART 1 - GENERAL

1.1 SCOPE

This section details product and execution requirements for VIDEO MANAGEMENT SYSTEM for the project.

Work includes furnishing all labor, materials, tools and equipment, and documentation required for a complete turnkey working system as specified in this Section. VMS shall consist of but not be limited to, Cameras, Monitors, Conduit, Boxes, Cable and Wired Devices. Programming work sheets and camera view setup is considered part of installation as well as coordination with UKPD, Stanley Security and Salient Systems.

Unless noted otherwise, "Contractor" shall refer to VMS Integrator & Installer.

Communications routing from VMS Servers to Cameras shall be via Owner LAN.

Coordinate with any and all trade contractors as required to provide a fully functioning system.

Unless noted otherwise, "Contractor" shall refer to security system integrator & installer.

Applicable provisions of Division 1 shall govern all work under this section.

Video surveillance can be restricted or prohibited by law. This document details technical considerations only. It is assumed that registration, licensing, policies regarding disclosure and privacy (notification, processing of images, time and date stamping, recording of sound, etc.), and or legal obligations are responsibility of Owner.

1.2 RELATED WORK

Related Division 28 Sections include:

1. 281643 - PERIMETER SECURITY SAFETY

Related Sections in other divisions of Work:

2. 087100 - DOOR HARDWARE
3. 260000 - ELECTRIC
4. 270000 - COMMUNICATIONS

1.3 REFERENCES AND STANDARDS

Work under this Section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 1 General Requirements.

All work and materials shall conform in every detail to rules and requirements of National Fire Protection Association, Kentucky Electrical Code, University of Kentucky Standards and University of Kentucky ITS Standards. UKITS standards can be found online at the following link: https://www.uky.edu/cpmd/design-standards/divisions-20---29---facility-services-subgroup and click on Division 270000 to find the latest version.

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

Other applicable standards are as follows:

1. ANSI/IEEE C2 - National Electrical Safety Code
2. NFPA 70-1999 - National Electrical Code

3. IEEE/ANSI 142-1982 – Recommendations for Grounding of Industrial & Commercial Power Systems.
4. NTSC/EIA RS-170A Video Standard
5. IEEE 802.3 standards for CSMA/CD (Ethernet) based LANs
6. Emissions: FCC 15, Class A; CE: EN55022 (Emissions)
7. CE: EN50082-01 (Immunity)
8. CE, UL 1950; CUL 1950 CE: EN60950 (Safety)
9. State of Kentucky
10. City of Lexington, KY

1.4 DEFINITIONS AND ABBREVIATIONS

VMS – Video Management System

LAN – Local Area Network

1.5 WORK BY OWNER

Owner shall provide:

1. Verify exact security device mounting locations.
2. Verify Acceptable per-camera field-of-view information.
3. Enterprise-wide Data Network / LAN to be utilized by VMS system.
4. Cross-connections from VMS components to building LAN, contractor provides all interconnection cables (Patch Cables) as needed but may not connect to LAN without ITS oversight and approval.
5. All active LAN components (switches, routers) as required for Security system function.
6. IP-address allotment and management for VMS devices as needed.

1.6 SUBMITTALS

Product Data: For each type of product indicated.

System Design drawings with cable routing, device location and labeling.

Communication and Security Closet layouts.

Camera View Modeling.

1.7 QUALITY ASSURANCE

Video Management System Contractor shall:

1. Have successfully completed two (2) Salient Systems projects in equal magnitude of the system specified in following sections. Be fully certified by Salient Systems for Sales and Installation of Salient equipment. Proper proof of certification with Salient will be submitted at time of Bid.

1.8 GUARANTEE

Warranty requirements for Video Management System (VMS) shall be two (2) years on all parts and labor commencing on Date of Substantial Completion. Those requirements apply to all components covered in this section.

PART 2 - PRODUCTS

2.1 GENERAL

VMS system shall deliver high quality; color video over an IP, UTP structured cable system using H.264 /H.265 compression and shall provide for monitoring and recording of all cameras in system as indicated herein and on project Drawings. The VMS allows event-based monitoring of campus and situational awareness though IP cameras centrally managed from the University of Kentucky Police Department Operations Center. The VMS utilizes analytics to identify potential situations on campus and preserving evidence for authorities to review. The Salient VMS has the capability to be securely monitored via mobile devices or off-campus locations, video sharing with outside public safety first responders.

Video shall be configurable from a workstation on the University LAN using standard Browser software.

2.2 IP VIDEO CAMERA (FIXED)

Interior Camera shall be: Axis P3374-V, Hanwha Techwin XND-L6080V.

Elevator Cameras shall be: Axis M3057-PLVE or approved equivalent.

Exterior Camera shall be: Axis P3375-LVE, Hanwha Techwin XNV-L6080R or approved equivalent.

Camera shall:

1. Be ceiling / wall mountable dome-type.
2. Be IP-native.
3. Utilize Power-over-Ethernet (PoE) for device power.
4. Be designed to provide video streams at the minimum HDTV 720p (1280x720) resolution at 30 frames per second using H. 264 / H.265.
5. Be equipped with Day/Night functionality, Wide Dynamic Range (WDR), color video to ½ lux, black and white below ½ lux and feature remote back focus capabilities.
6. Be provided complete with standard interior (3-9 mm nominal) auto-iris lens.
7. Per-camera lens selection dependent upon Owner-required field-of-view.
8. Have a smoked bubble.
9. Have housing and mount color to match surrounding architectural colors.

2.3 NETWORK VIDEO SERVER:

Security Cameras shall be connected to the owners Security LAN by UKCNS personnel and SMS VAR of Record, Stanley Security. Cameras shall be routed to Management Servers and Recording Servers via the Owners Security VAN. Installing Integrator shall complete all Camera Programing worksheets and provide to Stanley Security for System Programing and addition of Cameras to the Campus VMS. Integrator shall coordinate with VAR of Record, Stanley Security to include the cost of this programing in their bid for project. Contact Stanley Security. Stanley Security Group Contact person is Vicky Daugherty (912-246-9466) Vicky.Daugherty@sbdinc.com.

2.4 WIRE AND CABLE

General

1. Provide and install all device DATA cables as per UKITS and Division 270000 requirements. DATA cabling for Security cameras shall be terminated in each DATA Closet, in approved labeled patch panels (As per Division 270000 requirements). Camera cabling should be terminated in jacks at the camera device. Contractor to provide all patch cables. All exterior camera cables shall be provided with Surge protection units on each cable. Proper cable types must be must as per UKITS standards and Division 270000 requirements.
2. Provide all interconnecting system cabling at Security Closets and Communication Closets as well at security device end points. All UKITS standards must be followed. Exterior cameras that exceed the normal distance for copper cable must be installed with Fiber Cable as per UKITS Standards and Division 270000 requirements. At these fiber locations a Rugged / Hardened Switch is required, this switch should be provided by contractor by purchase thru UKITS..
3. Bond metallic system components in all Communications Closets and Security Closets to existing in-room ground bar.
4. Confirm and provide any necessary interface cabling with existing Access Control system.

PART 3 - EXECUTION

3.1 GENERAL

Work performed for installation of VMS system shall be performed by Security System Integrator – “Contractor”.

Provide equipment as indicated on Drawings and specified herein.

Provide all labor and materials necessary to construct systems as described herein to include furnishing and installing all system equipment, interconnecting cabling, programming and start-up, software (including software upgrades and reprogramming as necessary), termination components, mounting hardware, incidentals, accessories, testing, labeling, documentation and training as detailed in following sections.

1. Neatly lace, dress and support cabling.
2. Coordinate any downtime with Owner.

Prior to installation:

3. Conduit and equipment back boxes are as required. Contractor is responsible for coordination with all trades to ensure that conduit and back boxes are correctly placed for VMS use. Contractor is responsible for coordinating installation of conduit and boxes to make sure they are installed on schedule with other trades and are coordinated as to not interfere with other systems or pathways.
4. 120V AC Power is as required and is properly located.
5. LAN structured cabling is as required and properly located and installation has been coordinated with other trades.
6. Coordinate all devices and locations prior to equipment installation with owner.
7. Coordinate Owner-desired camera views, providing camera modeling prior to installation.
8. Coordinate Camera housing and mount finishes with Architect and Owner.

Install and wire equipment in accordance with University of Kentucky ITS Standards, manufacturer’s recommendations, and accepted engineering and installation practices.

Mount system components as recommended by manufacturer. All equipment mounting in Communication Closets must be approved by UK ITS prior to installation.

9. Arrange equipment to facilitate permanent access for use and maintenance.

3.2 CABLE INSTALLATION

Neatly lace, dress and support cabling.

Pull cables in accordance with cable manufacturer's recommendations and ANSI/EEE C2 Standards as well as University of Kentucky ITS Standards and all Division 270000 requirements.

1. Do not exceed manufacturer's recommended pulling tensions.
2. Do not install bruised, kinked, scored, deformed, or abraded cable.
3. Do not splice cable between indicated termination, tap, or junction points.
4. Remove and discard cable where damaged during installation and replace it with new cable.
5. Pull all cable by hand unless installation conditions require mechanical assistance.

Run all wire and cable continuous from device location to final point of termination. No mid-run cable splices shall be allowed.

Furnish and install all cable such that ample slack is supplied at device terminating end of cable to compensate for any final field modifications in camera location.

6. Loosely coil slack in “Figure-eight” in a manner that prevents kinking.
7. Loop radius shall be at least 4X minimum bend radius for cable.
8. Slack length of cable shall be 4 feet (minimum).

Provide code compliant fire proofing techniques for all penetrations of fire rated partitions and slabs, where penetrations are made by or used for installation of Video System.

Coordinate routing of wire and cable requiring isolation from power, radio frequency (RF), electromagnetic interference (EMI), telephone, etc. with Engineer.

At no time shall any cable be subjected to a bend less than manufacturer’s specified minimum radius. Also refer to UKITS Standards.

Provide grommets and strain relief material where necessary to avoid abrasion of wire and excess tension on Wire and Cable.

Make connections with solder-less devices, mechanically and electrically secured in accordance with manufacturers’ recommendations. Wire nuts shall not be an acceptable means of connecting wire and cable.

3.3 IP VIDEO CAMERAS

Mount Video Cameras per project drawings.

Field-verify exact locations and field-of-views with Owner prior to installation.

Provide video camera lenses to accommodate Owner-coordinated field-of-view per camera.

1. Field verify and confirm views with Owner prior to procurement and final installation and adjust camera positions and lens sizes as required upon installation.

Configure resolution, frame rate, password, etc. to match existing system installation, coordinate with UKPD.

Coordinate with Owner prior to installation to confirm required parameters.

Wire interface(s) to external alarms.

3.4 NETWORK CONNECTION

Cross-connections to building LAN by Owner, NO EQUIPMENT MAY BE CONNECTED TO UK NETWORKS BY ANY SUB CONTRACTOR, ONLY BY UK ITS personnel.

3.5 LABELING AND IDENTIFICATION

Labeling protocols to match all UK Security System installations.

1. Cabling, Hardware and Equipment shall be clearly labeled using a Code identifying each piece as unique throughout Video Camera System. This code will aid in identifying hardware for servicing and maintenance.
2. Labels and Tags shall be machine-generated using English character set in black ink on white background labels and Tags.
    a. Self-laminating permanent labels are required on cables; permanent non-marring labels are required on all other hardware/cabinets.
    b. No hand-written Labels or Tags shall be allowed.
    c. Dymo or Kroy type adhesive backed lettering is not acceptable.

Identify and tag all cables to denote function.

3. Tag shall indicate:
    a. System of which cable is a part,
    b. Indication of cable destination (e.g. room or component), and
    c. Unique alpha-numeric identifier that distinguishes cable from all others in system.

All labels shall be machine generated. Handwritten labeling is not acceptable.

Label all front panel controls used in normal operation of system using plastic laminate engraved labels or approved equal.

4. Firmly affix to panel or device.

Labeling Formats

5. To be defined by Owner prior to construction following practice for all campus Security System installations.

3.6 SYSTEM TESTING AND ACCEPTANCE

System shall be complete and fully operational before requesting final acceptance and scheduling system Integration into the Campus VMS.

Installation of all field devices will be inspected by Owner or Owner’s representative. Inspection will consider overall neatness and quality of installation, functionality of each individual device, mounting, wiring and labeling.

Conduct a seven-day burn-in test. Intent of burn-in test shall be to prove System by placing it in near real operating conditions prior to connection to Campus VMS.

1. During this period System shall be fully functional and programmed so that all points, controls, messages, prompts, etc. can be exercised and validated.

Provide written notification to Owner that system is completely installed, integrated, burn-in testing completed and is fully functional as specified herein.

2. Submit schedule for acceptance testing. Representatives of Owner, UKPD and/or representative may witness test procedures.
3. Notify Owner UKPD and the representative in writing a minimum of two weeks in advance to allow for such participation.

4. Describe test procedures prior to testing and submit sample test form to Owner / Representative.

Prior to final acceptance test, equipment rooms and similar areas should be free of accumulation of waste materials or rubbish caused by operations under Contract.

Equipment shall be on and fully operational during any and all testing procedures.

5. Provide all personnel, equipment, and supplies necessary to perform site testing.
6. Supply a form of communication with remote parties in the team for use during test.
7. A manufacturer's representative shall be present on site to answer any questions that may be
   beyond technical capability of Contractor's employees, if Contractor so elects or by specific request of Representative Owner, at no charge to Representative or Owner.

During course of final acceptance test, Contractor shall be responsible for demonstrating that, without exception, provided VMS complies with contract requirements.

Testing shall include but not be limited to:

8. Continuity and conductor/connector integrity on all cables.
9. Demonstrate functionality of all cameras including:
   a. Owner-acceptable field of view.
   b. Response to alarms.
   c. Response to Access Control System inputs.
10. Confirm remote viewing, configuration and camera control via Browser and in the UKPD Operations Center. Confirm all Analytic uses on Cameras programmed for Analytic use.
    a. Confirm system rights settings for authorized users.
11. Demonstrate storage and retrieval of recorded video by date/time.

Owner retains the right to suspend and/or terminate testing at any time when system fails to perform as specified.

12. In event it becomes necessary to suspend test, Contractor shall work diligently to complete / repair all outstanding items to condition specified in Specification and as indicated on Security Drawings.
13. All of Owner's / Representative Fees and expenses related to suspended test will be deducted from Contractor's retainage.
14. Contractor shall supply Owner with a detailed completion schedule outlining phase by phase completion dates and a tentative date for a subsequent punch list retest.
15. During final acceptance test, no adjustments, repairs or modifications to system will be conducted without permission of Owner.

Upon successful completion of final acceptance test (or subsequent punch list retest) Owner or Representative will issue a letter of final acceptance.

Records of Test Results shall be included in System Documentation and submitted as detailed below.

3.7 OWNER TRAINING

Training course for system covered in this section shall be a minimum of 6-hours.

Maximum number of students to be (6).

1. Training materials shall be provided to all students.

Record, label, and catalog all training on DVD Videodiscs. Provide discs to Owner for future in-house training sessions and / or reviews. Furnish all temporary equipment necessary for taping all training sessions. Maintain accurate and up-to-date time sheets of all training sessions.

Contractor shall be on call during Warranty period to answer any questions Owner might have. The Owner reserves the right to use any excess training hours, not used by time of system completion, for future training as requested by Owner until total number of training hours has been completed.

3.8 DOCUMENTATION

All Owners manuals and or maintenance information shall be provided in printed form as well as electronic PDF format to the owner and owner representative.

3.9 WARRANTY AND SUPPORT

Unless otherwise noted, Contractor shall guarantee all materials, equipment, etc., two (2) years from date of final Owner acceptance of system. This guarantee shall include all labor, material and travel time.

Contractor/Integrator and/or manufacturer(s) of system equipment must offer:

1. Technical Support Capabilities (Technician onsite) response time onsite within 4 hours, 24-hours/7-days per week (“24/7”), and 365 days per year.
2. 24-hour turn-around (from receipt of item) for Repair or Replacement of failed components, 7-days per week.

END OF SECTION

SECTION 28 3113 FIRE DETECTION AND ALARM SYSTEMS

PART 1 - GENERAL

1.1 RELATED WORK

A. Section 21 1314 - Automatic Fire Sprinkler System

B. Section 26 0000 - General Electrical Requirements

C. Section 26 0519 - Low-Voltage Electrical Power Conductors and Cables

D. Section 26 0526 - Grounding and Bonding for Electrical Systems

E. Section 26 0533 - Raceway and Boxes for Electrical Systems

F. Section 26 0553 - Electrical Systems Identification

1.2 REFERENCE

A. Work under this section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.

1.3 SYSTEM DESIGNER/INSTALLER PERFORMANCE

A. This written specification section and the fire alarm drawings issued with them are intended to be used as a performance specification to assist the fire alarm system designer/installer with bidding the project and to demonstrate the Owner's, City of Lexington, KY and the Engineer's intent of how the building is to be operated. Not all fire alarm and mass notification devices are shown on the drawings required to provide a complete functioning fire alarm system. Variations in manufacturer's system components, layouts and programming require the manufacturer to design a system specifically for this facility based on their system's performance.

B. The fire alarm system provider's bid is to include all costs associated with providing a fully functioning and tested fire alarm and mass notification system within the project work boundary as indicated on the drawings that meet's all current applicable codes and University of Kentucky Facility Standards. All fire alarm and mass notification design, devices, raceways, cabling, programming, testing, commissioning and Owner training is to be provided. These components and additional items are described in this specification.

C. Additional work to be included that is outside of the project boundaries indicated on the drawings:

1. Communication fiber and/or copper conductors and raceways to facilitate connection to adjacent structures and/or ties to a campus fire alarm loop or direct connection to fire alarm monitoring station.
2. Programming as required in adjacent or connected structures to allow a supervisory signal from this facilities fire alarm system to the adjacent or connected structure's fire alarm system.
3. Programming and connectivity as may be required at the campus central monitoring location and central mass notification system.

D. Fire alarm system coordination with other trades is required to assure system all tie in points, remote monitoring and control requirements, and alarm signals are provided. Other trades or systems include, but are not limited to:

1. Automatic Water Sprinkler System
2. Gaseous Fire Suppression System
3. Pre-action Fire Suppression System
4. Ansel Fire Extinguishing System
5. Building Automation System
6. Access Control and Security System
7. Heating and Ventilation System
8. Smoke Evacuation/Purge/Control System
9. Building Electrical System
10. Building Lighting Control System

E. Designer/Installer is to be:

1. NICET certified
2. Employed by the system manufacturer or manufacturer's licensed installer
3. Familiar with the University of Kentucky Standards
4. Familiar with the City of Lexington life safety requirements and amendments to the IBC and NFPA codes

F. Bidding Clarification and Questions

1. All questions to the Owner/Engineer are to be provided a minimum of 5 days prior to bid.
2. Bids are to include all system design and installation costs described in this specification and are not to be based solely on the drawings.
3. All clarifications and exclusions are to be included with the bid.
4. Allowances in addition to the base bid included with the bid are only allowed with prior approval.
5. Change orders on the base bid will only be reviewed for approval for:
    a. Owner requested changes that impact fire alarm device count.
    b. Any change that results in moving a device or system component already installed.
    c. Changes initiated by other disciplines listed in 1.3D that result in additional devices and/or programming.

1.4 DESCRIPTION

A. In general, work consists of:

1. Design, furnish and install Class I, digital, addressable voice fire alarm system.
2. System to be wired, connected, and left in first class operating condition.
3. System includes:
    a. Control Panel(s)
    b. Annunciator Panel(s)
    c. Manual Stations
    d. Heat Detectors
    e. Smoke Detectors
    f. Alarm indicating appliances
    g. Addressable relays
    h. Trouble bells
    i. Raceways, boxes, fittings and conductors

j. Terminations
k. Other necessary material for complete operating systems.

4. Fire alarm system shall allow for loading and editing special instructions and operating sequences as required.
5. Systems shall be capable of on-site programming to accommodate system expansion and to facilitate changes in operation.
6. Software operations shall be stored in non-volatile programmable memory within fire alarm control panel. Loss of primary and secondary power shall not erase instructions stored in memory.
7. Systems shall be capable of being programmed and interfaced to be used as part of a Mass Notification System.

1.5 REFERENCE STANDARDS

A. ANSI A117.1 – Accessible and Usable Buildings and Facilities

B. IBC - 2012 - International Building Code

C. IEC60268 – Sound System Equipment

D. IFC - 2012 - International Fire Code

E. NECA 305 - Standard for Fire Alarm System Job Practices

F. NFPA 72 - National Fire Alarm Code

G. NFPA 101 - Life Safety Code

H. NFPA 170 – Standard for Fire Safety and Emergency Symbols

I. UL 268 - Smoke Detectors for Fire Protective Signaling Systems

J. UL 497B - Protectors for Communications and Fire Alarm Circuits

K. UL 521 - Heat Detectors for Fire Protective Signaling Systems

L. UL 864 - Control Units for Fire Protective Signaling Systems

M. UL 1480 - Speakers for Fire Protective Signaling Systems

N. UL 1481 - Power Supplies for Fire Protective Signaling Systems

O. UL 1711 - Amplifiers for Fire Protective Signaling Systems

P. UL 2572 – Standard for Mass Notification Systems

Q. University of Kentucky Facility Standards

1.6 QUALIFICATIONS

A. Equipment shall be supplied by company specializing in fire alarm and smoke detection systems with 5 yrs documented experience

B. Work shall be performed by licensed contractor regularly engaged in installation and servicing of fire alarm systems.

C. Furnish proof of 5 yrs documented experience and factory authorization to furnish and install equipment proposed.

D. Contractor shall be located within 100 miles of Project site.

1.7 SUBMITTALS

A. Submit design and shop drawings for equipment provided under this Section.

B. Submit bill of materials listing part number and quantity of components and devices.

C. Submit block diagrams showing layout and operation of entire system.

D. Submit schematic diagrams of circuits from field devices to terminal strip(s) associated with Control Panel.

1. Diagrams shall show schematic wiring of equipment and connections to be made to devices.
2. Terminal connections in equipment shall be numbered to correspond to diagrams.
3. Wiring diagrams shall be coordinated so that terminal numbering, circuit designation and equipment or device designations are same on drawings.

E. Submit standby battery power calculations.

F. Submit sound amplifier and strobe power supply calculations showing current draws for devices and modules during standby and alarm and trouble conditions.

G. Submit voltage drop calculations for both initiating and alarming circuits.

H. Submit to Authority Having Jurisdiction:

1. Copy of shop drawings as required to show component locations.
2. Upon receipt of comments from Authority, make resubmission if required to make clarifications or revisions to obtain approval.
3. Include fees associated with this in bid.

1.8 BUILDING SYSTEMS COMMISSIONING

A. An independent third party Commissioning Agent will document completion of the Mechanical, Fire Suppression, Plumbing, HVAC, Electrical, Communications and Electronic Safety and Security Systems for the project. The Construction Manager and Division Contractors are members of the Commissioning Team and will facilitate completion of the Commissioning process. Refer to section 019113 “Building Systems Commissioning” for the project Commissioning requirements and roles and responsibilities of each member of the Commissioning Team.”

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Simplex 4100ES

B. Notifier by Honeywell NFS

C. Edwards Systems Technology (EST)

D. Manufacturer must be capable of interfacing with the existing BBSRB Simplex fire alarm system.

2.2 SYSTEM OPERATIONS

A. Alarm Initiation

1. System alarm operation after activation of any manual station, automatic detection device, or sprinkler flow switch:
   a. Appropriate initiating device circuit red LED shall flash on Control Panel and remote annunciator until the alarm has been acknowledged at Control Panel or remote annunciator. Once acknowledged, this same LED shall latch on. Subsequent alarm received after acknowledging shall flash subsequent zone alarm LED on Control Panel and remote annunciator. Acknowledgment of alarm shall not reset activated device.
   b. Pulsing alarm tone shall occur within Control Panel and remote annunciator until event has been acknowledged.
   c. Alarm audible-indicating appliances shall sound in three-pulse temporal pattern until silenced by alarm silence switch at Control Panel or remote annunciator.
   d. Visual alarm indicating appliances shall operate in continuous flashing pattern until system is reset.
   e. Supervised signal to notify the Lexington Fire Department and University Police Station shall be activated.
   f. Doors held open by door control devices shall close.
   g. Mechanical controls shall activate air-handling systems as specified by Division 23.
   h. All locked doors in the path of egress shall unlock.
   i. All stairwell doors shall unlock.
   j. Lighting controlled by central lighting control system will turn on at full illumination level.

B. Silencing

1. Alarm audible indicating devices shall be silenced by operating alarm silence switch in Control Panel or by use of key operated switch at remote annunciator.
2. Strobes shall remain active until system is reset.
3. Subsequent zone alarm shall reactivate alarm signals.

C. Reset

1. SYSTEM RESET button shall be used to return system to its normal state after an alarm condition has been remedied.

D. Supervision

1. System shall independently supervise:
   a. Initiating device circuits.
   b. Sprinkler flow and tamper switches.
   c. Independently fused indicating appliance circuits.
   d. Auxiliary manual controls. "Off normal" position of any switch shall cause an "off normal" system trouble.

e. Remote annunciator panel. Any ground, short, or open in the wiring to Fire Alarm Control Panel, as well as malfunction of the annunciator panel shall be annunciated at Control Panel.
f. Incoming power. Power failure shall be audibly and visually indicated at Control Panel and remote annunciator. Green "power on" LED shall be displayed continuously while incoming power is present.
g. System batteries. Low battery condition or disconnection of battery shall be audibly and visually indicated at Control Panel and remote annunciator.
h. Adjacent conjoined buildings. An alarm condition in a conjoined building shall cause a supervisory alarm in this building.

2. Independently supervised circuits shall include visible amber "Trouble" LED to indicate disarrangement conditions per circuit.
3. Alarm activation of any initiation circuit shall not prevent subsequent alarm operation of any other initiation circuit.
4. Device activation shall be annunciated at Control Panel and remote annunciator.
5. Disarrangement conditions of any circuit shall not affect operation of other circuits.
6. System shall have provisions for disabling and enabling circuits individually for maintenance or testing purposes.

E. Power Requirements
1. Provide 120 VAC power via dedicated branch circuit.
2. Branch circuit shall have "breaker lock" to prevent accidentally de-energizing of power to fire alarm panel.
3. Circuit breaker shall be locking type and painted red and labeled "FIRE ALARM."
4. Provide disconnect switch for AC power near panel or within Fire Alarm Control Panel itself. Switch shall be labeled “Fire Alarm Power Disconnect.”
5. Where new Control Panel is to remain at same location as existing panel, contractor may use existing branch circuit, if it meets requirements stated above.
6. Provide power surge and transient protection.
7. Provide back-up battery capacity to operate entire system in normal supervisory mode for period of 24 h with 10 minutes of alarm operation at end of period.
8. System shall automatically transfer to standby batteries upon power failure.
   a. Battery charging and recharging operations shall be automatic.
9. Provide power limited, filtered and regulated battery charger.
   a. Charger shall:
      1) Be combination high rate/float maintenance type.
      2) Charge fully discharged battery to 70% in 12 h.
      3) Monitor for AC fail/disconnect, low/no battery, and high battery level.
      4) Include switches and associated LEDs for high rate and AC disconnect.
      5) Provide 5 amps of regulated 24VDC for peripheral devices requiring ± 5% regulation and 8 amps at 24 VDC for standard peripheral devices.
      6) Be compatible with lead acid batteries.
10. External circuits requiring system-operating power shall be 24 VDC and shall be individually supervised and fused at control panel.

F. Smoke Detection Operation
1. Smoke detector alarms shall be processed and reported immediately.
2. Upon building completion alarm verification shall be added to detector(s) as directed by project engineer.
   a. Alarm Verification operation shall be as follows:
      1) Activation of smoke detector(s) with alarm verification programming shall initiate an alarm verification operation whereby the panel will reset the activated detector and wait for a second alarm activation.

2) If, after (20) seconds and within (1) minute after resetting, a second alarm is reported from the same or any other smoke detector, the system shall process the alarm as described previously.
3) If no second alarm occurs within (1) minute the system shall resume normal operation.
4) Alarm verification shall operate only on single smoke detector alarm.
5) Other activated initiating devices or multiple smoke detector alarms shall be processed and reported immediately.
6) Alarm verification operation shall be selectable by device or zone.

G. Elevator Recall Operation

1. When an elevator lobby, elevator shaft or machine room smoke detector alarm is activated it shall cause Phase I Emergency Recall Operation, according to the following sequence:
   a. If alarmed detector is on any floor other than main level of egress, elevator car(s) shall be recalled to main level of egress.
   b. If alarmed detector is on main level of egress, elevator car(s) shall be recalled to pre-determined alternate recall level as determined by Owner.
2. Elevator lobby smoke detector shall annunciate on separate zone from other devices.
3. Zoning shall be done by floor.
4. Upon reset of Fire Alarm Control Panel, elevators shall automatically resume normal operations.

H. Elevator Shunt Trip

1. After elevator machine room or elevator shaft heat detector is activated, elevator control panel shall deactivate shunt trip breaker supplying power to elevator.
2. Specific elevator shaft zone shall be put into alarm and sound general fire alarm.

I. System Response

1. Maximum elapsed time from sensing fire at non-smoke detector initiating device or second smoke detector until it is recorded at Control Panel and remote annunciator shall not exceed 5 seconds, and not exceed 15 seconds for remote station reporting.

J. Air Handling Unit System Operation/Interface

1. Control Panel shall provide output alarm interface to air handling/energy management system controllers, which in turn shall perform automatic functions as specified in Division 23.
2. Fire alarm Control Panel shall provide manual control mode to override fire alarm panel’s signal so that air-handling units can be restarted.

K. Sprinkler System Operation/Interface

1. Activation of any standpipe or sprinkler valve supervisory (tamper) switch shall activate system supervisory service audible signal and illuminate LED at Control Panel and remote annunciator.
2. Panel shall provide differentiation between tamper valve operation and opens and/or grounds on initiation circuit wiring.
3. Pressing supervisory service acknowledge key will silence supervisory audible signal while maintaining supervisory service LED "on" indicating off-normal condition.

4. Restoring valve to normal position shall cause supervisory service audible signal to pulse indicating restoration to normal position.
5. Supervisory service acknowledge key shall silence audible signal.

L. Manual Evacuation (Drill) Operation

1. Manual evacuation (drill) switch shall be provided to operate alarm indicating appliances without causing other control circuits to be activated.
2. Should true alarm occur, alarm functions would return to normal operation immediately.

M. LED Test Operation

1. Activation of Lamp Test switch shall turn on all LED indicators and the local sounder and then return to previous condition.

N. System Diagnosis

1. System shall include special software to detect, diagnose, and report failures and isolate such failures to printed circuit board level.

O. Watch-Dog Timers

1. System shall include independent "Watch-Dog" timers to detect and report failure of any microprocessor circuit, memory, or software.

P. Walk Test Operation

1. Actuation of "Walk Test" switch/program at control panel shall activate "Walk Test" mode of system, which shall cause following to occur:
   a. Fire department circuit connection shall be bypassed.
   b. Control relay functions shall be bypassed, such as door holders, elevator capture, fan shut down, etc.
   c. Audio and visual circuits shall be bypassed.
   d. Control Panel shall show trouble condition.
   e. Alarm activation of initiation device shall cause audible signals to sound for 2 seconds.
   f. Panel shall automatically reset itself after signaling is complete.
   g. Momentary opening of initiating or indicating appliance circuit wiring shall cause audible signals to sound for 2 seconds indicating trouble condition.
   h. If system becomes inactive for period of longer than 30 minutes, panel shall default to normal fire alarm functions.
   i. Activation of any initiation device shall be silently logged as an alarm condition in historical data file.
2. Panel shall have capability of dividing system into distinctive walk test groups.

Q. One-Way Voice Communications

1. Automatic voice evacuation sequence shall be as follows:
   a. Audio alarm signal shall consist of alarm tone for maximum of 2 seconds followed by temporal code-three.
   b. Temporal code-three shall sound until alarm silence switch at Fire Alarm Control Panel or the remote annunciator has been operated.

c. Audio alarm operations of speaker circuit selection and alarm tone timing variations shall be activated by system software so that required future changes to evacuation sequence or re-arrangements of audio circuits can be facilitated by authorized personnel without additional components or rewiring.
d. System shall be configured to allow for "All Call" and selective voice paging from both the main Control Panel and the designated remote annunciator panel(s).

2. Selective Paging:
   a. Upon activation of any speaker manual control switch(es), two (2) seconds of tone shall sound over selected speakers.
   b. At end of tone, operator shall be able to make announcements via push-to-talk paging microphone over pre-selected speakers.
   c. Systems that require more than one switch activation (in addition to floor selections) to perform this function activation are not acceptable.
   d. Strobes shall flash only in selected area(s) or floor(s).
   e. As minimum, each floor, stairwell, and elevator car shall be a separate selectable zone.
3. All Call:
   a. Upon activation of "All Call" switch, two (2) seconds of tone shall sound over all speakers in system.
   b. At end of tone, the operator shall be able to make announcements via push-to-talk paging microphone over all system speakers.
   c. Strobes shall flash in all areas or floors.
   d. Systems that require more than one switch to perform this function activation are not acceptable.
   e. System shall automatically default to fire alarm operations if the microphone becomes inactive for more than one (1) minute.
   f. System is to be capable of being activated remotely from University Police Station.
4. System is to be capable of being used as part of a campus mass notification system.
   a. Separate fiber and/or data connection to initiate and control system as a listed mass notification system.
   b. Strobes are to be marked “ALERT” and meet University of Kentucky and City of Lexington Requirements for notification appliances for both fire and mass notification purposes.

R. Security System Interface

1. Provide addressable relay modules at each security power supply power input or connection to UL listed deactivation circuit for fail-safe door locks located within 5’ of power supply.
2. Activate relays on general alarm to release all locked doors in the path of egress.
3. Activate relays on general alarm to release all stairwell doors.
4. Provide supervised manual switch to allow door unlocking by user at panel (verify requirement with University of Kentucky Campus Security).
5. Doors are to remain locked during walk test.

S. Lighting Control System Interface

1. Provide contact closure on general alarm to indicate to lighting control system

T. HVAC/BAS Equipment Interface

1. Provide addressable relay modules at each BAS panel, air handling unit, and exhaust fan.
2. Provide control interface at fire alarm panel to allow remote manual on/off operation of air handling systems and allow smoke purge control.

3. Coordinate system requirements with BAS system provider.
4. System must transmit all points via BACnet to PPDMC Tridium System.

U. Smoke Damper Interface

1. Provide addressable relay modules at each smoke damper to allow for smoke damper operation in accordance with system requirements.

V. Adjacent Building Interface

1. Provide addressable relay module at all connected building fire alarm panels.
2. A general alarm in a building that is attached to this building shall be indicated as a supervisory alarm in the control panel and all held open doors are to release.

2.3 ENCLOSURE

A. Provide cabinets of sufficient size to accommodate equipment.

B. Cabinet shall be equipped with locks and transparent door panel providing tamper-proof enclosure, yet allowing full view of various lights and controls.

2.4 CONTROL PANEL

A. Provide expandable, modular construction Fire Alarm Control Panel with solid state, microprocessor based electronics.

B. Visual indicators shall be high contrast, LED type, or LCD readout.

C. Control Panel shall contain following features:

1. Number of zones as indicated on plans
2. Each zone in Panel shall include 1 red LED for ALARM and 1 yellow LED for TROUBLE - (complete descriptive LCD output read-out is acceptable)
3. One spare zone for each five active initiating zones
4. Alarm indicating appliance circuits with 25% spare available capacity on each circuit.
5. One spare circuit for each ten active horn speaker circuits
6. One spare circuit for each ten active strobe circuits
7. Supervised annunciator circuits
8. Reverse polarity remote station connection
9. One minimum Form C Alarm Contact (2.0 Amps ea.)
10. One minimum Form C Trouble Contact (2.0 Amps ea.)
11. Earth ground supervision circuit
12. Automatic battery charger and standby batteries
13. Resident non-volatile programmable operating system memory for all operating requirements.
14. Supervised manual evacuation switch (drill)
15. Supervised manual disconnect switch per zone with resound
16. Supervised manual disconnect switch for each indicating appliance circuit with resound

D. One red LED for system ALARM

E. One yellow LED for SUPERVISORY service for sprinkler system

F. One yellow LED for system TROUBLE

G. Green LED for system "POWER-ON"

H. Alarm acknowledge switch

I. Supervisory acknowledge switch for sprinkler system

J. Trouble acknowledge switch

K. Alarm silence switch

L. System reset switch

M. LED test switch

N. Fire department tie disconnect switch

O. Supervised manual door holder release bypass switch

P. Supervised manual elevator capture bypass switch

Q. Supervised manual fan shut down bypass (override) switch

R. Alarm verification module on smoke detector circuits only

S. Posted operating instructions near panel

T. One-way voice communication system

U. Supervised Water Flow Alarm Bypass Switch

2.5 ONE-WAY VOICE COMMUNICATION SYSTEM

A. Central audio control module:

1. Necessary alarm message/tone generation
2. Main and remote microphone connection
3. Mixer/pre-amplifier circuits
4. Continuous supervision for all circuits, amplifiers and modules.

B. Hand-held, push-to-talk microphone:

1. Recessed within a protective panel-mounted enclosure
2. Dynamic communication type with frequency range of 200 Hz to 4000 Hz
3. Equipped with self-winding 5’ coiled cable
4. Supervised for disconnection
5. LED indicator shall be provided to indicate microphone push-to-talk button has been pressed and speaker circuits are ready for transmission.

C. Audio control switch module:

1. Provide manual access to audio operations for authorized personnel

2. Include "All circuits" switch
3. "Aux Tone" switch
4. Tone generator stop switch
5. Switches and associated LED indicators shall be supervised for disarrangement on failure

D. Provide pre-recorded digitized voice message for automatic transmission to building occupants during alarm conditions.

1. Automatic message player shall not rely on tape or other mechanical means of transmitting evacuation message.
2. Standard message, approved by Authority Having Jurisdiction, shall be provided.
3. Message player must be capable of transmitting a custom message of up to three (3) minutes long.
4. Self-contained speaker and switching arrangement shall provide for testing of message(s) without disturbing occupants of the facility.

E. Audio power amplifiers:

1. 75 VRMS output
2. Frequency response of 100 Hz to 7000 Hz
3. Transformer
4. Self-contained filtered 24 VDC power supply
5. Amplifier monitoring circuits
6. Should a short develop on speaker circuit, the amplifier shall be current limited or automatically disconnected from that circuit.
7. Individual speaker circuits shall not be loaded to more than 75% of rated amplifier power output.

F. Provide sufficient amplifiers to operate system speakers at 1-watt tap simultaneously plus 50% reserve capacity.

1. Provide at least one back-up amplifier capable of automatically replacing any failed amplifier.
2. Stand-by amplifier shall be rated at same output capacity as the largest amplifier in evacuation system.

G. Speaker and strobe circuits shall be zoned by floor or as noted on plans, with can isolating module on each circuit.

H. Audio Evacuation Supervision:

1. Each speaker zone, amplifier, preamplifier, and power supply shall be supervised for component or circuit failure.
2. Detection of amplifier failure shall cause substitution of stand-by amplifier and:
   a. Initiate trouble alarm on fire alarm system
   b. Activate trouble light and audible signal at console
3. Power supplies shall have DC output of adequate capacity to handle total loads plus 30 percent spare capacity
4. Power supply shall be furnished for substitution of failed unit, to ensure that loss of power supply will not result in loss of coverage to any evacuation zone.
5. Provide minimum of one circuit for each zone or area of distinct communication.

I. Manual Voice Paging Sequence

1. System shall be configured to allow selective voice paging.
2. Upon activation of any speaker manual control switch, two (2), two (2) second beeps, similar to 900 Hz tone, shall sound over the speakers.
3. When speaker manual control switches are activated, control panel operator shall be able to make live voice announcement, via the push-to-talk paging microphone, over the pre-selected speakers/circuits.
4. Facility for total building evacuation and paging shall be provided by means of "All Call" switch, to allow for activation of all speakers.
5. Panel shall be capable of providing a method for remote fire fighters telephone patch-in to one-way voice communication speakers.
6. Manual operation shall be controlled at Fire Alarm Control Panel and remote microphone.
7. Remote fiber or data connection to be provided for connection to University of Kentucky campus mass notification system.

J. Tones

1. Main evacuating tone shall be temporal code-three.
2. Optional tones shall include:
   a. Hi/Lo
   b. Slow whoop
3. Hi/lo tone shall be free running tone with high frequency of 544 Hz and a low frequency of 440 Hz. "On time" (Hi) shall be 100 milliseconds while the "off time" (Lo) is 400 milliseconds.
4. Slow whoop tone shall be slowly ascending tone from 200 to 830 Hz in 2.5 seconds.
5. One primary and one secondary tone generator shall be furnished and constantly monitored.
   a. Automatic transfer to secondary unit should primary unit fail.
   b. Trouble signals shall indicate a failure of either primary or secondary unit.

2.6 REMOTE ANNUNCIATOR PANEL

A. Provide LED annunciator.

B. Annunciator:

1. Black enamel finish
2. Provide 1 red alarm LED and 1 amber trouble LED per initiation device circuit.
3. Communicate to Control Panel over 1 twisted shielded pair of wires.
4. Operating power shall be 24 VDC and be fused at Control Panel.

C. Wiring between annunciator panel and Fire Alarm Control Panel shall be supervised.

D. Annunciator:

1. Control push-button switches for; alarm silence, trouble silence, system reset and manual evacuation.
2. Key "enable" switch to activate or deactivate control and push-button switches
3. System trouble LED
4. Power on LED
5. Control switches shall have capability of being programmed on site to provide additional or nonstandard operations and functions.

2.7 PERIPHERAL DEVICES

A. Initiating device shall be labeled with zone number and order in zone. Information shall be visible from floor at device's location, i.e., (ZONE 1, 2 OF 3).

B. Speaker/strobe units shall be labeled with circuit numbers, i.e., (CKT 1)

C. Location of end-of-line device shall be indicated on device that contains same.

D. Labeling shall be done with legible machine-typed lettering.

2.8 MANUAL STATIONS

A. Manual stations:

1. Single action
2. Constructed of cast aluminum, red with raised white lettering and smooth high gloss finish.
3. Match University standard requirements

B. When station is operated, handle shall lock in open manner to facilitate quick visual identification of activated station.

2.9 SPEAKER/STROBE UNITS

A. Combination Speaker/Strobe Devices

1. Speakers:
   a. Operate on 75 VRMS supplied by system amplifiers circuit
   b. Include separate wire leads for in/out wiring for each leg of associated signal circuit. T tappings of signal device conductors shall not be acceptable.
   c. Be suitable for rear mounting behind audio-visual assemblies, which shall be flush or semi-flush mounted, with manufacturer back boxes and flush trim ring.
   d. Have field adjustable output taps, 3 taps minimum.
   e. Provide minimum sound pressure level of 85.7 dBA at 10’ using 1-watt tap.
   f. Speakers located in mechanical shall have 3 taps minimum with 8W being the highest.
   g. Include a blocking capacitor for line supervision and screw terminal for in-out wiring.
   h. Color is to be white with “ALERT” in red lettering.
2. Strobes:
   a. Multi tap units with taps at 15, 30, 75 and 110 cd
   b. Tapped at 15 candela peak power or as noted on drawings
   c. In compliance with ADA requirements
   d. On separate supervised circuit from horn circuit
   e. Synchronized so strobes units within sight of each other flash simultaneously
   f. Cover plate shall be White with "ALERT" in red lettering.
3. Strobe circuit loading shall be calculated at 75 cd tap for all devices.

B. Speaker Devices

1. Speakers without strobe units:
   a. Above listed features
   b. Flush ceiling mounted white baffle and recessed back box installation in suspended ceiling system where installed in areas with finished ceilings.

c. White baffle with surface mounted back box, furnished by speaker manufacturer, where installed in areas with exposed structure.
d. Cast metal grille and finished back box where installed in mechanical/interstitial spaces.

2.10 SMOKE DETECTORS

A. Smoke detectors:

1. Photoelectric type
2. Obtain operating power from the Fire Alarm Control Panel supervised detection circuit
3. Operating voltage shall be 24 VDC (nominal).
4. Have magnetically operated functional test switch
5. Have flashing status indicating LED for visual supervision. When detector is actuated, flashing LED shall latch on steady and at full brilliance.
6. Capable of being supplied with remote alarm LED indicator
7. Provide solid-state construction and compatibility with other normally open fire alarm detection loop devices, (heat detectors, manual stations, etc.).
8. Be factory calibrated to least allowable sensitivity adjustment

B. Detector may be reset by actuating Control Panel reset switch.

C. Detector head shall be easily disassembled to facilitate cleaning.

D. Detectors in living quarters are to have local alarm.

E. Detectors are to be white.

2.11 HEAT DETECTORS

A. Automatic heat detectors:

1. Low profile
2. 135°F combination rate-of-rise 15°F and fixed-temperature type, unless otherwise noted on the plans.
3. Latching type automatically restorable upon resetting the system
4. Include a status LED

2.12 DUCT SMOKE DETECTORS

A. Duct smoke detectors:

1. Photoelectric type
2. Installed in duct detector housing
3. Split type, i.e., mounting base with removable, locking detecting head. Contacts between base and head shall be bifurcated type using spring-type, self-wiping contacts.
4. Alarm LED shall be visible through transparent front cover of duct detector housing.

B. Removal of detector head shall interrupt supervisory circuit and cause trouble signal at control panel.

C. Duct housing couplings shall be slotted to insure proper alignment of sampling and exhaust tubes.

D. In mechanical rooms, remote alarm LED indicators:

1. Grouped on stainless steel cover plate mounted adjacent to main mechanical room door.
2. Labeled with detectors loop and address.

E. Floor plan of room showing detectors and addresses shall be located adjacent to mechanical room door.

1. Provide Plexiglas cover over plan.

2.13 SPRINKLER WATERFLOW SWITCHES - WET SYSTEMS

A. Waterflow switches shall be furnished and installed by Fire Protection Contractor under Division 21.

B. To prevent false alarms, flow switch shall incorporate adjustable time delay mechanism between the paddle-operated stem and alarm initiating contacts.

2.14 SPRINKLER VALVE TAMPER SWITCHES - WET SYSTEMS

A. Sprinkler valve tamper switches shall be furnished and installed by Fire Protection Contractor under Division 21.

B. Switch shall be provided with either 1 or 2 sets of S.P.D.T. micro switches as required.

2.15 DOOR HOLDERS

A. Magnetic door holders:

1. Provided by the General Contractor. Refer to Section 08 7100 – Door Hardware.
2. Capable of being surface, flush, or semi-flush mounted as required.

B. Power for door holders shall be 24 V.

2.16 FAULT ISOLATOR MODULE

A. Provide Fault Isolator Module (FIM) on initiating device circuits in following situations:

1. Loop extends to another floor
2. Loop extends to another building
3. For each 25 devices on a loop

B. Fault Isolator Module:

1. Automatically re-connect isolated section of loop upon correction of fault conditions.
2. Not require any address setting
3. Operations shall be totally automatic. It shall not be necessary to replace or reset FIM after its normal operation.
4. Include LED, which shall flash under normal operation and illuminate steady to indicate short circuit.

2.17 ADDRESSABLE RELAYS

A. Provide addressable relay modules for controlling or monitoring remote devices with the fire alarm system to include, but not limited to:

1. Air handling units/exhaust fans
2. Fire pumps
3. Flow/tamper locations
4. Elevator control panels
5. Security panels
6. Lighting control panels
7. Door hold-open release
8. Emergency lighting inverter
9. Non addressable detection and initiation devices
10. Smoke dampers
11. BAS panels

B. Relays are to have condition indicating LED.

PART 3 - EXECUTION

3.1 GENERAL

A. Class B circuiting shall be used except strobe circuits shall be class A.

B. Installation shall be done in neat, workmanlike manner in accordance with manufacturer's recommendations.

C. Smoke detectors shall not be mounted or mounted and protected from dust and damage until construction is completed.

3.2 RACEWAYS

A. Fire Alarm Panel Risers shall be in red metallic conduit system separate from other building wiring.

B. Branch Circuit wiring shall be in metallic conduit system separate from other building wiring.

C. Minimum 3/4” steel raceway. See Section 26 0533 - Raceway and Boxes for Electrical Systems.

D. Contractor shall size conduit and boxes by circular mil size of cable in conduit or box.

3.3 CONDUCTORS

A. Cables and wires shall be provided per manufacturer shop drawings.

B. Wiring shall be supervised.

C. Conductors shall be color-coded. Coding shall be consistent through out facility.

D. Green wire with yellow stripe shall be used only for equipment ground.

E. Control Panel Power wiring shall be #12 AWG minimum.

F. Control Panel shall have minimum #12 AWG equipment ground wire.

G. Where fire alarm circuits enter or leave building, additional transient 75 to 90 V gas tube protection shall be provided for each conductor.

H. Leave 8” wire tails at each device box and 36” wire tails at Control Panel and Remote Annunciator Panel(s).

I. Cable for RS 232-c devices (CRT, PRINTER) shall be two shielded-twisted pair.

J. Cable for RS 485 devices (Remote Annunciators) shall be shielded-twisted pair for data signal.

K. Wiring of initiating device circuits, alarm horn circuits, and alarm strobe circuits shall be #14 AWG minimum.

L. Fire alarm cable shall be held in place at device box by means of 2-screw connector (do not use squeeze or crimp type connectors).

M. Splices or connections shall be made within approved junction boxes and with approved fittings.

N. Boxes shall be red and labeled "FIRE ALARM SYSTEM" by decal or other approved markings.

O. Speaker and strobe circuits shall have separate conductors, and shall operate independently of each other.

P. Tray cable is not acceptable for use as fire alarm systems raceways.

3.4 DEVICE MOUNTING

A. Recommended mounting heights, and requirements are as follows:

1. Fire Alarm Control Panels
   a. Mount Control Panel so visual indicators and controls at 60” above floor level.
2. Remote Annunciators
   a. Mount panel so visual indicators and controls at 60” above floor level.
   b. Install multi-gang box as required by manufacturer, flush or surface mounted.
3. Audio-Visual Devices
   a. Install flush, semi-flush 6” below finished ceiling or 80” from bottom of device to finished floor.
   b. No devices protruding 4” or more shall be installed lower than 80”.
   c. Audio/visual devices may be installed on the ceilings in accordance with NFPA 72 - Table 2-A.
   d. For surface mounting, use manufacturer-supplied back boxes and trim plates.
   e. Mark each device with its circuit number.
4. Manual Stations
   a. Operable part of manual stations shall be installed not less than 42” and not more than 54” above finished floor.
   b. Manual Stations shall be in unobstructed locations.
   c. For surface mounting, use manufacturer-supplied back boxes and trim plates
   d. Mark unit’s address on inside and outside of housing.
5. Heat and Smoke Detectors
   a. Location of detectors shown on plans is schematic only. Detectors must be located according to code requirements.
   b. Surface mounted detectors shall be installed using back boxes equal to base size. Standard octagon and square boxes are not acceptable.
   c. Ceiling mounted detectors shall be located on the highest part of smooth ceiling so that edge of detector is no closer than 4” from sidewall.

d. Ceilings with beams, joists or soffits that exceed 8” in depth require special planning and closer spacing.
e. Wall mounted detectors shall be mounted with top of detector no closer than 4” from ceiling and no further away than 12”.
f. Smoke detectors shall not be installed closer than 3’ from air supply diffusers.
g. No detectors shall be installed in direct airflow.
h. Heat and smoke detectors should be located near center of open area, which they protect.
i. Mark zone number and ranking of each detector on its base.
j. For intelligent systems, mark address and loop number on each detector's base.

6. Addressable Relays
   a. Within 5’ of device it is controlling or monitoring.
   b. Contain relay within approved back-box.

3.5 CONTROL PANEL AND ANNUNCIATOR PANEL and NAC LAYOUT

A. Install panels in approved locations meeting University of Kentucky and City of Lexington Kentucky requirements. Designer is responsible for meeting with the Lexington Fire Department and getting approval of control panel and annunciator panel locations and requirements.

B. Coordinate panel locations with General Contractor and Architect to allow for wall depth and enclosure surrounding requirements.

C. Coordinate other annunciator panel requirements to be located in approved location as required by the City of Lexington and the University of Kentucky. These annunciator panels include, but are not limited to:

1. Elevator
2. Emergency Generator
3. Emergency Automatic Transfer Switch
4. Area of Rescue Assistance
5. Smoke Control System
6. Firefighter Two-Way Communication

D. Install risers, NAC and other gathering panels in 2-hour fire rated enclosures.

3.6 AUDIO DEVICE LAYOUT

A. Sound Level

1. Layout devices to meet code requirements based on expected ambient noise levels.
2. Speaker coverage to provide 15db over ambient in all areas of the facility.
3. Test speaker coverage with sound meter. Add speakers as needed to meet requirements at no cost to the Owner.

B. Intelligibility

~~1.~~ Layout devices to meet intelligibility of mass notification announcements **per UK standards and as determined by performance testing with UK Fire Marshal and AHJ.**

3.7 VISUAL DEVICE LAYOUT

A. Layout visual strobe devices to meet requirements stated in NFPA 72, ANSI A117.1, and the University of Kentucky Facility Standards.

B. Adjust candela level to meet requirements. Add devices **beyond the permit drawings** as necessary to meet requirements at **unit cost as agreed upon with UK.**

C. Spaces having an occupancy of more than two persons **and occupied by the public not familiar with the space** require a visual strobe device.

3.8 SPOT SMOKE DETECTION LAYOUT

A. Spacing, mounting height, ambient temperature and other environmental conditions are to meet the NFPA codes, local amendments, University of Kentucky Facilities Standards and manufacturer's requirements. Use non-addressable smoke detection and remote addressable relay where smoke detector is located in a space that has ambient conditions that violates the UL listing of that device.

B. Coordinate detector spacing and quantities with ceiling beam pockets. Provide additional detectors in each beam pocket to meet NFPA requirements as needed.

C. Provide VESDA air aspirating detection as indicated on drawings. Provide all relays required to connect VESDA system to fire alarm system.

D. General Spaces

1. Above fire alarm panels
2. Elevator lobbies, machine rooms
3. As required to support elevator recall requirements. Coordinate with sprinkler head locations
4. Fire pump room
5. Top of stairwells
6. Storage rooms
7. Electrical rooms
8. Telecom rooms
9. Control panel rooms
10. Dedicated equipment rooms
11. Other locations as shown on the drawings

3.9 MANUAL INITIATING DEVICE LAYOUT

A. Provide manual initiating devices to meet code requirements.

B. Coordinate egress doors, stairwell doors and egress paths with Architectural Life Safety Plan.

3.10 AUTOMATIC FIRE SUPRESSION SYSTEM INITIATION AND MONITORING

A. Provide system flow switch and tamper switch relays as required by codes and system provider.

B. Provide all monitoring relays for fire pump controller

C. Provide all monitoring and control relays for gaseous and pre-action suppression systems as required.

D. Provide trouble bell, control relays and power connection for trouble bell(s).

3.11 MONITORING AND CONTROL RELAY LAYOUT

A. Provide addressable monitoring relays for all:

1. Duct smoke detectors
2. Non addressable detectors
3. Duct smoke dampers
4. Door hold-open smoke detectors
5. Elevator control panels and/or recall system controllers
6. Automatic transfer switches
7. Emergency power generators
8. Building automation system panels
9. Non addressable interface devices
10. Remote monitoring of devices in inaccessible locations such as utility vaults

B. Provide addressable control relays for all:

1. Air handler and exhaust fan VFDs (provide for e-stop and manual control functions)
2. Door hold open power supplies
3. Security head-end panel
4. Stairwell door power supplies
5. Egress path door power supplies
6. Elevator control panels and/or recall system controllers
7. Lighting control panels

3.12 DEMOLITION

A. Existing equipment that is removed shall be inventoried and turned over to Owner

B. Upon inspection by Owner, Contractor shall dispose of equipment that is deemed useless to Owner.

C. Contractor shall remove abandoned devices and conduit not being reused.

3.13 IDENTIFICATION LABELS

A. Junction boxes shall be painted red and labeled "Fire Alarm."

B. Circuits must be labeled with name of circuit and area being served by circuit.

C. Labels shall be permanent, and be machine generated. NO HANDWRITTEN OR NON-PERMANENT LABELS SHALL BE ALLOWED.

D. Labels shall be self-laminating, white/transparent vinyl and be wrapped around cable.

E. Flag type labels are not allowed.

F. Labels shall be of adequate size to accommodate circumference of cable being labeled and properly self-laminate over full extent of printed area of label.

G. Adhesive type labels not permitted except for wire identification.

H. Wiring color code shall be maintained throughout installation.

I. Green wire shall be used only for equipment ground.

3.14 BUILDING MAP(S)

A. A. Building map(s) shall be provided adjacent to the main and remote annunciator panel(s) and shall consist of printed floor plans with color coded zones. Zone indications shall depict the exact zone number and alphanumerical labeling as shown on the FACP zone labels. Building map shall be a detailed floor plan with all room numbers, fire alarm zones, detectors, horns, alarm initiators, flow switches, sprinkler heads, sprinkler zones, and all other devices shown. "Zone No." shall be in 1/4" high letters. Maps shall be properly oriented and shall be 1/16" = 1' scale or 1/32' = 1' scale with written exception of the owner. Provide durable aluminum frames and all required mounting hardware and mount where indicated on plans. Aluminum frame must be such that it can be removed, disassembled and reassembled to allow replacement or revisions to the prints. The layers of the map in the frame from back of the frame to the front of the frame shall be as follows:

1. 1/8" Plexiglas

2. White backing mat

3. Pastel backing color layers for zones

4. Inked prints with floor plan, room #s, fire alarm zones, detectors, horns, alarm initiators, flow switches, sprinkler heads, sprinkler zones, and all other devices.

5. Spacer mat to allow print to be suspended from top of frame and reduce washboarding

6. 1/8" ultraviolet blocking plexiglass

7. 1/8" clear Lexan to prevent scratching

B. Building map(s) shall be installed, complete with "as built" corrections before system is left in operation and before the University will consider the project for substantial completion. Before this systems is left operational and reports to the UK Central Station, this map(s) must be in place.

3.15 MANUFACTURER'S SERVICES

A. Supervision of installation shall be provided by trained service technician from manufacturer of fire alarm equipment.

B. Technician shall be US certified and have had minimum of 2 yrs of service experience in fire alarm industry.

C. Technician's name shall appear on equipment submittals and letter of certification from fire alarm manufacturer shall be sent to project engineer.

D. Manufacturer's service technician shall be responsible for following items:

1. Pre-installation visit to job site to review equipment submittals and verify method by which system shall be wired.
2. Make periodic job site visits to verify installation and wiring of system.
3. Upon completion of wiring, final connections shall be made under supervision of technician.

4. At time of final checkout, technician shall give operational instructions to Owner and/or Owner's representative.
5. Job site visits shall be dated and documented in writing and signed by electrical contractor.
6. Discrepancy shall be noted on document and copy kept in system job folder, which shall be available to project engineer any time during project.

3.16 TESTING

A. Manufacturer's authorized representative shall perform complete functional test of each system and submit written report to Contractor attesting to proper operation of completed system prior to final inspection.

B. Contractor shall test each device in system before system is considered substantially complete.

C. Completed fire alarm system shall be fully tested by Contractor in presence of Owner's representative and local Fire Marshal.

D. Upon completion of successful test, Contractor shall:

1. Certify system to Owner in writing
2. Complete NFPA 1-7.2.1 record of completion form
3. Provide as-builts and O&M manuals.

3.17 WARRANTY

A. Warrant completed fire alarm system wiring and equipment to be free from inherent mechanical and electrical defects for a period of **1** ~~2~~ yrs from the date of substantial completion of project.

B. Post warranty period along with company's name and telephone number inside fire alarm panel.

C. Warranty service for equipment shall be provided by system supplier's factory trained representative.

D. Warranty shall include parts, labor and necessary travel.

E. Occupied facility shall not be without UL and NFPA approved and fully operational fire alarm system for period longer than 2 h. Emergency response shall be provided within 2 h of notification, to contractor, of failure of system to perform operationally per UL and NFPA standards.

F. Non-emergency service calls shall be responded to within 24 h of notification to contractor.

G. Repairs and/or replacement shall be completed within 72 h of time of notification. Other than emergency, actual repairs and/or replacement shall be provided during normal working hours, Monday through Friday, excluding holidays.

H. If repair and/or replacement cannot be made within prescribed time, other means and methods of protection shall be provided to insure safety of building occupants during which time system is not in compliance with standards. This may involve up to and include hiring Owner approved qualified personnel to stand fire watch, at contractor's expense.

3.18 TRAINING

A. Contractor shall provide minimum of 4 h system operation training for Owner, Architect/Engineer, and fire department personnel.

B. Training session shall be at a time to be stipulated by Owner.

C. Training shall be completed prior to final inspection.

3.19 SPARE PARTS

A. Contractor shall provide the following spare parts in quantities shown, with a minimum of 1/item:

Quantity	Type of Device Present
10%	Photoelectric smoke detectors
10%	Heat detectors
10%	Smoke and heat detector bases
1%	Duct detectors with housing and sample tubes
1%	Horn/strobe Units
1%	Strobes
1%	Manual Stations
1%	Beam Detectors

END OF SECTION