PATHS CLINIC AT
ALBERT HARRIS ELEMENTARY

FOR

MARTINSVILLE CITY PUBLIC SCHOOLS

MARTINSVILLE, VIRGINIA

PROJECT MANUAL AND SPECIFICATIONS
CONSTRUCTION DOCUMENTS – VOL. 2

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architecture · planning · interiors

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Comm. No. 25117-01

10 July 2026

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PROJECT MANUAL
INCLUDING SPECIFICATIONS
FOR CONSTRUCTION OF

PATHS CLINIC AT ALBERT HARRIS ELEMENTARY
MARTINSVILLE CITY PUBLIC SCHOOL
710 SMITH STREET
MARTINSVILLE, VIRGINIA 24112

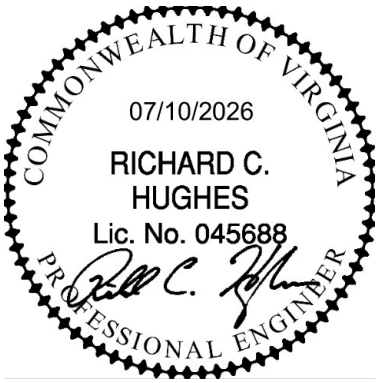
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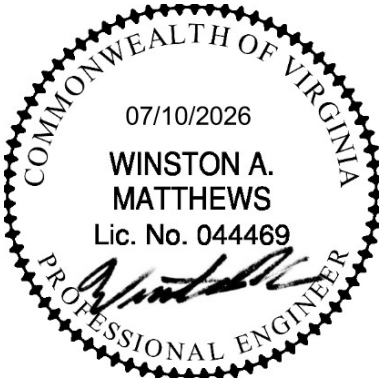
RRMM ARCHITECTS
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ROANOKE, VIRGINIA

LAWRENCE PERRY & ASSOCIATES – MECHANICAL & ELECTRICAL ENGINEERS
TIMMONS GROUP – CIVIL ENGINEERS









DATE OF ISSUANCE:
10 July 2026

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SECTION 000004 - TABLE OF CONTENTS

BIDDING AND CONTRACT REQUIREMENTS

VOLUME 1

BIDDING DOCUMENTS SECTION

Cover 000001
Title Page 000002
Project Directory 000003
Table of Contents 000004
Invitation for Bids 001116
Instructions to Bidders, AIA A701-2018 002113
Supplementary Instructions to Bidders 002213
Pre-Bid Question Form 002214
Bid Form 004200
Bid Bond Form AIA A-310-2010 004300

GENERAL CONDITIONS

Standard Form of Agreement Between Owner and Contractor, AIA A101-2017 007100
Insurance and Bonds AIA A101—2017 Exhibit A 007101
General Conditions of the Contract for Construction, AIA A201-2017 ..... .007200
Supplementary General Conditions 007300
Standard Payment Bond Form AIA A-312-2010 007400
Standard Performance Bond Form AIA A-312-2010 007500
Contractor's Qualification Statement AIA A305-2020 007600

SPECIFICATIONS

DIVISION		SECTION
1 - GENERAL REQUIREMENTS	Summary of Work	011100
	Items of Special Note	011500
	Special Conditions	013000
	Submittals and Submittal Procedures	013300
	Contract Closeout	017000
	Cleaning	017400
	Construction Waste Management and Disposal	017419
2 - EXISTING CONDITIONS	Selective Site Demolition	024113
	Building Demolition	024116

3 -	CONCRETE	not used.	
4 -	MASONRY	not used.	
5 -	METALS	not used.	
6 -	WOOD AND PLASTICS	Rough Carpentry	061000
		Plastic-Laminate-Clad Architectural Cabinets	064116
7 -	THERMAL AND MOISTURE PROTECTION	Dampproofing and Waterproofing	071000
		Building Insulation	072100
		Sheet Metal	076000
		Joint Sealants	079200
8 -	DOORS AND WINDOWS	Hollow Metal Doors and Frames	081113
		Wood Doors	081400
		Access Doors	083100
		Aluminum Doors and Frames	085113
		Finish Hardware	087100
		Glass and Glazing	088100
9 -	FINISHES	Gypsum Board Assemblies	092116
		Ceramic Tiling	093013
		Acoustical Panel Ceilings	095113
		Resilient Base and Accessories	096513
		Resilient Sheet Flooring	096516
		Resilient Tile Flooring	096519
		Tile Carpeting	096813
		Interior Painting	099124
10 -	SPECIALTIES	Miscellaneous Specialties.	101000
		Wall and Door Protection	102600
		Post Supported Extruded Walkway Cover	107325
11 -	EQUIPMENT	not used.	
12 -	FURNISHINGS	Roller Window Shades	122413
		Solid Surfacing Countertops	123661.16
13 -	SPECIAL CONSTRUCTION	not used.	
14 -	CONVEYING SYSTEMS	not used.	

VOLUME 2

21 - FIRE SUPPRESSION	not used.	
22 - PLUMBING	Plumbing General Requirements	220000
	Plumbing Insulation	220700
	Facility Water Distribution	221100
	Drainage Systems	221300
	Plumbing Fixtures	224000
	Gas System for Laboratory and Healthcare Facilities	226300
23 - HVAC	Heating, Ventilating and Air Conditioning (HVAC)	230000
	Testing, Adjusting and Balancing for HVAC	230593
	HVAC Insulation	230700
	Instrumentation and Control for HVAC	230900
	HVAC Piping	232000
	Variable Speed Drives	232133
	HVAC Air Distribution	233000
	HVAC Fans	233400
	Central HVAC Equipment	237000
	Decentralized Unitary HVAC Equipment	238100
	Convection Heating and Cooling Units	238200
26 - ELECTRICAL	Basic Requirements for Electrical Systems	260100
	Low Voltage Electrical Power Conductors and Cables	260519
	Grounding and Bonding for Electrical Systems	260526
	Hangers and Supports for Electrical Systems	260529
	Raceways and Boxes for Electrical Systems	260533
	Identification for Electrical Systems	260553
	Wiring Connections for Electrical Systems	260583
	Lighting Controls	260943
	Low-Voltage Distribution Transformers	262213
	Panelboards	262416
	Wiring Devices and Miscellaneous Equipment	262726
	Fuses	262813
	Enclosed Switches	262816
	Diesel-Engine-Driven Packaged Generator Set	263113.13
	Surge Protective Devices (SPD)	264313
	Lighting – Interior, Exterior, and Emergency	265000
27 - COMMUNI-CATIONS	Infrastructure for Building Telecommunications Cabling System	271013
28 - ELECTRONIC SAFETY AND SECURITY	not used.	

31 - EARTHWORK	Earthwork	312000
32 - EXTERIOR IMPROVEMENTS	Asphalt Paving	321216
	Site Concrete	321313
	Pavement Markings, Signs and Specialties	321700
33 - UTILITIES	Sanitary Sewer	333000
40 – APPENDIX	Hazardous Materials Inspection Report Asbestos and lead paint.	400001

END OF SECTION 000004

SECTION 220000 - PLUMBING GENERAL REQUIREMENTS

PART 1: GENERAL

1.1 DESCRIPTION:

A. This section of the specifications shall be applicable to all phases of plumbing work covered by specifications and drawings issued for this project.

B. The "General Conditions of the Contract," "Supplementary General Conditions," and all other similar general requirements issued for this project shall apply to all plumbing work and are hereby made a part of this section.

C. The Contractor and/or his representatives shall be fully acquainted with the design and operation of the systems and equipment described in these specifications and on the drawings.

D. Work included under this section shall include complete systems as shown on the plans and as specified. Provide supervision, labor, material, equipment, machinery, plant, and other items necessary to complete the plumbing systems. It is the intention of these specifications and drawings to call for finished work, tested, and ready for operation.

E. Definitions:

1. "Owner" and "Contractor" shall mean the respective parties to the prime contract governing the project. Only one contractor is recognized as a party to this contract. Where the terms "Plumbing Contractor" or "Subcontractor" are used, it is for convenience only.
2. "Architect/Engineer" shall mean the firm and authorized representatives of the firm engaged by the Owner for architectural and engineering services related to this project.
3. "Plumbing" shall mean all work related to plumbing systems including sanitary and storm drainage, domestic water, gas, compressed air, fuel oil, and similar systems, including all related components, accessories, controls, and miscellaneous work required for a complete system.
4. "Contract Documents" shall mean and include the agreement, the drawings and specifications and all modifications thereto authorized by the Owner in writing prior to final completion of the project.

    a. The term "Agreement" shall mean the completed and signed contract form.
    b. The term "Drawings" shall mean the drawings prepared by the Architect/Engineer for specific use in bidding and execution of the work.
    c. The term "Specifications" shall include the legal and procedural documents, the general conditions, special conditions, and the technical specifications.
    d. The term "Technical Specifications" shall mean that part of the specifications which describes, outlines, and stipulates the kind and quality of the materials to be furnished, the quality of workmanship required, and the methods to be used in the construction under the contract. For convenience, the plumbing portions of the technical specifications are arranged into one general section and several detailed

sections related to the various trades represented in the work. Such arrangement and references shall not operate to make the Architect/Engineer an arbiter in establishing the limits of any subcontract or trade.

5. "Work" of the Contractor shall mean labor or materials or both.
6. "As shown," "as indicated," "as detailed," or words of similar import shall mean reference to the drawings included in the contract documents, unless stated otherwise.
7. "As directed," "as required," "as permitted," "approved," or words of similar import shall mean that the direction, requirement, permission, approval, or acceptance of the Architect/Engineer is intended unless stated otherwise.
8. "As necessary" shall mean that which is necessary to achieve satisfactory completion of the work in order to provide the intended function and form of the project in compliance with the contract documents.
9. "Provide" shall mean "provide complete and in place," that is "furnish and install," ready for beneficial occupancy by the Owner. Except where stated otherwise, description of any work in the contract documents shall mean that the work shall be provided by the Contractor, even though the words "provide" or "furnish and install" do not accompany the description.
10. "Similar" shall be interpreted in a general sense and not as meaning identical, and all related details shall be worked out in respect to their location and their connection with other parts of the work.
11. Exposed: Piping and equipment exposed to view in finished rooms.
12. Option or Optional: Contractor's choice of an alternate material or method.
13. “Sprinkler” shall mean all work related to fire suppression systems including sprinkler, standpipe, fire pump, and similar work, including all related components, accessories, controls, and miscellaneous work required for a complete system.

1.2 INTENT OF CONTRACT DOCUMENTS:

A. The contract documents are complementary, and what is called for in one place shall be as binding as if called for in all places. Where variances occur between drawings and specifications or within either document itself, include in the contract price the item or arrangement of better quality, greater quantity, or higher cost. Agreement shall take precedence over the specifications and drawings. Figured dimensions shall be used in preference to scaling the drawings. In case of conflict between large and small scale drawings, the large scale drawings shall govern.

B. The plumbing drawings show the general arrangement of all piping, equipment, and appurtenances and shall be followed as closely as actual building construction and the work of other trades will permit. The plumbing work shall conform to the requirements shown on the plumbing drawings. Architectural and structural drawings shall take precedence over plumbing drawings. Because of the small scale of the plumbing drawings, it is not possible to indicate all offsets, fittings, and accessories which may be required. The Contractor shall investigate the structural and finish conditions affecting the work and shall arrange his work accordingly, providing such fittings, valves, boxes, offsets, transitions, and other accessories as may be required to meet such conditions.

1.3 CODES AND STANDARDS:

A. All materials and workmanship shall comply with all applicable codes, state and federal laws, local ordinances, industry standards, utility company regulations, and all other criteria which normally apply to work of this nature.

B. In case of difference between building codes, state laws, federal laws, local ordinances, industry standards, utility company regulations, other criteria and the contract documents, the more stringent regulations will apply. The Contractor shall promptly notify the Architect/Engineer in writing of any such difference.

C. If the Contractor performs any work that does not comply with these contract documents or the requirements of the applicable building codes, state laws, local ordinances, industry standards, utility company regulations, and other applicable criteria, he shall bear all costs arising in correcting the deficiencies.

D. The standards referred to, except as modified in the specifications, shall have full force and effect as though printed in these specifications. The manufacturer and trades involved shall be familiar with the application of these standards.

E. Applicable codes and standards shall include, but are not necessarily restricted to, the most recently recognized issues of the following:

1. Building Codes:

    a. Virginia Uniform Statewide Building Code
    b. International Plumbing Code and accumulative supplements.

2. Industry Standards, Codes, and Specifications:

a.	AASHO	American Association of State Highway Officials
b.	ABA	Architectural Barriers Act
c.	ADA	Americans with Disabilities Act
d.	AGA	American Gas Association
e.	ANSI	American National Standards Institute
f.	ASHRAE	American Society of Heating, Refrigeration, and Air Conditioning Engineers
g.	ASME	American Society of Mechanical Engineers
h.	ASPE	American Society of Plumbing Engineers
i.	ASSE	American Society of Sanitary Engineering
j.	ASTM	American Society of Testing and Materials
k.	AWS	American Welding Society
l.	CISPI	Cast Iron Soil Pipe Institute
m.	CSA	Canadian Standards Association
n.	AWWA	American Water Works Association
o.	FS	Federal Specification

p.	MSS	Manufacturer's Standardization Society of the Valve and Fittings Industry, Inc.
q.	NBS	National Bureau of Standards
r.	NEC	National Electrical Code
s.	NSF	National Sanitation Foundation
t.	PDI	Plumbing & Drainage Institute
u.	UL	Underwriters' Laboratories, Inc.
v.	UFAS	Uniform Federal Accessibility Standards (2012)

1.4 GOVERNMENTAL FEES, PERMITS, AND INSPECTIONS:

A. Under each applicable section of the detailed plumbing specifications, the Contractor shall obtain and pay for all required licenses, permits, charges for connections to outside services, fees and inspections. Upon completion of the work under each section of the detailed plumbing specifications, the Contractor shall furnish a certificate of final inspection to the Architect/Engineer from the governmental inspection department having jurisdiction.

1.5 VISITING THE SITE:

A. Each Contractor shall be responsible for visiting the site before bidding the job to familiarize himself with all existing conditions to be met in the execution of the work under this contract. No additional compensation will be allowed for any changes which may be required to make because of site conditions.

1.6 QUALITY ASSURANCE:

A. Product Criteria:

1. All materials shall be new and shall bear the manufacturer's name, trade name, and the UL label in every case where a standard has been established for this particular material. The equipment to be furnished shall be essentially the standard product of a manufacturer regularly engaged in the production of the required type of equipment and shall be the manufacturer's latest approved design. All equipment shall bear a permanent and legible factory-applied nameplate to permit identification of manufacturer, model number and type of unit.
2. Equipment Service: Products shall be supported by a service organization which maintains an adequate inventory of repair parts and is located, in the opinion of the Architect/Engineer, reasonably close to the site.
3. Multiple Units: When two or more units of materials or equipment of the same type or class are required, these units shall be products of one manufacturer to provide for uniform appearance, operation, and maintenance.
4. Assembled Units: Manufacturers of equipment assemblies, which use components made by others, assume complete responsibility for the final assembled product.

B. Manufacturers' directions shall be followed in the delivery, storage, protection, and installation of all equipment and materials. The Contractor shall promptly notify the Architect/Engineer in writing of any conflict between any requirements of the contract documents and the written instructions before proceeding with the work. If the Contractor performs any work that does not comply with the manufacturers' directions or such written instructions from the Architect/Engineer, he shall bear all costs arising in correcting the deficiencies.

C. Factory Start-up by the manufacturer's Factory Certified Representative shall be provided where required for each water heater or other equipment specified to have factory start-up. Letters signed by the Representative stating that their equipment has been started, tested, and is operating safely shall be submitted to the Owner as part of the bound Operations and Maintenance Instructions manual specified in section 2.10 CATALOG DATA FOR OWNER of this specification.

1.7 BIDDING INSTRUCTIONS:

A. Products are generally specified by a performance specification and/or by manufacturer's name and model number or trade name.

B. When specified only by a performance specification, the Contractor may use any manufacturer who meets the performance specification and applicable codes. (The Contractor shall be subject to the requirements of 1.9 - SHOP DRAWINGS.)

C. When several products/manufacturers are specified together, then the Contractor has the option of using any product/manufacturer listed. The Contractor shall be subject to the requirements of 1.9 - SHOP DRAWINGS. The Contractor's bid shall be compiled on the use of the listed products without exception. Substitutions will only be considered after the contract has been executed and shall be subject to the requirements of 1.8 - SUBSTITUTIONS.

D. When several products/manufacturers are specified together and the system design is based on one of the listed products by specific model number(s) or catalog number(s), then the Contractor has the option of using the one specific product or any other product/manufacturer listed. In either case, the Contractor shall be subject to the requirements of 1.9 - SHOP DRAWINGS. However, when the other listed product/ manufacturer is used, the Contractor shall be responsible for determining that the product(s) will be compatible with building design, electrical design, plumbing design, and the product(s) will not necessitate design modifications by the Architect/Engineer. The Contractors bid shall be compiled on the use of the listed products without exception. Substitutions will only be considered after the Contract has been executed and shall be subject to the requirements of 1.8 - SUBSTITUTIONS. If the products/manufacturer are listed to be "only," then substitutions will not be considered.

E. When only one manufacturer's name is listed, this shall be the basis of the bid. The Contractor's bid shall be compiled on the use of the listed product. Substitutions will only be considered after the Contract has been executed and shall be subject to the requirements of 1.8 - SUBSTITUTIONS.

1.8 SUBSTITUTIONS:

A. Substitutions will not be considered during the bid.

B. After the Contract has been executed, the Architect/Engineer will consider a formal request for a review of substituted products in place of those specified, under the following conditions:

1. Not later than 30 days from the Contract Date, the Contractor shall provide a list of products proposed as substitutions, including the name, manufacturer, and section of the specifications governing the product.
2. The request shall be accompanied by accurate cost data on the proposed substitutions indicating whether or not a modification of the Contract Sum is to be considered.

C. Substitutions are understood to mean that the installing Contractor:

1. Has personally investigated the proposed substitute and has determined that it is equal or superior in all respects to the item specified;
2. Will provide the same guarantee for the substitution that he would for the item or equipment specified;
3. Certifies that the cost data is complete and includes all related costs under this Contract, and waives all claims for additional cost related to the installation of the accepted substitute;
4. Has coordinated the installation of the substitute, providing design modifications and changes as required for the work to be complete in all respects;
5. Has coordinated the installation of the substitute with the General Contractor pertaining to changes required for the work to be complete with all trades and all changes shall be provided without additional cost to the Owner.

D. The acceptance by the Architect/Engineer of any or all of those substitute items listed by the Contractor for review shall not constitute an approval of the substitute but shall mean that the Contractor may then submit detailed shop drawings for review.

E. When a request for substitution is granted, shop drawings will be reviewed by the Architect/Engineer. Shop drawings not complete with proper review information will not be reviewed and will be returned unchecked. If after two submittals, the substitute equipment is not approved, the specified equipment shall be provided.

1.9 SHOP DRAWINGS:

A. Shop Drawings are required for all material and equipment that is specified by a manufacturer's name or as indicated in the technical specifications. Furnish the number of copies required by the General and Special Conditions of the Contract, preferably one digital (pdf) copy. Submittal data for related equipment (equipment in the same specification section) shall be submitted at one time ***and shall be submitted as a digital file (pdf)***. Allow 10 business days for review of shop drawing submittals, starting from the date LPA, Inc. receives the submittals.

B. Substitutions will not be considered if:

1. They are indicated or implied on shop drawing submissions without information specified in 1.8 - SUBSTITUTIONS.
2. They require a substantial revision of the Contract Documents in order to accommodate their use.

C. Identify submittals with PROJECT NAME and NUMBER, CONTRACTOR'S NAME, SECTION NUMBER & NAME, and PARAGRAPH NUMBER of SPECIFICATION GOVERNING, MANUFACTURER, MODEL or STYLE, and CONTRACTOR's REVIEW STAMP. Submittals shall be detailed, dimensioned drawings showing construction, size and arrangement, service clearances, performance characteristics, and capacity. Submittals not properly identified or containing information of a general nature will not be reviewed and will be returned unchecked.

D. Where submittals are provided that include multiple types or styles of the specified item and/or multiple options, THE EXACT ITEM AND OPTIONS BEING SUBMITTED SHALL BE CLEARLY MARKED ON THE SUBMITTAL SHEET.

E. Submittals shall include manufacturers' standard warranty information for the products being submitted.

F. Acceptance of shop drawings shall not be considered as a guarantee of measurements or building conditions. Acceptance shall not relieve the Contractor from the responsibility or necessity of furnishing material or performing work required by the drawings and specifications. Submittal data on any one item shall not be reviewed more than three (3) times. If not accepted after the third review, the Contractor shall provide the equipment upon which the design was based.

G. Failure to submit shop drawings in ample time for checking shall not entitle an extension of contract time, and no claim for extension by reason of such default will be allowed.

H. No material or equipment, for which submittals are required, may be delivered to or installed at the job site until submittals have been accepted.

I. Unless a specific finish is indicated in the contract documents, wherever a choice of finish is available for the specified item, submit accurate color chips or charts to the Architect for review and selection.

1.10 PLUMBING AND SPRINKLER REQUEST FOR INFORMATION (RFI's):

A. Refer to the Conditions of the Contract (General and Supplementary) and Division 1 for RFI definitions, requirements, and procedures. All plumbing and sprinkler RFI's will require up to 5 business days for review, starting from the date LPA, Inc received the RFI's.

1.11 PLUMBING AND SPRINKLER SUBMITTALS:

A. Refer to the Conditions of the Contract (General and Supplementary) and Division 1 for RFI definitions, requirements, and procedures. All plumbing and sprinkler submittals will require up to 10 business days for review, starting from the date LPA, Inc. received the submittals.

PART 2: PRODUCTS

2.1 PAINTING:

A. General - Paint plumbing equipment and material in Equipment Rooms and utility type areas and located outside of the building or on the roof. Painting of equipment and material in finished rooms or areas shall be accomplished as described in PAINTING Section of the Architectural Specifications. Painting in concealed spaces shall be limited to equipment and materials not otherwise protected from rusting such as hangers and supports. Paint shall be products of Sherwin-Williams, Pittsburgh, or Pratt-Lambert. All paints, finishes and coatings shall comply with Green Seal Standards GS-11, and SCAQMD Rule #1113 VOC limits for paints and coatings.

B. Workmanship - The work shall be accomplished by workmen skilled in the painting trade after testing is complete and systems are ready for operation. Surfaces to be painted shall be completely dry before applying paint. Surfaces shall not be painted when the temperature is below 50 Deg. F or above 120 Deg. F, or when they are exposed to hot sun. Materials shall be evenly spread and smoothly flowed on without runs or sags. Each coat shall be thoroughly dry before application of succeeding coat. The painters shall protect adjacent surfaces with drip covers during the process of painting. Upon completion, paint spots, if any, shall be removed from adjacent surfaces.

C. Preparation of surface - Metal surfaces shall be cleaned with solvent before applying materials. Rust and scale shall be removed by wire brushing or sanding. Galvanized surfaces shall be pretreated with a phosphoric acid cleaning solution and primed with Sherwin-Williams "Galvanized Iron Primer."

D. Painting - After preparation as described above, each item shall be painted as follows, except color of paint for equipment and material located outside of the building or on the roof shall be as selected by the Architect.

1. Painting is not required of equipment, equipment supports, and hangers with a factory-finish coat. Patch painting is required of any damaged areas to match factory-finish coat. Painting is required where equipment or equipment supports do not have factory-finish paint. Equipment and associated hangers and supports shall be primed with one coat of alkyd, zinc potassium chromate metal primer, except insulated surfaces shall be primed with one coat Sherwin-Williams "Wall Primer and Sealer." Finish with two coats of Sherwin-Williams "Metalastic II-Steel Gray" Enamel. Exterior of belt guards and other protective guards shall be finished with two coats of machinery enamel in OSHA yellow color. Interior of items covered by belt guards and other protective guards shall be

finished with two coats of machinery enamel in OSHA orange color. Nameplates on equipment shall not be painted.

2. Exposed pipes, conduits, and associated hangers exposed in equipment rooms and other unfinished areas such as storage areas shall have two finish coats of paint of the same color as adjacent walls or ceilings. Bare copper pipe shall not be painted. Canvas or paper jacket insulation of pipes exposed in unfinished areas shall be primed with Sherwin-Williams "Wall Primer and Sealer" before final two coats of paint. Hangers and supports in concealed areas not protected by factory-finish paint shall have one coat of Sherwin-Williams "Kromik Metal Primer."

E. Identification of pipes and equipment:

1. Equipment - Each piece of equipment shall be identified by stenciled marking that will read the same as the identification shown on plumbing drawings. Stencil letters shall be 2 inches high upper case painted with Sherwin-Williams "Metalastic II" white enamel.
2. Pipes shall be identified using pre-printed markers sized appropriately for the pipes being identified (shop drawings required). Markers shall be Seton "Setmark" type or approved equal or equivalent stencil. Pipe identification shall meet the most current edition of ANSI Specification A13.1. Apply a minimum of two complete wraps of tape at each end of pre-printed pipe markers equal to Seton Style #AR or approved equal. Markers shall be located close to valves or flanges and adjacent to changes in direction, branches and where pipes pass through walls or floors, and at maximum intervals of 15 feet on straight runs. Provide a Color Code Chart, framed with glass front, indicating piping service and color code schedule. Post in Mechanical Room where directed by Engineer.
3. Color code schedule

COLOR BANDING CODE

Number	Color	Catalog Number
1.	Orange	No. F65 E 36
2.	Blue	No. F65 L 3
3.	Brown	No. F65 N 11
4.	Red	No. F65 R 1
5.	Black	No. F65 B 1
6.	Yellow	No. F65 Y 48
7.	Green	No. F65 G 40

4. Pipe shall be identified with flow arrows as described below

a. Arrows shall be stencil type.
b. Arrows shall be readable from floor.
c. Arrows shall be installed every 15'-0" maximum.
d. Arrows shall be painted on pipes.

F. Identification of Valves: Properly mark service and control valves. Valve markers shall be metal tags with designations stamped thereon or laminated engraved plastic chained with jack chains (not beaded chains) to their respective valves. Identification symbols or designations shall be the same as shown on the Contract Documents.

G. Equipment locations above acoustic tile ceilings: Provide colored brass push-pins complete with a minimum 1/2" shank and 5/8" diameter head. Pin head color shall be blue or color as selected by Architect or Owner. Locate push-pins directly below all scheduled plumbing equipment.

2.2 MOTORS, CONTROL, ELECTRICAL WIRING AND POWER REQUIREMENTS:

A. Domestic water temperature control wiring, equipment control wiring, and interlock wiring necessary for the proper sequence of operation of plumbing equipment shall be furnished as part of the Plumbing Work. Control wiring is any wiring, regardless of voltage, related to plumbing equipment that is not the equipment power circuit from the circuit breaker in the panelboard to the motor starter or safety disconnect switch and to the motor or equipment junction box. Where control devices (On-Off switch, Aquastat, etc.) that are intended to interrupt the motor or equipment power circuit are provided by the Plumbing Contractor and are mounted other than on or directly adjacent to the controlled equipment, the Plumbing Contractor shall provide wiring through these devices regardless of voltage or phases. All wiring shall conform to applicable sections of Divisions 26, 27, and 28 of the specifications. All low voltage control wiring in inaccessible areas or in exposed areas shall be in metal conduit and shall comply with the specifications of Divisions 26, 27, and 28. All low voltage control wiring in unexposed, accessible areas shall be wire in conduit or U.L. approved plenum rated cable supported from the structure with ties spaced 3'-0" on center. All 120 volt wiring shall be wire in conduit and shall comply with the specifications of Divisions 26, 27, and 28 of the specifications.

B. All equipment that has electrical connections shall have wiring terminals/connectors rated for not less than 75 deg. C. If terminals/connectors are provided that are rated for less than 75 deg. C., the mechanical contractor shall incur all costs associated with upsizing wire and conduit as required by the National Electrical Code.

C. Voltage requirements for equipment that has electrical connections shall comply with the following voltage ranges as listed in ANSI C8.4.1, Voltage Tolerance Standard:

- 480 Volt Equipment: Utilization Voltage Range = 504 Volts to 440 Volts.
- 277 Volt Equipment: Utilization Voltage Range = 291 Volts to 254 Volts.
- 208 Volt Equipment: Utilization Voltage Range = 218 Volts to 191 Volts.
- 120 Volt Equipment: Utilization Voltage Range = 126 Volts to 110 Volts.

D. Equipment that has voltage requirements which fall outside of the above values shall be provided with special power conditioning equipment as required to maintain the necessary voltage ranges to the equipment. Such conditioning equipment shall be provided by the equipment manufacturer as part of the equipment package at no additional cost to the owner.

2.3 FIRE-STOPPING:

A. Pipe penetrations of rated walls, floors, and floor-ceiling assemblies shall be constructed in accordance with Underwriter's Laboratories, Inc., Fire Resistance Directory, Volume II, Hourly Ratings for Through Firestop Penetrations. The Contractor shall provide U.L. firestop penetrations according to the particular wall, floor, or floor-ceiling assembly rating, construction type, pipe material, pipe size, insulation requirements, sleeve requirements, and the contractor's choice of firestop products as listed by U.L. Refer to the architectural drawings for the wall, floor, or floor-ceiling assembly construction types and ratings.

2.4 PIPE AND EQUIPMENT SUPPORTS AND RESTRAINTS:

A. Under each applicable section of the detailed plumbing specifications, the Contractor shall furnish and install all accessories, connections, bases, guards, supports, and incidental items necessary to fully complete the work, ready for use, occupancy, and operation by the Owner.

B. Type Numbers Specified: MSS SP-58; for selection and application, MSS SP-69. Refer to Division 05, METALS, for miscellaneous metal support materials and prime coat painting.

C. For Attachment to Concrete Construction:

1. Concrete Insert: MSS SP-69, Type 18
2. Self-Drilling Expansion Shields and Machine Bolt Expansion Anchors: Fed. Spec. FF-S-325, permitted in concrete not less than four inches thick. Applied load shall not exceed one-fourth the proof test load listed in Fed. Spec. FF-S-235.
3. Power-Driven Fasteners: Permitted in existing concrete or masonry not less than four inches thick when approved by the Architect/ Engineer for each job condition. Use fasteners capable of supporting a 1000 pound test load, with the actual load not exceeding 50 pounds.

D. For Attachment to Steel Construction; MSS SP-69:

1. Welded Attachment: Type 22.
2. Beam Clamps: Types 20, 21, 28 or 29. Type 23 C-clamp may be used on steel beams only for individual copper tubing up to 7/8-inch outside diameter. Beam clamps on steel joists shall be concentric loading type. Beam clamps that are attached to only one side of a joist are NOT acceptable.

E. Attachment to Metal Pan or Deck: As required for materials specified in Division 05 - METALS.

F. Hanger Rods: Hot-rolled steel, ASTM A 36 or A 575 for allowable load listed in MSS SP-58. For piping, provide adjustment means for controlling level or slope. Types 13 or 15 turnbuckles shall provide 1-1/2 inches minimum of adjustment and incorporate locknuts. All-thread rods are acceptable.

G. Multiple (Trapeze) Hangers: Galvanized, cold formed, lipped steel channel horizontal member, not less than 1-1/2 inches by 1-1/2 inches, No. 12 gage, designed to accept special spring held, hardened steel nuts. Not permitted for condensate piping, fire and sprinkler piping or chemical waste drain piping.

1. Allowable Hanger Load: Manufacturers rating less 200 pounds.
2. Guide individual pipes on the horizontal member of every other trapeze hanger with 1/4-inch U-bolt fabricated from steel rod. Provide Type 40 insulation shield, secured by two 2-inch galvanized steel bands, for insulated piping at each hanger.

H. Pipe Hangers and Supports: Use hangers sized to encircle insulation on insulated piping. Refer to Section 22 07 00 - PLUMBING INSULATION, for insulation thickness. To protect insulation, provide Type 39 saddles for roller type supports. Provide Type 40 insulation shields at all other types of supports and hangers including those for pre-insulated piping.

1. General Types (MSS SP-69):

a. Standard Clevis Hanger: Type 1; provide locknut
b. Riser Clamps: Type 8 or 42
c. Wall Brackets: Types 31, 32, or 33
d. Saddle Support: Type 36, 37, or 38
e. Roller Support: Type 41, 43, or 46
f. Turnbuckle: Types 13 or 15
g. U-Bolt Clamp: Type 24
h. For Uninsulated Copper Tube: Material compatible for use with copper to prevent electrolysis
i. Supports for Plastic or Glass Piping: As recommended by the pipe manufacturer

2. Plumbing Piping:

a. Sprinkler System: NFPA or Factory Mutual approved types.
b. Horizontal Piping: Types 1, 5, 7, 9, and 10
c. Chrome Plated Piping: Chrome plated supports
d. Hangers and Supports in Pipe Chase: Prefabricated system ABS self-extinguishing material, not subject to electrolytic action, to hold piping, prevent vibration, and compensate for all static and operational conditions
e. Blocking, Stays and Bracing: Angle iron or preformed metal channel shapes, 18 gage minimum

I. Support hubless cast iron pipe and fittings per CISPI 301-12. Brace hubless cast iron pipe and fittings 5 inches and larger using Holdrite 117 Series No-Hub Pipe and Fitting Restraints or approved equal.

2.5 PIPE SLEEVES:

A. Locate sleeves during normal course of work. Provide sleeves for piping and conduit passing through concrete floor slabs and concrete, masonry, tile, and gypsum wall construction.

Sleeves shall not be provided for piping and conduit running embedded in concrete or slab on grade, except that copper piping shall require sleeves through slabs on grade. Sleeves through structural members shall be only as directed by Architect. In interior wall, provide 1/4 inch space all around between sleeve and conduit, piping, or insulation of piping.

B. Sleeves placed in exterior walls below grade shall be O.Z. Gedney Type 'FSK', Thunderline 'LINK SEAL', Polywater PGKD Series or equal sleeve assemblies sized for the pipe or conduit encountered, except for cast iron piping. Sleeve assembly shall provide watertight seal and electrical insulation to reduce cathodic reaction. When a sleeve passes through a wall below a concrete slab on grade, the sealing assembly shall be on the outside of the wall. When a sleeve passes through a wall into a crawl space or the building interior, the sealing assembly shall be in the crawl space or interior of the building. Provide sleeve assembly for copper piping through slab on grade, with sealing assembly located on interior side of floor slab. Where cast iron pipes pass through an exterior wall below grade, provide an iron-pipe sleeve two (2) pipe sizes greater than pipe passing through. Caulk between pipe and sleeve with a rubber-based compound.

C. Where sleeves are located through fire-rated walls and floor/ceiling assemblies, provide sleeves and protect the penetration in accordance with Underwriter's Laboratories, Inc., Fire Resistance Directory, Volume II, Ratings for Through Firestop Penetrations.

D. Sleeves in mechanical rooms with floor drains or hose bibbs shall extend 4 inches above floor. Provide flanges or flashing rings with sleeves in floors with waterproof membrane and clamp or flash into the membrane. Provide sleeves flush with floor in other rooms.

E. Sleeves shall be constructed of 20 gage galvanized sheet steel with lock seam joints for all sleeves set in concrete floor slabs terminating flush with the floor. All other sleeves shall be constructed of galvanized steel pipe unless otherwise indicated.

F. Fasten sleeves securely in floors or 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 from being forced into the space between pipe and sleeve during construction.

G. All penetrations through exterior walls shall be sealed. Caulk above grade penetrations with a rubber-based compound.

2.6 WALL, FLOOR AND CEILING PLATES (ESCUTCHEONS):

A. Material and Type: Chrome plated brass or chrome plated steel, one piece or split type with concealed hinge, with setscrew for fastening to pipe, or sleeve. Use plates that fit tight around pipes, cover openings around pipes, and cover the entire pipe sleeve projection on all pipes including sanitary rough-ins. **Escutcheons for sprinkler heads shall be threaded and shall be listed for use with the sprinklers provided.**

B. Thickness: Not less than 3/32-inch for floor plates. For wall and ceiling plates, not less than 0.025 for up to 3-inch pipe, 0.035 for larger pipe.

C. Locations: Provide at all locations where pipe penetrates floors, walls and ceilings in exposed locations, except mechanical rooms.

2.7 ACCESS PANELS:

A. Under each applicable section of the detailed plumbing specifications, the Contractor shall provide access panels in all locations where required for access to concealed valves, traps, air cushions, controls, and any other equipment or materials requiring inspection or maintenance. Access panels shall be of adequate size and properly located so that concealed items will be readily accessible for servicing or for removing and replacing if necessary, except as indicated or specified otherwise. Access panels are not required in ceilings formed of removable acoustical panels.

B. Access panels that are not fire-rated shall be Milcor or equal. Provide modular-sized access panels in inaccessible acoustic tile ceilings sized according to the tile size. Provide Milcor metal access panels with cam lock, continuous hinge and mounting trim to match finish encountered. Provide natural anodized aluminum finish for panels in kitchens and toilets. Provide prime finished steel for panels in other areas. Paint panels in finished areas to match finish surface.

C. Where indicated and where access panels are installed in walls of shafts that are not sealed at each floor, access panels shall be Milcor or equal "Fire-Rated" and shall bear the Underwriters' Laboratories, Inc. Class B, 1-1/2 hour label. Openings shall be framed in accordance with the access panel manufacturer's recommendations. Frames shall be not lighter than 16-gage steel. Panels shall be not lighter than 20-gage steel and shall be insulated sandwich type. Panels shall have a continuous hinge, self-lubricating lock, a direct action-knurled knob, and an interior latch release mechanism.

2.8 CHARTS, DIAGRAMS, AND SCHEMES:

A. Charts, diagrams, and schemes listed below shall be provided under each applicable section of the detailed plumbing specifications by the Contractor, framed under glass, and installed where shown on the drawings or directed in the field. All charts, diagrams, and schemes shall be complete, neat, clear, legible, and permanent.

B. Valve identification chart with typewritten schedule of all valves giving their tag number, description, location in building via room number, system served, and normal operation position.

C. Piping schemes where required by the detailed specifications.

2.9 CATALOG DATA FOR OWNER:

A. Furnish one (1) bound copy or one (1) digital file (pdf format) of all Catalog Data on each manufactured item of equipment used in the mechanical work, complete with index listing the products alphabetically by name, together with the names and addresses of manufacturers, sales, and service representatives. Furnish two (2) bound copies or one (1) digital file (pdf format) of all Operating and Maintenance Instructions of each item of equipment. A single comprehensive file or digital file of all Catalog Data and Operating and Maintenance Instructions shall be submitted to the Engineer for review prior to transmittal to the Owner. Single sections or multiple files will not be reviewed.

2.10 RECORD OF AS-BUILTS AND CONDITIONS:

A. Provide a complete set of prints and electronic version of plumbing and sprinkler plans marked to indicate as-built conditions which are different from those shown on the original construction documents. Site as-built conditions which are different from the construction documents shall be dimensioned from building or identifiable marker. Accurate locations of all concealed utility lines, both interior and exterior shall be recorded. These drawings shall be delivered to the Architect/Engineer before being turned over to the Owner.

PART 3: EXECUTION

3.1 INSTALLATION:

A. Coordination of Work:

1. The Contractor shall compare the plumbing drawings and specifications with the drawings and specifications of other trades, and shall report any discrepancies between them to the Architect/Engineer, and shall obtain from him written instructions for changes necessary in the plumbing work. The plumbing work shall be installed in cooperation with other trades installing interrelated work. Before installation, the Contractor shall make proper provision to avoid interferences in a manner approved by the Architect/Engineer. All changes required in the work of the Contractor caused by his neglect to do so shall be made by him at his own expense.
2. Anchor bolts, sleeves, inserts, and supports that may be required for the work shall be fully coordinated and compatible with the related equipment or materials. Locations shall be determined by the trade installing the related equipment or materials.
3. Slots, chases, openings, and recesses through floors, walls, ceilings, roofs, and partitions shall be located by the trades requiring them.
4. Locations of pipes, equipment, fixtures, etc., shall be adjusted to accommodate the work to interferences anticipated and encountered. The installing Contractors shall coordinate their work to the building structure and to other trades as directed by the General Contractor. No additional compensation or extension of completion time will be granted for extra work caused by a lack of coordination. The installing Contractor shall provide dimensions and locations of all openings, shafts, and similar items to the General Contractor for his coordination and execution. Work shall be installed as required so as

not to interfere with or delay the building construction. Pipes, etc., shall be concealed above ceilings, in walls, or in floors as applicable in all areas of the building except in equipment rooms, unfinished storage rooms, or other areas specifically noted to the contrary.

a. Right-of-Way: Lines which pitch shall have right-of-way over those which do not pitch. For example, plumbing drains shall normally have right-of-way. Lines whose elevations cannot be changed shall have the right-of-way over lines whose elevations can be changed.
b. Offsets, transitions, and changes in direction of pipes shall be made as required to maintain proper head room and pitch of sloping lines whether or not indicated on the drawings. The Contractor shall furnish and install all traps, drains, sanitary vents, etc., as required to affect these offsets, transitions, and changes in direction.

5. Exact locations of items such as hose bibbs, wall hydrants, fire department hose valves and other similar items in finished areas of the building and on the exterior of the building shall be coordinated with each other, the building structure, and architectural features thereof so as to be aligned with or centered on other items as applicable. Locations indicated on the drawings are approximate. Trades shall coordinate their work with door swings, block coursing, tile arrangement, required clearances and other similar features before establishing the location of any components. Before any related work has begun, the Architect/Engineer may direct reasonable minor changes in equipment locations with no increase in contract price to the Owner. Before roughing in conduit or pipe, verify the location of equipment to be connected.
6. Installation and Arrangement: The Contractor shall install all plumbing work to permit removal of all parts requiring periodic replacement or maintenance. The Contractor shall arrange pipes and equipment to permit ready access to valves, cocks, traps, motors, control components, and to clear the openings of swinging and overhead doors and of access panels.
7. Drawings by Contractor: When directed by the Architect/Engineer, the Contractor shall submit for review by Architect/Engineer drawings clearly showing certain portions of the plumbing work and its relation to the work of other trades before beginning shop fabrication or erection in the field.
8. Dimensions: The Contractor shall ensure that items to be furnished fit the space available. He shall make necessary field measurements to ascertain space requirements, including those for connections, and shall furnish and install such sizes and shapes of equipment that the final installation shall suit the true intent and meaning of the drawings and specifications. If he concludes that there is insufficient space for installation or specified materials, he shall immediately notify the Architect/Engineer of the conflict and shall stop affected work until he receives instructions as to how to proceed from the Architect/Engineer.
9. Damage to Work: The Contractor is responsible for damage caused by his work or workmen. Repairing of damaged work shall be done by the Contractor as directed by the Engineer at no additional cost.
10. Connections to Existing Facilities, Piping Systems, Etc: All connections to existing facilities, piping systems, etc., shall be made as required or deemed necessary to ensure the maintenance of continued operation of the above and provide the very minimum of interruption. This Contractor shall make such temporary connections as may be required

to facilitate this work and to protect the existing building from damage. Any work which will in any way affect the continued operation of any existing facility shall be coordinated with the proper authorities as well as the Architect-Engineer before any service is interrupted.

11. The Contractor shall be responsible for any interruptions to existing services and shall repair any damages to existing systems caused by his operations.

B. Protection and Cleaning:

1. Equipment and materials shall be carefully handled, properly stored, and adequately protected to prevent damage before and during installation, in accordance with the manufacturer's recommendations. Damaged or defective items, in the opinion of the Architect/Engineer, shall be replaced.
2. All items subject to moisture damage (such as controls and electrical equipment) shall be stored in dry, heated spaces.
3. Protect all finished parts of equipment, such as shafts and bearings where accessible, from rust prior to operation by means of protective grease coating and wrapping. Close pipe openings with caps or plugs during installation. Tightly cover and protect fixtures and equipment against dirt, water, chemical or mechanical injury. Clean plumbing equipment to remove dust, oil, dirt, plaster, mortar, trash, or paint. Piping and conduit shall be blown out or flushed of all foreign matter before wires are pulled in or before connections are made to equipment or systems. **(Clean each boiler in accordance with manufacturer's instructions before connecting to the system.)**

C. Protection of Electrical and I.T. Equipment: Plumbing and sprinkler piping and any other piping containing liquids shall NOT be installed directly over electrical panelboards, switchboards, I.T. equipment or motor control centers, unless the pipe is a minimum of 6 feet above the electrical equipment or above a structural ceiling (concrete cap or similar). If compliance with this requirement is not possible, notify the engineer immediately. If the piping is directly above and at least 6 feet above the electrical equipment, provide a galvanized steel drain pan installed directly under the piping. Drain pan shall have minimum 2 inch high sides with a drain pipe connection at the lowest point and shall be full width of the electrical equipment being protected. Extend drain pipe to exterior or to nearest floor drain.

D. Concrete and Grout: Use concrete and shrink compensating grout 3000 psi minimum.

E. Install gauges, thermometers, valves and other devices with due regard for ease in reading or operating and maintaining said devices. Locate and position thermometers and gages to be easily read by operator standing on floor or walkway provided. Servicing shall not require dismantling adjacent equipment or pipe work.

F. Work in Existing Building:

1. Cut required openings through existing masonry and reinforced concrete using diamond core drills. Use of pneumatic hammer type drills, impact type electric drills, and hand or manual hammer type drills will be permitted only with approval of the Architect/Engineer. Locate openings that will least effect structural slabs, columns, ribs or beams. Refer to the Architect/Engineer for determination of proper design for

openings through structural sections and opening layouts approval, prior to cutting or drilling into structure. After Architect/Engineer's approval, carefully cut opening through construction not larger than is absolutely necessary for the required installation.

2. Remove existing work as necessary to install new work. Except as otherwise shown or specified, do not cut, alter or remove any structural work or any ducts, plumbing, steam, gas or electric work without approval of Architect/Engineer. Existing work (walls, ceilings, partitions, floors, mechanical, and electrical work) disturbed or removed as a result of performing required new work shall be patched, repaired, reinstalled, replaced with new work, and refinished and left in as good condition as existed before commencing work. Existing work to be altered or extended that is found to be defective in any way shall be reported to the Architect/Engineer before it is disturbed. Materials and workmanship used in restoring work shall conform in type and quality to that of original existing construction, except as otherwise shown or specified.
3. Continuity of service shall be maintained to all existing systems, except for designated short intervals during which connections are to be made. Interruptions shall be coordinated with the Owner as to the time and duration.
4. Upon completion of contract, deliver work complete and undamaged. Damage that is caused by Contractor or Contractor's workmen to existing structures, grounds, or utilities or to work done by others shall be repaired by Contractor and left in as good condition as existed prior to damaging.

    a. At Contractor's own expense, Contractor shall immediately restore to service and repair any damage caused by Contractor's workmen to existing piping and conduits, wires, cable, etc., of utility services or of fire protection system and communications systems (except telephone) which are not scheduled for discontinuance or abandonment.
    b. Restoration work required by damage to telephone systems shall be done by telephone company at Contractor's expense.

3.2 GENERAL PIPING INSTALLATION:

A. Under each applicable section of the detailed plumbing specifications, the Contractor shall furnish and install as shown on the drawings or as necessary to complete the working system in accordance with the intent of the drawings and specifications, a complete system of piping, valves, supports, anchors, sleeves, and all other appurtenances. The piping drawings are diagrammatic and indicate the general location and connections. The piping may have to be offset, lowered, or raised as required or as directed at the site. This does not relieve the Contractor of responsibility for the proper erection of systems of piping in every respect suitable for the work intended as described in the specifications and as approved by the Architect/Engineer. Wherever two dissimilar metals join in any piping system, install a dielectric fitting at their intersection.

B. Erection: Piping shall be properly supported and adequate provisions shall be made for expansion, contraction, slope, and anchorage without damage to joints or hangers. All piping shall be cut accurately for fabrication to measurements established at the construction site. Pipe shall be worked into place without springing and/or forcing, properly clearing all windows, doors, and other openings and equipment. Cutting or other weakening of the building structure

to facilitate piping installation will not be permitted without written approval. Pipe extending through the roof shall be properly flashed. All changes in direction shall be made with fittings. Wherever pipe hanger bears directly on the pipe being supported, the hanger shall be of the same material as the pipe.

C. Arrangement: All piping shall be arranged so as not to interfere with removal of other equipment or devices nor to block access to doors, windows, manholes, or other access openings. Piping shall be arranged so as to facilitate removal of tube bundles. Flanges or unions, as applicable for the type of piping specified, shall be provided in the piping at connections to all items of equipment. Piping shall be placed and installed so that there will be no interference with the installation of the equipment, ducts, etc. All piping shall be installed to ensure noiseless circulation. All piping shall be erected and pitched to ensure proper drainage. Piping shall be installed so as to avoid liquid or air pockets throughout the work. Pipe in finished areas shall be concealed. Install piping generally parallel to walls and column centerlines, unless shown otherwise on the drawings. Space piping, including insulation, to provide one inch minimum clearance between adjacent piping or other surface. Pipe shall be installed to permit free expansion and contraction without damage to joints or hangers. Exposed piping shall be installed in practical alignment with the building. All valves and specialties shall be placed to permit easy operation and access, and all valves shall be regulated, packed, and glands adjusted at the completion of the work before final acceptance. Water pipes shall not be installed in attic spaces, crawl spaces, exterior walls or similar areas which are subject to freezing, unless indicated to be heat traced.

D. Installation of Underground Pipe: Each pipe shall be laid true to line and grade and in such manner as to form a close concentric joint with adjoining pipe and to prevent sudden offsets to flow line. As work progresses, the interior of the pipe shall be cleared of dirt and superfluous materials of every description. Where cleaning after laying is difficult because of small pipe size, a suitable swag or drag shall be kept in the pipe and pulled forward past each joint immediately after jointing has been completed. Trenches shall be kept free from water until pipe jointing material has set. Pipe shall not be laid when the condition of the trench or weather is unsuitable for such work. At all times when work is not in progress, all open ends of pipe and fittings shall be securely closed so that no water, earth, or other substance will enter the pipe or fittings.

3.3 PIPE AND EQUIPMENT SUPPORTS:

A. Supports: The Contractor shall support plumb, rigid, and true to line all work and equipment furnished under each section of these specifications. The Contractor shall study thoroughly all general, structural, and plumbing drawings, shop drawings, and catalog data to determine how equipment, fixtures, piping, ductwork, etc., are to be supported, mounted, or suspended, and shall provide extra steel bolts, inserts, pipe stands, brackets and accessories for proper support, whether or not shown on the drawings. When directed, the Contractor shall submit drawings showing supports for review by the Architect/Engineer.

B. Where hanger spacing does not correspond with joist or rib spacing, use structural steel channels secured directly to joist and rib structure that will correspond to the required hanger spacing, and then suspend the equipment and piping from the channels. Drill or burn holes in structural steel only with the prior approval of the Architect/Engineer.

C. Use of chain, wire or strap hangers; wood for blocking stays or bracing; or hangers suspended from piping above will not be permitted. If products are rusty, replace or thoroughly clean and coat with prime paint.

D. Use hanger rods that are straight and vertical. Turnbuckles for vertical adjustments may be omitted where limited space prevents use. Provide a minimum of 2-inch clearance between pipe or pipe covering and adjacent work. Pipe hanger rods shall be attached to the top chord only on steel joists and beams by joist or beam clamps, without welding. Where clamps cannot be attached to the top chord of joists or beams, trapeze hangers shall be provided.

E. Horizontal Pipe Support Spacing:

1. Cast Iron: Five feet on centers maximum spacing. At least one hanger on each full length of pipe, close to hub where possible and at least one within 24 inches of each fitting, and wherever else required to prevent tendency toward deflection due to load. Provide a hanger at upper angle at each drop. Locate hangers adjacent to hubs on multiple fittings not more than four feet on centers.
2. Plastic and Glass Pipe: Support in accordance with manufacturer's recommendations.
3. For support spacing of all other horizontal piping, refer to MSS SP-69 and provide additional supports at valves, strainers, inline pumps and other heavy components. Provide a support within one foot of each elbow.

F. Vertical Pipe Supports--Cast Iron Stacks: Base of stacks shall be supported on concrete, brick in cement mortar, or metal brackets permanently attached to building structure. Support stacks on each building floor structure, but not to exceed 15 feet spacing.

G. Connections: All piping connecting to pumps and other equipment shall be installed without strain at the piping connection. The Contractor shall be required as directed to remove the bolts in flanged connections or to disconnect piping to demonstrate that piping has been so connected.

3.4 EXCAVATION AND TRENCHING:

A. Under each applicable section of the detailed plumbing specifications, the Contractor shall perform all excavation of every description and of whatever substances encountered, to the depths indicated on the drawings or as otherwise specified. No extras will be allowed for rock unless indicated otherwise. During excavation, material suitable for backfilling shall be piled in an orderly manner a sufficient distance from the banks of the trench to avoid overloading and to prevent slides or cave-ins. All excavated materials not required or suitable for backfill shall be removed and wasted as indicated on the drawings or as directed by the Architect/Engineer. Such grading shall be done as may be necessary to prevent surface water from flowing into trenches or other excavations, and any water accumulating therein shall be removed by

pumping or by other approved method. Such sheeting and shoring shall be done as may be necessary for the protection of the work and for the safety of personnel. Unless otherwise indicated, excavation shall be by open cut except that short sections of a trench may be tunneled if, in the opinion of the Architect/Engineer, the pipe can be safely and properly installed and backfill can be properly tamped in such tunnel sections.

B. Trench Excavations (Includes under building and 5 feet outside of building): Trenches shall be of necessary width for the proper laying of the pipe or duct, and the banks shall be as nearly vertical as practicable. The bottom of the trenches shall be accurately graded to provide uniform bearing and support for each section of the pipe on undisturbed soil at every point along its entire length. Except where rock is encountered, care shall be taken not to excavate below the depths indicated. Where rock excavations are required, the rock shall be excavated to a minimum over depth of 4 inches below the trench depths indicated on the drawings or specified. Over-depths in the rock excavation and authorized over depths shall be backfilled with loose, granular, moist earth, thoroughly tamped. When corrosive material or unstable soil or material that is incapable of supporting the pipe is encountered in the bottom of the trench, the Contractor shall promptly notify the Architect/Engineer. Such unsuitable soil or material shall be removed to a depth as directed by Architect/Engineer and the trench backfilled to the proper grade with coarse sand, fine gravel, or other suitable backfill material, as directed by the Architect/Engineer.

C. Sanitary Sewers, Storm Sewers, and Water Mains: The width of the trench at and below the top of the pipe shall be such that the clear space between the barrel of the pipe and the trench shall be between 6 and 12 inches on either side of the pipe. The width of the trench above that level may be as wide as necessary for sheeting and bracing and the proper performance of the work. The bottom of the trench shall be rounded so that at least the bottom quadrant of the pipe shall rest firmly on undisturbed soil for as much of the full length of the barrel as proper jointing operations will permit. This part of the excavation shall be done manually only a few feet in advance of the pipe laying by men skilled in this type of work.

D. Protection of Existing Utilities: Existing utility lines to be retained that are shown on the drawings or the locations of which are made known to the Contractor prior to excavation, as well as all utility lines uncovered during excavation operations, shall be protected from damage during excavation and backfilling, and if damaged, shall be repaired by the Contractor, at his expense.

3.5 BACKFILLING OF TRENCHES:

A. Trenches shall not be backfilled until all required pressure and other tests and inspections have been performed and until the utilities systems as installed conform to the requirements of the drawings and specifications. Trenches for piping shall be carefully backfilled with materials consisting of earth, loam, sandy clay, sand and gravel, soft shale, or other approved materials saved from the excavation or borrowed as required. The backfill materials shall be granular in nature and shall not contain coal, dust, cinders, ashes, roots, sod, rubbish, corrosive materials, large clods of earth, or stones over 2-inch maximum dimension. The Architect/Engineer may reject any on-site or borrowed materials which he considers unsuitable for the intended use of the fill.

B. Controlled compacted backfill shall be used under slabs-on-grade, building structure, concrete paving, asphaltic concrete paving, driveway, parking areas, and other areas so specified or indicated on the drawings. All backfill required to raise the surface to the desired subgrade shall be continuously controlled and placed in maximum of 8-inch loosely placed lifts and compacted to 100 percent maximum dry density beneath the building and 95 percent under all paved drives and parking areas in accordance with ASTM D 698 (Standard Proctor). The soils engineer shall check each lift and submit reports to the Architect/Engineer in accordance with Division 31 - Earthwork.

C. Normal Backfill: Where controlled compacted backfill is not required, such as grassed areas, the trenches shall be carefully backfilled with material in eight-inch layers and thoroughly and carefully rammed until cover is not less than one foot. The remainder of the backfill material shall then be carefully placed in the trench in one-foot layers and tamped. The surface shall be graded to a reasonable uniformity and the mounding over trenches left in a uniform and neat condition as approved by the Architect/Engineer.

D. Test for Displacement of Sewers: Storm and sanitary sewer mains shall be checked by the Contractor to determine whether any displacement of the pipe has occurred after the trench has been backfilled to two feet or more above the pipe. A light shall be flashed between manhole locations and through each straight section of pipe. If the illuminated interior of the pipeline shows poor alignment, displaced pipe, or any other defects, in the opinion of the Architect/Engineer, such defects shall be remedied by the Contractor at his expense.

E. Plants, turf, and surfacing that are to remain in the area of the excavation shall be carefully removed and placed where they will not be damaged. After the excavations are filled, the plants, turf, and surfacing shall be replaced as directed. Provide repairs for sidewalks, driveways, and other cement and asphalt surfaces which are damaged during excavating to match the adjacent work in material and finish.

3.6 CUTTING AND PATCHING:

A. The Contractor shall be responsible for all required digging, cutting, etc., incident to the work, and shall thereafter make all required repairs necessary to restore the cut structure or material to the condition existing prior to the cutting. In no case shall the Contractor cut into any major structural element, beam, or column without the written approval of the Architect/Engineer. All cutting, patching, repairing, or replacing of work required because of fault, error, tardiness, or damage by any trade shall be performed with no increase in the contract price to the Owner.

B. Patch and repair roof in accordance with requirements of existing roof warranties and manufacturer's standard approved details.

3.7 OPERATING AND PERFORMANCE TESTS:

A. Prior to the final inspection, perform required tests as specified under each applicable section of the detailed plumbing specifications, and submit the test reports and records to the Architect/Engineer.

B. Should evidence of malfunction in any tested system, or piece of equipment or component part thereof, occur during or as a result of tests, make proper corrections, repairs or replacements, and repeat tests at no additional cost to the Owner.

3.8 QUIET OPERATION AND VIBRATION:

A. Systems shall operate under conditions of load without unusual or excessive noise or vibration. Unusual or excessive noise or vibration shall be corrected.

3.9 INSTRUCTIONS TO OWNER'S PERSONNEL:

A. Under each applicable section of the detailed plumbing specifications, the Contractor shall instruct the representative of the Owner in the proper operation and maintenance of all elements of the plumbing systems. A competent representative of the Contractor shall spend not less than two days in such formal instruction and shall spend such additional time as directed by the Architect/Engineer to fully prepare the Owner to operate and maintain the plumbing systems. The Contractor shall provide letter of instruction upon completion to the Architect/Engineer stating the date of instruction and the names of those in attendance.

3.10 GUARANTEE:

A. All plumbing equipment, materials, and labor required by the contract documents for this project shall be guaranteed to be free of defective materials or workmanship for a period of one year after final acceptance of the project. Defects in equipment, materials, or workmanship occurring during this period shall be corrected with new equipment and materials or additional labor at no cost to the Owner.

3.11 SITE VISIT REPORT:

A. Answer in writing each item of discrepancy noted on all site visit reports.

3.12 DEMOLITION:

A. Contractor shall visit the site before bidding to determine the extent and location of demolition to be performed.

B. Contractor to remove all pipes, equipment, etc. not required, reused or needed for reconnecting to the new systems. All items not required for the new system shall be removed.

C. The Owner shall select and retain such existing items indicated or required to be removed as he desires. Items selected by the Owner to be retained shall be removed and relocated to an Owner designated location by the Contractor.

D. All equipment, piping, conduit, etc. to remain and be reused shall be protected from damage. Any damage to existing material shall be repaired to original condition.

E. Coordinate all demolition activities with the phasing of construction. Demolition shall not affect operations of the building.

3.13 PHASING OF WORK:

A. The plumbing contractor is required to fully understand the phasing of work and to coordinate his work according to phasing plan drawings and related sections of the specifications.

B. Sections of the existing building will continue to be occupied during renovation. The contractor shall be responsible for retaining existing plumbing systems to serve the occupied sections of the building. Otherwise, the contractor shall provide interim plumbing systems for the occupied sections of the building.

C. The contractor is cautioned to fully understand the need to operate plumbing systems during construction.

D. Provide temporary plumbing to protect the owner's property from freeze damage and from high humidity. For new construction, provide plumbing for proper drying and application of finishes.

E. Portions of the renovated building will be reoccupied as sections of renovation become complete. The contractor shall be responsible for providing plumbing for the reoccupied sections of building.

END OF SECTION 220000

SECTION 220700 - PLUMBING INSULATION

PART 1: GENERAL

1.1 CONDITIONS:

A. The applicable provisions of Section 22 00 00, PLUMBING GENERAL REQUIREMENTS, are hereby made a part of this section, and the Contractor is cautioned to read Section 22 00 00 carefully as items of work applicable to this section are included in Section 22 00 00.

1.2 DESCRIPTION OF WORK:

A. The work to be performed under this section of the specifications comprises the furnishing of all labor and materials and the completion of all work of this section as shown on the drawings and/or herein specified.

B. Insulation materials and accessories shall be installed in a workmanlike manner by skilled and experienced workers who are regularly engaged in commercial insulation work.

C. In general, the work included under this section consists of, but is not limited to, field applied insulation for thermal efficiency and condensation control for plumbing piping and equipment.

1.3 RELATED WORK:

A. Section 22 00 00, PLUMBING GENERAL REQUIREMENTS.

B. Section 22 11 00, FACILITY WATER DISTRIBUTION.

C. Section 22 13 00, DRAINAGE SYSTEMS.

1.4 SUBMITTALS:

A. In accordance with Section 22 00 00, PLUMBING GENERAL REQUIREMENTS, furnish the following:

1. Manufacturer's Literature and Dimension Cuts:

    a. Insulation Materials: Each type used. State surface burning characteristics and thermal properties.
    b. Insulation Facings and Jackets: Each type used. State vapor barrier properties. State that white finish will be furnished for exposed pipe and equipment.
    c. Insulation Accessory Materials: Each type used.

d. Manufacturer's installation and fitting fabrication instructions for elastomeric unicellular insulation.
e. Make reference to applicable specification paragraph numbers for coordination.

1.5 DEFINITIONS:

A. Cold: Equipment or piping handling media at design temperature of 60 Deg. F. or below.

B. Hot: Equipment or piping handling media above 105 Deg. F.

C. PCF: Density, pounds per cubic foot.

D. Runout: Branch pipe connection up to one inch nominal size and not over 12 feet in length.

E. Thermal Conductance: Heat flow rate through materials.

1. Flat Surface: BTU per hour per square foot.
2. Pipe or Cylinder: BTU per hour per linear foot.

F. Thermal Conductivity (k): (BTU x inch thickness)/(hour x square foot x degree Fahrenheit temperature difference).

G. Finished Spaces: Spaces used for habitation or occupancy where rough surfaces are plastered, paneled, or otherwise treated to provide a pleasing appearance.

H. Unfinished Spaces: Spaces used for storage or work areas where appearance is not a factor, unexcavated spaces, crawl spaces, etc.

I. Concealed Spaces: Spaces between a ceiling and floor construction above or between double walls or furred-in areas, pipe shafts, etc.

J. Exposed: Open to view inside the building. For example, pipe run through a room, and not covered by other construction, is exposed.

PART 2: PRODUCTS

2.1 GENERAL:

A. Building characteristics of insulation materials shall comply with NFPA 90A, pertinent parts of which are noted as follows:

1. Pipe insulation and coverings shall meet the requirements of NFPA 90A Sections 4-3.3.1 and 4-3.3.2 when installed in plenums or concealed spaces used as part of the air distribution system.
2. In addition to NFPA, the insulation material shall not transform into a molten flaming liquid during combustion as characterized by some polyethylenes.

B. Test Methods: ASTM E 84, UL 723, or NFPA 255.

C. Insulation shall be Johns Manville, Owens Corning, Pittsburg Corning, or Armstrong. Trade names are used herein, unless indicated otherwise, to establish a standard of quality.

D. Specified k factors are at 75 Deg. F. mean temperature unless stated otherwise. Where optional insulation material is used, select thickness to provide thermal conductance no greater than that for the specified material. For pipe, use insulation manufacturer's published heat flow tables. For a flat surface, thermal conductance equal thermal conductivity (k) divided by the thickness of the insulation. For runout insulation and condensation control insulation, no thickness adjustment need be made.

E. All materials shall be compatible and suitable for service temperature and shall not contribute to corrosion or otherwise attack surfaces to which applied in either the wet or dry state.

F. Underwriters' Laboratories, Inc. label or listing, or satisfactory certified test report from an approved testing laboratory will be required to show that surface burning characteristics for materials to be used do not exceed specified ratings.

G. All sealants and adhesives must comply with all applicable South Coast Air Quality Management District (SCAQMD) VOC limits including but not limited to Rule #1168. All mastics and coatings must comply with all applicable Green Seal GS-11 VOC limits.

2.2 INSULATION FACINGS AND JACKETS:

A. Fed. Spec. HH-B-100 for Vapor Barrier Types I and II:

1. Puncture Test Method: ASTM D 781.
2. Type I, Low Vapor Transmission (0.02 Perm Rating), Beach Puncture 50 Units: For insulating facing on exposed equipment, and for all pipe insulation jackets. Facings and jackets shall be white all service type (ASJ) suitable for painting without priming.
3. Type II, Medium Vapor Transmission, Beach Puncture 25 Units: Foil-Scrim-Kraft (FSK) type for concealed equipment.
4. Factory composite materials may be used provided they have been tested and certified by the manufacturer to meet Beach puncture units specified above.
5. Fire and smoke treatment of jackets and facings shall be permanent. The use of water soluble treatments is not acceptable.
6. Pipe insulation jackets shall have 1-1/2 inch minimum lap at longitudinal joints and not less than 3-inch butt strips at end joints. Facing on board, blanket and block insulation shall have 2-inch laps or 3-inch minimum butt strips. Butt strip material shall be the same as the jacket or facing. Laps and butt strips may be self-sealing type with factory applied pressure sensitive adhesive.

2.3 MINERAL FIBER INSULATION:

A. Owens-Corning Fiberglass SSL II ASJ Heavy Density Sectional Pipe Insulation, Fed. Spec. HH-I-558, Form D, Type III (Molded), Class 12, k = 0.24.

B. Molded pipe fitting covering: Fed. Spec. HH-I-558, Form E. Class 16, k = 0.26, for temperatures up to 370 Deg. F.

C. Insulation thickness and type for various piping systems shall be as indicated in the following table (Pipe Size/Insulation Thickness).

PIPE SIZE/INSULATION THICKNESS(1)

System	Temp. Range (°F)	Runouts < 1"	1" to < 1-1/2"	1-1/2" to < 8"	8" & above	Ins. Type (2)
Domestic Hot Water & HWR (Copper)	90-140	1.0	1.0	1.5	1.5	A
	141-200	1.5	1.5	2.0	2.0	A
Tempered Water	85-109	1.0	1.0	1.0	1.0	A
Misc.	80-89	1.0	1.0	1.0	1.0	A
Domestic Cold Water (Copper)	56-79	1.0	1.0	1.0	1.0	A

NOTES:
(1) Minimum thickness for insulation listed in preceding table is based on Thermal Conductivity, 'k' not exceeding 0.27 Btu per inch/hr. x sq. ft. x Deg. F. based on Mean Temperature of 75 Deg. F. Insulation with greater Thermal Conductivity shall have increased thickness to provide same performance characteristics as specified.
(2) A Fiberglass type insulation.

2.4 ELASTOMERIC INSULATION (COPPER):

A. Armstrong Armaflex II pipe insulation, fed. Spec. HH-I-573 and HH-I-1751/2, K = 0.27, flame spread not over 25, smoke developed not over 50, (1/2 inch thick test material), for temperatures from -40 Deg. F to 211 Deg. F. No jacket required.

2.5 INSULATION ACCESSORY MATERIALS:

A. Insulation inserts at pipe supports:

1. Material: Cellular glass or calcium silicate 1/2 section of insulation, same thickness as adjacent insulation.
2. Provide inserts for all insulated piping greater than 1-1/2 inch diameter. Install with metal insulation shields furnished with pipe supports, Section 22 00 00, PLUMBING GENERAL REQUIREMENTS. Minimum insert length: 10 inches for up to 3 inch pipe, 12 inches for 3 to 6 inch pipe, and 16 inches for 8 to 10 inch pipe.

B. Adhesives, Mastics, Cement:

1. Mil. Spec. MIL-A-3316B, Class 1: Jacket and lap adhesive and protective finish coating for insulation.
2. Mil. Spec. MIL-A-3316B, Class 2: Adhesive for laps for adhering insulation to metal surfaces.
3. Mil. Spec. MIL-A-24179A, Type II, Class 1: Adhesive for installing flexible unicellular insulation and for laps and general use.
4. Mil. Spec. MIL-B-19565B, Type 1 or Type II: Vapor barrier compound for indoor use.
5. Fed. Spec. SS-C-160A, Type IIIB, (ASTM C 449): Mineral fiber hydraulic-setting thermal insulating and finishing cement.
6. Other: Insulation manufacturer's published recommendations.

C. Mechanical Fasteners:

1. Pins, Anchors: Welded pins, or metal or nylon anchors with tin-coated or fiber washer, or clips. Pin diameter shall be as recommended by the insulation manufacturer.
2. Staples: Outward clinching monel or stainless steel.
3. Wire: 18 gage soft annealed galvanized, or 14 gage copper clad steel or nickel copper alloy.
4. Bands: 3/4-inch nominal width, brass, aluminum or stainless steel.

D. Reinforcement and Finishes:

1. Glass Fabric, Open Weave: ASTM D 1668, Type III (resin treated) and Type 1 (asphalt treated).
2. Glass Fiber Fitting Tape: Mil. Spec. MIL-C-20070, Type II, Class 1.
3. Tape for Flexible Unicellular Insulation: Scotch No. 472, Nashua PE-12, or approved equal recommended by the insulation manufacturer.
4. PVC Fitting Cover: Fed. Spec. L-P-535D, Composition A, Type II, Grade GU, with Form B mineral fiber insert, for media temperature 45 Deg. F. to 250 Deg. F. Below 45 Deg. F. and above 250 Deg. F., provide double layer insert. Provide color matching, vapor barrier, pressure sensitive tape.

E. Firestopping Material: Refer to Section 22 00 00, PLUMBING GENERAL REQUIREMENTS.

PART 3: EXECUTION

3.1 GENERAL INSULATION REQUIREMENTS:

A. Required pressure tests of joints and connections shall be completed before application of insulation. Surface shall be clean and dry with all foreign materials, such as dirt, oil, loose scale, and rust removed.

B. Insulation materials and accessories shall be installed in a workmanlike manner by skilled and experienced workers who are regularly engaged in commercial insulation work. If any insulation material has become wet because of transit or job site exposure to moisture or water, the Contractor shall not install such material, and shall remove it from the job site. No insulation material shall be installed that has become damaged in any way. The Contractor shall also use necessary means to protect his work and materials.

C. Except for specific exceptions, insulate entire specified equipment and piping systems. Insulate each pipe individually. Do not use scrap pieces of insulation where a full length section will fit.

D. Insulation materials shall be installed in a first class manner with smooth and even surfaces, with jackets and facings drawn tight and smoothly cemented down at all laps. Insulation shall be continuous through all sleeves and openings. Vapor barriers shall be continuous and uninterrupted throughout systems with operating temperature 60 Deg. F. and below. Lap and seal vapor barrier over ends and exposed edges of insulation. Anchors, supports, and other metal projections through insulation on cold surfaces shall be insulated and vapor sealed for a minimum length of six inches.

E. Insulation on hot piping and equipment shall be terminated square or beveled with insulating cement, covered with jacket, at items not to be insulated, access openings and nameplates.

F. On cold systems, vapor barrier performance is extremely important. Particular care must be given to vapor sealing the fitting cover or finish to the insulation vapor barrier. All penetrations of the jacket and exposed ends of insulation must be sealed with vapor barrier mastic. All valve stems must be sealed with caulking which allows free movement of the stem but provides a seal against moisture incursion.

G. Plumbing Work Not To Be Insulated:

1. Piping and valves for fire protection system.
2. Chromium plated brass piping.
3. Domestic Hot Water: Unions, flexible connectors, control valves, expansion tank, pump.

H. Apply insulation materials subject to the manufacturer's recommended temperature limits. Apply adhesives, mastics and coatings at the manufacturer's recommended minimum coverage.

I. New insulation (as specified herein) shall be provided and installed for existing piping at all locations where insulation has been removed during asbestos abatement and/or demolition of adjoining equipment. Contractor shall obtain and examine the asbestos abatement documents to determine the extent of the work.

J. Where hot, cold and/or tempered water piping are bundled together, each pipe shall be insulated individually to prevent transfer of heat to other piping systems.

K. All exposed insulation shall be provided with PVC jacket with no inserts to protect insulation against impact, UVC exposure and water.

3.2 INSULATION INSTALLATION:

A. Molded Mineral Fiber Pipe and Tubing Covering:

1. Fit insulation to pipe aligning longitudinal joints. Seal longitudinal joint laps and circumferential butt strips by rubbing hard with a nylon sealing tool to assure a positive seal. Staples may be used to assist in securing insulation. Seal all vapor barrier penetrations with vapor barrier mastic. Provide inserts and install with metal insulation shields at outside pipe supports.
2. Fittings, Flange and Valve Insulation:

    a. Fiberglass Pipe insulation shall be installed with joints butted firmly together. Valves and devices requiring access shall be insulated with mitered sections of insulation equal in thermal resistance and thickness to the adjoining insulation. Fittings shall be covered with Schuller "Zeston" type, pre-molded PVC fitting covers. Jackets on pipe insulation shall be stapled using outward clinching type staples spaced 3" apart at least 1/4" from the lap edge on systems operating at 80 Deg. F. and above; below 80 Deg. F. the laps are to be vapor sealed using self-sealing lap, lap seal gun, or adhesive. All insulation elbows, fittings, flanges, joints, laps, voids, punctures, and end tapers shall be sealed with two coats of Foster Vapor Out 30-33 or Childers Chil Out CP-33 vapor barrier mastic and reinforcing mesh (total 35 mils or 0.9 mm dry film thickness) regardless of service and before Zeston covers are applied.
    b. Fitting tape shall extend over the adjacent pipe insulation and overlap on itself at least two inches.

B. Elastomeric Insulation:

1. Apply insulation and fabricate fittings in accordance with the manufacturer's installation instructions.
2. Pipe and Tubing Insulation:

    a. Use proper size material. Do not stretch or strain insulation.
    b. To avoid undue compression of insulation, provide inserts at supports as recommended by the insulation manufacturer. Insulation shields are provided under Section 22 00 00, PLUMBING GENERAL REQUIREMENTS.

c. Elastomeric insulation shall be slipped on the pipe prior to connection wherever possible. Pipe leak tests shall be performed prior to the insulation of fittings. Where the slip-on technique is not possible longitudinal slit insulation shall be snapped on the pipe. All seams, voids, and butt joints shall be sealed with a vapor barrier adhesive or taped with 1-1/2 inch wide 3M #471 tape.

d. Fittings and valves shall be insulated with mitered sections of insulation. All joints shall be secured and sealed with vapor barrier adhesive. Approved factory-made fittings such as F & D Mfgr. and Supply Co. may be used.

END OF SECTION 220700

SECTION 221100 - FACILITY WATER DISTRIBUTION

PART 1: GENERAL

1.1 CONDITIONS:

A. The applicable provisions of Section 22 00 00, PLUMBING GENERAL REQUIREMENTS, are hereby made a part of this section and the Contractor is cautioned to read Section 22 00 00 carefully as items of work applicable to this section are included in Section 22 00 00.

1.2 DESCRIPTION OF WORK:

A. The work includes providing a complete plumbing system including, but not necessarily restricted to, the following:

1. Domestic water system to a point five feet away from exterior building walls.
2. Installation and connections to miscellaneous equipment furnished by Owner.
3. Connections to fixtures and equipment provided under other sections of these specifications.
4. Miscellaneous work as described herein, as shown on drawings, and as required for a complete system.

1.3 RELATED WORK:

A. Section 22 00 00, PLUMBING GENERAL REQUIREMENTS.

B. Pipe Insulation: Section 22 07 00, INSULATION

C. Plumbing Fixtures: Section 22 40 00, PLUMBING FIXTURES

1.4 SUBMITTALS:

A. Manufacturer's shop drawings shall indicate that piping and equipment meet specified codes. All piping, pump systems, equipment, and fittings that are connected to potable water systems, shall meet the 1996 Safe Water Drinking Act and the 2011 Reduction of Lead in Drinking Water Act, and where applicable, meeting NSF Standard 61, and be so labeled and be so certified. In accordance with Section 22 00 00, PLUMBING GENERAL REQUIREMENTS, furnish the following:

1. Manufacturer's Literature and Data:

a. Piping
b. Valves
c. Backflow Preventers

d. Strainers
e. Shock Absorbers
f. Access Panels
g. Tempering Valves
h. Pipe Supports (except hangers)

PART 2: PRODUCTS

2.1 PIPE AND EQUIPMENT SUPPORTS, PIPE SLEEVES, AND WALL CEILING PLATES:

A. Provide in accordance with specifications in Section 22 00 00, PLUMBING GENERAL REQUIREMENTS.

2.2 INTERIOR DOMESTIC WATER PIPING (DISTRIBUTION):

A. Copper Tube and Fittings: All interior and exterior copper tubing shall be Certified Tube (NOT Standard Tube or Streamline Tube) meeting all chemical, mechanical AND dimensional requirements of the applicable ASTM standards.

1. Tube: ASTM B 88:

a. Above ground: Type L, hard drawn.
b. Below ground: Type K, hard drawn.

2. Fittings: Wrought copper, ASME B16.22 or cast copper alloy ASME B16.18. Victaulic or accepted equal full flow copper fittings with grooved ends. Grooved copper fittings shall be copper per ASTM B75 alloy C12200; bronze sand cast per ASTM B-584 copper alloy CDA 844 (81-3-7-9) per ANSI B16.18.
3. Joints:

a. Above ground: Soldered in accordance with ASTM B828, ASTM B32 lead free solder, ASTM B813 lead free flux. Lead free shall mean less than 0.2 percent lead. Grooved end copper piping systems as manufactured by Victaulic Company of America or accepted equal may be installed 2" – 8". For grooved end systems, couplings shall be copper tubing sized manufactured to ASTM A536 ductile iron Grade 65-45-12 painted copper color alkyd enamel. Gaskets for grooved system shall be of flush seal pressure responsive design having properties as designated in ASTM D2000. Installation-Ready, for direct slab installation without field disassembly. Victaulic Style 607H or equal.
b. Gaskets shall be UL classified in accordance with ANSI/NSF-61 for Potable water service.
c. Below ground: Brazed with AWS A5.8 filler metal (lead free).

B. Brass, Copper, Chromium-plated nipples - ASTM B687.

C. Press Fittings: Copper press fittings by Viega, Ridgid Tool Company or accepted equal, requirements of ASME B16.18 or ASME B16.22. O-rings for copper press fittings shall be EPDM.

D. Push-to-Connect Fittings: Copper push-to-connect fittings by Sharkbite, Victaulic Company, "Permalynx", Mueller "ProLine", meeting requirements ot ASME B16.18 or ASME B16.22, with stainless steel internal components and EPDM seals.

2.3 EXPOSED WATER PIPING:

A. Finished Room: Use full iron pipe size chrome plated brass piping for exposed water piping connecting fixtures, including those furnished by the Owner or specified in other sections.

1. Pipe: Red brass, standard weight, chrome plated.
2. Fittings: Screwed brass or bronze, Class A, 125 pound, drainage pattern for waste.
3. Nipples: Brass, standard weight.
4. Unions: Brass or bronze. Unions 2-1/2 inches and larger shall be flange type with approved gaskets.

B. Unfinished and Mechanical Rooms: Chrome-plated brass piping is not required. Paint as specified in Section 22 00 00 PLUMBING GENERAL REQUIREMENTS.

2.4 VALVES:

A. General: All valves and specialties shall be suitable for 125 psi working pressure except as otherwise indicated. Each item shall have threaded, flanged, press or sweat connections as applicable to match joints specified for its respective service. All valves on domestic water piping shall be installed BELOW ductwork and other piping for ease of access.

B. Valves: Hot and Cold Domestic Water Service Acceptable manufacturers subject to compliance with requirements are Nibco, Apollo, Jenkins, Hammond, Milwaukee, Lunkenheimer, Watts and Victaulic.

1. Ball valves: Valves 2 1/2 inch and smaller shall be rated 150 psi SWP and 600 psi non-shock WOG and shall have 2 piece cast bronze bodies, TFE seats, full port, separate packnut with adjustable stem packing, anti-blowout stems and chrome-plated brass/bronze ball. Valve ends shall have full depth ANSI threads or extended solder connections and be manufactured to comply with MSS-SP110. [NIBCO T585-80-LF (threaded); S585-80-LF (solder)].

Note: Where piping is insulated, ball valves shall be equipped with 2" extended handles of non-thermal conductive material. Also, provide a protective sleeve that allows operation of the valve without breaking the vapor seal or disturbing the insulation. Memory stops, which are fully adjustable after insulation is applied, shall be included. [NIBCO T585/70NS (threaded); S585-0NS (solder)]

2. Check valves: Valves 2 inch and smaller shall be Y-pattern swing-type manufactured in accordance with MSS-SP-139, Class 125, bronze ASTM B-62 body with TFE seat disc. Where higher operating pressures approach 150 psi, Class 150 valves of like construction shall be used. Valve ends shall be threaded or solder-type. [Class 125 NIBCO T413-Y (threaded); S413-Y (solder); Class 150 NIBCO T433-Y (threaded); S433-Y (solder)]

C. Water Hammer Arrestors: Mifab WHB Series, Josam "Absorbotron" 75000 Series, Smith 5000 Series “Hydrotrols”, Zurn Z1700 “Shoktrols”, Wade “Shokstop” or equal, bellows type, lead-free, stainless steel. (SA-A Max. 11 SFU; SA-B Max. 32 SFU; SA-C Max. 60 SFU) Provide on both hot and cold water branches at end of lines serving all water closets, urinals, lavatories, sinks, showers, laundries, wall hydrants and where shown on drawings. Job fabricated air chambers will not be permitted. O-ring type shock absorbers will not be accepted. (ASME/ANSI A112.26.1 OR ASSE 1010)

D. Tempering Valves:

1. Lavatory Tempering Valves: Watts Model Series LFUSG-B-M2 undersink guardian ASSE 1070 and CSA B-125 thermostatic tempering valve for single lavatories. Provide at all lavatory locations. Set valve for minimum 105, maximum 109 Deg. F.
2. Exposed Assembly for Eye/Face Wash: Leonard TA-300-LF, Lawler 911EF, or Powers ES150 with solid bimetal thermostat and internal cold water bypass, locking temperature regulator to prevent accidental movement, set for 85 Deg. F. (29 Deg. C.). Mixing valve shall close down on failure of cold water supply and have special internal cold water bypass capable of 4 GPM at 30 PSI upon failure of hot water supply. Full 1/2" bottom inlets and 1/2" top outlet, integral wall support and dial thermometer (range 0 to 140 Deg. F., -10 to 60 Deg. C.), rough bronze finish.

2.5 BACKFLOW PREVENTERS:

A. Provide a backflow prevention device at any point in the plumbing system where the potable water supply comes in contact with a potential source of contamination. Device shall be same size as line in which installed. Device shall be certified by recognized testing laboratory listed. Provide air gaps with drain pipe (if piped to floor drain) the same size as vent discharge on all backflow preventers with atmospheric vent. Extend drain to nearest floor drain (with air gap) or to exterior wall (hard piped without air gap). Listed below is a list of connection to the potable water system which shall be protected against backflow or back siphonage:

1. Spill-Resistant Anti-Siphon Vacuum Breakers (ASSE 1056): Watts 008PCQT or equal.

   a. Dental Pump Equipment
   b. Dental Chairs

PART 3: EXECUTION

3.1 INSTALLATION:

A. General:

1. Suspended horizontal piping shall be supported by adjustable wrought steel clevis hangers. Where supports bear on copper pipe, they shall be copper plated. Chain, strap, wire or other make-shift devices will not be permitted as hangers or supports. Hangers on all insulated pipes shall go around the insulation, with galvanized sheet steel saddle of sufficient size and thickness to prevent crushing of the insulation. Risers shall be securely supported and braced in an approved manner. Hangers for metal piping shall be spaced not over 6 feet apart for pipe 1/2 inch or smaller, 8 feet apart for 3/4 inch pipes and not over 10 feet apart for pipes 1 inch or larger. Hangers shall be located at all changes in direction. Maximum pipe support spacing shall be in accordance with Table 1 – MAXIMUM PIPING SUPPORT SPACING, except where grooved couplings are used, no pipe length shall be left unsupported between any two grooved couplings:

Table 1 - Maximum Piping Support Spacing

PIPING MATERIAL	MAXIMUM HORIZONTAL SPACING (feet)	MAXIMUM VERTICAL SPACING (feet)
ABS Pipe	4	10[c]
Brass Pipe	10	10
Brass Tubing, 1¼-inch Diameter & Smaller	6	10
Brass Tubing, 1½-inch Diameter & Larger	10	10
Cast-Iron Pipe[b]	5	15
Copper or Copper-Alloy Pipe	12	10
Copper or Copper-Alloy Tubing, 1¼-inch Diameter and Smaller	6	10
Copper or Copper-Alloy Tubing, 1½-inch Diameter & Larger	10	10
PVC Pipe	4	10[c]
Steel Pipe	12	15

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm
a. See Section 301.18.
b. The maximum horizontal spacing of cast-iron pipe hangers shall be increased to 10 feet where 10-foot lengths of pipe are installed.
c. Mid-story guide.

2. Install branch piping for water from the respective piping systems and connect to all fixtures, valves, outlets, and equipment, including those furnished by the Owner or specified in other sections of these specifications. Approximate locations for roughing-in are shown on the contract drawings. No piping or roughing-in shall be started until data showing exact locations for equipment and connections required are provided by the Architect. This data shall then be used for roughing-in equipment. Individual stops and other connection components not furnished with the equipment, but required for a complete installation, shall be provided under this section of these specifications. All

exposed trim and fixture supply pipe, including but not limited to lavatory and water closet rough-in piping, except in laundry, shall be chrome-plated.

3. Install trim and fittings provided with casework, cabinets, and laboratories, but not installed at point of fabrication.
4. Pipe shall be round and straight. Cutting shall be done with proper tools. Pipe shall be reamed to full size after cutting.
5. All pipe runs shall be laid out and scheduled to avoid interferences with other work.
6. Press connections: Copper press fittings shall be made in accordance with the manufacturers installation instructions. The tubing shall be fully inserted into the fitting and the tubing marked at the shoulder of the fitting. The fitting alignment shall be checked against the mark on the tubing to assure the tubing is fully engaged (inserted) in the fitting. The joints shall be pressed using the tool approved by the manufacturer.
7. Install valves with stem in horizontal position whenever possible. All valves shall be easily accessible. Isolation gate valves shall be installed on each side of each major piece of equipment and at other points indicated or required for draining, isolation, or sectionalizing purposes. Discharge of relief valves and backflow preventers shall be piped full size of valve connection to 6 inches above nearest floor drain or to exterior concrete pad as marked on drawings. Pipe shall be supported so that weight of pipe is not on valve body. Trap primers shall be piped full size to the floor drain indicated.
8. Unions or flanged joints shall be provided on each side of each valve 2-1/2 inch or larger and in each line immediately preceding the connection of each major piece of equipment. Unions shall be 125 psi bronze seat type. Flanges shall be ANSI standard 125 psi service with 1/16 inch thick composition or red rubber gaskets. Where grooved end piping and butterfly valves are used, Victaulic Style 608 valves with 607H couplings will be considered unions.
9. Joints between pipes of dissimilar metals shall have dielectric fittings such as unions, flanges or Clearflow dielectric nipples to isolate metals. Isolation shall be accomplished by non-metallic sleeves or couplings of materials suitable to withstand temperatures and pressures encountered.
10. Grooved joints shall be installed in accordance with the manufacturer’s latest published installation instructions. Grooved ends shall be clean and free from indentations, projections, and roll marks in the area from pipe end to groove. Gaskets shall be of an elastomer grade suitable for the intended service, and shall be molded and produced by the coupling manufacturer. The grooved coupling manufacturer’s factory trained representative shall provide on-site training for contractor’s field personnel in the use of grooving tools and installation of grooved joint products. The representative shall periodically visit the jobsite and review contractor is following best recommended practices in grooved product installation. A distributor’s representative is not considered qualified to conduct the training or jobsite visits.
11. Anchors for pipe shall be provided at all flush valves and fixtures or where required to localize pipe movement. Anchors shall consist of brass collars bolted to the pipe and rigidly connected to the building structure in an approved manner and so as not to damage the building structure.
12. Provide manufacturer's certification of all Pro-Press piping installations for full manufacturer's warranty.

B. Domestic water piping shall conform to the following:

1. Grade all lines to facilitate drainage. Provide hosed-end drain valves at bottom of risers. All unnecessary traps in circulating lines shall be avoided.
2. Connect branch lines at bottom of main serving fixtures below and pitch down so that main may be drained through fixture. Connect branch lines to top of main serving only fixtures located on floor above.
3. Provide drain lines from reduced pressure backflow preventers to nearest floor drain or to exterior concrete pad.
4. Install domestic hot water piping such that non-circulated portions of piping to public lavatories are less than 24 inches total length.

3.2 PROTECTION OF ELECTRICAL EQUIPMENT:

A. Refer to Specification Section 220000, Paragraph 3.01.C.1 for requirements for piping above electrical equipment.

3.3 PROTECTION OF PLASTIC PIPE:

A. All plastic piping shall be installed with sufficient distance and insulation relative to recessed light fixtures in accordance with Plastics Pipe Institute (PPI) Technical Note 56 “Installation of Plastic Pressure Piping Materials Near IC-Rated and Non-IC-Rated Recessed Lighting Fixtures”.

3.4 TESTS:

A. General: Contractor shall provide all instruments, materials, and labor required. Tests shall be made in the presence of the Owner or Authority having jurisdiction or as otherwise directed by the Architect, who shall be given five (5) days notice by this Contractor of his readiness to perform such tests. Any leaks that develop during the tests shall be repaired by remaking the joint or replacing pipe and fittings. Temporary caulking will not be permitted. No piping shall be insulated or concealed until it has been tested, with results acceptable to the Architect. Air testing will be acceptable where permitted by the Virginia Uniform Statewide Building Code. Do NOT perform air testing on systems where plastic piping, including CPVC and PEX piping, are installed. Test systems either in its entirety or in sections.

B. Potable Water System: Test after installation of piping and domestic water heaters, but before piping is concealed, before covering is applied, and before plumbing fixtures are connected. Fill systems with water and maintain hydrostatic pressure of 125 psig or at 50 percent higher than actual operating pressure which ever is greater for one hour during inspection and prove tight without any loss of pressure.

C. Optional tests for connections to existing systems: After installation of piping and connecting to existing systems, and where herein before specified tests are impractical, test all new piping under actual operating conditions and prove tight to the satisfaction of the Architect.

D. Reduced pressure principle backflow preventers, double check-valve, assemblies, and pressure vacuum breaker assemblies shall be tested to determine whether they are operable. The testing procedure shall be in accordance with one of the following:

1. Reduced Pressure Principle: ASSE 5010-1013-1-91 with August 1992 Revisions.
2. Double Check-Valve: ASSE 5010-1015-1-91 with August 1992 Revisions; ASSE 5010-1015-2-91 with August 1992 Revisions; ASSE 5010-1015-3-91 with August 1992 Revisions; ASSE 5010-1015-4-91 with August 1992 Revisions.
3. Pressure Vacuum Breaker: ASSE 5010-1020-1-91.

3.5 DISINFECTION (COPPER PIPING SYSTEMS):

A. After tests have been successfully completed, thoroughly flush and disinfect the interior domestic water distribution system in accordance with the local Health Department. In the absence of a prescribed procedure, systems shall be disinfected in accordance with AWWA C651 or AWWA C652 and Section 610 of the 2021 Virginia Plumbing Code.

B. Optimal Disinfection: After all tests have been satisfactorily completed, the entire water distribution system shall be thoroughly flushed and disinfected. Disinfect by tapping the main and introducing a solution of chlorine and water in such quantity as to provide a concentration of not less than 50 PPM with all water lines filled with water from the water main connection to all supply outlets. Care shall be taken not to flush the lines at this time. Air only shall be allowed to escape. This solution shall be allowed to stand in the lines for not less than twenty-four hours, after which the lines shall be flushed out until a residual reading of 0.5 PPM is obtained. After disinfection is complete, a bacteriological test shall be performed on the system. If contamination is still present, repeat the disinfection procedure until no contamination is present.

3.6 CLEANING:

A. Remove trash, plaster, dust, paint spots and all foreign matter from outside of all piping and equipment.

B. The Contractor shall check each length of pipe before it is put in place to make certain there is not foreign material (stones, sand, etc.) in the systems. Provide temporary bypass around equipment if or as required. All plumbing pipes shall be thoroughly flushed with water to remove construction debris before final connections are made to equipment and fixtures.

3.7 REPORTS:

A. Reports of cleaning, disinfection and testing: Contractor shall verify ***in writing before completion of the job*** that all specified cleaning procedures, tests, and disinfection have been performed, with results as specified or as required by codes.

END OF SECTION 221100

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SECTION 221300 - DRAINAGE SYSTEMS

PART 1: GENERAL

1.1 CONDITIONS:

A. The applicable provisions of Section 22 00 00, PLUMBING GENERAL REQUIREMENTS, are hereby made a part of this section and the Contractor is cautioned to read Section 22 00 00 carefully as items of work applicable to this section are included in Section 22 00 00.

1.2 DESCRIPTION OF WORK:

A. The work includes providing a complete plumbing system including, but not necessarily restricted to, the following:

1. Sanitary sewer system to a point five feet away from exterior building walls.
2. Installation and connections to miscellaneous equipment furnished by Owner.
3. Connections to fixtures and equipment provided under other sections of these specifications.
4. Miscellaneous work as described herein, as shown on drawings, and as required for a complete system.

1.3 RELATED WORK:

A. Supports: Division 05, METAL FABRICATIONS.

B. Section 22 00 00, PLUMBING GENERAL REQUIREMENTS.

C. Pipe Insulation: Section 22 07 00, INSULATION.

D. Plumbing Fixtures: Section 22 40 00, PLUMBING FIXTURES.

1.4 SUBMITTALS:

A. Manufacturer's shop drawings shall indicate that piping and equipment meet specified codes. In accordance with Section 22 00 00, PLUMBING GENERAL REQUIREMENTS, furnish the following:

1. Manufacturer's Literature and Data:

a. Piping
b. Valves
c. Floor Drains

d. Cleanouts
e. Access Panels
f. Pipe supports

B. Acceptable Manufacturers: Josam, Mifab, Smith, Wade, Watts, Zurn

PART 2: PRODUCTS

2.1 PIPE AND EQUIPMENT SUPPORTS, PIPE SLEEVES, AND WALL CEILING PLATES:

A. Provide in accordance with specifications in Section 22 00 00, PLUMBING GENERAL REQUIREMENTS.

2.2 SOIL, WASTE, VENT, RAIN CONDUCTOR, CONDENSATE DRAIN PIPING:

A. Cast Iron Soil Pipe and Fittings: Used for pipe buried in or in contact with earth and for extension of pipe to a distance of approximately five feet outside of building walls. May be used for piping above ground, where space within partitions involved can accommodate greatest diameter of cast iron soil pipe without any dimension deviation from the requirements of contract drawings. Pipe shall be bell and spigot, modified hub, or plain end (no-hub) as required by selected jointing method. Pipe and fittings shall be listed by NSF International, IAPMO, ICC or other third party organization that is accredited as an ANSI-Guide 65 organization as listed on www.ansi.org. Drains from urinals shall be cast iron or PVC piping.

1. Soil, Waste, and Vent Piping Material (Pipe and Fittings): ASTM A74, ASTM A888 or CISPI 301, service weight.
2. Joints: Provide any one of the following types to suit pipe furnished.

    a. Lead and oakum and caulked by hand.
    b. Mechanical: Compression-type (ASTM C564) molded neoprene gasket. Gaskets shall suit class of pipe being jointed. Dual-service gaskets will not be accepted.
    c. Mechanical: Mechanical joint coupling (ASTM C564) (CSA CAN/CSA-B602) shall be heavy duty and shall consist of a stainless steel coupling and neoprene gasket with center stop. Do not install below grade.
    d. Adapters: Where service weight pipe is connected to extra heavy pipe and extra heavy fittings of chair carriers, provide adapters or similar system to make tight, leakproof joints.

3. Coating: Provide a heavy coat of asphalt or bitumastic paint on pipe buried in earth or installed in cinders or concrete construction.
4. Cast Iron Soil Pipe Markings: All cast iron soil pipe shall be clearly marked with the manufacturer’s name, country of origin, eight-digit date code, pipe diameter and length, relevant ASTM standard, and registered trademark of the third party certifier.

5. Material Test Reports: Supplier of cast iron soil pipe shall be able to supply material test reports in accordance with the relevant ASTM standard and shall include testing and analysis on radioactivity, dimensional characteristics, tensile strength, and chemical/metallurgical content. Suppliers shall also supply MSDS sheets on all coatings.

B. Plastic Pipe: May be used for piping above ground and below ground. Foam core piping is NOT acceptable. All plastic pipe, fittings and components shall be third party certified as conforming to NSF 14 and NSF 61. PVC shall not be used where waste temperatures exceed 140 Deg. F., such as the Dental Instrument Washer and Mechanical Rooms. PVC shall not be used in return air plenums. Schedule 80 PVC nipples will be acceptable for urinal connection.

1. Pipe: PVC Schedule 40 DWV, ASTM D 2665.
2. Soil, Waste, & Vent Fittings: PVC ASTM D3311 fittings for solvent joints.
3. Joints: ASTM F656 purple primer, solvent ASTM D2564 (Not Purple in color) complying with SCAQMD Rule #1168, joints made in accordance with ASTM D2855 and NSF 14.

2.3 EXPOSED WASTE PIPING:

A. Finished Room: Use full size chrome plated brass piping for exposed waste piping connecting fixtures, including those furnished by the Owner or specified in other sections.

1. Pipe: Red brass, standard weight, chrome plated.
2. Fittings: Screwed brass or bronze, drainage pattern for waste.
3. Nipples: Brass, standard weight.

B. Unfinished and Mechanical Rooms: Chrome-plated brass piping is not required. Paint as specified in Section 22 00 00, PLUMBING GENERAL REQUIREMENTS.

2.4 CLEANOUTS:

A. Same size as pipe served up to 4 inches. Cleanouts shall be easily accessible. Provide a minimum of 18-inch clearance for 6 inch and smaller pipes for rodding. Cleanouts shall be provided at the base of each soil stack, waste stack, vertical rain conductor at all points in sanitary drainage systems where direction change is more than 45 degrees, where required by code, and where indicated on the drawings. All cleanout plugs shall be bronze, set in graphite grease. All cleanout covers shall be secured with vandal resistant screws unless noted otherwise. (ASTM A74, ASME A112.3.1, ASME A112.36.2M) Covers shall be set flush with finished floor or wall unless otherwise indicated. Provide carpet markers in all carpeted areas.

1. Cleanouts at base of vertical stacks: Josam 58600-COT, Smith 4532S, Zurn Z1446 with stainless steel wall cover and tapped for center screw threaded bronze plug. Josam 58540-19 with 58600 wall cover for 8 inch size. Cleanout plug located

approximately 30 inches above floor. Cleanout plugs under lavatories and sinks located approximately 10 inches above floor.

2. In horizontal runs above grade: Cleanouts shall be iron body ferrule with bronze screw plug in fitting or tapped cast iron ferrule with bronze plug.
3. In Floors: Floor cleanouts shall have cast iron body, bronze plug, and ABS or cast iron frame with round or square adjustable heavy-duty scoriated vandal resistant nickel bronze top. Unit shall be vertically adjustable for a minimum of two inches. When waterproof membrane is used in floor, provide clamping collars on cleanouts. Cleanouts shall consist of a "Y" fitting and a 1/8 bend. In carpeted areas, provide carpet cleanout markers.

    a. For mechanical rooms and heavy traffic floors: Josam Series 55000-X-2-SD-VP, Smith 4108C-U, Zurn ZN1400-HD-VP cast iron floor cleanout with vandal resistant heavy-duty round or square tractor cover.
    b. For light traffic floors: Josam Series 55000-VP, Smith 4028C-U, Zurn ZN1400-VP cast iron floor cleanout with (secured)(vandal resistant) round or square cover plate of satin bronze for finished concrete floors and of nickel-brass elsewhere.
    c. For vinyl floors: MIFAB C1100-RFC, Jay R. Smith 4021S-F-C-U cast iron floor cleanout with (vandal-proof) (security) cover plate of satin bronze for finished concrete floors and of nickel-brass elsewhere, with membrane clamp.

4. Exterior Cleanout: Josam Series 55000-X-VP, Smith 4028C-U, Zurn Z1400-VP cast iron floor cleanout with cast iron vandal-resistant heavy-duty tractor cover. Extend cast iron soil pipe from sanitary sewer main two-way cleanout fitting and set cleanout in 12 inch x 12 inch x 6 inch concrete pad for 4 inch size and less, 16 inch x 16 inch x 6 inch pad for larger size. Top of cleanout and concrete pad to be flush with finished surface.

2.5 DRAINS:

A. Floor drains shall have outlets suitable for inside caulking. Provide suitable clamping device and extensions if required, where installed in connection with waterproofing membrane. Puncturing membrane other than for drain opening will not be permitted. All floor drains shall be furnished complete with 4-inch deep seal P-trap. All strainers shall be secured with vandal resistant screws unless noted otherwise. All floor drains and trench drains shall conform to ASME A112.6.3 or CSA B79.

1. For mechanical rooms: Josam 30000-E-VP, Smith 2005-D, Zurn Z-415-N coated cast iron floor drain, two-piece body with double drainage flange, WEJLOC invertible non-puncturing flashing collar, weepholes, bottom outlet, adjustable satin Nikaloy vandal resistant round or square medium-duty tractor strainer, and perforated stainless steel basket.
2. Trap sealer:

    a. Sure Seal Model SS pre-assembled inline floor drain trap sealer. Sealer shall be constructed of high density polyethylene (HDPE) housing and keeper pin,

heavy duty silicone diaphragm, and soft EPDM sealing gaskets. Rated for floor ASSE-1072 AF-GW third party testing and listed by IAPMO. Provide in all floor drains.

b. Proset Model (TG22G-2”), (TG33G-3”), (TG34G-4”) Preassembled inline floor drain trap guard insert. The trap guard device shall be constructed of PVC insert, “O” Rings for 4 graduated sizes, elastomeric PVC flexible material diaphragm, sealed to pipe with adhesive caulk. Rated for ASME A112.6.3, NSF/ANSI 14 and CSA B79. Provide in all floor drains.

c. Mifab “Mi-Gard” Series inline floor drain trap seal device with UV resistant ABS plastic frame, silicon rubber sealing flapper and four flexible sealing ribs. Tested and certified to ASSE 1072 and listed with IAPMO and ICC. Provide in all floor drains.

2.6 TRAPS:

A. Provide traps on all sanitary branch waste connections from fixtures or equipment not provided with traps. Exposed brass shall be polished brass chromium plated with nipple, cleanout, and setscrew escutcheons. Concealed traps may be rough cast brass. Slip joints not permitted on sewer side of trap. Traps shall correspond to fittings on cast iron soil pipe and size shall be as required by connected service or fixture. Traps for equipment with acid-resistant drain system shall be of the same material specified for acid-resistant piping or Polypropylene. Provide 4 inch deep seal traps for all floor drains (and floor sinks) (and areaway drains) (and deck drains) (and trench drains) (hub drains). Provide traps with trap primer connections at all locations where trap primers are indicated.

2.7 WATERPROOFING:

A. Provide at points where pipes pass through membrane waterproofed floors or walls in contact with earth. Waterproofing shall consist of 6-pound sheet lead mopped-in between piles of waterproofing membrane. Flange out lead at opening for pipe and caulk into a cast iron pipe hub set just below line of membrane waterproofing to form watertight joint through floors.

2.8 DRAIN TEMPERING VALVE:

A. ThermOmegaTech Industrial Tempering Valve or equal drain tempering valve (DTV). Wastewater tempering, self-operating, thermal activator, brass body, 303 stainless steel spring and piston, 125 PSIG maximum inlet water pressure and 250°F maximum temperature. Full open temperature (120°F, 125°F, 130°F and 140°F). Valve shall have a warranty for 18 months.

PART 3: EXECUTION

3.1 INSTALLATION:

A. General:

1. Suspended horizontal piping shall be supported by adjustable wrought steel clevis hangers. Chain, strap, wire or other make-shift devices will not be permitted as hangers or supports. Hangers on insulated pipes shall go around the insulation, with galvanized sheet steel saddle of sufficient size and thickness to prevent crushing of the insulation. Risers and stacks shall be securely supported and braced in an approved manner. Hangers for plastic piping shall be 4 feet apart. Hangers shall be located at all changes in direction and at each joint for suspended soil, waste or storm branches and mains.
2. Install branch piping for waste from the respective piping systems and connect to all fixtures, outlets, casework, cabinets, and equipment, including those furnished by the Owner or specified in other sections of these specifications. Approximate locations for roughing-in are shown on the contract drawings. No piping or roughing-in shall be started until data showing exact locations for equipment and connections required are provided by the Architect. This data shall then be used for roughing-in equipment. Individual traps and other connection components not furnished with the equipment, but required for a complete installation, shall be provided under this section of these specifications. All exposed trim and fixture pipe, except in laundry, shall be chrome-plated.
3. Install trim and fittings provided with casework, cabinets, and laboratories, but not installed at point of fabrication.
4. Pipe shall be round and straight. Cutting shall be done with proper tools. Pipe, including plastic, shall be reamed to full size after cutting.
5. All pipe runs shall be laid out and scheduled to avoid interferences with other work.
6. Exterior sanitary sewer piping shall have a minimum of 36-inch cover unless indicated otherwise on drawings. Exterior underground PVC piping shall be buried in accordance with ASTM D2321 and the pipe manufacturer’s recommendations.
7. Plastic pipe shall not be located in return air ceiling plenums, and shall not be located in above ceiling or attic spaces constructed of combustible material.
8. Plastic pipe shall not penetrate a fire assembly or smokestop. Transitions from metal pipe to plastic pipe must be a minimum of 36 inches away from fire assembly or smokestop penetrations.
9. Caulked joints for cast iron sewer pipe shall be made by packing each joint two thirds full with pure tarred rope oakum, and filling remaining 1/3 full of molten lead. Minimum lead depth shall be 2-1/2 inches.
10. Compression gasket joints for cast iron sewer pipe shall be made with neoprene compression gaskets conforming to ASTM C-564 and suitable for use with hub and spigot pipe and fittings. Gaskets shall be installed in strict accordance with manufacturer's recommendations.
11. No-hub joints for cast iron pipes shall be made with neoprene gaskets (ASTM C564) and stainless steel clamps conforming to ASTM C564 AND ASTM C1277. Joints shall be made in accordance with manufacturer's recommendations.

12. Mechanical joints elastomeric sealing sleeve for cast iron pipe shall be in accordance with ASTM C564.
13. Solvent cement for PVC piping shall be handled in accordance with ASTM F402.
14. Floor drains shall be installed with top of rim 1 inch below finished floor with floor sloped at 1/8 inch per foot down towards floor drain unless noted otherwise, coordinate with architectural drawings.

B. Piping shall conform to the following:

1. Waste:

a. Slope soil, waste, and vent piping as follows:

Pipe Size	Minimum Pitch Down
Soil, waste, and vent	
2-1/2 inch & smaller	1/4 inch to the foot
3 inch & larger	1/8 inch to the foot

b. Changes in direction of piping shall be made with fittings. Changes in direction of drainage piping shall be made by the appropriate use of long-sweep 1/4 bends, 1/6, 1/8, or 1/16 bends, 45 degree wyes, 1/2 wyes, or a combination of these fittings, except that changes in direction of flow from the horizontal to the vertical may be made with short-sweep 1/4 bends.

c. ***Contractor is cautioned to locate and verify invert of existing sanitary and storm sewer and to coordinate inverts of new work to suit existing conditions.***

d. Sanitary sewer shall be provided complete with all plumbing fixtures, drains, etc., properly connected and vented in accordance with the applicable codes.

3.2 PROTECTION OF ELECTRICAL EQUIPMENT:

A. Refer to Specification Section 220000, Paragraph 3.01.C.1 for requirements for piping above electrical equipment.

3.3 PROTECTION OF PLASTIC PIPE:

A. All plastic piping shall be installed with sufficient distance and insulation relative to recessed light fixtures in accordance with Plastics Pipe Institute (PPI) Technical Note 56 “Installation of Plastic Pressure Piping Materials Near IC-Rated and Non-IC-Rated Recessed Lighting Fixtures”.

3.4 TESTS:

A. General: Contractor shall provide all instruments, materials, and labor required. Tests shall be made in the presence of the Owner or Authority having jurisdiction or as otherwise

directed by the Architect, who shall be given five (5) days notice by this Contractor of his readiness to perform such tests. Any leaks that develop during the tests shall be repaired by remaking the joint or replacing pipe and fittings. Temporary caulking will not be permitted. No piping shall be insulated or concealed until it has been tested, with results acceptable to the Architect. Except for plastic piping, air testing will be acceptable for other piping materials where permitted by the Virginia Construction Code. Test systems either in its entirety or in sections.

B. Testing of Existing Underground and Underfloor Sanitary and Storm Piping: The plumbing design of this facility involves connecting to existing underground and underfloor sanitary and storm sewer piping systems. The condition of this piping is unknown. Therefore, the underground piping systems shall be tested for leakage and adequate flow prior to connection of the new systems. These tests are described below.

1. As soon as possible once construction activities commence, the Contractor shall isolate and test the existing underground sanitary and storm drainage piping for leakage and for proper flow by the following procedure:

    a. Existing underground sanitary and storm piping shall be tested for proper flow at each fixture and drain connection, and cleaned by rodding if obstructions are suspected. If insufficient flow is observed at any fixture or drain, pipes in the affected area shall be rodded until obstructions are cleared. The discharge shall be observed at the nearest manhole outside the building on the system being tested. If, after the entire system is rodded, an obstruction is not found and the system still exhibits inadequate flow, the Architect/Engineer shall immediately be notified.
    b. After verification of proper flow in the underground sanitary and storm drainage systems, the systems shall be tested for leaks. The discharge pipe shall be plugged at the nearest manhole outside the building on the system being tested, and all openings inside the building shall be tightly plugged except the highest opening of the section being tested. The system shall be filled with water to the overflow of the fixture or inlet at the highest opening, and shall hold full for 15 minutes. If the system fails to hold water for the specified time, the test shall be repeated for each branch line to determine the leak location. If the leak location cannot be determined after every section of the system has been tested, or if multiple leaks are found, the Architect/Engineer shall immediately be notified.
    c. After all flow and leak tests have been completed, the Contractor shall submit the test results in writing to the Architect/Engineer.

2. All repairs required to existing underground sanitary drainage systems to be reused, where deficiencies are discovered during testing or construction, shall be addressed by change order, or shall be addressed separately by the owner.

C. Soil, Waste, and Vent Systems: Conduct tests before trenches are backfilled or fixtures are connected. Conduct water test or air test, as directed in accordance with the Virginia Construction Code and this specification.

1. Water Test: If entire system is tested, tightly close all openings in pipes except highest opening, and fill system with water to point of overflow. If system is tested in sections, tightly plug each opening except highest opening of section under test, fill each section with water and test with at least 10-foot head of water. In testing successive sections, test at least upper 10 feet of next preceding section so that each joint or pipe except uppermost 10-foot head of water. Keep water in system, or in portion under test, for at least 15 minutes before inspection starts. System shall then be tight at all joints.
2. Final Test: When required by the Building Inspector, conduct as directed in accordance with Virginia Construction Code and this specification. Either one of the following tests may be used:

    a. Smoke Test: After fixtures are permanently connected and traps are filled with water, fill entire drainage and vent systems with smoke. When smoke appears at stack openings on the roof, the stack openings shall be closed and a pressure equivalent to a 1-inch water column shall be held for a test period of not less than 15 minutes. Chemical smoke prohibited.
    b. Peppermint Test: Introduce two ounces of peppermint into each line or stack.
    c. Air Test: Air test shall be made by forcing air into the system until obtaining a uniform gauge pressure of 5 psi or sufficient to balance a 10 inch column of mercury. This pressure shall be held for a test period of not less than 15 minutes. Testing procedures in excess of 5 psi can result in a dangerous situation and shall not be allowed. Plastic piping shall not be tested using air.

D. Optional tests for connections to existing systems: After installation of piping and connecting to existing systems, and where herein before specified tests are impractical, test all new piping under actual operating conditions and prove tight to the satisfaction of the Architect.

3.5 CLEANING:

A. After tests have been successfully completed, thoroughly flush the interior drainage system.

B. Remove trash, plaster, dust, paint spots, and all foreign matter from inside and outside of all fixtures and equipment.

C. The Contractor shall check each length of pipe before it is put in place to make certain there is not foreign material (stones, sand, etc.) in the systems. Provide temporary bypass around equipment if or as required. All plumbing pipes shall be thoroughly flushed with water to remove construction debris before final connections are made to equipment and fixtures.

3.6 REPORTS:

A. Reports of cleaning and testing: Contractor shall verify ***in writing before completion of the job*** that all specified cleaning procedures and tests have been performed, with results as specified or as required by codes.

END OF SECTION 221300

SECTION 224000 - PLUMBING FIXTURES

PART 1: GENERAL

1.1 CONDITIONS:

A. The applicable provisions of Section 22 00 00, PLUMBING GENERAL REQUIREMENTS, are hereby made a part of the section and the Contractor is cautioned to read Section 22 00 00 carefully as items of work applicable to this section are included in Section 22 00 00.

1.2 DESCRIPTION OF WORK:

A. The work to be performed under this section of the specifications comprises the furnishing of all labor and materials and the completion of all work of this section as shown on the drawings and/or herein specified.

B. In general, the work included under this section consists of, but is not limited to, the following:

1. Plumbing Fixtures
2. Plumbing Trim

1.3 RELATED WORK:

A. Section 22 00 00, PLUMBING GENERAL REQUIREMENTS.

1.4 SUBMITTALS:

A. In accordance with Section 22 00 00, PLUMBING GENERAL REQUIREMENTS, furnish the following:

1. Manufacturer's Literature and Dimension Cuts:

a. Plumbing Fixtures & Carriers
b. Plumbing Faucets & Flush Valves
c. Plumbing Traps and Fittings
d. Plumbing Supplies & Stop Valves
e. Plumbing Equipment

PART 2: PRODUCTS

2.1 GENERAL:

A. Fixtures equal to those as hereinafter specified shall be furnished and installed complete with all supplies, waste and vent connections, all fittings, all necessary hangers and supports, bolt caps, faucets, valves and traps. All trim, (except in Janitor's Closets), shall be brass with polished chromium plated finish with chrome setscrew escutcheon at wall, except fixture supply pipes may be chromium plated copper with chrome setscrew escutcheons at wall. Traps shall be cast brass (17 gauge) with cleanout plug. All fixtures shall be white except as otherwise indicated. Handicapped lavatories and sinks shall have both water supplies and trap insulated and wrapped with Handy-Shield (by Plumberex), Handi Lav-Guard (by Truebro) or Prowrap (by McGuire). Color shall be white and fasteners shall remain out of sight. All electric water coolers and drinking fountains shall have a di-electric fitting on the water supply and PVC trap on waste.

2.2 ACCEPTABLE MANUFACTURERS:

A. Subject to compliance with requirements

Water Closets:	Kohler, American Standard, Toto, Sloan, Zurn
Lavatories:	Kohler, American Standard, Toto, Zurn
Sinks:	Acorn-Sinks, Just, Kohler, Elkay, Toto, American Standard, MR Direct
Mop Sinks:	Florestone, Aqua Glass, Fiat
Electric Water Coolers:	Oasis, Elkay, Halsey Taylor, Murdock
Flush Valves:	Delany, Zurn, Sloan, Hydrotek
Faucets:	Kohler, Chicago, T & S, Zurn, American Standard, MR Direct, Hydrotek, Elkay
Water Closet Seats:	Kohler, Olsonite, Bemis, Church
Carriers:	J.R. Smith, Zurn, Josam, Mifab

2.3 CODE COMPLIANCE:

A. Manufacturer's shop drawings shall indicate that fixtures, fittings and equipment meet specified codes. Fixtures, fittings or equipment materials for potable water system shall not contain lead. All plumbing fixtures, flush valves, flush valve operators, flush tank operators, faucets, and fittings designated for handicapped installation, shall meet ICC/ANSI A117.1-2017 and The Americans with Disabilities Act 2010 (ADA) requirements. Fittings and fixtures that are connected to potable water systems shall meet the 1996 Safe Water Drinking Act and the 2011 Reduction of Lead in Drinking Water Act, and where applicable shall meet NSF Standard 61 and shall be labeled and certified. Faucets that supply drinking water shall comply with NSF 9.

B. Codes:

1. Vitreous china fixtures - ASME/ANSI A112.19.2M; ICC/ANSI A117.1-2017; ADA
2. Flush valves & tanks - ASSE 1037 with ASSE 1001 vacuum breaker on flush valves; ICC/ANSI A117.1-2017; ADA
3. Lavatory carrier - ASME/ANSI A112.6.1
4. Electric water coolers - ARI 1010; ICC/ANSI A117.1-2017; ADA. Unit shall be listed by Underwriters Laboratories for both the US and Canada and is to be compliant to ANSI/ASHRAE 18. Unit shall be certified to Public Law 111-380 (NO-LEAD) and NSF/ANSI/CAN 61. Fixture meets ADA, ADA Standing Person, and ADA Child requirements when mounted appropriately.
5. Stainless steel plumbing fixtures (sinks) - A112.19.3M; ICC/ANSI A117.1-2017; ADA
6. Faucets - ASSE 1025; ASME A112.18.1; ICC/ANSI A117.1-2017; ADA; NSF Standard 61 Section 9

2.4 STOPS:

A. Provide lock-shield, loose-key or screw driver pattern polished chromium plated angle stops, with each sink faucet, lavatory faucet or tank type plumbing fixture. Faucets for service sinks or mop sinks shall have stops integral with faucet. Locate stops below fixture in accessible location. Flush valves and shower valves shall be furnished with integral stops.

2.5 ESCUTCHEONS:

A. Heavy duty solid type chrome plated brass with set screws.

2.6 ROSETTA SPRAY NON-AERATED CONTROL DEVICE:

A. Smooth, bright stainless steel or satin finish, chrome-plated metal Rosetta spray non-aerated flow device shall provide non-aeration, clear, coherent Rosetta spray control flow device that will not splash in basin. Device shall also have a flow control restrictor and have vandal resistant housing.

B. Flow Control Restrictor:

1. Capable of restricting flow **to 0.5 GPM** for lavatories and **to 2.5 GPM** for sinks. See fixture specifications for GPM requirement for each fixture.
2. Compensates for pressure fluctuation maintaining flow rate specified above within 10 percent between 25 and 80 psig.
3. Operates by expansion and contraction, eliminates mineral/sediment build-up with self-clearing action, and is capable of easy manual cleaning.

C. Device manufactured by OMNI Products, Inc.

2.7 THERMOSTATIC MIXING VALVE:

A. Provide on all lavatories, refer to 22 11 00 2.7(Valves), section P. Tempering Valve.

2.8 FIXTURES:

Designation	Standard Fixture Type
SK-1	Sink: Elkay ELUH1212, 14-1/2 inch x 14-1/2 inch x 7 inch single compartment, undermount, 18 gauge, stainless steel with Elkay LKD-2437BHC with 4" lever handles, swing spout, 1.5 GPM at 60.0 psi discharge, laminar non-aerated flow device and LK-35 strainer.
MS	Mop Sink: Fiat Model MSB2424, 24 inch x 24 inch x 10 inch molded stone mop service basin, with Fiat E77AA24 bumper guard, stainless steel drain body and strainer, Fiat 830AA supply fitting with vacuum breaker, four arm handles, integral stops, wall brace, pailhook, threaded spout, Fiat 832AA, rubber hose and wall hook and Fiat 889CC mop hanger, and MSG2424 stainless steel wall guards.
IM	Ice Maker Outlet Box: Guy Gray or equal ice maker supply connection box, Model BIM875AB, 20-gauge galvanized steel box and faceplate, 1/4 turn ball valve and hammer arrestor. Install with bottom of box maximum 42 inches above finished floor.
Designation	Handicapped Fixture Type (ADA)
WC-1	Water closet: American Standard Madera 3043.001, vitreous china, 1.28 GPF elongated siphon jet bowl, 16-1/2 inches high, Bemis #1655SSCT white extra heavy duty solid plastic open front seat without cover, self-sustaining check hinge. Furnish Sloan G2 8111 BT-1.28-CP flush valve mounted 11-1/2 inches above bowl with vacuum breaker and vandal-resistant control cap assembly.
L-1	Lavatory: American Standard Lucerne 0355.012, 20-1/2 inch x 18-1/4 inch, vitreous china, 4-inch centers, wall hung, concealed arms, wall-hung lavatory, faucet ledge Standard Monterrey 5502.170.V15 4-inch center, 0.5 GPM flow device, vandal-resistant wrist blade handles, 7723.018 offset drain with perforated grid drain and tailpiece. Mount top of front rim 34 inches above finished floor. Provide concealed arms carrier similar to Jay R Smith 0700 or Josam 17100 floor-mounted lavatory carrier with leveling and securing screws, structural uprights and block bases.

SK-2	Sink: Elkay ELUHAD211555PD, 23-1/2 inch x 18-1/4" single compartment, undermount, 18 gauge, 5-3/8" inch deep bowl, stainless steel with Elkay LKD2437BHC faucet with 4" lever handles, swing spout, 0.5 GPM flow device, LKPDAD18B strainer and LKADOS tailpiece.
EWC	Electric Water Cooler/Bottle Filling Station: Elkay EZSTLG8WSLK bottle filling station and bi-level ADA non-filtered refrigerated cooler, lead-free, bi-level, front and side pushbars, Elkay cane apron for EZ Gray LKAPREZL, bottle filling station with sensor for touchless activation and 1.1 GPM fill, shut off timer, fan cooled, hermetically sealed refrigeration system, minimum capacity 8.0 GPH of 50 Deg. F. water at 90 Deg. F. ambient, 80 Deg. F. inlet water, stainless steel basin, stainless steel cabinet, flexible bubbler guard, 115 Volt, 60 Hz, 6 amps. Provide coordinated EWC carrier similar to Josam Series 17560-WCBL with double hanger plates, double bearing plates, adjustable supporting rods, structural uprights, welded feet and chrome-plated trim. Mount unit on wall so low side spout outlet is 36 inches above finished floor.
EEFW	Deck Mounted Eye/Face Wash Unit: Guardian G5022, Bradley S19-465EFW, or equal, with dual angled plastic antimicrobial soft flow spray heads with covers, ANSI Z358.1 compliant, 3.9 – 5.9 GPM flow rate, chrome-pated brass valve with extended stay-open handle, 8 foot at least 450 PSI burst strength reinforced thermoplastic hose.

PART 3: EXECUTION

3.1 INSTALLATION:

A. Supports and Fastenings: Secure all fixtures, equipment and trimmings to partitions, walls, etc., with brass through bolts, toggle bolts, expansion bolts, or power set fasteners, as required. Exposed heads of bolts and nuts in finished rooms to be hexagonal, polished chromium plated brass with rounded tops.

B. Through Bolts: For freestanding marble and metal stud partitions.

C. Toggle Bolts: For hollow masonry units, finished or unfinished.

D. Expansion Bolts: For brick or concrete or other solid masonry. To be 1/4-inch bolts, 20 threads per inch, and to extend at least three inches into masonry; to be fitted with loose tubing or sleeves extending into masonry. Wood plugs, fiber plugs, lead or other soft metal shields are prohibited.

E. Power Set Fasteners: May be used for concrete walls, shall be 1/4-inch threaded studs, 20 threads per inch, and shall extend at least 1-1/4 inches into wall.

F. Tightly cover and protect fixtures and equipment against dirt, water and chemical or mechanical injury.

G. Where water closets are floor mounted, lavatories and water coolers are wall mounted, seal between water closet and floor, and lavatory or water cooler and wall, with a silicon caulking compound. Counter mounted lavatories or sinks shall be sealed between countertop and lavatory or sink. Where fixtures are white in color, the caulking compound shall be white. Where fixtures are stainless steel, use transparent caulking compound.

3.2 CLEANING:

A. At completion of all work, fixtures, exposed materials and equipment shall be thoroughly cleaned.

END OF SECTION 224000

SECTION 226300 - GAS SYSTEMS FOR LABORATORY AND HEALTHCARE FACILITIES

PART 1: GENERAL

1.1 CONDITIONS:

A. The applicable provisions of Section 22 00 00, PLUMBING GENERAL REQUIREMENTS, are hereby made a part of this section and the Contractor is cautioned to read Section 22 00 00 carefully as items of work applicable to this section are included in Section 22 00 00.

1.2 DESCRIPTION OF WORK:

A. The work includes providing a complete plumbing system including, but not necessarily restricted to, the following:

1. Compressed air system.
2. Vacuum system.
3. Installation and connections to miscellaneous equipment furnished by Owner.
4. Connections to equipment provided under other sections of these specification.
5. Miscellaneous work as described herein, as shown on drawings, and as required for a complete system.

1.3 RELATED WORK:

A. Section 22 00 00, PLUMBING GENERAL REQUIREMENTS.

1.4 SUBMITTALS:

A. Manufacturer’s shop drawings shall indicate that fixtures and equipment meet specified codes. In accordance with Section 22 00 00, PLUMBING GENERAL REQUIREMENTS, furnish the following:

1. Manufacturer's Literature and Data:

    a. Piping
    b. Valves
    c. Wall Outlets
    d. Pipe supports

PART 2: PRODUCTS

2.1 PIPE AND EQUIPMENT SUPPORTS, PIPE SLEEVES, AND WALL CEILING PLATES:

A. Provide in accordance with specifications in Section 22 00 00, PLUMBING GENERAL REQUIREMENTS.

2.2 MEDICAL VACUUM AND AIR PIPING:

A. Pipe: Seamless copper Type K, L or ACR, ASTM B280.

1. Copper tube exposed, below ground, or concealed locations: Hard temper.

B. Fittings: Copper, brass, or bronze made for brazed or soldered joining.

C. Joints: Brazed (greater than 1000 Deg. F. melting temperature). AWS A5.8 filler metal.

2.3 VACUUM AND COMPRESSED AIR SYSTEMS:

A. General: Vacuum and Compressed air systems shall conform to NFPA 99 and shall be provided complete with all distribution piping, accessories and devices pertinent to the safety and operation of the system. Locations are indicated on the drawings. Installation shall be made in a workmanlike manner. Vacuum pump and air compressor provided by general contractor, final plumbing connections made by plumbing contractor.

B. Ball valves: Valves 2 1/2 inch and smaller shall be rated 600 psi non-shock cold working pressure and shall have 2-piece cast bronze bodies, TFE seats, full port, separate packnut with adjustable stem packing, anti-blowout stems and chrome-plated brass/bronze ball. Valves ends shall have full depth ANSI threads or extended solder connections and manufactured shall comply with MSS-SP110.

PART 3: EXECUTION

3.1 INSTALLATION:

A. General:

1. Suspended horizontal piping shall be supported. Where supports bear on copper pipe, they shall be copper plated. Chain, strap, wire or other make-shift devices will not be permitted as hangers or supports. Risers shall be securely supported and braced in an approved manner. Hangers shall be located at all changes in direction and at each joint.
2. Install branch piping from the respective piping systems and connect to all valves, outlets, and equipment, including those furnished by the Owner or specified in other sections of these specifications. Approximate locations for roughing-in are shown on the contract drawings. No piping or roughing-in shall be started until data showing exact

locations for equipment, and connections required are provided by the Architect. This data shall then be used for roughing-in equipment. Individual components not furnished with the equipment, but required for a complete installation, shall be provided under this section of these specifications.

3. Install trim and fittings provided with casework, cabinets, and laboratories, but not installed at point of fabrication.
4. Pipe shall be round and straight. Cutting shall be done with proper tools. Pipe shall be reamed to full size after cutting.
5. All pipe runs shall be laid out and scheduled to avoid interferences with other work.
6. Install valves with stem in horizontal position whenever possible and shall be easily accessible.
7. Medical Vacuum and Air Systems:

    a. Non-flammable medical gas systems: Provided and installed in accordance with the requirements of NFPA 99 Health Care Facilities.
    b. Piping shall be supported in accordance with MSS Standard Practice SP-69. Supports shall comply with MSS Standard Practice SP-58. Maximum support spacing shall be in accordance with NFPA 99.

3.2 TESTS:

A. General: Contractor shall provide all instruments, materials, and labor required. Tests shall be made in the presence of or as otherwise directed by the Architect, who shall be given five (5) days notice by this Contractor of his readiness to perform such tests. Any leaks that develop during the tests shall be repaired by remaking the joint or replacing pipe and fittings. Temporary caulking will not be permitted. No piping shall be concealed until it has been tested, with results acceptable to the Architect.

B. Vacuum System: Pressure test and cross-connection test shall comply with paragraph 5.3.9, NFPA 99, Health Care Facilities.

C. Non-flammable Medical Gas Systems: System verification tests and cross-connection tests shall comply with paragraph 5.1.12, NFPA 99, Health Care Facilities.

3.3 CLEANING:

A. Remove trash, plaster, dust, paint spots and all foreign matter from all piping and equipment.

B. The Contractor shall check each length of pipe before it is put in place to make certain there is not foreign material (stones, sand, etc.) in the systems. Provide temporary bypass around equipment if or as required. All medical gas piping systems shall be cleaned in accordance with NFPA 99.

3.4 REPORTS:

A. Report of cleaning, sterilizing and testing: Contractor shall verify in writing before completion of the job that all specified cleaning procedures, tests and sterilizing have been performed, with results as specified or as required by codes.

END OF SECTION 226300

SECTION 230000 - HEATING, VENTILATING AND AIR-CONDITIONING (HVAC)

PART 1: GENERAL

1.1 DESCRIPTION:

A. This section of the specifications shall be applicable to all phases of mechanical work covered by specifications and drawings issued for this project.

B. The "General Conditions of the Contract", "Supplementary General Conditions", and all other similar general requirements issued for this project shall apply to all mechanical work and are hereby made a part of this section.

C. The Contractor and/or his representatives shall be fully acquainted with the design and operation of the systems and equipment described in these specifications and on the drawings.

D. Work included under this section shall include complete systems as shown on the plans and as specified. Provide supervision, labor, material, equipment, machinery, plant, and other items necessary to complete the mechanical systems. It is the intention of these specifications and drawings to call for finished work, tested, and ready for operation.

E. Definitions:

1. "Owner" and "Contractor" shall mean the respective parties to the prime contract governing the project. Only one contractor is recognized as a party to this contract. Where the terms "Mechanical Contractor" or "Subcontractor" are used, it is for convenience only.
2. "Architect/Engineer" shall mean the firm and authorized representatives of the firm engaged by the Owner for architectural and engineering services related to this project.
3. "Mechanical" shall mean all work related to air conditioning, heating, ventilation, plumbing, sprinkler systems, noise and vibration control, and similar work, including all related components, accessories, controls, and miscellaneous work required for a complete system.
4. "Contract Documents" shall mean and include the agreement, the drawings and specifications and all modifications thereto authorized by the Owner in writing prior to final completion of the project.

    a. The term "Agreement" shall mean the completed and signed contract form.
    b. The term "Drawings" shall mean the drawings prepared by the Architect/Engineer for specific use in bidding and execution of the work.
    c. The term "Specifications" shall include the legal and procedural documents, the general conditions, special conditions, and the technical specifications.
    d. The term "Technical Specifications" shall mean that part of the specifications which describes, outlines, and stipulates the kind and quality of the materials to be furnished, the quality of workmanship required, and the methods to be used in the construction under the contract. For convenience, the mechanical portions of the technical specifications are arranged into one general section and several detailed

sections related to the various trades represented in the work. Such arrangement and references shall not operate to make the Architect/Engineer an arbiter in establishing the limits of any subcontract or trade.

5. "Work" of the Contractor shall mean labor or materials or both.
6. "As shown", "as indicated", "as detailed", or words of similar import shall mean reference to the drawings included in the contract documents, unless stated otherwise.
7. "As directed", "as required", "as permitted", "approved", or words of similar import shall mean that the direction, requirement, permission, approval, or acceptance of the Architect/Engineer is intended unless stated otherwise.
8. "As necessary" shall mean that which is necessary to achieve satisfactory completion of the work in order to provide the intended function and form of the project in compliance with the contract documents.
9. "Provide" shall mean "provide complete and in place", that is "furnish and install", ready for beneficial occupancy by the Owner. Except where stated otherwise, description of any work in the contract documents shall mean that the work shall be provided by the Contractor, even though the words "provide" or "furnish and install" do not accompany the description.
10. "Similar" shall be interpreted in a general sense and not as meaning identical, and all related details shall be worked out in respect to their location and their connection with other parts of the work.
11. Exposed: Piping, ductwork, and equipment exposed to view in finished rooms.
12. Option or Optional: Contractor's choice of an alternate material or method.

1.2 INTENT OF CONTRACT DOCUMENTS:

A. The contract documents are complementary, and what is called for in one place shall be as binding as if called for in all places. Where variances occur between drawings and specifications or within either document itself, include in the contract price the item or arrangement of better quality, greater quantity, or higher cost. Agreement shall take precedence over the specifications and drawings. Figured dimensions shall be used in preference to scaling the drawings. In case of conflict between large and small scale drawings, the large scale drawings shall govern.

B. The mechanical drawings show the general arrangement of all piping, equipment, and appurtenances and shall be followed as closely as actual building construction and the work of other trades will permit. The mechanical work shall conform to the requirements shown on all of the drawings. Architectural and structural drawings shall take precedence over mechanical drawings. Because of the small scale of the mechanical drawings, it is not possible to indicate all offsets, fittings, and accessories which may be required. The Contractor shall investigate the structural and finish conditions affecting the work and shall arrange his work accordingly, providing such fittings, valves, boxes, offsets, transitions, and other accessories as may be required to meet such conditions.

1.3 CODES AND STANDARDS:

A. All materials and workmanship shall comply with all applicable codes, state and federal laws, local ordinances, industry standards, utility company regulations, and all other criteria which normally apply to work of this nature.

B. In case of difference between building codes, state laws, federal laws, local ordinances, industry standards, utility company regulations, other criteria and the contract documents, the more stringent regulations will apply. The Contractor shall promptly notify the Architect/Engineer in writing of any such difference.

C. If the Contractor performs any work that does not comply with these contract documents or the requirements of the applicable building codes, state laws, local ordinances, industry standards, utility company regulations, and other applicable criteria, he shall bear all costs arising in correcting the deficiencies.

D. The standards referred to, except as modified in the specifications, shall have full force and effect as though printed in these specifications. The manufacturer and trades involved shall be familiar with the application of these standards.

E. Applicable codes and standards shall include, but are not necessarily restricted to, the most recently recognized issues of the following:

1. Building Codes:

   a. Virginia Uniform Statewide Building Code
   b. International Mechanical Code and accumulative supplements.

2. Industry Standards, Codes, and Specifications:

a.	AASHO -	American Association of State Highway Officials
b.	ADA -	Americans with Disabilities Act
c.	AGA -	American Gas Association
d.	ARI -	Air Conditioning and Refrigeration Institute
e.	AMCA-	Air Moving and Conditioning Association
f.	ANSI -	American National Standards Institute
g.	ASHRAE -	American Society of Heating, Refrigeration, and Air Conditioning Engineers
h.	ASME -	American Society of Mechanical Engineers
i.	ASSE -	American Society of Sanitary Engineering
j.	ASTM -	American Society of Testing and Materials
k.	AWS -	American Welding Society
l.	CISPI -	Cast Iron Soil Pipe Institute
m.	CSA -	Canadian Standards Association
n.	AWWA-	American Water Works Association
o.	FIA -	Factory Insurance Association
p.	FM -	Factory Mutual
q.	FS -	Federal Specification

r.	IBR -	Institute of Boiler and Radiator Manufacturers
s.	IRI -	Industrial Risk Insurers
t.	ISO -	Insurance Services Office
u.	MSS -	Manufacturer's Standardization Society of the Valve and Fittings Industry, Inc.
v.	NBS -	National Bureau of Standards
w.	NEC -	National Electrical Code
x.	NFPA -	National Fire Protection Association
y.	NSF -	National Sanitation Foundation
z.	PDI -	Plumbing & Drainage Institute
aa.	UL -	Underwriters' Laboratories, Inc.
bb.	SMACNA -	Sheet Metal and Air Conditioning Contractors' National Association
cc.	UFAC -	Uniform Federal Accessibility Standards
dd.	SCAQMD -	South Coast Air Quality Management District
ee.	GS -	Green Seal Standard

1.4 GOVERNMENTAL FEES, PERMITS, AND INSPECTIONS:

A. Under each applicable section of the detailed mechanical specifications, the Contractor shall obtain and pay for all required licenses, permits, charges for connections to outside services, fees and inspections. Upon completion of the work under each section of the detailed mechanical specifications, the Contractor shall furnish a certificate of final inspection to the Architect/Engineer from the governmental inspection department having jurisdiction.

1.5 VISITING THE SITE:

A. Each Contractor shall be responsible for visiting the site before bidding the job to familiarize himself with all existing conditions to be met in the execution of the work under this contract. No additional compensation will be allowed for any changes which may be required to make because of site conditions.

1.6 QUALITY ASSURANCE:

A. Product Criteria:

1. All materials shall be new and shall bear the manufacturer's name, trade name, and the UL label in every case where a standard has been established for this particular material. The equipment to be furnished shall be essentially the standard product of a manufacturer regularly engaged in the production of the required type of equipment, and shall be the manufacturer's latest approved design. All equipment shall bear a permanent and legible factory-applied nameplate to permit identification of manufacturer, model number and type of unit.

2. Equipment Service: Products shall be supported by a service organization which maintains an adequate inventory of repair parts and is located, in the opinion of the Architect/Engineer, reasonably close to the site.
3. Multiple Units: When two or more units of materials or equipment of the same type or class are required, these units shall be products of one manufacturer to provide for uniform appearance, operation, and maintenance.
4. Assembled Units: Manufacturers of equipment assemblies, which use components made by others, assume complete responsibility for the final assembled product.

B. Manufacturers' directions shall be followed in the delivery, storage, protection, and installation of all equipment and materials. The Contractor shall promptly notify the Architect/Engineer in writing of any conflict between any requirements of the contract documents and the written instructions before proceeding with the work. If the Contractor performs any work that does not comply with the manufacturers' directions or such written instructions from the Architect/Engineer, he shall bear all costs arising in correcting the deficiencies.

C. Factory Start-up by the manufacturer's Factory Certified Representative shall be provided for each Boiler, Chiller, Cooling Tower, Air Handling Unit (Packaged, Split, Central Station, Heat Pump, or ERV) and Variable Refrigerant System,. Letters signed by the Representative stating that their equipment has been started, tested, and is operating safely shall be submitted to the Owner as part of the bound Operations and Maintenance Instructions manual specified in section 2.10 CATALOG DATA FOR OWNER of this specification.

1.7 BIDDING INSTRUCTIONS:

A. Products are generally specified by a performance specification and/or by manufacturer's name and model number or trade name.

B. When specified only by a performance specification, the Contractor may use any manufacturer who meets the performance specification and applicable codes. (The Contractor shall be subject to the requirements of 1.9 - SHOP DRAWINGS.)

C. When several products/manufacturers are specified together, then the Contractor has the option of using any product/manufacturer listed. The Contractor shall be subject to the requirements of 1.9 - SHOP DRAWINGS. The Contractor's bid shall be compiled on the use of the listed products without exception. Substitutions will only be considered after the contract has been executed and shall be subject to the requirements of 1.8 - SUBSTITUTIONS.

D. When several products/manufacturers are specified together and the system design is based on one of the listed products by specific model number(s) or catalog number(s), then the Contractor has the option of using the one specific product or any other product/manufacturer listed. In either case, the Contractor shall be subject to the requirements of 1.9 - SHOP DRAWINGS. However, when the other listed product/manufacturer is used, the Contractor shall be responsible for determining that the product(s) will be compatible with building design, electrical design, mechanical design, and the product(s) will not necessitate design modifications by the Architect/Engineer. The Contractors bid shall be compiled on the use of the listed products without exception. Substitutions will only be considered after the Contract

has been executed and shall be subject to the requirements of 1.8 - SUBSTITUTIONS. If the products/manufacturer are listed to be "only", then substitutions will not be considered.

E. When only one manufacture's name is listed, this shall be the basis of the bid. The Contractor's bid shall be compiled on the use of the listed product. Substitutions will only be considered after the Contract has been executed and shall be subject to the requirements of 1.8 - SUBSTITUTIONS.

1.8 SUBSTITUTIONS:

A. Substitutions will not be considered during the bid.

B. After the Contract has been executed, the Architect/Engineer will consider a formal request for a review of substituted products in place of those specified, under the following conditions:

1. Not later than 30 days from the Contract Date, the Contractor shall provide a list of products proposed as substitutions, including the name, manufacturer, and section of the specifications governing the product.
2. The request shall be accompanied by accurate cost data on the proposed substitutions indicating whether or not a modification of the Contract Sum is to be considered.

C. Substitutions are understood to mean that the installing Contractor:

1. Has personally investigated the proposed substitute and has determined that it is equal or superior in all respects to the item specified;
2. Will provide the same guarantee for the substitution that he would for the item or equipment specified;
3. Certifies that the cost data is complete and includes all related costs under this Contract, and waives all claims for additional cost related to the installation of the accepted substitute;
4. Has coordinated the installation of the substitute, providing design modifications and changes as required for the work to be complete in all respects;
5. Has coordinated the installation of the substitute with the General Contractor pertaining to changes required for the work to be complete with all trades and all changes shall be provided without additional cost to the Owner.

D. The acceptance by the Architect/Engineer of any or all of those substitute items listed by the Contractor for review shall not constitute an approval of the substitute but shall mean that the Contractor may then submit detailed shop drawings for review. When a request for substitution is granted, shop drawings will be reviewed by the Architect/Engineer. Shop drawings not complete with proper review information will not be reviewed and will be returned unchecked. If after two submittals, the substitute equipment is not approved, the specified equipment shall be provided.

1.9 SHOP DRAWINGS:

A. Shop Drawings are required for all material and equipment that is specified by a manufacturer's name or as indicated in the technical specifications. Submittal data for related equipment shall be submitted at one time ***and shall be submitted as a digital file (pdf)***. Allow 10 business days for review of shop drawing submittals, starting from the date LPA, Inc. receives the submittals.

B. Substitutions will not be considered if:

1. They are indicated or implied on shop drawing submissions without information specified in 1.8 - SUBSTITUTIONS.
2. They require a substantial revision of the Contract Documents in order to accommodate their use.

C. Identify submittals with PROJECT NAME and NUMBER, CONTRACTOR'S NAME, SECTION NUMBER & NAME, and PARAGRAPH NUMBER of SPECIFICATION GOVERNING, MANUFACTURER, MODEL or STYLE, and CONTRACTOR's REVIEW STAMP. Submittals shall be detailed, dimensioned drawings showing construction, size and arrangement, service clearances, performance characteristics, and capacity. Submittals not properly identified or containing information of a general nature will not be reviewed and will be returned unchecked.

D. Acceptance of shop drawings shall not be considered as a guarantee of measurements or building conditions. Acceptance shall not relieve the Contractor from the responsibility or necessity of furnishing material or performing work required by the drawings and specifications. Submittal data on any one item shall not be reviewed more than three (3) times. If not accepted after the third review, the Contractor shall provide the equipment upon which the design was based.

E. Failure to submit shop drawings in ample time for checking shall not entitle an extension of contract time, and no claim for extension by reason of such default will be allowed.

F. No material or equipment, for which submittals are required, may be delivered to or installed at the job site until submittals have been accepted.

G. Unless a specific finish is indicated in the contract documents, wherever a choice of finish is available for the specified item, submit accurate color chips or charts to the Architect for review and selection.

1.10 OPERATING AND MAINTENANCE MANUALS:

A. Operating and Maintenance Manuals shall be submitted as separate comprehensive digital files (pdf) containing all materials related to each specific Division and named to reflect that particular Division. O&M Manuals will not be accepted if material for more than one division is combined into one file. O&M Manuals will not be accepted if materials for a particular division are submitted separately.

PART 2: PRODUCTS

2.1 DRIVE GUARDS:

A. For machinery and equipment, provide guards as shown in AMCA 410 for belts, chains, couplings, pulleys, sheaves, shafts, gears and other moving parts regardless of height above the floor. Drive guards may be excluded where motors and drives are inside factory fabricated unit casings.

B. Materials: Sheet steel, cast iron, expanded metal or wire mesh rigidly secured so as to be removable without disassembling pipe, duct, or electrical connections to equipment.

C. Access for Speed Measurement: One-inch diameter hole at each shaft center.

D. Lubrication: Guards shall not interfere with lubrication of equipment.

2.2 PAINTING:

A. General - Paint mechanical and electrical equipment and material in Equipment Rooms and utility type areas and located outside of the building or on the roof. Painting of equipment and material in finished rooms or areas shall be accomplished as described in PAINTING Section of the Architectural Specifications. Painting in concealed spaces shall be limited to equipment and materials not otherwise protected from rusting such as hangers and supports. Paint shall be products of Sherwin-Williams, Pittsburgh, or Pratt-Lambert. All paints, finishes and coatings shall comply with Green Seal Standard GS-11, GS-03, and SCAQMD Rule #1113 VOC limits for paints and coatings

B. Workmanship - The work shall be accomplished by workmen skilled in the painting trade after testing is complete and systems are ready for operation. Surfaces to be painted shall be completely dry before applying paint. Surfaces shall not be painted when the temperature is below 50 Deg. F or above 120 Deg. F, or when they are exposed to hot sun. Materials shall be evenly spread and smoothly flowed on without runs or sags. Each coat shall be thoroughly dry before application of succeeding coat. The painters shall protect adjacent surfaces with drip covers during the process of painting. Upon completion, paint spots, if any, shall be removed from adjacent surfaces.

C. Preparation of surface - Metal surfaces shall be cleaned with solvent before applying materials. Rust and scale shall be removed by wire brushing or sanding. Galvanized surfaces shall be pretreated with a phosphoric acid cleaning solution and primed with Sherwin-Williams "Galvanized Iron Primer".

D. Painting - After preparation as described above, each item shall be painted as follows, except color of paint for equipment and material located outside of the building or on the roof shall be as selected by the Architect.

1. Painting is not required of equipment, equipment supports, and hangers with a factory-finish coat. Patch painting is required of any damaged areas to match factory-finish coat. Painting is required where equipment or equipment supports do not have factory-finish paint. Painting shall be as follows:

    a. Uninsulated boiler surfaces and other similar hot surfaces shall be painted with two coats of silicone alkyd aluminum paint with a dry temperature resistance of 1000 Deg. F.
    b. Other equipment and associated hangers and supports shall be primed with one coat of alkyd, zinc potassium chromate metal primer, except insulated surfaces shall be primed with one coat Sherwin-Williams "Wall Primer and Sealer." Finish with two coats of Sherwin-Williams Steel Gray Enamel. Exterior of belt guards and other protective guards shall be finished with two coats of machinery enamel in OSHA yellow color. Interior of items covered by belt guards and other protective guards shall be finished with two coats of machinery enamel in OSHA orange color. Nameplates on equipment shall not be painted.

2. Ducts, pipes, and conduits - Interior duct behind grilles, registers, and diffusers shall have 1 finish coat of Sherwin-Williams Black Enamel. Exposed duct, pipes, conduits, and associated hangers exposed in equipment rooms and other unfinished areas such as storage areas shall have two finish coats of paint of the same color as adjacent walls or ceilings. Bare copper pipe shall not be painted. Canvas or paper jacket insulation of pipes or duct exposed in unfinished areas shall be primed and sealed before final two coats of paint. Hangers and supports in concealed areas not protected by factory-finish paint shall have one coat of metal primer.

E. Identification of pipes and equipment

1. Equipment - Each piece of equipment shall be identified by engraved nameplate that will read the same as the identification shown on mechanical or electrical drawings. Engraved name plates not less than 1” height, white letters on a black background, 1/16 inch thick plastic laminate, beveled edges, screw mounting. Seton Name Plate Company, EMED Co., Marking Services Inc., or equal.
2. Pipes shall be identified using pre-printed markers sized appropriately for the pipes being identified (shop drawings required). Markers shall be Seton "Setmark" type or equal. Pipe identification shall meet the most current edition of ANSI Specification A13.1. Markers shall be located close to valves or flanges and adjacent to changes in direction, branches and where pipes pass through walls or floors, and at intervals of 15 feet on straight runs. Provide a Color Code Chart, framed with glass front, indicating piping service and color code schedule. Post in Mechanical Room where directed by Engineer.

F. Identification of Valves: Properly mark service and control valves. Valve markers shall be metal tags with designations stamped thereon or laminated engraved plastic chained to their respective valves. Identification symbols or designations shall be the same as shown on the Contract Documents.

G. Equipment locations above acoustic tile ceilings: Provide colored brass push-pins complete with a minimum 1/2" shank and 5/8" diameter head. Pin head color shall be blue or color as selected by Architect or Owner. Locate push-pins directly below all scheduled mechanical equipment.

2.3 MOTORS, CONTROL, AND ELECTRICAL WIRING:

A. Provide motors in accordance with NEMA Standards and suitably designed to match the starting and running characteristics of the driven equipment. Unless indicated otherwise, motors less than 1/2 horsepower shall be wound for 120 volt, single phase, 60 hertz. Motors 1/2 horsepower and above, unless indicated otherwise, shall be wound for three phase, 60 hertz, 200 volt, 230 volt, or 460 volt as required by the system voltage. Select motors coordinated with the utilization voltage and phase. Motors for equipment with VFD shall be matched to the VFD.

B. All starters and safety switches, except for those specified to be furnished with the mechanical equipment, shall be furnished as part of the Electrical Work - Division 26.

C. Starters and safety switches furnished with the mechanical equipment shall comply with the specifications of Sections 26 28 16 and 26 29 13.13. Starters furnished as an integral part of the mechanical equipment shall be complete with properly sized overload heaters. Integral 3-phase motor starters and VFD's shall be provided with phase loss protection.

D. Temperature control wiring shall be furnished as part of the Mechanical Work, Section 23 09 00 - INSTRUMENTATION AND CONTROL FOR HVAC. Temperature control wiring is any wiring, regardless of voltage, related to mechanical equipment that is not the equipment power circuit from the circuit breaker in the panelboard to the motor starter or safety disconnect switch and to the motor or equipment junction box. Temperature control wiring shall include, regardless of voltage, power for control panels, power for actuators, signal for input and outputs, interlocks, and line voltage as herein specified to provide the proper operation and sequence of control for all heating, ventilating, and air conditioning equipment. All wiring shall conform to applicable sections of Division 26, 27 and 28 of the specifications.

1. Power for control panels shall be provided by Controls Contractor and shall be obtained from nearest receptacle or unswitched 120 volt lighting circuit. Control Contractor shall coordinate with Electrical Contractor when connecting to these circuits. Circuit directories in panelboards shall indicate where control panels are connected. When control panels require voltage other than 120 VAC, Control Contractor shall provide transformer to reduce voltage. All wiring shall conform to applicable sections of Division 26, 27 and 28 of the specifications.
2. Power for damper actuators and valves which are an integral part of mechanical equipment shall be provided by the Controls Contractor and shall be obtained from the power source to the equipment or the nearest receptacle circuit. Where power requirement for the actuator or valve is different from that supplied to the equipment, the Controls Contractor shall provide a transformer or tap the nearest receptacle circuit or unswitched 120 volt lighting circuit. Dampers located at fans shall be considered an

integral part of the mechanical equipment and shall be factory wired to the equipment power source.

3. Where equipment is controlled by a line voltage control device (thermostat, On-Off switch, Speed Switch, etc.) the Controls Contractor shall wire from the control device to the equipment, unless specifically indicated otherwise on the drawings.
4. Where control devices that are intended to interrupt the motor or equipment power circuit are provided by the Control System Contractor and are mounted other than on or directly adjacent to the controlled equipment, the Control System Contractor shall provide wiring through these devices regardless of voltage or phases.
5. All low voltage control wiring in inaccessible areas or in exposed areas shall be in metal conduit and shall comply with the specifications of Divisions 26, 27 and 28. All low voltage control wiring in unexposed, accessible areas shall be wire in conduit or U.L. approved plenum rated cable supported from the structure with ties spaced 4'-0" on center. Cable shall not be supported on ceiling, lights, or pipes. All low voltage control wiring penetrating walls or floors shall be in conduits. All 120 volt wiring shall be wire in conduit and shall comply with the specifications of Division 26, 27 and 28. All wall-mounted thermostats, sensors, and switches shall be mounted in recessed metal rough-in box.
6. The Controls Contractor shall coordinate with the Electrical Contractor all 120 volt power source, connections required for the controls system. The Controls Contractor shall verify that wiring of motors and controls provides the correct sequence of operation.
7. All equipment that has electrical connections shall have wiring terminals/connectors rated for not less than 75 deg. C. If terminals/connectors are provided and are rated for less than 75 deg. C., the mechanical contractor shall incur all costs associated with upsizing wire and conduit as required by the National Electrical Code.

E. Domestic water temperature control wiring, equipment control wiring, and interlock wiring necessary for the proper sequence of operation of plumbing equipment shall be furnished as part of the Mechanical Work, Section 22 34 36 - COMMERCIAL GAS DOMESTIC WATER HEATER and Section 22 11 13 - DOMESTIC WATER PUMPS. Control wiring is any wiring, regardless of voltage, related to mechanical equipment that is not the equipment power circuit from the circuit breaker in the panelboard to the motor starter or safety disconnect switch and to the motor or equipment junction box. Where control devices (thermostat, On-Off switch, Aquastat, etc.) That are intended to interrupt the motor or equipment power circuit are provided by the Plumbing Contractor and are mounted other than on or directly adjacent to the controlled equipment, the Plumbing Contractor shall provide wiring through these devices regardless of voltage or phases. All wiring shall conform to applicable sections of Division 26, 27 and 28 of the specifications. All low voltage control wiring in inaccessible areas or in exposed areas shall be in metal conduit and shall comply with the specifications of Divisions 26, 27 and 28. All low voltage control wiring in unexposed, accessible areas shall be wire in conduit or U.L. approved plenum rated cable supported from the structure with ties spaced 3'-0" on center. All 120 volt wiring shall be wire in conduit and shall comply with the specifications of Division 26, 27 and 28 of the specifications.

2.4 FIRE-STOPPING:

A. Pipe penetrations of rated walls, floors, and floor-ceiling assemblies shall be constructed in accordance with Underwriter's Laboratories, Inc., Fire Resistance Directory, Volume II, Hourly Ratings for Through Firestop Penetrations. The Contractor shall provide U.L. firestop penetrations according to the particular wall, floor, or floor-ceiling assembly rating, construction type, pipe material, pipe size, insulation requirements, sleeve requirements, and the contractor's choice of firestop products as listed by U.L. Refer to the architectural drawings for the wall, floor, or floor-ceiling assembly construction types and ratings.

2.5 PIPE AND EQUIPMENT SUPPORTS AND RESTRAINTS:

A. Under each applicable section of the detailed mechanical specifications, the Contractor shall furnish and install all accessories, connections, bases, guards, supports, and incidental items necessary to fully complete the work, ready for use, occupancy, and operation by the Owner.

B. Type Numbers Specified: MSS SP-58; for selection and application, MSS SP-69. Refer to Section METAL FABRICATIONS, for miscellaneous metal support materials and prime coat painting.

C. For Attachment to Concrete Construction

1. Concrete Insert: MSS SP-69, Type 18
2. Self-Drilling Expansion Shields and Machine Bolt Expansion Anchors: Fed. Spec. FF-S-325, permitted in concrete not less than four inches thick. Applied load shall not exceed one-fourth the proof test load listed in Fed. Spec. FF-S-235.
3. Power-Driven Fasteners: Permitted in existing concrete or masonry not less than four inches thick when approved by the Architect/ Engineer for each job condition. Use fasteners capable of supporting a 1000 pound test load, with the actual load not exceeding 50 pounds.

D. For Attachment to Steel Construction; MSS SP-69:

1. Welded Attachment: Type 22.
2. Beam Clamps: Types 20, 21, 28 or 29. Type 23 C-clamp may be used on steel beams only for individual copper tubing up to 7/8-inch outside diameter. Beam clamps on steel joists shall be concentric loading type. Beam clamps that are attached to only one side of a joist are NOT acceptable.

E. Attachment to Metal Pan or Deck: As required for materials specified in Section METAL DECKING.

F. For Attachment to Wood Construction: Wood screws or lag bolts.

G. Hanger Rods: Hot-rolled steel, ASTM A 36 or A 575 for allowable load listed in MSS SP-58. For piping, provide adjustment means for controlling level or slope. Types 13 or 15 turnbuckles shall provide 1-1/2 inches minimum of adjustment and incorporate locknuts. All-thread rods are acceptable.

H. Multiple (Trapeze) Hangers: Galvanized, cold formed, lipped steel channel horizontal member, not less than 1-1/2 inches by 1-1/2 inches, No. 12 gage, designed to accept special spring held, hardened steel nuts. Not permitted for steam supply and condensate piping, fire and sprinkler piping, or chemical waste drain piping.

1. Allowable Hanger Load: Manufacturers rating less 200 pounds.
2. Guide individual pipes on the horizontal member of every other trapeze hanger with 1/4-inch U-bolt fabricated from steel rod. Provide Type 40 insulation shield, secured by two 2-inch galvanized steel bands, for insulated piping at each hanger.

I. Pipe Hangers and Supports: Use hangers sized to encircle insulation on insulated piping. Refer to Section 23 07 00, HVAC INSULATION, for insulation thickness. To protect insulation, provide Type 39 saddles for roller type supports. Provide Type 40 insulation shields at all other types of supports and hangers including those for pre-insulated piping.

1. General Types (MSS SP-69):

a. Standard Clevis Hanger: Type 1; provide locknut.
b. Riser Clamps: Type 8 or 42.
c. Wall Brackets: Types 31, 32, or 33.
d. Roller Supports: Type 41, 43 and 46.
e. Saddle Support: Type 36, 37, or 38.
f. Turnbuckle: Types 13 or 15.
g. U-Bolt Clamp: Type 24.
h. For Uninsulated Copper Tube: Material compatible for use with copper to prevent electrolysis.
i. Supports for Plastic or Glass Piping: As recommended by the pipe manufacturer.

2. HVAC Piping:

a. Low, Medium and High Pressure Steam:

(1) Provide eye rod or Type 17 eye nut near the upper attachment.
(2) Piping 3 Inches and Larger: Type 43 roller hanger. For roller hangers requiring seismic bracing, provide a Type 1 clevis hanger with Type 41 roller attached by flat side bars.

b. Spring Supports (Expansion and Contraction of Vertical Piping):

(1) Movement up to 3/4-Inch: Type 51 or 52 variable spring unit with integral turnbuckle and load indicator.
(2) Movement more than 3/4-Inch: Type 54 or 55 constant support unit with integral adjusting nut, turnbuckle, and travel position indicator.

3. Plumbing Piping:

    a. Sprinkler System: NFPA or Factory Mutual approved types.
    b. Horizontal Piping: Types 1, 5, 7, 9, and 10.
    c. Chrome Plated Piping: Chrome plated supports.
    d. Hangers and Supports in Pipe Chase: Prefabricated system ABS self-extinguishing material, not subject to electrolytic action, to hold piping, prevent vibration, and compensate for all static and operational conditions.
    e. Blocking, Stays and Bracing: Angle iron or preformed metal channel shapes, 18 gage minimum.

J. Support hubless cast iron pipe and fittings per CISPI 301-12. Brace hubless cast iron pipe and fittings 5 inches and larger using Holdrite 117 Series No-Hub Pipe and Fitting Restraints or approved equal.

K. Concrete Equipment Bases: Unless otherwise noted on the drawings or in the specifications, concrete pads and bases not less than 4 inches high and which project not less than 3 inches beyond the equipment on all sides shall be provided for air handling units, fans, pumps, compressors, boilers, tank supports, and other similar floor-mounted equipment which normally requires foundations. Concrete shall conform to requirements in the concrete section of these specifications. The trade responsible for the supported equipment shall establish sizes and locations of the various concrete bases required and shall provide all necessary anchor bolts, together with templates for holding these bolts in position. Anchor bolts shall be placed in steel pipe sleeves to allow for adjustment, with a suitable plate at bottom end of sleeve to hold the bolt. When indicated in the drawings or detailed specifications, other floor-mounted items of equipment shall have a similar concrete base. Special vibration isolation foundations that are required are specified in the detailed specifications.

2.6 PIPE SLEEVES:

A. Locate sleeves during normal course of work. Provide sleeves for piping and conduit passing through concrete floor slabs and concrete, masonry, tile, and gypsum wall construction. Sleeves shall not be provided for piping and conduit running embedded in concrete or slab on grade, except that copper piping shall require sleeves through slabs on grade. Sleeves through structural members shall be only as directed by Architect. In interior wall, provide 1/4 inch space all around between sleeve and conduit, piping, or insulation of piping.

B. Sleeves placed in exterior walls below grade shall be O.Z. Gedney Type 'FSK' or equal, Thunderline 'LINK SEAL', or equal sleeve assemblies sized for the pipe or conduit encountered, except for cast iron piping. Sleeve assembly shall provide watertight seal and electrical insulation to reduce cathodic reaction. When a sleeve passes through a wall below a concrete slab on grade, the sealing assembly shall be on the outside of the wall. When a sleeve passes through a wall into a crawl space or the building interior, the sealing assembly shall be in the crawl space or interior of the building. Provide sleeve assembly for copper piping through slab on grade, with sealing assembly located on interior side of floor slab. Where cast iron pipes pass through an exterior wall below grade, provide an iron-pipe sleeve two (2) pipe

sizes greater than pipe passing through. Caulk between pipe and sleeve with a rubber-based compound.

C. Where sleeves are located through fire-rated walls and floor/ceiling assemblies, provide sleeves and protect the penetration in accordance with Underwriter's Laboratories, Inc., Fire Resistance Directory, Volume II, Ratings for Through Firestop Penetrations.

D. Sleeves in mechanical rooms with floor drains or hose bibbs shall extend 4 inches above floor. Provide flanges or flashing rings with sleeves in floors with waterproof membrane and clamp or flash into the membrane. Provide sleeves flush with floor in other rooms.

E. Sleeves shall be constructed of 20 gage galvanized sheet steel with lock seam joints for all sleeves set in concrete floor slabs terminating flush with the floor. All other sleeves shall be constructed of galvanized steel pipe unless otherwise indicated.

F. Fasten sleeves securely in floors or 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 from being forced into the space between pipe and sleeve during construction.

2.7 WALL, FLOOR AND CEILING PLATES (ESCUTCHEONS):

A. Material and Type: Chrome plated brass or chrome plated steel, one piece or split type with concealed hinge, with setscrew for fastening to pipe, or sleeve. Use plates that fit tight around pipes, cover openings around pipes, and cover the entire pipe sleeve projection.

B. Thickness: Not less than 3/32-inch for floor plates. For wall and ceiling plates, not less than 0.025 for up to 3-inch pipe, 0.035 for larger pipe.

C. Locations: Use where pipe penetrates floors, walls and ceilings in exposed locations, except mechanical rooms.

2.8 ACCESS PANELS:

A. Under each applicable section of the detailed mechanical specifications, the Contractor shall provide access panels in all locations where required for access to concealed valves, traps, air cushions, controls, dampers, damper operators, junction boxes, and any other equipment or materials requiring inspection or maintenance. Access panels shall be of adequate size and properly located so that concealed items will be readily accessible for servicing or for removing and replacing if necessary, except as indicated or specified otherwise. Access panels are not required in ceilings formed of removable acoustical panels.

B. Access panels that are not fire-rated shall be Milcor or equal. Provide modular-sized access panels in inaccessible acoustic tile ceilings sized according to the tile size. Provide Milcor metal access panels with cam lock and mounting trim to match finish encountered. Provide

natural anodized aluminum finish for panels in kitchens and toilets. Provide prime finished steel for panels in other areas. Paint panels in finished areas to match finish surface.

C. Where indicated and where access panels are installed in walls of shafts that are not sealed at each floor, access panels shall be Milcor or equal "Fire-Rated" and shall bear the Underwriters' Laboratories, Inc. Class B, 1-1/2 hour label. Openings shall be framed in accordance with the access panel manufacturer's recommendations. Frames shall be not lighter than 16-gage steel. Panels shall be not lighter than 20-gage steel and shall be insulated sandwich type. Panels shall have a continuous hinge, self-lubricating lock, a direct action-knurled knob, and an interior latch release mechanism.

2.9 CHARTS, DIAGRAMS, AND SCHEMES:

A. Charts, diagrams, and schemes listed below shall be provided under each applicable section of the detailed mechanical specifications by the Contractor, framed under glass, and installed where shown on the drawings or directed in the field. All charts, diagrams, and schemes shall be complete, neat, clear, legible, and permanent.

B. Electric sequence control diagrams of all mechanical system components.

C. Automatic temperature control diagrams identified as to name, sequence of operation, location, function, temperature setting, spring range, and manufacturer's part number.

D. Valve identification chart with typewritten schedule of all valves giving their tag number, description, system served, and normal operation position.

E. Piping schemes where required by the detailed specifications.

2.10 CATALOG DATA FOR OWNER:

A. Furnish one (1) bound copy or one (1) digital file (pdf format) of all Catalog Data on each manufactured item of equipment used in the mechanical work, complete with index listing the products alphabetically by name, together with the names and addresses of manufacturers, sales, and service representatives. Furnish two (2) bound copies or one (1) digital file (pdf format) of all Operating and Maintenance Instructions of each item of equipment. A single comprehensive file or digital file of all Catalog Data and Operating and Maintenance Instructions shall be submitted to the Engineer for review prior to transmittal to the Owner. Single sections or multiple files will not be reviewed.

2.11 RECORD OF AS-BUILTS AND CONDITIONS:

A. Provide a complete set of prints of mechanical plans marked to indicate as-built conditions which are different from those shown on the original construction documents. Site as-built conditions which are different from the construction documents shall be dimensioned from building or identifiable marker. Accurate locations of all concealed utility lines, both interior and exterior shall be recorded. These drawings shall be delivered to the Architect/Engineer before being turned over to the Owner.

PART 3: EXECUTION

3.1 INSTALLATION:

A. Coordination of Work:

1. The Contractor shall compare the mechanical drawings and specifications with the drawings and specifications of other trades, and shall report any discrepancies between them to the Architect/Engineer, and shall obtain from him written instructions for changes necessary in the mechanical work. The mechanical work shall be installed in cooperation with other trades installing interrelated work. Before installation, the Contractor shall make proper provision to avoid interferences in a manner approved by the Architect/Engineer. All changes required in the work of the Contractor caused by his neglect to do so shall be made by him at his own expense.
2. Anchor bolts, sleeves, inserts, and supports that may be required for the work shall be fully coordinated and compatible with the related equipment or materials. Locations shall be determined by the trade installing the related equipment or materials.
3. Slots, chases, openings, and recesses through floors, walls, ceilings, roofs, and partitions shall be located by the trades requiring them.
4. Locations of pipes, ducts, equipment, fixtures, etc., shall be adjusted to accommodate the work to interferences anticipated and encountered. The installing Contractors shall coordinate their work to the building structure and to other trades as directed by the General Contractor. No additional compensation or extension of completion time will be granted for extra work caused by a lack of coordination. The installing Contractor shall provide dimensions and locations of all openings, shafts, and similar items to the General Contractor for his coordination and execution. Work shall be installed as required so as not to interfere with or delay the building construction. Pipes, ducts, etc., shall be concealed above ceilings, in walls, or in floors as applicable in all areas of the building except in equipment rooms, unfinished storage rooms, or other areas specifically noted to the contrary.

    a. Right-of-Way: Lines which pitch shall have right-of-way over those which do not pitch. For example, plumbing drains shall normally have right-of-way. Lines whose elevations cannot be changed shall have the right-of-way over lines whose elevations can be changed.
    b. Offsets, transitions, and changes in direction of pipes and ducts shall be made as required to maintain proper head room and pitch of sloping lines whether or not indicated on the drawings. The Contractor shall furnish and install all traps,

drains, air vents, sanitary vents, etc., as required to affect these offsets, transitions, and changes in direction.

5. Exact locations of items such as diffusers, grilles, thermostats, hose bibbs, wall hydrants, and other similar items in finished areas of the building and on the exterior of the building shall be coordinated with each other, the building structure, and architectural features thereof so as to be aligned with or centered on other items as applicable. Locations indicated on the drawings are approximate. Trades shall coordinate their work with door swings, block coursing, tile arrangement, and other similar features before establishing the location of any components. Before any related work has begun, the Architect/Engineer may direct reasonable minor changes in equipment locations with no increase in contract price to the Owner. Thermostats shall be mounted so that the top of the thermostat is 48" above the floor and aligned with the top of the light switch plates and 8" from the light switch if shown on the drawings adjacent to a light switch. Room thermostat locations shall be coordinated with door swings, light switches and other wall mounted items. Corridor thermostats shall be mounted 60" above finished floor. Before roughing in conduit or pipe, verify the location of equipment to be connected.
6. Installation and Arrangement: The Contractor shall install all mechanical work to permit removal of coils, heat exchanger bundles, boiler tubes, fan shafts and wheels, filters, belt guards, sheaves and drives, and all other parts requiring periodic replacement or maintenance. The Contractor shall arrange pipes, ducts, and equipment to permit ready access to valves, cocks, traps, motors, control components, and to clear the openings of swinging and overhead doors and of access panels.
7. Ductwork: The Contractor shall change the cross-sectional dimensions of ductwork when required to meet job conditions but shall maintain at least the same equivalent cross-sectional area. The Contractor shall secure the approval of the Architect/Engineer prior to fabrication of ductwork requiring substantial changes. Ductwork shall not be fabricated until coordination with available space.
8. Drawings by Contractor: When directed by the Architect/Engineer, the Contractor shall submit for review by Architect/Engineer drawings clearly showing certain portions of the mechanical work and its relation to the work of other trades before beginning shop fabrication or erection in the field.
9. Dimensions: The Contractor shall ensure that items to be furnished fit the space available. He shall make necessary field measurements to ascertain space requirements, including those for connections, and shall furnish and install such sizes and shapes of equipment that the final installation shall suite the true intent and meaning of the drawings and specifications. If he concludes that there is insufficient space for installation or specified materials, he shall immediately notify the Architect/Engineer of the conflict and shall stop affected work until he receives instructions as to how to proceed from the Architect/Engineer.
10. Damage to Work: The Contractor is responsible for damage caused by his work or workmen. Repairing of damaged work shall be done by the Contractor as directed by the Engineer at no additional cost.
11. The Contractor shall be responsible for any interruptions to existing services and shall repair any damages to existing systems caused by his operations.

B. Protection and Cleaning:

1. Equipment and materials shall be carefully handled, properly stored, and adequately protected to prevent damage before and during installation, in accordance with the manufacturer's recommendations. Damaged or defective items, in the opinion of the Architect/Engineer, shall be replaced.
2. All items subject to moisture damage (such as controls and electrical equipment) shall be stored in dry, heated spaces.
3. Protect all finished parts of equipment, such as shafts and bearings where accessible, from rust prior to operation by means of protective grease coating and wrapping. Close pipe openings with caps or plugs during installation. Tightly cover and protect fixtures and equipment against dirt, water, chemical or mechanical injury. Clean mechanical equipment to remove dust, oil, dirt, plaster, mortar, trash, or paint. Piping, conduit, and ductwork shall be blown out or flushed of all foreign matter before wires are pulled in or before connections are made to equipment or systems. (Clean each boiler in accordance with manufacturer's instructions before connecting to the system.) Provide temporary filters for air units that are operated during construction. After all construction dirt has been removed from the building, install new filters in air units.

C. Concrete and Grout: Use concrete and shrink compensating grout 3000 psi minimum.

D. Install gages, thermometers, valves and other devices with due regard for ease in reading or operating and maintaining said devices. Locate and position thermometers and gages to be easily read by operator standing on floor or walkway provided. Servicing shall not require dismantling adjacent equipment or pipe work.

E. Work in Existing Buildings:

1. Cut required openings through existing masonry and reinforced concrete using diamond core drills. Use of pneumatic hammer type drills, impact type electric drills, and hand or manual hammer type drills will be permitted only with approval of the Architect/Engineer. Locate openings that will least effect structural slabs, columns, ribs or beams. Refer to the Architect/Engineer for determination of proper design for openings through structural sections and opening layouts approval, prior to cutting or drilling into structure. After Architect/Engineer's approval, carefully cut opening through construction not larger than is absolutely necessary for the required installation.
2. Remove existing work as necessary to install new work. Except as otherwise shown or specified, do not cut, alter or remove any structural work or any ducts, plumbing, steam, gas or electric work without approval of Architect/Engineer. Existing work (walls, ceilings, partitions, floors, mechanical, and electrical work) disturbed or removed as a result of performing required new work shall be patched, repaired, reinstalled, replaced with new work, and refinished and left in as good condition as existed before commencing work. Existing work to be altered or extended that is found to be defective in any way shall be reported to the Architect/Engineer before it is disturbed. Materials and workmanship used in restoring work shall conform in type and quality to that of original existing construction, except as otherwise shown or specified.

3. Continuity of service shall be maintained to all existing systems, except for designated short intervals during which connections are to be made. Interruptions shall be coordinated with the Owner as to the time and duration.
4. Upon completion of contract, deliver work complete and undamaged. Damage that is caused by Contractor or Contractor's workmen to existing structures, grounds, or utilities or to work done by others shall be repaired by Contractor and left in as good condition as existed prior to damaging.

    a. At Contractor's own expense, Contractor shall immediately restore to service and repair any damage caused by Contractor's workmen to existing piping and conduits, wires, cable, etc., of utility services or of fire protection system and communications systems (except telephone) which are not scheduled for discontinuance or abandonment.
    b. Restoration work required by damage to telephone systems shall be done by telephone company at Contractor's expense.

3.2 PIPING:

A. Under each applicable section of the detailed mechanical specifications, the Contractor shall furnish and install as shown on the drawings or as necessary to complete the working system in accordance with the intent of the drawings and specifications, a complete system of piping, valves, supports, anchors, sleeves, and all other appurtenances. The piping drawings are diagrammatic and indicate the general location and connections. The piping may have to be offset, lowered, or raised as required or as directed at the site. This does not relieve the Contractor of responsibility for the proper erection of systems of piping in every respect suitable for the work intended as described in the specifications and as approved by the Architect/Engineer. Wherever two dissimilar metals join in any piping system, install a dielectric fitting at their intersection.

B. Installation: Piping shall be properly supported and adequate provisions shall be made for expansion, contraction, slope, and anchorage without damage to joints or hangers. All piping shall be cut accurately for fabrication to measurements established at the construction site. Pipe shall be worked into place without springing and/or forcing, properly clearing all windows, doors, and other openings and equipment. Cutting or other weakening of the building structure to facilitate piping installation will not be permitted without written approval. Pipe extending through the roof shall be properly flashed. All changes in direction shall be made with fittings. Wherever pipe hanger bears directly on the pipe being supported, the hanger shall be of the same material as the pipe.

C. Arrangement: All piping shall be arranged so as not to interfere with removal of other equipment or devices nor to block access to doors, windows, manholes, or other access openings. Piping shall be arranged so as to facilitate removal of tube bundles. Flanges or unions, as applicable for the type of piping specified, shall be provided in the piping at connections to all items of equipment. Piping shall be placed and installed so that there will be no interference with the installation of the equipment, ducts, etc. All piping shall be installed to ensure noiseless circulation. All piping shall be erected and pitched to ensure proper drainage. Piping shall be installed so as to avoid liquid or air pockets throughout the work. Pipe in

finished areas shall be concealed. Exposed piping shall be installed in practical alignment with the building. All valves and specialties shall be placed to permit easy operation and access, and all valves shall be regulated, packed, and glands adjusted at the completion of the work before final acceptance. Water pipes shall not be installed in attic spaces, crawl spaces or similar areas which are subject to freezing, unless indicated to be heat traced.

3.3 PIPE AND EQUIPMENT SUPPORTS:

A. Supports: The Contractor shall support plumb, rigid, and true to line all work and equipment furnished under each section of these specifications. The Contractor shall study thoroughly all general, structural, and mechanical drawings, shop drawings, and catalog data to determine how equipment, fixtures, piping, ductwork, etc., are to be supported, mounted, or suspended, and shall provide extra steel bolts, inserts, pipe stands, brackets and accessories for proper support, whether or not shown on the drawings. When directed, the Contractor shall submit drawings showing supports for review by the Architect/Engineer.

B. Where hanger spacing does not correspond with joist or rib spacing, use structural steel channels secured directly to joist and rib structure that will correspond to the required hanger spacing, and then suspend the equipment and piping from the channels. Drill or burn holes in structural steel only with the prior approval of the Architect/Engineer.

C. Use of chain, wire or strap hangers; wood for blocking stays or bracing; or hangers suspended from piping above will not be permitted. If products are rusty, replace or thoroughly clean and coat with prime paint.

D. Use hanger rods that are straight and vertical. Turnbuckles for vertical adjustments may be omitted where limited space prevents use. Provide a minimum of 2-inch clearance between pipe or pipe covering and adjacent work.

E. Horizontal Pipe Support Spacing:

1. Cast Iron: Five feet on centers maximum spacing. At least one hanger on each full length of pipe, close to hub where possible and at least one within 24 inches of each fitting, and wherever else required to prevent tendency toward deflection due to load. Provide a hanger at upper angle at each drop. Locate hangers adjacent to hubs on multiple fittings not more than four feet on centers.
2. For support spacing of all other horizontal piping, refer to MSS SP-69 and provide additional supports at valves, strainers, inline pumps and other heavy components. Provide a support within one foot of each elbow.
3. Black Steel Gas Piping: 8 feet on centers maximum spacing for on-roof horizontal supports. Provide a support within one (1) foot of each elbow.

F. Vertical Pipe Supports – HVAC and Gas:

1. Vertical runs less than 15 feet long may be supported by the hangers on the connecting horizontal runs.

2. Up to 6-Inch Pipe, 60 Feet Long or Not Over 12-Inch Pipe Up to 30 Feet Long: Riser clamps bolted to pipe below couplings or welded to pipe and resting securely on the building structure.
3. Vertical pipe larger than the foregoing, support on base elbows or tees, or substantial pipe legs extending to the building structure.

G. Connections: All piping connecting to equipment shall be installed without strain at the piping connection. The Contractor shall be required as directed to remove the bolts in flanged connections or to disconnect piping to demonstrate that piping has been so connected.

H. Gas Piping Supports: Shall have electro-galvanized steel top with (aluminum roller) (polymeric) supports, the roller axle, fittings and other hardware shall be galvanized steel or polymeric material. Support base shall be secured to roof with adhesive roofing mastic. Roofing membrane shall be compatible with mastic. Consult manufacturer of existing roofing system if isolation pads are required between roof membrane and support base. Consult manufacturer of existing or new roofing system to verify appropriate adhesive to bond base to roofing surface. Do not use wood as support materials. (Support base shall be secured to roof with zinc-coated bolts to structure.)

I. Gas Piping Anchors: Shall be bolted or field welded to piping. Anchors shall be attached with zinc-coated or galvanized bolts or field welded to angle iron attached to building structure and HVAC equipment curb.

3.4 MOTOR AND DRIVE ALIGNMENT:

A. Belt Drive: Set driving and driven shafts parallel and align so that the corresponding grooves are in the same plane.

B. Direct-Connect Drive: Securely mount motor in accurate alignment so that shafts are free from both angular and parallel misalignment when both motor and driven machine are operating at normal temperatures.

3.5 EXCAVATION AND TRENCHING:

A. Under each applicable section of the detailed mechanical specifications, the Contractor shall perform all excavation of every description and of whatever substances encountered, to the depths indicated on the drawings or as otherwise specified. No extras will be allowed for rock unless indicated otherwise. During excavation, material suitable for backfilling shall be piled in an orderly manner a sufficient distance from the banks of the trench to avoid overloading and to prevent slides or cave-ins. All excavated materials not required or suitable for backfill shall be removed and wasted as indicated on the drawings or as directed by the Architect/Engineer. Such grading shall be done as may be necessary to prevent surface water from flowing into trenches or other excavations, and any water accumulating therein shall be removed by pumping or by other approved method. Such sheeting and shoring shall be done as may be necessary for the protection of the work and for the safety of personnel. Unless otherwise indicated, excavation shall be by open cut except that short sections of a trench may be

tunneled if, in the opinion of the Architect/Engineer, the pipe or duct can be safely and properly installed and backfill can be properly tamped in such tunnel sections.

B. Trench Excavations (Includes under building and 5 feet outside of building): Trenches shall be of necessary width for the proper laying of the pipe or duct, and the banks shall be as nearly vertical as practicable. The bottom of the trenches shall be accurately graded to provide uniform bearing and support for each section of the pipe or duct on undisturbed soil at every point along its entire length. Except where rock is encountered, care shall be taken not to excavate below the depths indicated. Where rock excavations are required, the rock shall be excavated to a minimum over depth of 4 inches below the trench depths indicated on the drawings or specified. Over-depths in the rock excavation and authorized over depths shall be backfilled with loose, granular, moist earth, thoroughly tamped. When corrosive material or unstable soil or material that is incapable of supporting the pipe is encountered in the bottom of the trench, the Contractor shall promptly notify the Architect/Engineer. Such unsuitable soil or material shall be removed to a depth as directed by Architect/Engineer and the trench backfilled to the proper grade with coarse sand, fine gravel, or other suitable backfill material, as directed by the Architect/Engineer.

C. Sanitary Sewers, Storm Sewers, and Water Mains: The width of the trench at and below the top of the pipe shall be such that the clear space between the barrel of the pipe and the trench shall be between 6 and 12 inches on either side of the pipe. The width of the trench above that level may be as wide as necessary for sheeting and bracing and the proper performance of the work. The bottom of the trench shall be rounded so that at least the bottom quadrant of the pipe shall rest firmly on undisturbed soil for as much of the full length of the barrel as proper jointing operations will permit. This part of the excavation shall be done manually only a few feet in advance of the pipe laying by men skilled in this type of work.

D. Protection of Existing Utilities: Existing utility lines to be retained that are shown on the drawings or the locations of which are made known to the Contractor prior to excavation, as well as all utility lines uncovered during excavation operations, shall be protected from damage during excavation and backfilling, and if damaged, shall be repaired by the Contractor, at his expense.

3.6 BACKFILLING OF TRENCHES:

A. Trenches shall not be backfilled until all required pressure and other tests and inspections have been performed and until the utilities systems as installed conform to the requirements of the drawings and specifications. Trenches for piping or duct shall be carefully backfilled with materials consisting of earth, loam, sandy clay, sand and gravel, soft shale, or other approved materials saved from the excavation or borrowed as required. The backfill materials shall be granular in nature and shall not contain coal, dust, cinders, ashes, roots, sod, rubbish, corrosive materials, large clods of earth, or stones over 2-inch maximum dimension. The Architect/Engineer may reject any on-site or borrowed materials which he considers unsuitable for the intended use of the fill.

B. Controlled compacted backfill shall be used under slabs-on-grade, building structure, concrete paving, asphaltic concrete paving, driveway, parking areas, and other areas so specified or

indicated on the drawings. All backfill required to raise the surface to the desired subgrade shall be continuously controlled and placed in maximum of 8-inch loosely placed lifts and compacted to 100 percent maximum dry density beneath the building and 95 percent under all paved drives and parking areas in accordance with ASTM D 698 (Standard Proctor). The soils engineer shall check each lift and submit reports to the Architect/Engineer in accordance with Section, Earthwork.

C. Normal Backfill: Where controlled compacted backfill is not required, such as grassed areas, the trenches shall be carefully backfilled with material in eight-inch layers and thoroughly and carefully rammed until cover is not less than one foot. The remainder of the backfill material shall then be carefully placed in the trench in one-foot layers and tamped. The surface shall be graded to a reasonable uniformity and the mounding over trenches left in a uniform and neat condition as approved by the Architect/Engineer.

D. Test for Displacement of Sewers: Storm and sanitary sewer mains shall be checked by the Contractor to determine whether any displacement of the pipe has occurred after the trench has been backfilled to two feet or more above the pipe. A light shall be flashed between manhole locations and through each straight section of pipe. If the illuminated interior of the pipeline shows poor alignment, displaced pipe, or any other defects, in the opinion of the Architect/Engineer, such defects shall be remedied by the Contractor at his expense.

E. Plants, turf, and surfacing that are to remain in the area of the excavation shall be carefully removed and placed where they will not be damaged. After the excavations are filled, the plants, turf, and surfacing shall be replaced as directed. Provide repairs for sidewalks, driveways, and other cement and asphalt surfaces which are damaged during excavating to match the adjacent work in material and finish.

3.7 CUTTING AND PATCHING:

A. The Contractor shall be responsible for all required digging, cutting, etc., incident to the work, and shall thereafter make all required repairs necessary to restore the cut structure or material to the condition existing prior to the cutting. In no case shall the Contractor cut into any major structural element, beam, or column without the written approval of the Architect/Engineer. All cutting, patching, repairing, or replacing of work required because of fault, error, tardiness, or damage by any trade shall be performed with no increase in the contract price to the Owner.

B. Patch and repair roof in accordance with requirements of existing roof warranties and manufacturer's standard approved details.

3.8 LUBRICATION:

A. Under each applicable section of the detailed mechanical specifications, the Contractor shall provide all oil and grease required for the operation of all equipment until acceptance by the Owner. The type and application of all lubricants shall conform to the recommendations of the manufacturer of the equipment involved. The Contractor shall be held responsible for all damage to bearings while the equipment is being operated by him up to the date of acceptance

of the project. This Contractor shall be required to protect all bearings during installation and shall thoroughly grease or otherwise protect steel shafts and other bare ferrous parts to prevent corrosion. All equipment shall be provided with covers as necessary for proper protection against damage or deterioration during construction.

3.9 OPERATING AND PERFORMANCE TESTS:

A. Prior to the final inspection, perform required tests as specified in Section 23 05 93, TESTING, ADJUSTING AND BALANCING FOR HVAC, and submit the test reports and records to the Architect/Engineer.

B. Should evidence of malfunction in any tested system, or piece of equipment or component part thereof, occur during or as a result of tests, make proper corrections, repairs or replacements, and repeat tests at no additional cost to the Owner.

C. When completion of certain work or system occurs at a time when final control settings and adjustments cannot be properly made to make performance tests, then make performance tests for heating systems and for cooling systems respectively during first actual seasonal use of respective systems following completion of the work.

3.10 QUIET OPERATION AND VIBRATION:

A. Systems shall operate under conditions of load without unusual or excessive noise or vibration. Unusual or excessive noise or vibration shall be corrected.

3.11 INSTRUCTIONS TO OWNER'S PERSONNEL:

A. Under each applicable section of the detailed mechanical specifications, the Contractor shall instruct the representative of the Owner in the proper operation and maintenance of all elements of the mechanical systems. A competent representative of the Contractor shall spend not less than two days in such formal instruction and shall spend such additional time as directed by the Architect/Engineer to fully prepare the Owner to operate and maintain the mechanical systems. The Contractor shall provide letter of instruction upon completion to the Architect/Engineer stating the date of instruction and the names of those in attendance.

3.12 GUARANTEE:

A. All mechanical equipment, materials, and labor required by the contract documents for this project shall be guaranteed to be free of defective materials or workmanship for a period of one year after final acceptance of the project. Defects in equipment, materials, or workmanship occurring during this period shall be corrected with new equipment and materials or additional labor at no cost to the Owner.

3.13 SITE VISIT REPORT:

A. Answer in writing each item of discrepancy noted on all site visit reports.

3.14 DEMOLITION:

A. Contractor shall visit the site before bidding to determine the extent and location of demolition to be performed.

B. Contractor to remove all pipes, ducts, equipment, controls, etc. not required, reused or needed for reconnecting to the new systems. All items not required for the new system shall be removed.

C. The Owner shall select and retain such existing items indicated or required to be removed as he desires. Items selected by the Owner to be retained shall be removed and relocated to an Owner designated location by the Contractor.

D. All equipment, piping, ductwork, conduit, etc. to remain and be reused shall be protected from damage. Any damage to existing material shall be repaired to original condition.

E. Coordinate all demolition activities with the phasing of construction. Demolition shall not affect operations of the building.

3.15 PHASING OF WORK:

A. The mechanical contractor is required to fully understand the phasing of work and to coordinate his work according to phasing plan drawings and related sections of the specifications.

B. Sections of the existing building will continue to be occupied during renovation. The contractor shall be responsible for retaining existing HVAC systems to serve the occupied sections of the building. Otherwise, the contractor shall provide interim HVAC systems for the occupied sections of the building.

C. The contractor is cautioned to fully understand the need to operate HVAC systems during construction and to block off ductwork serving areas under construction. Protect return ductwork with temporary filters at air inlet grilles, etc.

D. Provide temporary HVAC to protect the owner's property from freeze damage and from high humidity. For new construction, provide HVAC for proper drying and application of finishes.

E. Portions of the renovated building will be reoccupied as sections of renovation become complete. The contractor shall be responsible for providing HVAC for the reoccupied sections of building.

END OF SECTION 230000

SECTION 230593 - TESTING, ADJUSTING AND BALANCING FOR HVAC

PART 1: GENERAL

1.1 CONDITIONS:

A. The applicable provisions of Section 23 00 00, HEATING, VENTILATING AND AIR-CONDITIONING (HVAC) are hereby made a part of this section, and the Contractor is cautioned to read Section 23 00 00 carefully as items of work applicable to this section are included in Section 23 00 00.

1.2 DESCRIPTION OF WORK:

A. Testing, adjusting, and balancing (TAB) of heating, ventilating and air conditioning (HVAC) systems.

B. The Contractor shall provide all labor, materials, instruments, equipment and service and shall perform all operations required for testing, adjusting, and balancing of systems and related work to obtain the performance of the systems as shown on the drawings and in the specifications.

C. Definitions:

1. Basic TAB terms used in this section: "Testing, Adjusting and Balancing" of ASHRAE Handbook, latest edition.
2. TAB: Testing, adjusting and balancing. The process of checking and adjusting HVAC systems to meet design objectives.
3. AABA: Associated Air Balance Council.
4. NEBB: National Environmental Balancing Bureau.
5. Hydronic Systems: Includes heating water and chilled water (HVAC).
6. Air Systems: Includes all supply air, return air, exhaust air and outside air systems.

1.3 RELATED WORK:

A. Section 23 00 00, HEATING, VENTILATING AND AIR-CONDITIONING (HVAC).

B. Section 23 09 00, INSTRUMENTATION AND CONTROLS FOR HVAC.

C. Section 23 20 00, HVAC PIPING AND PUMPS.

D. Section 23 21 33, VARIABLE SPEED DRIVES.

E. Section 23 30 00, HVAC AIR DISTRIBUTION.

F. Section 23 34 00, HVAC FANS.

G. Section 23 38 00, VENTILATION HOODS.

H. Section 23 70 00, CENTRAL HVAC EQUIPMENT.

I. Section 23 81 00, DECENTRALIZED UNITARY HVAC EQUIPMENT.

J. Section 23 82 00, CONVECTION HEATING AND COOLING UNITS.

1.4 QUALITY ASSURANCE:

A. TAB Agency Qualifications: The Contractor shall provide the services of a firm certified by the Associated Air Balancing Council, or the National Environment Balancing Bureau to adjust and balance all heating, ventilating, air conditioning, and exhaust systems. All personnel involved in the execution of the work shall be experienced in the balancing of mechanical systems. The firm shall not be the installer of the systems to be tested and shall be otherwise independent of the project.

B. Performance Criteria: Work shall be performed in accordance with the approved TAB Agenda.

C. Test Equipment Criteria: The basic instrumentation requirements and accuracy/calibration required by AABC (Section Two) or Section II of the NEBB Procedural Standards for Testing, Adjusting and Balancing of Environmental Systems.

D. Guarantee: The AABC or NEBB certified firm shall guarantee that all testing, adjusting and balancing work shall be performed in accordance with NEBB standards and procedures and shall provide evidence of their certification for the Architect/Engineer.

1.5 THE TAB AGENDA:

A. Definition: The proposed TAB procedures and proposed forms, diagrams, and reports for documenting the TAB work.

B. Preparation: By the TAB Agency for review and approval by the Architect/ Engineer.

C. The agenda shall include one complete set of the AABC or NEBB publications or, in the case of other TAB organizations, comparable publications to establish an approved systematic and uniform set of procedures.

D. The Agenda shall also include the following detailed narrative procedures, system diagrams and forms for test results.

1. Specific standard procedures required and proposed for each system. Additional procedures for variable flow systems shall be developed by the TAB Agency and included for review and approval.

2. Specified test forms for recording each TAB procedure and for recording sound and vibration measurements. Additional test forms for any variable flow systems shall be developed by TAB agency and submitted for review and approval.
3. System diagrams for each air and water system. Diagrams may be single line. In addition to the information recorded for standard AABC or NEBB procedures, report the following information:

    a. Air Handling Units: Show design and actual CFM (outside air, return air, supply air). Measure and record each mode (minimum OA and 100% OA) where economizer cycle is specified.
    b. Duct Distribution Systems: Record residual pressures at inlets of volume controlled terminals at ends of system. Show actual pressures at all static pressure control points utilized for constant or variable flow systems.
    c. Variable Flow Systems (Water): Include in test forms provisions for measuring and reporting GPM (primary, secondary), system pressures, motor loads, other pertinent data, at full unthrottled capacity and at design (100 percent) flows. Modulate systems by varying the supply temperature of the medium or other approved means.
    d. Water Systems: Record system fill pressures and expansion tank (level, pressure, temperature) conditions. Record shut-off heads for all pumps and compare with pumps curves to determine if correct pump impellers have been installed.

1.6 SUBMITTALS:

A. In accordance with Section 23 00 00, HEATING, VENTILATING AND AIR-CONDITIONING (HVAC) General Requirements, furnish the following:

1. TAB Agency qualifications, submit name and qualifications of job supervisor.
2. Upon approval of TAB Agency, submit TAB AGENDA for approval.
3. After completion of tests, the Contractor shall submit three copies of complete test reports for approval. Applicable NEBB or AABC reporting forms shall be used. Where test results differ from specified design conditions, indicating a contract deficiency, include explanatory comments in report. The Contractor shall submit final reports prior to requesting the final inspection for the project.
4. Approved copy of report shall be bound in Operations and Maintenance Manuals; see Section 23 00 00, HEATING, VENTILATING AND AIR-CONDITIONING (HVAC) General Requirements.

PART 2: PRODUCTS

2.1 GENERAL:

A. The TAB agency shall be responsible for all items or materials necessary for connection of its instrumentation to the ductwork, piping or equipment. Test ports in ducts and plenums shall be installed by the Mechanical Contractor as directed by the TAB agency during the construction

of the systems. Test ports shall be identified. Do not proceed with testing, adjusting, and balancing work until systems are complete and operational.

PART 3: EXECUTION

3.1 GENERAL:

A. The General Contractor shall furnish a complete set of HVAC drawings and specifications to the TAB agency. The agency shall review plans and specifications prior to systems installation and submit a written report indicating deficiencies in the system that would preclude the proper adjusting, balancing, and testing of the system. The HVAC system shall be complete and fully operational with clean air filters and clean pipe strainers prior to system balancing. The TAB agency shall review the installed system for proper installation of testing, adjusting, and balancing equipment and submit a written report indicating system conditions. The Mechanical Contractor shall provide support through factory representatives, equipment mechanics, and control technicians to work with the balancing organization to adjust equipment and controls to obtain design performance.

B. Coordinate TAB procedures with any phased construction requirements for the project so that usable increments of finished work may be accepted for beneficial occupancy. Systems serving partially occupied phases of the project may require balancing for each phase prior to final balancing.

C. Allow sufficient time in construction schedule for TAB prior to final inspection for the project.

D. Accomplish TAB in accordance with the Agenda approved by the Architect/Engineer. Put all HVAC systems into full operation and continue operation of the systems during each working day of TAB.

E. Notify Architect/Engineer 48 hours prior to TAB work.

F. The TAB agency shall be responsible for adjusting sheaves to acquire required air quantities. If the sheaves require replacement, the sheaves and belts will be replaced by the installer of the equipment.

G. One week before the final site visit, the balancing organization shall provide the Architect/Engineer with three (3) typed copies of balance reports, in format recommended by NEBB. The report shall contain the following:

1. Project name, location, contractors names, balancing organizations' name, and date.
2. Balancing organizations' certification and individual certified qualifications of persons responsible for supervising and performing the actual work.
3. Brief description of balancing instruments used for this project and their latest calibration performance.
4. Weather conditions at the beginning and end of each day to include; outside dry bulb and wet bulb temperatures, general weather description and cloud cover.

5. System data for each unit:

    a. Installation data as applicable; mark, location, manufacturer, model, size, arrangement, motor HP, voltage, phase, and full load amps.
    b. Design quantities and balance readings taken during the balancing operation indicating the quantity measured on the first reading, and the final, balanced, measured quantity for air and hydronic balance.

3.2 AIR BALANCE:

A. Place all interactive systems in operation with all filters installed and automatic control systems completed and operating. Artificially load air filters by partial blanking or other means to produce air pressure drop midway between the clean and dirty condition. Set/reset room thermostats as necessary to check heating and cooling function, and flow rates for factory set air terminal units and adjust units if not correct.

B. Balance systems to design ratings. Adjust fan speeds to provide design flows, including system diversities, at actual system pressures. V-belt drives, including fixed pitch requirements, are specified in Section 23 00 00, HEATING, VENTILATING AND AIR-CONDITIONING (HVAC) General Requirements. Coordinate VAV balancing, including supply and return fan volume controls, with Section 23 09 00, Instrumentation and Controls for HVAC. Set supply fan static pressure control as low as practicable and still maintain required pressure at the remote terminal units. The drive motor of each fan shall not be loaded over the corrected full load amperage rating of the motor involved.

C. Make pitot tube traverses of all trunk lines and major branches when required to determine proper proportioning of air flows. Air flow measuring devices, where installed, may be utilized for this purpose.

D. Record pressure drop readings across all major systems.

E. Make flow measurements at each terminal device and each supply, return, or exhaust diffuser. Adjust each air outlet unit within plus or minus 10 percent of design requirements. Adjust grilles and diffusers to minimize drafts in all areas.

F. Adjust outside air and return air quantities for all systems to within plus or minus 10 percent.

G. Adjust exhaust systems to CFM requirements. After balance is completed, change variable shims to fixed shims.

H. Test function of automatic dampers and operation of air terminal units.

I. Any adjustments necessary to achieve the specified results shall be provided by the Contractor who furnished and installed such equipment under his contractual obligations. Such adjustments may encompass, but are not necessarily restricted to, the changing of pulleys and belts.

J. Report the air balance readings for the following as further specified in 3.01.G:

1. Air handling equipment - Outdoor air quantity, return air quantity, supply air quantity, fan speed (rpm), static pressure at fan suction and discharge (inches wg.), and actual motor amp and voltage reading.
2. Exhaust fans - Air quantity, fan speed (rpm) and static pressure, actual motor amps and voltage reading.
3. Each air distribution outlet and inlet identified by location and size, air velocity (fpm) and computed air quantity (cfm).
4. Water coils - Air flow (cfm), entering and leaving air temperatures (DB and WB), load (BTU or MBH).
5. Energy Recovery Wheels - Air flow (cfm), entering and leaving air temperatures (DB and WB), load (BTU or MBH).
6. Temperature in each room in building and thermostat setting.

3.3 HYDRONIC BALANCE:

A. Perform final hydronic balance after all systems have been flushed, cleaned, and filled.

B. Hydronic balance includes performance readings on all pumps, coils, heat exchangers, and flow measuring devices. Adjust pump flows to actual system heads by adjustment of balancing valves. Flow measuring devices take precedence over pump head readings. Record discrepancies for evaluation. The drive motors shall not be loaded over the corrected full load amperage rating of the motor involved.

C. Report pressure drop readings across all major system components both for flow determination and deviations between actual and design values.

D. Record on flow diagrams the flows obtained in each of the various circuits and modes of operation. Designate the manual rebalancing effort that is necessary for optimum operations. Measure flows in primary and secondary pumping systems when operating independently and jointly. Measure and record flows and power consumption of variable flow systems at maximum flow conditions and in increments of 10 percent reductions to a minimum system condition.

E. Report the hydronic balance readings for the following as further specified in 3.01.G:

1. Water coils - Water flow (gpm), entering and leaving water temperatures.
2. Refrigerant coils - Air flow (cfm), entering and leaving air temperatures (DB and WB), load (BTU and MBH).

3.4 TEMPERATURE CONTROL TEST:

A. After the heating, ventilating and air conditioning systems have been adjusted and balanced completely, a six hour test shall be run on both the heating and cooling cycles, including the economizer cycle, to determine whether the systems are responding to the temperature controls.

Thermostat settings, thermostat temperature readings, and an independent temperature measurement at the thermostat shall be recorded at each thermostat. If the tests on both the heating and cooling cycles can not be made together because of the time of the year, the test not made shall be performed later when conditions are acceptable. A supplement to the final report shall be filed when later tests are made.

B. Test Verification - The TAB agency shall attest by letter that all equipment has been wired and tested to see that the indicated sequence of motor control is established, that all safety controls function properly, that all motor protective devices are sized correctly, and that the systems are operating at the points set on the controls.

C. Control Setting - During the performance tests, control settings may require adjustment and if so, shall be adjusted to produce the best balanced system operation. The final setting of each operating and safety control shall be recorded. This shall include but not be limited to thermostats, limit controls, damper position switches, smokestats, firestats, freezestats, aquastats, and other similar items.

D. Marking of settings - Upon completion of system balancing the settings of adjustment devices including valves and dampers shall be permanently marked. Do not mark room mounted thermostats.

END OF SECTION 230593

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SECTION 230700 - HVAC INSULATION

PART 1: GENERAL

1.1 CONDITIONS:

A. The applicable provisions of Section 23 00 00, HEATING, VENTILATING AND AIR-CONDITIONING (HVAC) General Requirements, are hereby made a part of this section, and the Contractor is cautioned to read Section 23 00 00 carefully as items of work applicable to this section are included in Section 23 00 00.

1.2 DESCRIPTION OF WORK:

A. The work to be performed under this section of the specifications comprises the furnishing of all labor and materials and the completion of all work of this section as shown on the drawings and/or herein specified.

B. Insulation materials and accessories shall be installed in a workmanlike manner by skilled and experienced workers who are regularly engaged in commercial insulation work.

C. In general, the work included under this section consists of, but is not limited to, the following:

1. Field applied insulation for thermal efficiency and condensation control for HVAC and plumbing piping, ductwork and equipment.

1.3 RELATED WORK:

A. Section 23 00 00, HEATING, VENTILATING AND AIR-CONDITIONING (HVAC).

B. Section 23 20 00, HVAC PIPING AND PUMPS.

C. Section 23 30 00, HVAC AIR DISTRIBUTION.

D. Section 23 34 00, HVAC FANS.

E. Section 23 70 00, CENTRAL HVAC EQUIPMENT.

F. Section 23 81 00, DECENTRALIZED UNITARY HVAC EQUIPMENT.

G. Section 23 82 00, CONVECTION HEATING AND COOLING UNITS.

1.4 SUBMITTALS:

A. In accordance with Section 23 00 00, HEATING, VENTILATING AND AIR-CONDITIONING (HVAC) General Requirements, furnish the following:

1. Manufacturer's Literature and Dimension Cuts:

a. Insulation Materials: Each type used. State surface burning characteristics and thermal properties.
b. Insulation Facings and Jackets: Each type used. State vapor barrier properties. State that white finish will be furnished for exposed pipe, ductwork, casings, and equipment.
c. Insulation Accessory Materials: Each type used.
d. Manufacturer's installation and fitting fabrication instructions for elastomeric unicellular insulation.
e. Make reference to applicable specification paragraph numbers for coordination.

1.5 DEFINITIONS:

A. Air Conditioned Space: Space directly supplied with cooled air.

B. Cold: Equipment, ductwork or piping handling media at design temperature of 60 Deg. F. or below.

C. Hot: Ductwork handling air at design temperature above 60 Deg. F.; equipment or piping handling media above 105 Deg. F.

D. PCF: Density, pounds per cubic foot.

E. VOC’s: Volatile Organic Compounds

F. Runout: Branch pipe connection up to one inch nominal size and not over 12 feet in length to a floor mounted or ceiling mounted terminal unit.

G. Thermal Conductance: Heat flow rate through materials.

1. Flat Surface: BTU per hour per square foot.
2. Pipe or Cylinder: BTU per hour per linear foot.

H. Thermal Conductivity (k): (BTU · in thickness)/(hr · ft2 · °F temperature difference).

I. Outside: Open to view beyond the exterior side of walls, above the roof and unexcavated or crawl spaces, above or beneath pier floors, in tunnels or exposed on all sides in trenches connected or not connected to an exterior portion of a building.

J. Finished Spaces: Spaces used for habitation or occupancy where rough surfaces are plastered, paneled, or otherwise treated to provide a pleasing appearance.

K. Unfinished Spaces: Spaces used for storage or work areas where appearance is not a factor, unexcavated spaces, crawl spaces, etc.

L. Concealed Spaces: Spaces between a ceiling and floor construction above or between double walls or furred-in areas, pipe and duct shafts, etc.

M. Exposed: Open to view inside the building. For example, pipe run through a room, and not covered by other construction, is exposed.

PART 2: PRODUCTS

2.1 GENERAL:

A. Building characteristics of insulation materials shall comply with NFPA 90A, pertinent parts of which are noted as follows:

1. Duct coverings, duct linings, vapor barrier facings, tapes, and core materials in panels used in duct systems shall have a flame spread rating not over 25 without evidence of continued progressive combustion and a smoke developed rating not higher than 50. If coverings and linings are to be applied with adhesives, they shall be tested as applied with such adhesives, or the adhesives used shall have a flame spread rating not over 25 and a smoke developed rating no higher than 50 when in the final dry state.
2. Duct coverings and linings shall not flame, glow, smolder, or smoke when tested in accordance with ASTM C 411 at the temperature to which it is exposed in service. In no case shall the test temperature be below 250 Deg. F.
3. Pipe insulation and coverings shall meet the requirements of 2-3.3.1 and 2-3.3.2 when installed in ducts, plenums, or concealed spaces used as part of the air distribution system.
4. In addition to NFPA, the insulation material shall not transform into a molten flaming liquid during combustion as characterized by some polyethylenes.

B. Test Methods: ASTM E 84, UL 723, or NFPA 255.

C. Insulation shall be Johns Manville, Owens Corning, Pittsburg Corning, or Armacell. Trade names are used herein, unless indicated otherwise, to establish a standard of quality.

D. Specified k factors are at 75 Deg. F. mean temperature unless stated otherwise. Where optional insulation material is used, select thickness to provide thermal conductance no greater than that for the specified material. For pipe, use insulation manufacturer's published heat flow tables. For a flat surface, thermal conductance equal thermal conductivity (k) divided by the thickness of the insulation. For runout insulation and condensation control insulation, no thickness adjustment need be made.

E. All materials shall be compatible and suitable for service temperature and shall not contribute to corrosion or otherwise attack surfaces to which applied in either the wet or dry state.

F. Underwriters' Laboratories, Inc. label or listing, or satisfactory certified test report from an approved testing laboratory will be required to show that surface burning characteristics for materials to be used do not exceed specified ratings.

G. All sealants and adhesives must comply with all applicable South Coast Air Quality Management District (SCAQMD) VOC limits including but not limited to Rule #1168. All mastics and coatings must comply with all applicable Green Seal GS-11 VOC limits.

2.2 FACINGS AND JACKETS:

A. Fed. Spec. HH-B-100 for Vapor Barrier Types I and II:

1. Puncture Test Method: ASTM D 781.
2. Type I, Low Vapor Transmission (0.02 Perm Rating), Beach Puncture 50 Units: For insulating facing on exposed ductwork, casings, and equipment, and for all pipe insulation jackets. Facings and jackets shall be white all service type (ASJ) suitable for painting without priming.
3. Type II, Medium Vapor Transmission, Beach Puncture 25 Units: Foil-Scrim-Kraft (FSK) type for concealed ductwork and equipment.
4. Factory composite materials may be used provided they have been tested and certified by the manufacturer to meet Beach puncture units specified above.
5. Fire and smoke treatment of jackets and facings shall be permanent. The use of water soluble treatments is not acceptable.
6. Pipe insulation jackets shall have 1-1/2 inch minimum lap at longitudinal joints and not less than 3-inch butt strips at end joints. Facing on board, blanket and block insulation shall have 2-inch laps or 3-inch minimum butt strips. Butt strip material shall be the same as the jacket or facing. Laps and butt strips may be self-sealing type with factory applied pressure sensitive adhesive.

2.3 MINERAL FIBER INSULATION:

A. Owens-Corning Faced Duct Wrap Fiberglass Insulation - FRK Type 100, ASTMC 553-92 (Blanket, Flexible), Density 1 pcf, k = 0.31, for temperatures up to 250 Deg. F.

1. Concealed supply air ductwork within building's thermal envelope shall be 1-1/2 inch thick insulation.
2. Concealed outdoor air ductwork within building's thermal envelope shall be 2-inch thick insulation.
3. Concealed supply air ductwork outside building's thermal envelope shall be 2-inch thick insulation.
4. Concealed return air ductwork within building's thermal envelope need not be insulated.
5. Concealed return air ductwork outside building's thermal envelope shall be 2-inch thick insulation.
6. Concealed exhaust air ductwork within building's thermal envelope and within 10 feet of connection to outdoors shall be 1-1/2 inch thick insulation.

7. Concealed exhaust air ductwork outside building's thermal envelope shall be 1-1/2 inch thick insulation.
8. Concealed ductwork with acoustic lining within the building's thermal envelope need not be insulated.
9. Concealed ductwork with acoustic lining outside building's thermal envelope shall be 1-1/2 inch thick insulation.

B. Owens-Corning 705 Rigid Board Fiberglass Insulation, ASTM 612, 6 pcf density, with white laminated kraft-aluminum foil reinforced all-service vapor barrier facing.

1. Exposed outside air ductwork shall be 2-inch thick insulation.
2. Exposed supply air ductwork shall be 1-1/2 inch thick insulation.
3. Exposed return air ductwork and exhaust air ductwork in non-air conditioned spaces shall be 1-1/2 inch thick insulation.
4. Exposed ductwork with acoustic lining need not be insulated.

C. Owens-Corning Fiberglass SSL II ASJ Heavy Density Sectional Pipe Insulation, Fed. Spec. HH-I-558, Form D, Type III (Molded), Class 12, k = 0.24.

D. Molded pipe fitting covering: Fed. Spec. HH-I-558, Form E. Class 16, k = 0.26, for temperatures up to 370 Deg. F.

E. Insulation thickness and type for various piping systems shall be as indicated in the following table (Pipe Size/Insulation Thickness).

PIPE SIZE/INSULATION THICKNESS(1)

System	Temp. Range (°F)	Less than 1"	1" to 1-1/4"	1-1/2" to 3"	4" to 6"	8" & Up	Ins. Type (4)
Heating Water	140-200	1.5	1.5	2.0	2.0	2.0	A
Domestic Hot Water	90-159	1.5	1.5	2.0	2.0	2.0	A
Misc.	80-89	1.0	1.0	1.0	1.0	1.0	A,B
Domestic Cold Water	56-79	1.0	1.0	1.0	1.0	1.0	A
Chilled Water	40-55	1.0	1.0	1.5	1.5	2.0	A
Condensate Drain	45-75	0.5	0.5	1.0	1.0	1.0	A,B

Refrig./ Brine	Below 40 (6)	1.0	1.0	1.5	1.5	1.5	B
Horizontal Storm (3)	Any	---	---	1.0	1.5		A

NOTES:
(1) Minimum thickness for insulation listed in preceding table is based on Thermal Conductivity, 'k' not exceeding 0.27 Btu per inch/hr. x sq. ft. x Deg. F. based on Mean Temperature of 75 Deg. F. Insulation with greater Thermal Conductivity shall have increased thickness to provide same performance characteristics as specified.
(2) All horizontal sanitary piping above Kitchen or Dining Area only.
(3) All horizontal storm piping above lowest floor including roof drains from underside of deck to just below fitting at top of vertical portion of stack. Fittings at top and bottom of vertical sections of horizontal offsets shall be insulated. Lap joints, tape and seal.
(4) A - Fiberglass type insulation; B - Elastomeric type insulation.
(5) Runouts to individual terminal units (not exceeding 12 ft. in length).
(6) Also insulate all refrigerant pipes located in hot spaces such as attics.

2.4 ELASTOMERIC INSULATION:

A. Armstrong Armaflex II Pipe Insulation, Fed. Spec. HH-I-573 and HH-I-1751/2, k = 0.27, flame spread not over 25, smoke developed not over 50 (1/2-inch thick test material), for temperatures from minus 40 Deg. F. to 211 Deg. F. No jacket required.

2.5 CELLULAR GLASS INSULATION:

A. Pittsburgh Corning Foamglas Insulation, ASTM C 552, Type II, class 2, 8.5 pcf, closed cell rigid type.

1. Buried steam piping, not in conduit, shall have 2 inch thick insulation.
2. Buried pumped condensate piping, not in conduit, shall have 1 inch thick insulation.
3. Outside piping shall have insulation thickness as indicated in table or as indicated on drawing. Protect with aluminum jacket.

2.6 ACCESSORY MATERIALS:

A. Insulation inserts at pipe supports:

1. Material: Cellular glass or calcium silicate 1/2 section of insulation, same thickness as adjacent insulation.

2. Provide inserts for all insulated piping greater than 1-1/2 inch diameter. Install with metal insulation shields furnished with pipe supports, Section 23 00 00, HEATING, VENTILATING AND AIR-CONDITIONING (HVAC) General Requirements. Minimum insert length: 10 inches for up to 3 inch pipe, 12 inches for 3 to 6 inch pipe, 16 inches for 8 to 10 inch pipe, and 22 inches for pipe 12 inches and larger.

B. Adhesives, Mastics, Cement:

1. Mil. Spec. MIL-A-3316B, Class 1: Jacket and lap adhesive and protective finish coating for insulation.
2. Mil. Spec. MIL-A-3316B, Class 2: Adhesive for laps for adhering insulation to metal surfaces.
3. Mil. Spec. MIL-A-24179A, Type II, Class 1: Adhesive for installing flexible unicellular insulation and for laps and general use.
4. Mil. Spec. MIL-B-19565B, Type 1 or Type II and be listed on Qualified Products Database (QPD): Vapor barrier compound for outdoor use.
5. Fed. Spec. SS-C-160A, Type IIIB, (ASTM C 449): Mineral fiber hydraulic-setting thermal insulating and finishing cement.
6. Other: Insulation manufacturer's published recommendations.

C. Mechanical Fasteners:

1. Pins, Anchors: Welded pins, or metal or nylon anchors with tin-coated or fiber washer, or clips. Pin diameter shall be as recommended by the insulation manufacturer.
2. Staples: Outward clinching monel or stainless steel.
3. Wire: 18 gage soft annealed galvanized, or 14 gage copper clad steel or nickel copper alloy.
4. Bands: 3/4-inch nominal width, brass, aluminum or stainless steel.

D. Reinforcement and Finishes:

1. Glass Fabric, Open Weave: ASTM D 1668, Type III (resin treated) and Type 1 (asphalt treated).
2. Glass Fiber Fitting Tape: Mil. Spec. MIL-C-20070, Type II, Class 1.
3. Tape for Flexible Unicellular Insulation: Scotch No. 472, Nashua PE-12, or approved equal recommended by the insulation manufacturer.
4. PVC Fitting Cover: Fed. Spec. L-P-535D, Composition A, Type II, Grade GU, with Form B mineral fiber insert, for media temperature 45 Deg. F. to 250 Deg. F. Below 45 Deg. F. and above 250 Deg. F., provide double layer insert. Provide color matching, vapor barrier, pressure sensitive tape.

E. Firestopping Material: Refer to Section 23 00 00, HEATING, VENTILATING AND AIR-CONDITIONING (HVAC).

PART 3: EXECUTION

3.1 GENERAL:

A. Required pressure tests of joints and connections shall be completed before application of insulation. Surface shall be clean and dry with all foreign materials, such as dirt, oil, loose scale, and rust removed.

B. Insulation materials and accessories shall be installed in a workmanlike manner by skilled and experienced workers who are regularly engaged in commercial insulation work. If any insulation material has become wet because of transit or job site exposure to moisture or water, the Contractor shall not install such material, and shall remove it from the job site. No insulation material shall be installed that has become damaged in any way. The Contractor shall also use necessary means to protect his work and materials.

C. Except for specific exceptions, insulate entire specified equipment, piping, and duct systems. Insulate each pipe and duct individually. Do not use scrap pieces of insulation where a full length section will fit.

D. Insulation materials shall be installed in a first class manner with smooth and even surfaces, with jackets and facings drawn tight and smoothly cemented down at all laps. Insulation shall be continuous through all sleeves and openings, except at fire dampers and duct heaters (NFPA 90A). Vapor barriers shall be continuous and uninterrupted throughout systems with operating temperature 60 Deg. F. and below. Lap and seal vapor barrier over ends and exposed edges of insulation. Anchors, supports, and other metal projections through insulation on cold surfaces shall be insulated and vapor sealed for a minimum length of six inches.

E. Insulation on hot piping and equipment shall be terminated square or beveled with insulating cement, covered with jacket, at items not to be insulated, access openings and nameplates.

F. On cold systems, vapor barrier performance is extremely important. Particular care must be given to vapor sealing the fitting cover or finish to the insulation vapor barrier. All penetrations of the jacket and exposed ends of insulation must be sealed with vapor barrier mastic. All valve stems must be sealed with caulking which allows free movement of the stem but provides a seal against moisture incursion.

G. HVAC Work Not To Be Insulated:

1. Internally insulated ductwork and air handling units.
2. Equipment: Heating water pumps, expansion tanks.
3. In Hot Piping: Unions, flexible connectors, control valves and discharge vent piping.
4. Factory insulated flexible ducts.
5. Factory insulated supply air diffusers.

H. Plumbing Work Not To Be Insulated:

1. Piping and valves of fire protection system.

2. Chromium plated brass piping (except hot water and drain piping under handicapped lavatories).
3. Domestic Hot Water: Unions, flexible connectors, control valves, expansion tank, pump.

I. Apply insulation materials subject to the manufacturer's recommended temperature limits. Apply adhesives, mastics and coatings at the manufacturer's recommended minimum coverage.

3.2 INSTALLATION:

A. Flexible Mineral Fiber Blanket:

1. Adhere insulation to metal with 4-inch wide strips of insulation bonding adhesive at 8 inches on center. Additionally secure insulation to bottom of ducts exceeding 24 inches in width with pins welded or adhered 18 inches on centers. Secure washers on pins. Butt insulation edges and seal joints with laps and butt strips. Staples may be used to assist in securing insulation. Seal all vapor barrier penetrations with vapor barrier mastic. Sagging duct insulation will not be acceptable.
2. Supply air ductwork to be insulated includes main and branch ducts from fan discharge to room supply outlets and the bodies of ceiling outlets to prevent condensation. To prevent condensation, insulate trapeze type supports and angle iron hangers for flat oval ducts.

B. Molded Mineral Fiber Pipe and Tubing Covering:

1. Fit insulation to pipe aligning longitudinal joints. Seal longitudinal joint laps and circumferential butt strips by rubbing hard with a nylon sealing tool to assure a positive seal. Staples may be used to assist in securing insulation. Seal all vapor barrier penetrations with vapor barrier mastic. Provide inserts and install with metal insulation shields at outside pipe supports.
2. Fittings, Flange and Valve Insulation:

a. Fiberglass Pipe insulation shall be installed with joints butted firmly together. Valves and devices requiring access shall be insulation with mitered sections of insulation equal in thermal resistance and thickness to the adjoining insulation. Fittings shall be covered with Schuller "Zeston" type, pre-molded PVC fitting covers. Jackets on pipe insulation shall be stapled using outward clinching type staples spaced 3" apart at least 1/4" from the lap edge on systems operating at 80 Deg. F. and above; below 80 Deg. F. the laps are to be vapor sealed using self-sealing lap, lap seal gun, or adhesive. All insulation elbows, fittings, flanges, joints, laps, voids, punctures, and end tapers shall be sealed with two coats of Foster Vapor Out 30-33 or Childers Chil Out CP-33 vapor barrier mastic and reinforcing mesh (total 35 mils or 0.9 mm dry film thickness) regardless of service and before Zeston covers are applied.
b. Fitting tape shall extend over the adjacent pipe insulation and overlap on itself at least two inches.

C. Elastomeric Insulation:

1. Apply insulation and fabricate fittings in accordance with the manufacturer's installation instructions.
2. Pipe and Tubing Insulation:

   a. Use proper size material. Do not stretch or strain insulation.
   b. To avoid undue compression of insulation, provide inserts at supports as recommended by the insulation manufacturer. Insulation shields are provided under Section 23 00 00, HEATING, VENTILATING AND AIR-CONDITIONING (HVAC).
   c. Elastomeric insulation shall be slipped on the pipe prior to connection wherever possible. Pipe leak tests shall be performed prior to the insulation of fittings. Where the slip-on technique is not possible longitudinal slit insulation shall be snapped on the pipe. All seams, voids, and butt joints shall be sealed with a Foster 85-75 or Childers CP-82 vapor barrier adhesive or taped with 1-1/2 inch wide 3M #471 tape.
   d. Fittings and valves shall be insulated with mitered sections of insulation. All joints shall be secured and sealed with vapor barrier adhesive. Approved factory-made fittings such as F & D Mfgr. and Supply Co. may be used.

3. On exterior refrigerant suction piping, provide two coats of Armstrong Armaflex Finish (vinyl lacquer) or Foster 30-64 on the insulation.

D. Rigid Mineral Fiber Board: Secure rigid insulation by impaling over pins or anchors located not more than 3 inches from edge of boards and spaced not more than 18-inch centers and secured with washers and clips. Spot-weld anchor pins or attach with a Foster 85-60 or Childers CP-127 adhesive especially designed for use on metal surfaces. Apply insulation with joints tightly butted. Where vapor barrier is specified, all joints, breaks, seams, punctures, and voids shall be filled with vapor barrier mastic and covered with vapor seal material identical to that surrounding. Neatly bevel insulation around name plates and access plates and doors. Each pin or anchor shall be capable of supporting a 20-pound load. Protruding ends of clips shall be cut off flush after clips are secured and sealed with aluminum backed pressure sensitive tape and coated with vapor barrier mastic.

E. Duct-mounted heating coils and variable air volume terminal box heating coils shall be insulated with external duct insulation as specified for cold systems. Where adjacent duct or unit is internally lined, extend external insulation minimum 2" onto adjacent item. Completely vapor seal insulation around coil and seal to adjacent surface.

F. Hot piping serving heating coils located downstream from cooling coils including remote duct-mounted coils, coils at terminal units, etc., shall be insulated a minimum of 5 feet from the coil connection as specified for cold piping. All valves, flanges, unions, flexible connections, etc., within the insulated length shall also be insulated.

G. Heaters and Tanks: Domestic water heaters, hot water storage tanks, and converters shall be insulated with 1-1/2" thick Hydrous calcium silicate blocks with edges tightly butted and secured with 1/2 x .015" thick galvanized steel bands not over 12" on center. Finish with Schuller No. 375 insulating cement troweled on in two 1/2" thick coats over chicken wire. Last coat shall be mixed 2-to-1 by weight with Portland cement and shall be troweled smooth.

H. Roof Drain: The bottom of each roof drain, including deck clamps, shall be insulated with 1" thick fiber glass flexible insulation with an 'R' value of 4.16 with 1 mil foil-scrim-kraft paper jacket. Insulation shall be held securely in place with tape. Joints shall be lapped. Joints, voids, and punctures in the jacket shall be effectively vapor sealed with Foster Vapor Out 30-33 or Childers CP-33 Chil Out.

END OF SECTION 230700

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SECTION 230900 - INSTRUMENTATION AND CONTROL FOR HVAC

PART 1: GENERAL

1.1 CONDITIONS:

A. The applicable provisions of Section 23 00 00, HEATING, VENTILATING AND AIR-CONDITIONING (HVAC) are hereby made a part of this section and the Contractor is cautioned to read Section 15050 carefully, especially paragraph 2.3 Motors, Control and Electrical Wiring as items of work applicable to this section.

1.2 RELATED WORK:

A. Section 23 00 00, HEATING, VENTILATING AND AIR-CONDITIONING (HVAC).

B. Section 23 05 93, TESTING, ADJUSTING, AND BALANCING FOR HVAC

C. Section 23 20 00, HVAC PIPING.

D. Section 23 30 00, HVAC AIR DISTRIBUTION.

E. Section 23 34 00, HVAC FANS.

F. Section 23 70 00, CENTRAL HVAC EQUIPMENT

G. Section 23 81 00, DECENTRALIZED UNITARY HVAC EQUIPMENT

H. Section 23 82 00, CONVECTION HEATING AND COOLING UNITS.

1.3 COORDINATION OF SPECIFICATIONS:

A. Control Valves: Furnish per 23 09 00; Install per 23 20 00.

B. Control Pipe Wells: Furnish per 23 09 00; Install per 23 20 00

C. Motorized Dampers: Furnish Damper per 23 30 00; Furnish Actuator per 23 09 00; Install Damper per 23 30 00; Install Actuator per 23 09 00.

D. Temperature Control Wiring: Furnish and install per 23 00 00 and 23 09 00.

E. Wall Rough-in for Controls: Furnish and install per 23 00 00 and 23 09 00.

F. Interlock Wiring for Smoke Detector and Fire Alarm: Furnish and install per Electrical Specifications.

G. Central Controls Panel Connections for Power, Modem and Fire Alarm: Furnish and install per Electrical Specifications. (The Mechanical Contractor shall be responsible for these connections as they may not be indicated on the electrical drawings.) Power connections for all Building Automation System (BAS) control panels shall be connected to emergency electrical circuits designated on the Electrical Drawings. Circuit breakers will be provided as shown on Electrical Panel Schedule.

H. NOTE: The technical specifications are arranged for convenience and such arrangement shall not operate to make the Architect/Engineer an arbiter in establishing the limits of any subcontract or trade.

1.4 WORK INCLUDED:

A. Furnish an extension to the existing Trane Tracer / BACnet-based system. Existing Trane operator's workstation in central maintenance shall be connected via Ethernet (No exceptions). The operator's workstation, all building controllers, application controllers, and all input/output devices shall communicate primarily using the protocols and network standards as defined by ANSI/ASHRAE Standard 135–2001, BACnet and Trane Tracer.

B. Provide all necessary Trane Tracer & BACnet-compliant hardware and software to meet the system's functional specifications.

C. Prepare individual hardware layouts, interconnection drawings, and software configuration from project design data.

D. Implement the detailed design for all analog and binary objects, system databases, graphic displays, logs, and management reports based on control descriptions, logic drawings, configuration data, and bid documents.

E. Design, provide, and install all equipment cabinets, panels, data communication network cables needed, and all associated hardware.

F. Provide and install all interconnecting cables between supplied cabinets, application controllers, and input/output devices.

G. Provide and install all interconnecting cables between all operator's terminals and peripheral devices (such as printers, etc.) supplied under this section.

H. Provide complete manufacturer's specifications for all items that are supplied. Include vendor name of every item supplied.

I. Provide supervisory specialists and technicians at the job site to assist in all phases of system installation, startup, and commissioning.

J. Provide a comprehensive operator and technician training program as described herein.

K. Provide as-built documentation, operator's terminal software, diagrams, and all other associated project operational documentation (such as technical manuals) on approved media, the sum total of which accurately represents the final system.

L. Provide new sensors, dampers, valves, and install only new electronic actuators. No used components shall be used as any part or piece of installed system.

1.5 SYSTEM DESCRIPTION:

A. A distributed logic control system complete with all software and hardware functions shall be provided and installed. System shall be primarily based on Trane Tracer and ANSI/ASHRAE Standard 135-2001, BACnet. This system is to control all mechanical equipment, including all unitary equipment such as fan-powered terminal boxes, AC units, etc. and all air handlers, VAV boxes, fans and any other listed equipment using native BACnet-compliant components.

B. Operator's workstation software (existing Trane). Software functions delivered on this project shall include password protection, scheduling (including optimum start), alarming, logging of historical data, full graphics including animation, after-hours billing program, demand limiting, full suite of field engineering tools including graphical programming and applications. Systems using operating systems other than that described above are strictly prohibited. All software required to program application specific controllers and all field level devices and controllers will be left with the owner. All software passwords required to program and make future changes to the system will also become the property of the owner. All software required to make any program changes anywhere in the system along with scheduling,and trending applications will be left with the owner. All software passwords required to program and make future changes to schedules, trends and related program changes will also become the property of the owner. All software required for all field engineering tools including graphical programming and applications will be left with the owner. All software passwords required to program and make future changes to field engineering tools including graphical programming and applications will be left with the Owner.

C. Building controllers shall include complete energy management software, including scheduling building control strategies with optimum start and logging routines. All energy management software and firmware shall be resident in field hardware and shall not be dependent on the operator's terminal. Operator's terminal software is to be used for access to field-based energy management functions only. Provide zone-by-zone direct digital logic control of space temperature, scheduling, runtime accumulation, equipment alarm reporting, and override timers for after-hours usage.

D. Room sensors shall be provided with the room setpoint within preset limits and set desired override time. User shall also be able to start and stop unit from the sensor. Include all necessary wiring and firmware such that room sensor includes field service mode. Field service mode shall allow technician to balance VAV zones and access any parameter in zone controller. Room sensors shall be architecturally pleasing, sense temperature, allow tenant

to override system and adjust temperature setpoint, and include a jack that allows the service technician to adjust any zone parameter. Include all wiring for sensor and field service tool.

E. All application controllers for every terminal unit (FTB, CUH, UH, etc.), air handler, all central plant equipment, and any other piece of controlled equipment shall be fully programmable. Application controllers shall be mounted next to controlled equipment and communicate with building controller.

1.6 APPROVED MANUFACTURERS:

A. Only approved control manufacturers may bid upon meeting all requirements of the specifications.

B. Approved Control Manufacturers:

1. Trane – No Substitutes

C. Hardware:

1. Direct Digital Control System Hardware:

a. Complete bill of materials indicating quantity, manufacturer, model number, and relevant technical data of equipment to be used.
b. Manufacturer's description and technical data such as performance curves, product specifications, and installation and maintenance instructions for items listed below:

(1) Direct digital controllers (controller panels)
(2) All gateway devices
(3) All devices used to translate proprietary communication protocols into BACNET Standard, ASHRAE/ANSI 135-2001, BACnet
(4) Control panels
(5) Power supplies
(6) Operator interface equipment
(7) Wiring

c. Wiring diagrams and layouts for each control panel, GATEWAY DEVICES, AND ALL DEVICES USED TO TRANSLATE PROPRIETARY COMMUNICATION PROTOCOLS INTO BACNET STANDARD. Show termination numbers.
d. Floor plan schematic diagrams indicating field sensor and controller locations.

2. Central System Hardware and Software:

a. Complete bill of material indicating quantity, manufacturer, model number, and relevant technical data of equipment used.

b. Manufacturer's description and technical data such as product specifications and installation and maintenance instructions for items listed below: and for relevant items furnished under this contract not listed below:

(1) Interface equipment between CPU or server and control panels
(2) Operating System software
(3) Operator interface software
(4) Color graphic software
(5) Third-party software
(6) ALL GATEWAY DEVICES
(7) ALL DEVICES USED TO TRANSLATE PROPRIETARY COMMUNICATION PROTOCOLS INTO BACNET STANDARD, ASHRAE/ANSI 135-2001, BACnet

c. Schematic diagrams of control, communication, and power wiring for central system installation. Show interface wiring to control system.
d. Network riser diagrams of wiring between central control unit and control panels.

3. Controlled Systems:

a. Schematic diagram of each controlled system. Label control points with point names. Graphically show locations of control elements.
b. Schematic wiring diagram of each controlled system. Label control elements and terminals. Where a control element is also shown on control system schematic, use the same name.
c. Instrumentation list (Bill of Materials) for each controlled system. List each control system element in a table. Show element name, type of device, manufacturer, model number, and product data sheet number.
d. Complete description of control system operation including sequences of operation. Include and reference schematic diagram of controlled system. List I/O points and software points specified in Section 230900. Indicate alarmed and trended points.

4. BACnet Protocol Implementation for integration to third party equipment.

1.7 QUALITY ASSURANCE:

A. The BAS system shall be designed and installed, commissioned and serviced by manufacturer employed, factory trained personnel. Manufacturer shall have an in-place support facility within 2 hours response time of the site with technical staff, spare parts inventory and necessary test and diagnostic equipment. Distributors or licensed installing contractors are not acceptable.

The manufacturer shall provide full time, experienced project manager for this work, responsible for direct supervision of the design, installation, start up and commissioning of the BAS system.

The Bidder shall be regularly engaged in the manufacturing, installation and maintenance of BAS systems and shall have demonstrated technical expertise and experience in the manufacture, installation and maintenance of BAS systems similar in size and complexity to this project. Bidders shall provide a list of at least 10 projects, similar in size and scope to this project completed within the past 3 years.

B. The BAS system manufacturer must be Trane, Inc.

C. Materials and equipment shall be the catalogued products of manufacturers regularly engaged in production and installation of automatic temperature control systems and shall be manufacturer's latest standard design that complies with the specification requirements.

D. All BAS peer-to-peer network controllers, central system controllers and local user displays shall be UL Listed under Standard UL 916, category PAZX.

E. All electronic equipment shall conform to the requirements of FCC Regulation, Part 15, Governing Radio Frequency Electromagnetic Interference and be so labeled.

F. Control system shall be engineered, programmed and supported completely by Trane representative’s that live within 20 miles of project site.

1.8 REFERENCE STANDARDS:

A. The latest edition of the following standards and codes in effect and amended as of supplier's proposal date, and any applicable subsections thereof , shall govern design and selection of equipment and material supplied:

1. American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE).
2. ANSI/ASHRAE Standard 135-2001, BACnet.
3. Uniform Building Code (UBC), including local amendments.
4. UL 916 Underwriters Laboratories Standard for Energy Management Equipment. Canada and the US.
5. National Electrical Code (NEC).
6. FCC Part 15, Subpart J, Class A
7. EMC Directive 89/336/EEC (European CE Mark)
8. UL-864 UUKL listing for Smoke Controls for any equipment used in smoke control sequences

B. City, county, state, and federal regulations and codes in effect as of contract date.

C. Except as otherwise indicated the system supplier shall secure and pay for all permits, inspections, and certifications required for his work and arrange for necessary approvals by the governing authorities.

1.9 SUBMITTALS:

A. Drawings:

1. The system supplier shall submit engineered drawings, control sequence, and bill of materials for approval.
2. Drawings shall be submitted in the following standard sizes: 11” x 17” (ANSI B).
3. Eight complete sets (copies) of submittal drawings shall be provided.
4. Drawings shall be available on CD-ROM.

B. System Documentation - Include the following in submittal package:

1. System configuration diagrams in simplified block format.
2. All input/output object listings and an alarm point summary listing.
3. Electrical drawings that show all system internal and external connection points, terminal block layouts, and terminal identification.
4. Complete bill of materials, valve schedule and damper schedule.
5. Manufacturer's instructions and drawings for installation, maintenance, and operation of all purchased items.
6. Overall system operation and maintenance instructions—including preventive maintenance and troubleshooting instructions.
7. For all system elements—operator’s workstation(s), building controller(s), application controllers, routers, and repeaters,—provide BACnet Protocol Implementation Conformance Statements (PICS) as per ANSI/ASHRAE Standard 135-2001.
8. Provide complete description and documentation of any proprietary (non-BACnet) services and/or objects used in the system.
9. A list of all functions available and a sample of function block programming that shall be part of delivered system.

C. Project Management: The vendor shall provide a detailed project design and installation schedule with time markings and details for hardware items and software development phases. Schedule shall show all the target dates for transmission of project information and documents and shall indicate timing and dates for system installation, debugging, and commissioning.

1.10 WARRANTY:

A. Warranty shall cover all costs for parts, labor, associated travel, and expenses for a period of one year from completion of system acceptance.

B. 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. 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.

C. This warranty shall apply equally to both hardware and software.

PART 2: PRODUCTS

2.1 OPERATOR'S WORKSTATION (Existing Trane Tracer):

A. Communications: Include Ethernet network connections.

B. Time Schedule Adjustment:

1. Access shall allow user to view and edit all schedules in the system. This includes standard, holiday and event schedules as described in BAS specification. Display of schedules shall show interaction of all schedules on a single display so user sees an overview of how all work together. User shall be able to edit schedules from this display.
2. Display of all 3 schedules must show all ON times for standard, holiday and event schedules in different colors on a given day. In addition, OFF times for each must also be shown in additional colors. User shall be able to select from standard calendar what days are to be scheduled and same display shall show all points and zones affected. User shall be able to set time for one day and select all days of the week that shall be affected as a recurrence of that same schedule for that given day.
3. Schedule list shall show all schedules currently defined. This list shall include all standard, holiday and event schedules. In addition, user shall be able to select a list that shows all scheduled points and zones.

C. Logging of Information: User shall use standard Trane technology to view all trend logs in system. User shall be able to view logged data in tabular form or graphical format. User shall be able to adjust time interval of logged data viewed and shall be able to adjust y axis of data viewed in graphical format. User shall also be able to down-load data through the interface to local computer.

D. Alarm Handling: Interface shall display alarms as they occur. User shall be able to acknowledge alarms using Trane Tracer.

E. Ethernet Page Generation: Pages shall be generated automatically from the BAS displays that reside on the BAS server. User shall access Trane Tracer per existing methods.

F. Password Security and Activity Log: Per Trane existing.

2.2 CENTRAL PLANT AND AIR HANDLER APPLICATION CONTROLLERS:

A. Provide PXCM PXC technology.

B. Application controllers shall include universal inputs for each application.

C. All program sequences shall be stored on board application controller in EEPROM. No batteries shall be needed to retain logic program. All calculations shall be completed using floating-point math and system shall support display of all information in floating-point

nomenclature at operator's terminal. Programming of application controller shall be completely modifiable in the field. Operator shall program logic sequences by graphically moving function blocks on screen and tying blocks together on screen. Application controller shall be programmed using programming tools as described in operator's terminal section.

2.3 TERMINAL UNIT APPLICATION CONTROLLERS (AC UNITS):

A. Provide one application controller for each piece of unitary mechanical equipment that adequately covers all objects listed in object list for unit. All controllers shall interface to building controller via network.

2.4 VAV BOX CONTROLLERS:

A. Provide one application controller for each VAV box that adequately covers all objects listed in object list for unit. All controllers shall interface to building controller.

2.5 SENSORS and MISCELLANEOUS DEVICES:

A. Temperature Sensors: All temperature sensors to be solid state electronic, factory-calibrated to within 0.5°F, totally interchangeable with housing appropriate for application. Wall sensors to be installed as indicated on drawings. Mount 48 inches about finished floor. Duct sensors to be installed such that the sensing element is in the main air stream. Immersion sensors to be installed in wells provided by control contractor, but installed by mechanical contractor. Immersion wells shall be filled with thermal compound before installation of immersion sensors. Outside air sensors shall be installed away from exhaust or relief vents, not in an outside air intake and in a location that is in the shade most of the day.

B. Carbon Monoxide Detector:

1. Provide Fyrnetics carbon monoxide detector or equal (120V-1PH) complete with auxiliary hearing impaired strobe light in each Mechanical Room with gas-fired equipment. Provide additional detectors for Music D110 and Art D104.
2. The system shall monitor parts per million of carbon monoxide and shall alarm at a predetermined level of concentration (adjustable setpoint). The alarm shall activate the unit alarm light, horn, and a remote strobe light located at all entrances to mechanical rooms. The detector shall de-energize the horn upon safe carbon monoxide levels, however, the warning lights shall require manual reset. Detector shall be complete with remote sensors output for Building Automation System and contactors for output to the Fire Alarm system. Carbon monoxide detectors shall have battery back-up.
3. Alarms shall be monitored through the DDC control system.

C. Field Service Tool:

1. Field service tool shall allow technician to view and modify all setpoints and tuning parameters stored in application controller. In addition, technician shall be able to view status of all inputs and outputs on digital readout. Each piece of data shall have a data code associated with it that is customizable.
2. Field service tool shall plug into wall sensor and provide all the functionality specified. Operator workstation shall include the capability to disable operation of the field service tool.
3. Provide NO Field Service Tools for this project or laptop PC.

2.6 ELECTRONIC ACTUATORS AND VALVES:

A. Quality Assurance for Actuators and Valves:

1. UL Listed Standard 873 and C.S.A. Class 4813 02 certified.
2. NEMA 2 rated enclosures for inside mounting, provide with weather shield for outside mounting.
3. Five-year manufacturers warranty. Two-year unconditional and three-year product defect from date of installation.

B. Execution Details for Actuators and Valves:

1. Furnish a Freeze-stat and install “Hard Wire” interlock to disconnect the mechanical spring return actuator power circuit for fail-safe operation. Use of the control signal to drive the actuators closed is not acceptable.
2. Each DDC analog output point shall have an actuator feedback signal, independent of control signal, wired and terminated in the control panel for true position information and troubleshooting. Or the actuator feedback signal may be wired to the DDC as an analog input for true actuator position status.
3. VAV box damper actuation shall be Floating type or Analog (2-10vdc, 4-20ma).
4. Booster-heat valve actuation shall be Floating type or Analog (2-10vdc, 4-20ma).
5. Primary valve control shall be Analog (2-10vdc, 4-20ma).

C. Actuators for Damper and Control Valves ½" to 6" shall be Electric unless otherwise specified, provide actuators as follows:

1. UL Listed Standard 873 and Canadian Standards association Class 481302 shall certify Actuators.
2. NEMA 2 rated actuator enclosures are. Use additional weather shield to protect actuator when mounted outside.
3. 5 year Manufacturers Warranty. Two-year unconditional + Three year product defect from date of installation.
4. Mechanical spring shall be provided when specified. Capacitors or other non-mechanical forms of fail-safe are not acceptable.

5. Position indicator device shall be installed and made visible to the exposed side of the Actuator. For damper short shaft mounting, a separate indicator shall be provided to the exposed side of the Actuator.
6. Overload Protection: Actuators shall provide protection against actuator burnout by using an internal current limiting circuit or digital motor rotation sensing circuit. Circuit shall insure that actuators cannot burn out due to stalled damper or mechanical and electrical paralleling. End switches to deactivate the actuator at the end of rotation are acceptable only for Butterfly Valve actuators.
7. A push button gearbox release shall be provided for all non-spring actuators.
8. Modulating actuators shall be 24Vac and consume 10VA power or less.
9. Conduit connectors are required when specified and when code requires it.

D. Damper Actuators:

1. Outside Air and Exhaust Air Damper Actuators shall be Mechanical Spring Return. Capacitors or other non-mechanical forms of fail-safe are not acceptable. The actuator mounting arrangement and spring return feature shall permit normally open or normally closed positions of the damper as required.
2. Economizer Actuators shall utilize Analog control 2-10 VDC, Floating control is not acceptable.
3. Electric damper actuators (including VAV box actuators) shall be direct shaft mounted and use a V-bolt and toothed V-clamp causing a cold weld effect for positive gripping. Single bolt or setscrew type fasteners are not acceptable.
4. One electronic actuator shall be direct shaft mounted per damper section. No connecting rods or jackshafts shall be needed. Small outside air and return air economizer dampers may be mechanically linked together if one actuator has sufficient torque to drive both and damper drive shafts are both horizontal installed.
5. Multi-section dampers with electric actuators shall be arranged so that each damper section operates individually. One electronic actuator shall be direct shaft mounted per damper section. (See below execution section for more installation details.)

E. Valve Actuators ½" to 6":

1. Mechanical spring shall be provided on all actuators for pre-heat coil and actuators for AHU heating or cooling coil when units are mounted outside. See plans for fail save flow function: Normal Open or Normal Closed. Capacitors or other non-mechanical forms of fail-safe are not acceptable.
2. All zone service actuators shall be non-spring return unless otherwise specified.
3. The valve actuator shall be capable of providing the minimum torque required for proper valve close off for the required application.
4. All control valves actuators shall have an attached 3-foot cable for easy installation to a junction box.
5. Override handle and gearbox release shall be provided for all non-spring return valve actuators.

F. Control Dampers. The BAS contractor shall furnish and size all automatic control dampers unless provided with packaged equipment. The sheet metal contractor shall install all dampers unless provided with packaged equipment.

1. All dampers used for modulating service shall be opposed blade type arrange for normally open or normally closed operation as required. The damper is to be sized so that when wide open the pressure drop is a sufficient amount of its close-off pressure drop for effective throttling.
2. All dampers used for two-position or open-close control shall be parallel blade type arranged for normally open or closed operation as required.
3. Damper linkage hardware shall be constructed of aluminum or corrosion resistant zinc & nickel-plated steel and furnished as follows:
4. Bearing support bracket and drive blade pin extension shall be provided for each damper section. Sheet metal contractor shall install bearing support bracket and drive blade pin extension. Sheet metal contractor shall provide permanent indication of blade position by scratching or marking the visible end of the drive blade pin extension.
5. Drive pin may be round only if V-bolt and toothed V-clamp is used to cause a cold weld effect for positive gripping. For Single bolt or set-screw type actuator fasteners, round damper pin shafts must be milled with at least one side flat to avoid slippage.
6. Damper manufacturer shall supply alignment plates for all multi-section dampers.

G. Control Valves ½" to 6": The BAS contractor shall furnish all specified motorized control valves and actuators. BAS contractor shall furnish all control wiring to actuators. The Plumbing contractor shall install all valves. Equal Percentage control characteristic shall be provided for all water coil control valves. Linear valve characteristic is acceptable for 3-way valves 2½ inch and above.

1. Characterized Control Valves shall be used for hydronic heating or cooling applications and small to medium AHU water coil applications to 100GPM. Actuators are non-spring return for terminal unit coil control unless otherwise noted. If the coil is exposed to the Outside Air stream then see plans for Spring Return requirement.

    a. Leakage is Zero percent, Close-off is 200psi, Maximum differential is 30psi. Rangeablity is 500:1.
    b. Valves 1/2 inch through 2 inches shall be nickel-plated forged brass body, NPT screw type connections.
    c. Valves 1/2 inch through 1-1/4 inches shall be rated for ANSI Class 600 working pressure. Valves 1-1/2 inch and 2 inches shall be rated for ANSI Class 400 working pressure.
    d. The operating temperature range shall be 0° to 250° F.
    e. Stainless steel ball & stem shall be furnished on all modulating valves.
    f. Seats shall be fiberglass reinforced Teflon.
    g. Two-way and three-way valves shall have an equal percentage control port. Full stem rotation is required for maximum flow to insure stable BTU control of the coil.
    h. Three-way valve shall be applicable for both mixing and diverting.
    i. The characterizing disc is made of TEFZEL and shall be keyed and held secure by a retaining ring.
    j. The valves shall have a blow out proof stem design.
    k. The stem packing shall consist of 2 lubricated O-rings designed for on-off or modulating service and require no maintenance.

l. The valves shall have an ISO type, 4-bolt flange, for mounting actuator in any orientation parallel or perpendicular to the pipe.
m. A non-metallic thermal isolation adapter shall separate valve flange from actuator.
n. One fastening screw shall secure the direct coupling of the thermal isolation adapter between the actuator and the valve. This will prevent all lateral or rotational forces from affecting the stem and it's packing O-rings.

2. Globe valves ½" to 2" shall be used for steam control or water flow applications.

a. Valves shall be bronze body, NPT screw type, and shall be rated for ANSI Class 250 working pressure.
b. Valves 1/2 inch (DN15) through 2 inches (DN50) with spring return actuators shall close off against 50 psi pressure differential with Class III leakage (.1%).
c. The operating temperature range shall be 20° to 280° F.
d. Spring loaded TFE packing shall protect against leakage at the stem.
e. Two-way valves shall have an equal percentage control port.
f. Three-way valves shall a linear control and bypass port.
g. Mixing and diverting valves must be installed specific to the valve design.

3. Globe Valve 2 ½ to 6":

a. Valves 2-1/2 inch (DN65) through 6 inches (DN50) shall be iron body, 125 lb. flanged with Class III (.1%) close-off leakage at 50 psi differential.
b. Valves with spring return actuators shall close off against 50 psi pressure differential with Class III leakage (.1%).
c. Flow type for two-way valves shall be equal percentage. Flow type for three-way valves shall be linear.
d. Mixing and diverting valves must be installed specific to the valve design.

H. Butterfly valves: Butterfly Valves shall be sized for modulating service at 60-70 degree stem rotation. Isolation valves shall be line-size. Design velocity shall be less than 12 feet per second when used with standard EPDM seats.

1. Body is Cast Iron.
2. Disc is Aluminum Bronze standard.
3. Seat is EPDM Standard.
4. Body Pressure is 200 psi, -30F to 275F.
5. Flange is ANSI 125/250.
6. Media Temperature Range is –22F to 240F.
7. Maximum Differential Pressure is 200 psi for 2" to 6" size.

I. Butterfly Valve Industrial Actuators:

1. Actuators shall be approved under Canadian Standards Association or other Nationally Recognized Testing Laboratory to UL standards. CSA Class 4813 02 or equal. Enclosure shall be NEMA 4 (weatherproof) enclosure and will have an industrial quality coating.

    a. Actuator shall have a motor rated for continuous duty. The motor shall be fractional horsepower; permanent split capacitor type designed to operate on a 120 VAC, 1 pH, 60 Hz supply. Two adjustable cam actuated end travel limit switches shall be provided to control direction of travel. A self-resetting thermal switch shall be imbedded in the motor for overload protection.
    b. Reduction gearing shall be designed to withstand the actual motor stall torque. Gears shall be hardened alloy steel, permanently lubricated. A self-locking gear assembly or a brake shall be supplied.
    c. Actuator shall have a 6 ft wiring harness provided for ease in field wiring (above 1500 in-lbs). Two adjustable SPDT cam-actuated auxiliary switches, rated at 250 VAC shall be provided for indication of open and closed position. Actuator shall have heater and thermostat to minimize condensation within the actuator housing.
    d. Actuator shall be equipped with a hand wheel for manual override to permit operation of the valve in the event of electrical power failure or system malfunction. Hand wheel must be permanently attached to the actuator and when in manual operation electrical power to the actuator will be permanently interrupted. The hand wheel will not rotate while the actuator is electrically driven.
    e. The actuator shall be Analog, floating, or two position as called out in the control sequence of operation. All Analog valves shall be positive positioning, and respond to a 2-10 VDC, 4-20 mA, or adjustable signal as required. Analog actuators shall have a digital control card allowing any voltage input for control and any DC voltage feedback signal for position indication.

2. Performance Verification Test:

    a. Control loops shall cause productive actuation with each movement of the actuator and actuators shall modulate at a rate which is stable and responsive. Actuator movement shall not occur before the effects of previous movement have affected the sensor.
    b. Actuator shall have capability of signaling a trouble alarm when the actuator Stop-Go Ratio exceeds 30%.

3. Actuator Mounting for Damper and Valve arrangements shall comply to the following:

    a. Damper Actuators: Shall not be installed in the air stream
    b. A weather shield shall be used if actuators are located outside. For Damper Actuators use clear plastic enclosure.
    c. Damper or valve actuator ambient temperature shall not exceed 122 Deg. F. through any combination of medium temperature or surrounding air.

Appropriate air gaps, thermal isolation washers or spacers, standoff legs, or insulation shall be provided as necessary

d. Actuator cords or conduit shall incorporate a drip leg if condensation is possible. Water shall not be allowed to contact actuator or internal parts. Location of conduits in temperatures dropping below dew point shall be avoided to prevent water from condensing in conduit and running into actuator.

e. Damper mounting arrangements shall comply to the following:

(1) The ventilation subcontractor shall furnish and install damper channel supports and sheet metal collars.
(2) No jack shafting of damper sections shall be allowed.
(3) Multi-section dampers shall be arranged so that each damper section operates individually. One electronic actuator shall be direct shaft mounted per section.

f. Size damper sections based on actuator manufacturers specific recommendations for face velocity, differential pressure and damper type. In general:

(1) Damper section shall not exceed 24 ft-sq. with face velocity £ 1500 FPM.
(2) Damper section shall not exceed 18 ft-sq. with face velocity £ 2500 FPM.
(3) Damper section shall not exceed 13 ft-sq. with face velocity £ 3000 FPM.

g. Multiple section dampers of two or more shall be arranged to allow actuators to be direct shaft mounted on the outside of the duct.

h. Multiple section dampers of three or more sections wide shall be arranged with a 3-sided vertical channel (8'' wide by 6" deep) within the duct or fan housing and between adjacent damper sections. Vertical channel shall be anchored at the top and bottom to the fan housing or building structure for support. The sides of each damper frame shall be connected to the channels. Holes in the channel shall allow damper drive blade shafts to pass through channel for direct shaft mounting of actuators. Open side of channel shall be faced down stream of the airflow, except for exhaust air dampers.

i. Multiple section dampers to be mounted flush within a wall or housing opening shall receive either vertical channel supports as descried above or sheet metal standout collars. Sheet metal collars (12" minimum) shall bring each damper section out of the wall to allow direct shaft mounting of the actuator on the side of the collar.

4. Valve Sizing for Water Coil:

a. On/Off Control Valves shall be line size.

b. Modulating Control Valve Body Size may be reduced at most two pipe sizes from the line size or not less than ½ the pipe size. The BAS contractor shall size all water coil control valves for the application as follows:

(1) Booster-heat valves shall be sized not to exceed 4-9psi differential pressure. Size valve for 50% Valve Authority. Valve design pressure drop is equal to the sum of coil drop plus the balance valve drop.
(2) Primary valves shall be sized not to exceed 5-15psi differential pressure. Size valve for 50% Valve Authority. Valve design pressure drop is equal to the sum of coil drop plus the balance valve drop.
(3) Butterfly valves shall be sized for modulating service at 60-70 degree rotation. Design velocity shall be 12 feet per second or less when used with standard EPDM seats.

c. Valve Mounting arrangements shall comply to the following:

(1) Unions shall be provided on all ports of two-way and three-way valves.
(2) Install three-way equal percentage Characterized Control valves in a mixing configuration with the "A" port piped to the coil.
(3) Install 2½ inch and above, Three-Way globe valves, as manufactured for mixing or diverting service to the coil.

2.7 ENCLOSURES:

A. All controllers, power supplies and relays shall be mounted in enclosures.

B. Enclosures may be NEMA 1 when located in a clean, dry, indoor environment. Indoor enclosures shall be NEMA 12 when installed in other than a clean environment.

C. Enclosures shall have hinged, locking doors.

D. Provide laminated plastic nameplates for all enclosures in any mechanical room or electrical room. Include location and unit served on nameplate. Laminated plastic shall be 1/8" thick sized appropriately to make label easy to read.

PART 3: EXECUTION

3.1 EXAMINATION:

A. Prior to starting work, carefully inspect installed work of other trades and verify that such work is complete to the point where work of this Section may properly commence.

B. Notify the owners' representative in writing of conditions detrimental to the proper and timely completion of the work.

C. Do not begin work until all unsatisfactory conditions are resolved.

3.2 INSTALLATION (GENERAL):

A. Install in accordance with manufacturer's instructions.

B. Provide all miscellaneous devices, hardware, software, interconnections installation and programming required to ensure a complete operating system in accordance with the sequences of operation and point schedules.

3.3 LOCATION AND INSTALLATION OF COMPONENTS:

A. Locate and install components for easy accessibility; in general, mount 48 inches above floor with minimum 3'-0" clear access space in front of units. Obtain approval on locations from owner’s representative prior to installation.

B. All instruments, switches, transmitters, etc., shall be suitably wired and mounted to protect them from vibration, moisture and high or low temperatures.

C. Identify all equipment and panels. Provide permanently mounted tags for all panels.

D. Provide stainless steel or brass thermowells suitable for respective application and for installation under other sections—sized to suit pipe diameter without restricting flow.

3.4 INTERLOCKING AND CONTROL WIRING:

A. Provide all interlock and control wiring. All wiring shall be installed neatly and professionally, in accordance with Specification Division 16 and all national, state and local electrical codes.

B. Provide wiring as required by functions as specified and as recommended by equipment manufacturers, to serve specified control functions. Provide shielded low capacitance wire for all communications trunks.

C. Control wiring shall not be installed in power circuit raceways. Magnetic starters and disconnect switches shall not be used as junction boxes. Provide auxiliary junction boxes as required. Coordinate location and arrangement of all control equipment with the owner's representative prior to rough-in.

D. Provide auxiliary pilot duty relays on motor starters as required for control function.

E. Provide power for all control components from nearest electrical control panel or as indicated on the electrical drawings—coordinate with electrical contractor.

F. All control wiring in the mechanical, electrical, telephone and boiler rooms to be installed in raceways. All other wiring to be installed neatly and inconspicuously per local code requirements. If local code allows, control wiring above accessible ceiling spaces may be run with plenum rated cable (without conduit).

3.5 DDC OBJECT TYPE SUMMARY:

A. Provide all database generation.

B. Displays: System displays shall show all analog and binary object types within the system. They shall be logically laid out for easy use by the owner. Provide outside air temperature indication on all system displays associated with economizer cycles.

C. Run Time Totalization: At a minimum, run time totalization shall be incorporated for each monitored supply fan, return fan, exhaust fan, hot water and chilled water pumps. Warning limits for each point shall be entered for alarm and or maintenance purposes.

D. Trendlog: All binary and analog object types (including zones) shall have the capability to be automatically trended.

E. Alarm: All analog inputs (High/Low Limits) and selected binary input alarm points shall be prioritized and routed (locally or remotely) with alarm message per owner's requirements.

F. Database Save: Provide back-up database for all stand-alone application controllers on disk.

3.6 FIELD SERVICES:

A. Prepare and start logic control system under provisions of this section.

B. Start-up and commission systems. Allow sufficient time for start-up and commissioning prior to placing control systems in permanent operation.

C. Provide the capability for off-site monitoring at control contractor's local or main office. At a minimum, off-site facility shall be capable of system diagnostics and software download. Owner shall provide phone line for this service for 1 year or as specified.

D. Provide Owner's Representative with spare parts list. Identify equipment critical to maintaining the integrity of the operating system.

3.7 TRAINING:

A. Provide application engineer to instruct owner in operation of systems and equipment.

B. Provide system operator’s training to include (but not limited to) such items as the following: modification of data displays, alarm and status descriptors, requesting data, execution of commands and request of logs. Provide this training to a minimum of 3 persons.

C. Provide on-site training above as required, up to 16 hours as part of this contract.

3.8 DEMONSTRATION:

A. Provide systems demonstration under provisions of Section 15010.

B. Demonstrate complete operating system to owner's representative.

C. Provide certificate stating that control system has been tested and adjusted for proper operation.

PART 4: SEQUENCE OF OPERATIONS

4.1 GENERAL:

A. Provide a complete and operational temperature control and building automation system based on the following points and sequence of operation. The system shall be complete as to sequences and standard control practices. The determined point list is the minimum amount of points that are to be provided. If additional points are required to meet the sequence of operation, they will be provided.

B. BACnet Object List

1. The following points as defined for each piece of equipment are designated as follows:

a. Binary Out (BO) - Defined as any two-state output (start/stop) (enable/disable), etc.
b. Binary In (BI) - Defined as any two-state input (alarm, status), etc.
c. Analog In (AI) - Defined as any variable input (temperature) (position), etc.
d. Analog Out (AO) - Defined as any electrical variable output. 0–20mA, 4–20mA and 0–10VDC are the only acceptable analog outputs. The driver for analog outputs must come from both hardware and software resident in the controllers. Transducers will not be acceptable under any circumstance.

4.2 CONTROL SEQUENCES:

A. Ductless Split Air Conditioning Units:

1. Each unit shall be controlled by a wall-mounted thermostat with programmable setpoints provided with each unit. The supply fan shall operate continuously. On a call for cooling, the controls shall stage on the DX cooling to maintain setpoint. On a call for heating (SAC- only), the controls shall stage on the electric resistance heat to maintain setpoint.
2. Safeties: An alarm shall annunciate the BAS whenever the condensate pump malfunctions. The BAS shall monitor unit status and room temperature.

B. Indoor VAV Energy Recovery Air Handling Units (AHU-CLRM1):

1. Occupied Mode: During occupied periods (as determined by the BAS) the supply and return/exhaust fans shall operate continuously.

a. Cooling: On a call for cooling, the BAS shall modulate open the outside air damper to maintain discharge air setpoint per an enthalpy economizer in response to the mixed air temperature sensor reading. As an option for the Owner, dry-bulb economizer logic shall also be provided in the programming. On a continued call for cooling, the BAS shall modulate the outside air damper back to its minimum setting and modulate the cooling coil control valve to maintain discharge air temperature setpoint, range adjustable. The discharge air setpoint shall be reset not less than 25% of the difference between the unit supply air temperature and the space temperature setpoint by the variable air volume terminal box calling for the least amount of cooling at its maximum primary air flow setpoint. Cooling shall include integrated economizer control to run simultaneously with the cooling to extend economizer operation when conditions are favorable. An enthalpy economizer shall compare indoor and outdoor enthalpy and modulate the unit outdoor air damper, recirculation air damper and exhaust air damper and energize the unit exhaust air fan during the cooling cycle to provide up to 100% outdoor air for free cooling. The economizer shall be disabled when the outside air temperature reaches 75 Deg. F.

b Dehumidification Control: Space humidity shall be measured by a return air duct-mounted humidistat. Upon a call for dehumidification (setpoint adjustable), the unit cooling discharge air reset control shall be over-ridden to lower the discharge air temperature to provide dehumidification of the supply air to satisfy the space humidity setpoint. Variable air volume terminal boxes shall modulate and provide reheat to prevent over-cooling of the spaces.

c. Heating: On a call for heating, the BAS shall modulate the outside air damper to minimum and also modulate the hot water heating coil control valve to maintain discharge air temperature setpoint. The discharge air temperature setpoint shall be reset by the variable air volume terminal box calling for the least amount of heat at its minimum primary air flow setpoint.

d. Outdoor Air: The outdoor air damper shall remain in the minimum position, except to modulate open in the economizer cycle. A damper end switch shall confirm damper position (open-min/open-max/closed) and the alarm the BAS upon failure to make position required for the sequence commanded.

e. VAV: The unit return/exhaust air fan shall operate as required to maintain building static pressure setpoint. A differential pressure controller shall compare the indoor air pressure with the outdoor ambient atmospheric pressure. The exhaust fan variable speed drive (VFD) shall modulate to control the building pressure within adjustable setpoints. A duct static pressure controller shall modulate the variable speed drive (VFD) of the supply air fan to maintain a constant static pressure at a point 2/3 down the supply air duct. The static pressure setpoint shall automatically be reset to conserve fan energy based upon the minimum duct static pressure required to satisfy the 'critical' variable volume box.

2. Unoccupied Mode: During unoccupied periods (as determined by the BAS) the BAS shall optimally stop the unit and control heating and cooling to reach unoccupied setpoint prior to the scheduled unoccupied time. The supply and return air fans shall be de-energized and outdoor air damper shall be closed. The recirculation air damper shall be open and the supply and return fans shall cycle to maintain night set-back temperatures. When the outdoor air temperature drops below 36 Deg. F., the heating water coil control valve shall remain partially open and the chilled water coil control valve shall be fully opened for freeze protection. On a manual call for override from the temperature sensor override button, the system shall return to the occupied mode of operation for a set period of time (adjustable).
3. Morning Warm-up/Cool Down Mode: The BAS shall optimally start the unit and modulate the heating or cooling water coil control valve to reach occupied setpoint by scheduled occupied time. The outside air damper shall be closed. The unit shall signal all variable air volume terminal boxes to full flow until the morning warmup/cool down setpoint is reached and the unit returns to occupied mode.
4. Energy Recovery Module: Cooling and heating shall be provided by the energy recovery wheel. An adjustable setpoint temperature sensor located in the outdoor air stream on the face of the wheel shall indicate the discharge air temperature. During economizer operation, when temperature and humidity conditions are suitable as determined by the BAS, the energy recovery wheel shall be de-energized. The BAS shall provide wheel exhaust air bypass damper control and wheel control to initiate defrost control. As outdoor air temperature falls and the wheel can't maintain discharge air temperature setpoint, the heating water coil control valve shall modulate to maintain discharge air temperature setpoint. The exhaust air fan variable speed drive (VFD) shall vary the exhaust air flow to maintain space static pressure.
4. A low limit sensor located across the face of the chilled water coil shall de-energize the unit fans, close the outdoor and exhaust air dampers and alarm the BAS.
5. Safeties: A duct smoke detector shall be provided in the return duct upstream of the air filters. On detection of products of combustion, the duct smoke detector shall stop the unit supply and exhaust fans and alarm the BAS and the Fire Alarm System.
6. Outdoor Air: The outdoor air damper shall remain in the open position during occupied periods as determined by the BAS. A damper end switch shall confirm damper position (open/closed) and the alarm the BAS upon failure to make position required for the sequence commanded.

C. Shut-Off Variable Volume Terminal Boxes (VV-):

1. Occupied Mode: On a call for cooling from the zone temperature sensor, the BAS shall modulate the air damper between its minimum (20%) and maximum settings to maintain zone temperature setpoint. On a call for heating the first stage shall modulate the heating water coil control valve while the airflow is maintained at the deadband flowrate. If the heating water coil control valve is at its maximum position and the space temperature continues to fall, the second stage of heating shall modulate the air flowrate from the deadband flowrate up to the heating maximum flowrate (50% of the zone peak design flowrate). Occupied space temperature set-points shall be 75 Deg. F in cooling and 70 Deg. F in heating (adjustable, confirm with Owner). If the air damper

operates at maximum air flow and is unable to maintain heating or cooling setpoint, then the BAS shall reset the associated air handling unit supply air temperature.

2. Deadband: Temperature deadband between heating and cooling mode shall be 5°F, at which time the heating water to the VV box is disabled.
3. Unoccupied Mode: On a call for heating from the zone temperature sensor, the BAS shall modulate open the air damper from the minimum to the maximum setting to maintain night temperature setback. Unoccupied space setback temperature shall be 85 Deg. F in cooling and 55 Deg. F in heating – (adjustable, confirm with Owner). If the air damper operates at maximum air flow and is unable to maintain the night temperature setback, then the BAS shall reset up the associated air handling unit supply air temperature. On a manual call for override from a space override button, the system shall return to the occupied mode of operation for a set period of time.
4. Morning Warm-Up/Cool-Down: On a signal from its associated air handling unit, the air damper shall open to its maximum setting until the morning warm-up/cool down setpoint is reached for its respective zone temperature sensor. If the air damper operates at maximum air flow and is unable to reach the morning setpoint, then the BAS shall reset the associated air handling unit supply air temperature.

D. Fans: Exhaust Fan EF- shall be controlled by a wall-mounted cooling thermostat. When the space temperature exceeds the setting of the thermostat, the fan shall be energized. When the fan is energized, the unit motorized damper shall be fully open. The exhaust fan status shall be monitored by the BAS and alarm of off-normal conditions.

4.3 POINT LISTS:

A. The following point lists are provided as a minimum basis for control. Other points shall be provided as required to accomplish the Control Sequences and to provide a complete control system for automatic and safe control of the HVAC equipment.

B. See attached pages 230900-23 through 230900-27.

END OF SECTION 230900

SYSTEM POINT LIST

SYSTEM POINT DESCRIPTION	ANALOG															BINARY											SYSTEM FEATURES																												NOTES
	INPUT											OUTPUT				INPUT							OUTPUT					ALARMS									PROGRAMS																
INDOOR VARIABLE AIR VOLUME AIR HANDLING UNIT with ENERGY RECOVERY (AH-CLRM1) (Page 1 of 2)	TEMPERATURE	PRESSURE	RH	KW	KWH	PPM	GPM	PERCENT	CFM	SETPOINT		DDC (4-20 mA or 0-10 vdc)		SETPOINT ADJ.		PNEU. TRANSDUCER	STATUS ON/OFF	FILTER STATUS	STATUS OPEN/CLOSED	STATUS	NO. OF STARTS	TIMED OVERRIDE		OFF/ON	OPEN/CLOSE	LOCK OUT	ENABLE/DISABLE		HIGH ANALOG	LOW ANALOG	BINARY		PROOF	SENSOR FAIL	FLOW FAIL	COMM. FAIL	DIAGNOSTICS		TIME SCHEDULING	DEMAND LIGHTING	OPTIMAL START/STOP	RESET (SCHEDULE)	EVENT PROGRAM	DDC	ALARM INSTRUCT	MAINT. WK. ORD.	RUN TIME	EXP. MESSAGE	SET BACK/SET UP	NIGHT PURGE	TIMED OVERRIDE			
CONTROLLER																	X									X								X					X		X				X			X				
SUPPLY AND EXHAUST FANS																	X						X								X		X																		
SUPPLY AIR	X									X		X		X														X	X			X									X												
PREHEAT COIL (CONTROL VALVE)												X																																									
COOLING COIL (CONTROL VALVE)												X																																								
OUTSIDE AIR	X		X																														X									X												
TIMED OVERRIDE																					X																																
REMOTE SETPOINT														X																													X											
SUPPLY AIR LOW LIMIT																				X											X																						
FILTER STATUS																		X													X																						
AVERAGE COIL DISCHARGE	X																											X	X				X																				CW & HW
RETURN AIR HUMIDISTAT			X							X				X														X																								
SUPPLY AND EXHAUST STATIC		X								X				X																			X																				
SUPPLY AND EXHAUST FAN MODULATION (VFD)								X		X		X		X			x						X											X																			
VFD FAIL (SUPPLY AND EXHAUST FAN)																														X																						

GENERAL NOTES: PROVIDE ONE COLOR GRAPHIC PER UNIT WITH ALL DYNAMIC DATA SHOWN.

SYSTEM POINT LIST

SYSTEM POINT DESCRIPTION

INDOOR VARIABLE AIR VOLUME AIR HANDLING UNIT with ENERGY RECOVERY (RTU-2M) (Page 2 of 2)

SYSTEM POINT DESCRIPTION	ANALOG INPUT: TEMPERATURE	ANALOG INPUT: PRESSURE	ANALOG INPUT: RELATIVE HUMIDITY	ANALOG INPUT: KW	ANALOG INPUT: KWH	ANALOG INPUT: CFM	ANALOG INPUT:	ANALOG INPUT: PERCENT	ANALOG INPUT: PERCENT RLA	ANALOG INPUT:	ANALOG OUTPUT: DDC (4-20 mA or 0-10 VDC)	ANALOG OUTPUT:	ANALOG OUTPUT: SETPOINT ADJ.	ANALOG OUTPUT:	ANALOG OUTPUT:	BINARY INPUT: STATUS	BINARY INPUT: STATUS ON/OFF	BINARY INPUT: FILTER STATUS	BINARY INPUT: STATUS OPEN/CLOSED	BINARY INPUT: TIMED OVERRIDE	BINARY INPUT:	BINARY OUTPUT: STOP/START	BINARY OUTPUT: OPEN/CLOSED	BINARY OUTPUT: LOCK OUT	BINARY OUTPUT: ENABLE/DISABLE	BINARY OUTPUT:
HX ENTHALPY WHEEL																X									X	
EXHAUST AIR ENT HX	X																									
EXHAUST AIR LEAV. HX	X																									
OUTDOOR AIR ENT. HX	X																									
OUTDOOR AIR LEAV. HX	X																									
RECIRCULATION AIR DAMPER											X								X						X	
EXHAUST AIR BYPASS DAMPER											X								X						X	
OUTDOOR AIR BYPASS DAMPER											X								X						X	
OUTDOOR AIR DAMPER											X								X						X	
EXHAUST AIR DAMPER											X								X						X	

SYSTEM POINT DESCRIPTION	ALARMS: HIGH ANALOG	ALARMS: LOW ANALOG	ALARMS: BINARY	ALARMS: PROOF	ALARMS: SENSOR FAIL	ALARMS: FLOW FAIL	ALARMS: COMM. FAIL	ALARMS: DIAGNOSTICS	ALARMS: DIRTY FILTER	PROGRAMS: TIME SCHEDULING	PROGRAMS: OPT. START/STOP	PROGRAMS: DEMAND LIMITING	PROGRAMS: RESET	PROGRAMS: EVENT PROGRAM	PROGRAMS: DDC	PROGRAMS: ALARM INSTRUCT	PROGRAMS: MAINT. WK. ORD.	PROGRAMS: RUN TIME	PROGRAMS: SETPOINT ADJ.	PROGRAMS: SET BACK/SET UP	PROGRAMS: NIGHT PURGE	PROGRAMS: TENANT BILLING	PROGRAMS: CHILLER SEQUENCING	PROGRAMS: TOTALIZING	PROGRAMS: TIMED OVERRIDE	PROGRAMS:	NOTES
HX ENTHALPY WHEEL				X																							
EXHAUST AIR ENT HX	X	X			X		X																				
EXHAUST AIR LEAV. HX	X	X			X		X																				
OUTDOOR AIR ENT. HX	X	X			X		X																				
OUTDOOR AIR LEAV. HX	X	X			X		X																				
RECIRCULATION AIR DAMPER																											
EXHAUST AIR BYPASS DAMPER																											
OUTDOOR AIR BYPASS DAMPER																											
OUTDOOR AIR DAMPER																											
EXHAUST AIR DAMPER																											

GENERAL NOTES: PROVIDE ONE COLOR GRAPHIC PER UNIT WITH ALL DYNAMIC DATA SHOWN.

SYSTEM POINT LIST

SYSTEM POINT DESCRIPTION	ANALOG															BINARY										SYSTEM FEATURES																																	NOTES
	INPUT												OUTPUT			INPUT						OUTPUT					ALARMS										PROGRAMS																					
SHUT-OFF VARIABLE AIR VOLUME (VV) TERMINAL BOXES (PAGE 1 OF 2)		TEMPERATURE	PRESSURE	RH	KW	KWH	BTU/HR	GPM	PERCENT	CFM	SETPOINT			DDC (4-20 mg 0-10 vdc)		SETPOINT ADJ.		PNEU. TRANSDUCER	STATUS ON/OFF	FILTER STATUS	STATUS OPEN/CLOSED	STATUS	NO. OF STARTS	TIMED OVERRIDE		OFF/ON	OPEN/CLOSE	LOCK OUT	ENABLE/DISABLE		HIGH ANALOG	LOW ANALOG	BINARY	PROOF	SENSOR FAIL	FLOW FAIL	COMM. FAIL	DIAGNOSTICS			TIME SCHEDULING	DEMAND LIGHTING	OPTIMAL START/STOP	RESET	EVENT PROGRAM	DDC	ALARM INSTRUCT	MAINT. WK. ORD.	RUN TIME	EXP. MESSAGE	SET BACK/SET UP	NIGHT PURGE	TENANT BILLING	CHILLER SEQUENCING	TOTALIZING	TIMED OVERRIDE		
SPACE TEMP		X									X			X		X														X	X			X		X																					
HEATING SETPOINT											X			X		X																																											
COOLING SETPOINT											X			X		X																																										
CFM										X				X																						X																					
MAX. CFM																X																																									
MIN. CFM																X																																									
HEATING MIN. CFM																X																																								
HEATING COIL (CONTROL VALVE)														X																																									
UNOCCUPIED HTG. SETPOINT																X																																								
UNOCCUPIED CLG. SETPOINT																X																																								
TIMED OVERRIDE REQUEST																								X																																

GENERAL NOTES: PROVIDE ONE COLOR GRAPHIC PER UNIT WITH ALL DYNAMIC DATA SHOWN.

SYSTEM POINT LIST

SYSTEM POINT DESCRIPTION		ANALOG														BINARY										SYSTEM FEATURES																																	NOTES
		INPUT											OUTPUT				INPUT							OUTPUT					ALARMS											PROGRAMS																					
VV TERMINAL BOXES (PAGE 2 OF 2)		TEMPERATURE	PRESSURE	RH	KW	KWH	BTU/HR	GPM	PERCENT	CFM			DDC (4-20 mg 0-10 vdc)		SETPOINT ADJ. (MANUAL)		PNEU. TRANSDUCER	STATUS ON/OFF	FILTER STATUS	STATUS OPEN/CLOSED	STATUS	TIMED OVERRIDE		OFF/ON	OPEN/CLOSE	LOCK OUT	ENABLE/DISABLE		HIGH ANALOG	LOW ANALOG	BINARY	PROOF	SENSOR FAIL	FLOW FAIL	COMM. FAIL	DIAGNOSTICS			TIME SCHEDULING	DEMAND LIGHTING	OPTIMAL START/STOP	RESET	EVENT PROGRAM	DDC	ALARM INSTRUCT	MAINT. WK. ORD.	RUN TIME	EXP. MESSAGE	SET BACK/SET UP	NIGHT PURGE	TENANT BILLING	CHILLER SEQUENCING	TOTALIZING	TIMED OVERRIDE	
CONTROL OFFSET															X																																										
RECALIBRATE										X																																																
MAX. ZONE TEMP/GROUP		X																											X																												
MIN. ZONE TEMP/GROUP		X																												X																											
MAX. ZONE		X																																										X														
MIN. ZONE		X																																										X														
MAX. DAMPER POSITION									X																																			X														

GENERAL NOTES: PROVIDE ONE COLOR GRAPHIC PER UNIT WITH ALL DYNAMIC DATA SHOWN.

SYSTEM POINT LIST

ANALOG

SYSTEM POINT DESCRIPTION		INPUT									OUTPUT				
MISCELLANEOUS		TEMPERATURE	PRESSURE	RH	KW	GPM	PPM	PERCENT	CFM	KWH	DDC		SETPOINT ADJ.		
MISC. EXHAUST FANS															
DUCTLESS SPLIT SYSTEM AC UNITS		X													

BINARY

SYSTEM POINT DESCRIPTION	INPUT						OUTPUT				
MISCELLANEOUS	STATUS ON/OFF	FILTER STATUS	STATUS OPEN/CLOSED	STATUS	NO. OF STARTS	TIMED OVERRIDE	OFF/ON	OPEN/CLOSE	LOCK OUT	ENABLE/DISABLE	LOCAL/REMOTE
MISC. EXHAUST FANS	X						X				
DUCTLESS SPLIT SYSTEM AC UNITS	X						X				

SYSTEM FEATURES

SYSTEM POINT DESCRIPTION	ALARMS									
MISCELLANEOUS	HIGH ANALOG	LOW ANALOG	HIGH BINARY	LOW BINARY	PROOF	SENSOR FAIL	FLOW FAIL	CONDENSATE PUMP FAIL	LOCKOUT (VOTE)	DIAGNOSTICS
MISC. EXHAUST FANS										
DUCTLESS SPLIT SYSTEM AC UNITS								X		

SYSTEM POINT DESCRIPTION	PROGRAMS																	NOTES
MISCELLANEOUS	TIME SCHEDULING	DEMAND LIMITING	OPT. START/STOP	RESET	EVENT PROGRAM	DDC	ALARM INSTRUCT	MAINT. WK. ORD.	RUN TIME	EXP. MESSAGE	SET BACK/SET UP	NIGHT PURGE	TENANT BILLING	TREND LOG				
MISC. EXHAUST FANS	X																	
DUCTLESS SPLIT SYSTEM AC UNITS							X											

GENERAL NOTES: COORDINATE QUANTITY OF LIGHTING CONTACTORS WITH ELECTRICAL DRAWINGS.

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SECTION 232000 - HVAC PIPING

PART 1: GENERAL

1.1 CONDITIONS:

A. The applicable provisions of Section 23 00 00, HEATING, VENTILATING AND AIR-CONDITIONING (HVAC) are hereby made a part of this section, and the Contractor is cautioned to read Section 23 00 00 carefully as items of work applicable to this section are included in Section 23 00 00.

1.2 DESCRIPTION OF WORK:

A. Piping to connect HVAC equipment, including the following:

1. Heating Water Piping
2. Chilled Water Piping
3. Refrigerant Piping
4. Condensate Drain Piping

B. Installation of control valves and instrument wells referred to in other Division 23 sections.

C. Hydronic System Components

1.3 RELATED WORK:

A. Section 23 00 00, HEATING, VENTILATING AND AIR-CONDITIONING (HVAC).

B. Section 23 05 93, TESTING, ADJUSTING, AND BALANCING FOR HVAC.

C. Section 23 07 00, HVAC INSULATION.

D. Section 23 09 00, INSTRUMENTATION AND CONTROL FOR HVAC.

E. Section 23 30 00, HVAC AIR DISTRIBUTION.

F. Section 23 70 00, CENTRAL HVAC EQUIPMENT.

G. Section 23 81 00, DECENTRALIZED UNITARY HVAC EQUIPMENT.

H. Section 23 82 00, CONVECTION HEATING AND COOLING UNITS.

1.4 SUBMITTALS:

A. In accordance with Section 23 00 00, HEATING, VENTILATING AND AIR-CONDITIONING (HVAC), furnish the following:

1. Manufacturer's Literature and Data with pump curve (where applicable):

a. Pipe and equipment supports. Submit calculations for variable spring and constant support hangers
b. Pipe and tubing, with specification, class or type, and schedule
c. Pipe fittings, including miscellaneous adapters and special fittings
d. Flanges, gaskets and bolting
e. Valves of all types
f. Strainers
g. Gages
h. Refrigerant valves and components
i. Flexible connectors for water service
j. All specified hydronic system components
k. Water flow measuring devices
l. Thermometers and tests wells

PART 2: PRODUCTS

2.1 PIPE AND EQUIPMENT SUPPORTS, PIPE SLEEVES, AND WALL AND CEILING PLATES:

A. Provide in accordance with specifications in Section 23 00 00, HEATING, VENTILATING AND AIR-CONDITIONING (HVAC).

2.2 PIPE AND TUBING:

A. Heating Water Piping and Chilled Water Piping (2-1/2 Inch and Larger):

1. Black Steel: ASTM A 53 Schedule 40 standard weight.

B. Heating Water Piping and Chilled Water Piping (2-Inch and Smaller):

1. Black Steel: ASTM A 53 Schedule 40 standard weight.
2. Copper Water Tube Option: ASTM B 88, Type L, hard drawn. Except underground lines shall be Type K hard drawn copper tubing.

C. Cooling Coil Condensate Drain Piping:

1. From Air Handling Units: Copper water tube, ASTM B 88, Type L, hard drawn copper tubing.

D. Refrigerant Piping:

1. Copper Tubing: ASTM B 280, type ACR, cleaned, dehydrated and sealed seamless.

2.3 FITTINGS FOR STEEL PIPE:

A. 2-1/2 Inch and Larger: Welded, flanged, or grooved joints suitable for 125 psi service.

1. Butt Weld Fittings: ANSI B16.9 with same wall thickness as connecting piping. Elbows shall be long radius type unless otherwise noted.
2. Welding Flanges and Bolting: ANSI B16.5.

a. Water Service: Weld neck or slip-on plain face, with 1/8-inch thick full face neoprene gasket suitable for 220 Deg. F.
b. Flange Bolting: Carbon steel machine bolts or studs and nuts, ASTM A 307, Grade B.
c. Grooved: ASTM A-536 ductile iron couplings, ASTM A-153 galvanized, Victaulic Style 77.

(1) Heating water gasket suitable for 230 Deg. F continuous service.
(2) Chilled water gaskets shall be suitable for the intended service.
(3) Steam service not applicable.

B. 2-Inch and Smaller: Threaded or welded, suitable for 125 psi service.

1. Butt Welding: ANSI B16.9 with same wall thickness as connecting piping.
2. Forged Steel, Socket welding or Threaded: ANSI B16.11.
3. Threaded: 150 pound malleable iron, ASTM B16.3. Bushing reduction of a single pipe size, or use of close nipples, is not acceptable.
4. Unions: Fed. Spec. WW-U-531.
5. Water Hose Connection Adapter: Brass, pipe thread to 3/4-inch garden hose thread, with hose cap nut.

C. Welded Branch and Tap Connections: Forged steel weldolets and thredolets may be used for branch connections up to one pipe size smaller than the main. Forged steel half-couplings, ANSI B16.11 may be used for drain, vent and gage connections.

2.4 FITTINGS:

A. Copper Tubing:

1. Solder Joint: Wrought copper, ANSI B16.22.

a. Solder for Drain Piping: 95-5 tin-antimony, ASTM B 32 (95TA).
b. Solder for Refrigerant Piping: Silver brazing alloy.

B. Bronze Flanges and Flanged Fittings: ANSI B16.24.

2.5 DIELECTRIC FITTINGS:

A. Provide where copper and ferrous metal are joined.

1. 2 Inch and Less: Threaded dielectric union.
2. 2-1/2 Inch and Larger: Flange union with dielectric gasket and bolt sleeves.

2.6 THREADED JOINTS:

A. Pipe Thread: ANSI B2.1.

B. Lubricant or Sealant: Oil and graphite or other compound approved for the intended service.

2.7 VALVES:

A. Valves shall be Stockham, Milwaukee, Nibco, or Victaulic. All valves shall be suitable for 125 psi working pressure unless noted otherwise. Valves shall have threaded or grooved connections, except where flanges are specified they shall have flanged connections or where installed in hard drawn copper lines they may have sweat connections.

B. Service Valves:

1. 2-1/2 Inch and Smaller:

a. Gate valve: ASTM B-62 bronze body and solid wedge disc, rising stem MSS SP-80, Class 125.
b. Ball valve: ASTM B-584 Alloy 844 bronze body and stainless steel ball with teflon seats, conventional port, and blowout proof stems MSS SP-110, 150 PSI/600 PSI non-shock. Provide extended stem per application.

2. 3 Inch and Larger:

a. Water service: ASTM A-536 ductile iron body butterfly, ASTM B-148 alloy 954/955 disc, EPDM seats, Class 200, locking-type manual lever.
b. Steam service (low pressure): Iron body gate, solid bronze wedge disc, flanged, outside screw and yoke, MSS SP-70, bronze mounted, Class 1 (125 psig).

C. Globe Valves:

1. 2-Inch and Smaller: ASTM B-62 bronze body and disc, MSS SP-80, Class 125.
2. 2-1/2 Inch and Larger: Similar to above, but ASTM A-126 flanged cast iron body, with bronze trim, bolt bonnet, OS & Y, renewable seat and disc.

D. Check valves in sizes up to and including 2 inch shall be all bronze, swing type, with regrinding disc capable of being reground without removing the valve body from the line. Sizes 2-1/2 inch and larger shall be iron body, bronze-trimmed, regrinding seat, swing type, for water service.

E. Refrigerant components shall include sight glass, filter drier, solenoid valve, charging valve, expansion valve and isolation valves. Refrigerant valves shall conform to ANSI B31.5. Refrigerant drier shall conform to ARI 710. Refrigerant circuit access ports shall be fitted with locking type tamper resistant caps in strict accordance with the IMC.

F. Balancing Cocks: Combination balancing and shut-off valves shall incorporate a position indicator and memory stop or locking device so the valve can be closed without disturbing the setting, and be returned to the balanced position without further adjustment.

1. 4-Inch and Larger: Butterfly valves or plug valves.
2. 3-Inch and Smaller: Resilient faced eccentric plug or lubricated plug type, iron or steel body, bronze plug and bearings, wrench operated, rated 175 psig at 200 Deg. F.

2.8 STRAINERS:

A. Mueller Steam Specialty Co. No. 351 Y type.

1. Water Services: Rated 125 psig saturated steam at 450 Deg. F.

a. 2-1/2 Inch and Larger: Flanged, iron body, basket type (No. 165).
b. 2-Inch and Smaller: Bronze, threaded ends, Y type (No. 351).

2. Screens: Bronze, monel metal or 18-8 stainless steel, free area not less than 2-1/2 times pipe area, with perforations as follows:

a. Water Service:

(1) 2-1/2 Inch and Larger: 1/16-inch diameter perforations.
(2) 2 Inch and Smaller: 1/32-inch diameter perforations.

B. Provide blow off outlet with pipe nipple and gate valve.

2.9 FLEXIBLE CONNECTORS FOR REFRIGERANT PIPING:

A. Flexible bronze or stainless steel piping connectors shall be Spring-Flex type MFP, style BF as manufactured by Vibration Mountings and Controls, Inc.

2.10 FLEXIBLE CONNECTORS FOR WATER SERVICE:

A. Flexible pipe joints shall be Flexonics Model PCS, stainless steel braided hose, pipe line size, flanged, minimum 125 psi working pressure at 250 degrees F.

2.11 EXPANSION JOINTS:

A. Expansion joints shall be Flexonic internally guided, corrugated bellows, expansion compensator, Type HB, 2" minimum stroke, suitable for (steam) (hot water) service. Grooved pipe couplings and expansion compensators shall provide for expansion in grooved piping systems.

B. Expansion joints shall be Kelflex GTI-M-311 (or equal) dual or single internally guided, corrugated bellows, expansion compensator, 2" minimum stroke, suitable for hot water service. Grooved pipe couplings and expansion compensators shall provide for expansion in grooved piping systems. Provide necessary pipe alignment guides as required for expansion joint installation.

2.12 FLEXIBLE CONNECTORS FOR WATER SERVICE:

A. Flexible pipe joints shall be Flexonics Model PCS, stainless steel braided hose, pipe line size,flanged, minimum 125 psi working pressure at 250 Deg. F.

2.13 HYDRONIC SYSTEM COMPONENTS:

A. Air Vents: Manual air vents shall be chromium-plated brass 1/8" NPT coin-operated type. Provide extension tube if required to maintain access to vent operator.

B. Drains: Drains shall be accessible with 3/4" hose-end drain valve unless indicated otherwise.

2.14 WATER FLOW MEASURING DEVICES:

A. Circuit setters shall be Bell and Gossett bronze balance valve with provisions for connecting a portable differential pressure meter. Meter connections shall have built-in check valves. An integral pointer shall register degree of valve opening. Each balance valve shall be constructed for 125 lbs. working pressure at 250 Deg. F. Furnish one differential meter Model RO-5 complete with meter, cutoffs, piping, fitting, and hose. The valve pressure drop and the setting shall determine the actual system flow rate.

B. Automatic Flow Control Valves shall be Griswold, Autoflow, Hays or equal and shall be provided at all water source heat pump units. Valves shall be automatic pressure compensating type and factory set to provide specified flow rates within five (5) percent regardless of system pressure. Valves shall be selected to provide specified flow rates with a minimum pressure differential of 2 psig and maximum pressure drop of 10 feet of water. Where system

differential exceeds 32 psig, valves shall be selected for a range of 4-57 psig. Valve body shall be suitable for use with piping system and internal working parts shall be stainless steel, nickel plated brass or elastomeric diaphragm. All valves shall be provided with union and pressure-temperature test ports suitable for connecting differential pressure measuring devices. All valves shall be wye configuration for removal of controlling element without removing valve from piping. Each valve shall be identified as to direction of flow and flow rate. One differential pressure meter shall be provided complete with dual hose kit, valves, flow conversion chart and carrying case. Meter and accessories shall be turned over to the Owner upon final acceptance of the project.

2.15 GAGES, PRESSURE AND COMPOUND:

A. Pressure gauges shall be Ashcroft bourdon tube, general service type suitable for 125 psi service. Gauges shall not be less than 4" dial type with aluminum case and gauge cock. Gauges shall be graduated in feet of water and psi.

B. Range of Gages: Provide range equal to at least 150 percent of normal operating range.

2.16 THERMOMETERS:

A. Weksler Instruments Type AA, Fed. Spec. GG-T-321, non-mercury fluid filled type, blue column, clear plastic window, with 6-inch brass stem, straight, adjustable angle as required for each in reading.

B. Scale: Not less than nine inches, range as described below, two degree graduations.

C. Separable Socket (Well): Brass, extension neck type to clear pipe insulation.

D. Scale ranges may be slightly greater than shown to meet manufacturer's standard.

PART 3: EXECUTION

3.1 PIPING INSTALLATION:

A. General:

1. The drawings show the general arrangement of pipe and equipment but do not show all fittings and offsets that may be necessary.
2. Store materials to avoid excessive exposure to weather or foreign materials. Keep inside of piping relatively clean during installation and protect open ends when work is not in progress.
3. Support piping securely. Refer to Section 23 00 00, HEATING, VENTILATING AND AIR-CONDITIONING (HVAC). Suspended horizontal piping shall be supported by adjustable wrought steel clevis hangers, except that straight runs of piping with 40 feet or more between anchor and expansion device shall be supported on roller type hangers

or supports. Protection saddle, welded to pipe, shall be provided at each roller support. All supports shall be attached to the building structure and shall in no way be attached to the supports or other equipment, piping, or ductwork. Where supports bear on copper pipe, they shall be copper plated. Chain, strap, or other makeshift devices will not be permitted as hangers or supports. Maximum pipe support spacing shall be in accordance with Table 1 – MAXIMUM PIPING SUPPORT SPACING, except where grooved couplings are used, no pipe length shall be left unsupported between any two grooved couplings:

Table 1 - Maximum Piping Support Spacing

PIPING MATERIAL	MAXIMUM HORIZONTAL SPACING (feet)	MAXIMUM VERTICAL SPACING (feet)
ABS Pipe	4	10[c]
Aluminum Pipe and Tubing	10	15
Brass Pipe	10	10
Brass Tubing, 1¼-inch Diameter & Smaller	6	10
Brass Tubing, 1½-inch Diameter & Larger	10	10
Cast-Iron Pipe[b]	5	15
Copper or Copper-Alloy Pipe	12	10
Copper or Copper-Alloy Tubing, 1¼-inch Diameter and Smaller	6	10
Copper or Copper-Alloy Tubing, 1½-inch Diameter & Larger	10	10
CPVC Pipe or Tubing, 1-inch & Smaller	3	10[c]
CPVC Pipe or Tubing, 1¼-inch & Larger	4	10[c]
Lead Pipe	Continuous	4
PB Pipe or Tubing	2-2/3 (32 inches)	4
PEX Tubing	2-2/3 (32 inches)	10[c]
Polypropylene (PP) Pipe or Tubing, 1-inch or Smaller	2-2/3 (32 inches)	10[c]
Polypropylene (PP) Pipe or Tubing, 1¼-inch or Larger	4	10[c]
PVC Pipe	4	10[c]
Steel Tubing	8	10
Steel Pipe	12	15

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm

a. See Section 301.18.
b. The maximum horizontal spacing of cast-iron pipe hangers shall be increased to 10 feet where 10-foot lengths of pipe are installed.
c. Mid-story guide.

4. Supports on chilled water and condensate drain lines shall be provided with a 12" long section of hydrous calcium silicate, which shall have joints sealed and covered with a

vapor barrier jacket. Hanger rods shall be 3/8" diameter size for pipes up through 2", 1/2" diameter size for 1-1/2" through 3", 5/8" diameter for pipes 4" through 5", and 7/8" diameter size for 6" through 12". Pipe hanger rods shall be attached to the top chord only on steel joists and beams by joist or beam clamps without welding. Welding of support rods and connection at any place other than the top chord will not be permitted unless written approval is granted by the Architect.

5. Install piping generally parallel to walls and column centerlines, unless shown otherwise on the drawings. Space piping, including insulation, to provide one inch minimum clearance between adjacent piping or other surface. Pipe shall be installed to permit free expansion and contraction without damage to joints or hangers. Slope piping down in the direction of flow not less than one inch in 40 feet. Provide eccentric reducers to keep bottom of sloped piping flat. All high points in water lines shall be provided with manual-air vents, all low points with drains. Condensate drain lines shall slope 1/8" per foot in direction of flow.
6. Anchors for pipe shall be provided as indicated or as required at the job site to localize expansion and contraction of pipe. Anchors shall consist of heavy steel or brass collars bolted or welded to the pipe and rigidly connected to the building structure unless indicated otherwise. Anchor braces shall not be attached in places where they will damage or injure the structure during installation or by the weight or expansion force of the pipe line after installation.
7. Locate and orient valves to permit proper operation and access for maintenance of packing, seat and disc. Generally locate valve stems in overhead piping in horizontal position. Control valves usually require reducers to connect to pipe sizes shown on the drawings. Isolation service valves shall be installed on each side of major piece of equipment such as a pump, boiler, chiller, heating coil, cooling coil and other similar items, and at any other points indicated or required for draining, isolation or sectionalizing purposes. Control valves shall be installed in accordance with control manufacturer's recommendations.
8. Offset equipment connections to allow valving off for maintenance and repair with minimal removal of piping. Provide flexibility in equipment connections and branch line takeoffs with 3-elbow swing joints where noted on the drawings.
9. Tee water piping runouts or branches into the side of mains or other branches. Avoid bull-head tee, which is two return lines entering opposite ends of a tee and exiting out the common side or two supply lines exiting opposite ends of a tee and entering the common side.
10. Connect piping to equipment as shown on the drawings. Piping connections to equipment shall be provided with unions or flanges. (Banked water coils shall be piped in reverse return arrangement.) (Steam coils shall be trapped individually.) (Vacuum breaker shall be provided at steam supply connection to each steam coil or steam bundle.) A straight spool piece equal in length to impeller diameter shall be provided at suction connection to each pump. Install components furnished by others such as:

    a. Flow elements (orifice unions), control valve bodies, flow switches, pressure taps with valve, and wells for sensors.
    b. Thermometer Wells: In pipes 2-1/2 inches and smaller, increase the pipe size to provide free area equal to the upstream pipe area.

B. Pipe Joints:

1. Sweated: Copper tubing shall be cut square, ends reamed, and all filings and dust wiped from interior of pipe. Joints shall be soldered with solder drawn through the full fitting length. Excess solder shall be wiped from joint before solder hardens. Solder shall be 95/5 composition; 50/50 will not be allowed.
2. Threaded: Threaded joints shall be made with tapered threads properly cut. Joints shall be made tight with a stiff mixture of litharge and glycerin or other approved thread joint compound applied with a brush to the male threads only. Not more than three threads shall show after the joint is made up.
3. Grooved: Pipe coupling joints shall be assembled according to manufacturer's specifications. Pipe shall be square cut and grooved in accordance to manufacturer's specifications. Gaskets shall be verified as suitable for the intended service and shall be coated on the lips and back with a thin uniform coat of lubricant. The coupling housing shall be assembled over the gasket and shall engage both grooves. The nuts shall be uniformly tightened until the housing pads are firmly together metal to metal.
4. Welded: Joints shall be fusion-welded by qualified welders in accordance with ANSI B31.10, unless otherwise required. Changes in direction of piping shall be made with fittings only. Mitering or notching pipe to form elbows and tees or other similar type construction will not be permitted. Saddle-type welding outlets may be used for equipment take-offs from the mains.
5. Flanges and Unions: Fittings shall be faced true and made square and tight. Unions shall be 125 psi service, bronze seat type. Flanges shall be ANSI Standard 125 psi service with 1/16" thick red rubber gaskets. Unions and flange joints shall be provided on each side of each valve 2-1/2" or larger and in each line immediately preceding the connection to each major piece of equipment such as a (pump), (converter), (boiler), (chiller), (heating coil), (cooling coil) and other similar items.
6. Dielectric fittings such as couplings, unions, or flanges, shall be installed to isolate pipes of non-ferrous metal where connection is made to ferrous metal. Isolation shall be accomplished by non-metallic, unthreaded sleeves or gaskets or a combination of both. Fittings shall be so designed that the installing tools cannot come in contact with the insulating material. Materials shall withstand pressure and temperature as required.

C. Leak Testing: Inspect all joints and connections for leaks and workmanship and make corrections as necessary.

1. A hydrostatic test at 1.5 times design pressure for 4 hours. Factory tested equipment (converters, exchangers, coils, etc.) need not be field tested. Avoid excessive pressure on mechanical seals and safety devices.
2. Refrigerant Piping:

    a. Refrigerant Piping System: The system shall be tested for tightness after installation and before insulation is applied. Controls and other equipment that may be damaged by the test pressure employed shall be temporarily removed or made inoperative before the tests are made and the openings shall be plugged or capped. Threaded, soldered, or brazed joints that leak shall be corrected by having the joints remade. Welded joints that leak shall be repaired by cutting out

the faulty weld affected section and rewelding the joint or renewing the section of pipe.

b. Test Pressures: Refrigerant system test pressures for tightness shall not be less than ANSI 15 or ANSI B31.5 test pressures specified.

c. Charging the System for Test: The low and high pressure side of the system shall be charged with a dry, inert gas, such as nitrogen or anhydrous carbon dioxide using a small amount of the refrigerant gas to act as a tracer. A pressure limiting or reducing valve with pressure gage shall be used on the high pressure gas tank to limit the pressure in the system to the specified test pressure for the respective refrigerant.

d. Leakage Test: With the system charged to the desired pressure, the gas supply shall be tightly shut off and the system held for 30 minutes, during which time there shall be no loss of pressure. If a pressure drop, not attributable to temperature changes, occurs during this period the entire system shall be checked with a halide torch or an electronic leak detector. When leaks are found, they shall be repaired and another 30 minute period at the test pressure shall be made. Testing and repair shall continue until there is no loss of pressure.

e. Evacuation: After completion of testing of refrigerant system for leaks, remove all air and moisture from the system by using a high vacuum pump. The pump shall be capable of reducing the absolute pressure in the system to a point where any water present in the lines will vaporize at a temperature appreciably below the ambient temperature and will be withdrawn from the system. Before conducting the evacuation test, inspect the vacuum pump oil for purity and provide new oil charge if existing charge is contaminated. Evacuate the system to a maximum absolute pressure of 0.020-inches of mercury (500 microns) or lower. During the evacuation, the ambient temperature shall not be less than 35 degrees F. Pressure gages shall be used for measurement of pressure. Upon achieving evacuation of system, valve off the vacuum pump from the system for a period of at least 12 hours. The system shall be considered tight and dry and free of air if the absolute pressure has not increased by more than .002-inches of mercury (50 microns) at the expiration of this period. Repeat the pressure test if the pressure rise exceeds 0.02-inches of mercury which indicates a leak in the system or presence of moisture. If no leaks are found, resume the evacuation test and continue until dryness of system is achieved. When a satisfactory vacuum has been obtained, it shall be broken with the introduction of vapor (no liquid) and subsequent sealing off of the system.

f. Charging: Provide the initial charge of refrigerant. Charge by connecting the drums of refrigerant to the system charging connection, to feed the liquid refrigerant into the low side of the system where it will be evaporated. The gross and net weights of the drum shall be noted, and the drum placed on a scale so that it may be determined when it has been emptied. The charging connection shall be loosely connected to the system connection, so that the initial flow of refrigerant will expel air from the connection, following which the loose joint shall be tightened. When the system vacuum has been broken by the refrigerant, the compressor shall be started and operated while charging continues. The following procedures and precautions shall be exercised during the charging operation:

(1) The refrigerant condensing system shall be placed in operation.
(2) The fluid circulation system of water coolers or evaporator fans of a direct expansion system, shall be placed in operation.
(3) Compressor discharge pressure shall not be permitted to become excessive.

3.2 FLUSHING AND CLEANING PIPING SYSTEMS:

A. Water Piping: Clean systems as recommended by the suppliers of the boiler water treatment chemicals specified in this section.

1. Initial Flushing: Remove loose dirt, mill scale, metal chips, weld beads, rust, and like deleterious substances without damage to any system component. Bypass factory cleaned equipment unless acceptable means of protection are provided and subsequent inspection of hide-out areas takes place. Isolate or protect clean system components, including pumps and pressure vessels, and remove any component which may be damaged. Open all valves, drains, vents and strainers at all system levels. Remove plugs, caps, spool pieces, and components to facilitate early debris discharge from system. Sectionalize system to obtain debris carrying velocity of 6 feet per second, if possible. Connect deadend supply and return heads as necessary. Flush bottoms of risers. Install temporary strainers where necessary to protect down-stream equipment. Supply and remove flushing water and drainage by various type hose, temporary or permanent piping and Contractor's booster pumps. Flush until clean.
2. Cleaning: Using products recommended by the suppliers of the boiler water treatment chemicals specified in this section, circulate systems at normal temperature to remove adherent organic soil, hydrocarbons, flux, pipe mill varnish, pipe joint compounds, iron oxide, and like deleterious substances not removed by initial flushing, without chemical or mechanical damage to any system component. Removal of tightly adherent mill scale is not required. Keep isolated equipment which is "clean" and where deadend debris accumulation cannot occur. Sectionalize system as possible, to circulate at velocities not less than 6 feet per second. Circulate each section for not less than 4 hours. Blowdown all strainers, or remove and clean as frequently as necessary. Drain and prepare for final flushing.
3. Final Flushing: Return system to conditions required by initial flushing after all cleaning solution has been displaced by clean make-up. Flush all deadends and isolated clean equipment. Gently operate all valves to dislodge any debris in valve body by throttling velocity. Flush not less than one hour.

3.3 WATER TREATMENT:

A. The Contractor shall provide services of the Owner’s water treatment firm to test the raw water at the site and provide chemicals necessary to maintain the following characteristics of water in the boiler for a period of one year:

Hardness:	0.00
Iron:	0.00
Total Dissolved Solids:	1500-1750 ppm (as Ca C03)
Silica:	60 ppm or less
pH:	10.4 or above

B. Close and fill system as soon as possible after final flushing to minimize corrosion.

C. Charge system with chemicals.

3.4 OPERATING AND PERFORMANCE TEST AND INSTRUCTION:

A. Perform all tests and make reports in accordance with Section 23 00 00, HEATING, VENTILATING AND AIR-CONDITIONING (HVAC) and Section 23 05 93, TESTING, ADJUSTING, AND BALANCING FOR HVAC.

END OF SECTION 232000

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SECTION 232133 - VARIABLE SPEED DRIVES

PART 1: GENERAL

1.1 CONDITIONS:

A. The applicable provisions of Section 23 00 00, HEATING, VENTILATING AND AIR-CONDITIONING (HVAC), are hereby made a part of this section and the Contractor is cautioned to read Section 23 00 00 carefully as items of work applicable to this section are included in Section 23 00 00.

1.2 DESCRIPTION OF WORK:

A. Variable Speed Drive

B. Variable Speed Drive Bypass

1.3 RELATED WORK:

A. Section 23 00 00, HEATING, VENTILATING AND AIR-CONDITIONING (HVAC).

B. Section 23 05 93, TESTING, ADJUSTING AND BALANCING FOR HVAC

C. Section 23 09 00, INSTRUMENTATION AND CONTROL FOR HVAC

D. Section 23 20 00, HVAC PIPING.

E. Section 23 34 00, HVAC FANS.

F. Section 23 70 00, CENTRAL HVAC EQUIPMENT.

G. Section 23 81 00, DECENTRALIZED UNITARY HVAC EQUIPMENT.

1.4 REFERENCES:

A. ANSI - American National Standards Institute

B. NEMA - National Electrical Manufacturers Association

C. UL - Underwriters Laboratories. Inc.

D. ETL - Electrical Testing Laboratories

E. CSA - Canadian Standards Association

F. NEC- National Electrical Code

G. ISO - International Standards Organization

H. IEC - International Electrotechnical Commission

1.5 SUBMITTALS:

A. Submittals shall include the following:

1. Shop drawing indicating dimensions, required clearances and location and size of each field connection.
2. Power and control wiring diagrams.

B. Submittals must be specific to this project. Generic submittals will not be accepted.

1.6 QUALITY ASSURANCE:

A. The manufacturer shall have a minimum of 10 years experience in the design and construction of variable speed drives.

B. All functions of the variable speed drive shall be tested at the factory prior to shipment. This test shall be conducted with motors connected to the VFD output and it shall test all inputs, outputs and program execution specific to this application.

C. Manufacturer shall be listed by Underwriter's Laboratories as a manufacturer of variable speed drives.

PART 2: PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS:

A. Subject to compliance with the specifications, the following manufacturers shall be acceptable:

1. Danfoss
2. A.B.B.
3. Graham
4. Eaton

2.2 GENERAL:

A. This section of the specifications applies variable speed drives (VSD's) for pumps, and other equipment not specified to be provided as factory installed with equipment.

2.3 VARIABLE SPEED DRIVES:

A. Furnish and install variable speed drives for equipment where shown on the plans.

B. The variable speed drive(s) shall be pulse width modulation (PWM) type, microprocessor-controlled design. Unit shall be the VLT 6000 Series manufactured by Danfoss or equal.

C. The variable speed drive, including all factory installed options, shall have UL approval.

D. Enclosure shall be NEMA 1 ventilated for installation as a wall or free-standing rack mounted unit, depending on the amp rating. Drive shall be equipped with an input disconnect switch and fuses to protect against ground faults. A hand-off-automatic switch and speed potentiometer shall be mounted on the front of the enclosure. VSD's shall be provided with phase loss protection.

1. Variable speed drive shall utilize a diode bridge rectifier to convert three phase AC to a fixed DC voltage. Power factor shall remain above 0.95 regardless of speed or load. VSDs employing power factor correction capacitors shall not be acceptable.
2. Insulated gate bipolar transistors shall be used in the inverter section to convert the fixed DC voltage to a three phase, adjustable frequency.
3. The following customer modifiable adjustments shall be provided:

    a. Accel time: 0.1 to 1800 seconds
    b. Decel time: 0.1 to 1800 seconds
    c. Minimum frequency: 0 Hz
    d. Maximum frequency: 120 Hz
    e. Analog input filter: 0.1 to 10 seconds
    f. Analog outputs: 10 to 1 gain
    g. Volts/Hertz ratio

4. Speed reference signal shall be customer selectable for 0-10 VDC at 4-20 mA.
5. The VSD shall be suitable for elevations to 3300 feet above sea level without derating. Maximum operating ambient temperature shall not be less than 104 Deg. F. VSD shall be suitable for operation in environments up to 95% non-condensing humidity.
6. The VSD shall be capable of displaying the following information in plain English via a 40-character alphanumeric display:

    a. Frequency
    b. Voltage
    c. Current
    d. Kilowatts per hour
    e. Fault identification
    f. Percent torque
    g. Percent power
    h. RPM

7. All VSDs shall be warranted for a period of 24 months after shipment. This warranty shall cover parts and labor.
8. VSDs shall be compatible and coordinated to operate with the control system as provided under Section 23 09 00, INSTRUMENTATION AND CONTROL FOR HVAC.

E. Variable Speed Drive Bypass

1. The variable speed drive system shall be equipped with bypass for the system.
2. Bypass shall consist of a main power disconnect with ground fault protection, a pair of interlocked contactors and a motor overload relay. All are to be mounted in the VSD enclosure.
3. Bypass contactors shall be equipped with thermal motor overload protection.
4. A drive-off-bypass switch shall be provided on the front of the VSD enclosure.

PART 3: EXECUTION

3.1 INSTALLATION:

A. Install unit and accessories in accordance with manufacturer's written instructions and NEC.

B. Verify variable speed drive is being provided compatible with the associated motor.

C. Variable speed drives shall be installed and coordinated to operate and communicate with the system specified in Section 23 09 00, INSTRUMENTATION AND CONTROL FOR HVAC.

3.2 TESTS:

A. Perform tests and make reports in accordance with Section 23 00 00, HEATING, VENTILATING AND AIR-CONDITIONING (HVAC) and Section 23 05 93, TESTING, ADJUSTING AND BALANCING FOR HVAC.

END OF SECTION 232133

SECTION 233000 - HVAC AIR DISTRIBUTION

PART 1: GENERAL

1.1 CONDITIONS:

A. The applicable provisions of Section 23 00 00, HEATING, VENTILATING AND AIR-CONDITIONING (HVAC) are hereby made a part of this section, and the Contractor is cautioned to read Section 23 00 00 carefully as items of work applicable to this section are included in Section 23 00 00.

1.2 DESCRIPTION OF WORK:

A. Ductwork and accessories for HVAC including the following.

1. Supply air, return air, and general exhaust systems
2. Low pressure corrosion resistant exhaust systems

B. Installation of control dampers and smoke detectors referred to in other Division 23 sections.

C. Definitions:

1. Seal or Sealing: Use of liquid or mastic sealant, with or without compatible tape overlay, or gasketing of flanged joints, to keep air leakage at duct joints, seams and connections to an acceptable minimum.
2. SMACNA: Sheet Metal and Air Conditioning Contractors National Association, Inc. Publication entitled HVAC Duct Construction Standards Metal and Flexible, latest recognized edition.
3. Duct Pressure Classifications:

    a. General Duct System: 1-inch water column pressure class unless noted otherwise.
    b. Variable Volume Duct System: 2-inch water column pressure classification for duct upstream of the variable volume dampers.
    c. (AC-__ & AC-__) Duct Systems: (2, 3, 4, 6, or 10) inch water column pressure classification for supply ductwork.

4. Exposed Duct: Exposed to view in a finished room.
5. Outside Duct: Exposed to view beyond the exterior side of walls or above the roof.

1.3 RELATED WORK:

A. Section 23 00 00, HEATING, VENTILATING AND AIR-CONDITIONING (HVAC).

B. Section 23 05 93, TESTING, ADJUSTING, AND BALANCING FOR HVAC.

C. Section 23 07 00, HVAC INSULATION.

D. Section 23 09 00, INSTRUMENTATION AND CONTROL FOR HVAC.

E. Section 23 34 00, HVAC FANS.

F. Section 23 70 00, CENTRAL HVAC EQUIPMENT.

G. Section 23 81 00, DECENTRALIZED HVAC EQUIPMENT.

H. Section 23 82 00, CONVECTION HEATING AND COOLING UNITS.

1.4 QUALITY ASSURANCE:

A. Fire Safety Code: Comply with NFPA 90A.

B. Duct System Construction: SMACNA standards are the minimum acceptable quality.

C. Duct accessories exposed to the air stream, such as dampers of all types and access openings, shall be of the same material as the duct or provide at least the same level of corrosion resistance.

1.5 SUBMITTALS:

A. In accordance with Section 23 00 00, HEATING, VENTILATING AND AIR-CONDITIONING (HVAC), furnish the following:

1. Manufacturer's Literature and Data:

a. Volume, Motorized, and Backdraft Dampers
b. Prefabricated Metal Ductwork: Manufacturer's details for round and oval duct and fittings.
c. Duct Liner
d. Duct Access Doors, Panels, and Sections
e. Flexible ducts, connections fittings and clamps, with manufacturer's installation instructions.
f. Flexible connections
g. Air Outlets and Inlets
h. Louvers
i. Fire dampers
j. Smoke dampers
k. Fire/Smoke Dampers

PART 2: PRODUCTS

2.1 DUCT MATERIALS AND SEALANTS:

A. General: Except for systems specified otherwise, construct ducts, casings, and accessories of galvanized sheet steel, ASTM A 653, coating G90.

B. All Ductwork Associated with Supply, Return and Exhaust Air Systems for Locker and Shower Room Areas: Aluminum alloy sheets, ASTM B 209, alloy 1100, 3003, or 5052.

C. All ductwork exposed to view in finished spaces shall have paint grip to accept field painting.

D. Joint Sealing: Refer to Paragraphs 2.2 and 2.3 for sealing requirements. In addition all general duct systems shall meet Seal Class C and shall comply with South Coast Air Quality Management District (SCAQMD) Rules 1113, 1168 and Green Seal Standards GS-11 and GS03 for VOC limits.

1. Sealant: Elastomeric compound, gun or brush grade, maximum 25 flame spread and 50 smoke developed (dry state) compounded specifically for sealing ductwork. Use products as recommended by the manufacturer for each applicable system pressure. Generally provide liquid sealant, with or without compatible tape, for low clearance slip joints and heavy, permanently elastic, mastic type where clearances are larger. Oil base caulking and glazing compounds are not acceptable because they do not retain elasticity and bond.
2. Tape: The use of pressure sensitive tape as a general duct sealant is not acceptable.
3. A few of the many satisfactory sealants are as follows:

    a. Moore Tuff-Bond, #29 for low pressure, #12 for high pressure.
    b. Minnesota Mining and Manufacturing Company EC 800.
    c. Hardcast R 6350 tape and activator/adhesive.
    d. United Sheet Metal R-5966 (N), Listing #1.
    e. Borden Arabol E-3806 lagging adhesive plus 6 ounce canvas.

4. Gaskets in Flanged Joints: Soft neoprene.

E. Approved factory-made joints such as DUCTMATE SYSTEM may be used. Locking-type longitudinal joints and seams, other than the snap-lock and button-lock types, need not be sealed as specified in this section.

2.2 METAL DUCTS:

A. Gages, Reinforcement, Joints, Seams, Sealing, Fittings, Supports, and Other Details per SMACNA: Construct ducts not shown otherwise for 2 inches wg static pressure rating.

B. Sealing: All supply and return ductwork and plenums, regardless of pressure class, shall be sealed to SMACNA Seal Class A. Exhaust ductwork and plenums of pressure class greater than 2" shall be sealed to Seal Class A. All other exhaust ductwork and plenums shall be sealed to Seal Class C.

C. Volume Dampers: Single louver type and multi-louver type as detailed in SMACNA. Maximum blade louver width shall be 8-inch. Volume dampers exceeding 8-inch shall be multi-louver type. Dampers shall be a minimum two gauges heavier than duct in which installed.

1. Manual dampers shall be opposed blade construction for modulating service. Manual operator mechanism shall be locking-type quadrant operator as manufactured by Young Regulator Company or equal. End of damper rod on each damper shall be grooved to show damper position. Quadrant operators shall be installed on 1-1/2" high 4-bend galvanized steel bracket allowing duct insulation to be extended and sealed under the quadrant operator. (Where dampers occur behind or above finished portions of the building, operating rods shall be extended to 301 or 315 regulators installed flush with the finished surface.)
2. Motorized dampers shall be opposed blade construction for modulating service and parallel blade construction for two-position service. Motorized dampers shall be constructed with brass bearings, channel iron frame, interlocking blades and air-tight felt seals. Motor operators for dampers are specified in Section 23 09 00, INSTRUMENTATION AND CONTROL FOR HVAC.

D. Backdraft Dampers: Self-operating, multi-blade damper to open fully on 0.06 inch wg pressure difference and close by gravity. Aluminum, 16 gage frame, 0.023-inch blades of flat or elliptical shape, with tie-bar to connect blades for parallel operation. Provide resilient gasket for air seal and quiet operation. Blade pivots shall be in the nylon bushings. Provide adjustable counter-balance weight(s) as necessary for proper operation.

E. Turning Vanes: Provide in all square elbows even though not shown on the drawings. Turning vanes shall be factory fabricated. Vanes shall be hollow, double thickness in all ducts 18" or larger.

F. Air Deflectors: Factory fabricated for air diversion and volume control with operator as required for location in an accessible position. Adjustable deflectors shall be Young Air Extractor Model 890 with worm gear operator when behind grilles, with 301 operator when above plaster ceilings, and with 433 operator when it is accessible.

G. Plenums and Casings (Site Fabricated Units): Construct of galvanized steel panels joined by standing seams on outside of casing. Rivet or bolt all seams and joints on approximately 6" centers and seal with sealant. Reinforce with steel angles and provide diagonal bracing. Access doors shall be 36" x 18" with frame welded to plenum, three brass hinges and three brass tension fasteners operable from either side of door.

2.3 PREFABRICATED METAL DUCTWORK:

A. Gages, joints, seams, reinforcement, fittings, sealing, supports and other details for rectangular, round and oval duct shall be in accordance with SMACNA.

B. All supply and return ductwork and plenums, regardless of pressure class, shall be sealed to SMACNA Seal Class A. Exhaust ductwork and plenums of pressure class greater than 2" shall be sealed to Seal Class A. All other exhaust ductwork and plenums shall be sealed to Seal Class C.

C. Ducts and Casings: Submit details of proposed joints/sealing system. Unless shown otherwise, construct supply duct to 2 inches wg static pressure. Provide bolted construction and tie-rod reinforcement where required.

D. Round and Oval Ducts:

1. Spiral duct and all fittings shall be Semco, MKT or United McGill spiral lock-seam duct.
2. Elbows: Diameters 3 through 8 inches shall be two sections die stamped, all others shall be gored construction with all seams continuously welded. Coat galvanized areas of fittings damaged by welding with corrosion-resistant aluminum paint or galvanized repair compound.
3. Provide bellmouth, conical tees, laterals, reducers, and other low loss fittings as shown in SMACNA Standards.
4. Double wall insulated duct: Spiral double wall insulated pipe with matching fittings constructed from galvanized steel meeting ASTM-A527 and SMACNA. Outer shell for straight spiral pipe shall be 24-gauge for duct diameters through 24 inch, 22 gauge for duct diameters 25 inch through 34 inch, and 20 gauge for duct diameters 35 inch through 48 inch. Outer shell for fittings shall be 22 gauge for duct diameters 24 inch, and 20 gauge for duct diameters up to 48 inch. Insulation between pipe walls shall be 1-inch thick fiberglass with a thermal conductivity of 0.26 BTU/Hr./Sq. Ft./Deg. F. Inner shell shall be metal solid liner. Spiral pipe liner shall be 28 gauge. Fittings liner shall be solid metal type of 26 gauge for diameters through 34 inch and 24 gauge for diameters 35 inch through 48 inch diameter. Branch takeoffs shall be bell mouth type. Elbows shall be five-section type. Transitions shall be conical type. Duct connectors and fittings shall be casketed air-tight seal. Ductwork shall be provided and handled for "exposed" installation. Duct finish shall be A-60 annealed, paintable steel. Provide duct hangers, dampers, and appurtenances for a complete installation. All "exposed" ductwork shall be installed in a neat finished workmanlike manner and without visible duct sealant. Provide dimensional duct layout with shop drawing. Coordinate duct takeoffs with roof truss system.

E. Provide flat side reinforcement of oval ducts as recommended by the manufacturer and SMACNA. Because of high pressure loss, do not use internal tie-rod reinforcement unless approved by the Architect/Engineer.

F. Duct Hangers and Supports: Refer to SMACNA. Avoid use of trapeze hangers for round duct.

2.4 DUCT LINER (WHERE INDICATED ON DRAWINGS):

A. General: Liner shall be 1 inch thick, fiberglass duct liner with a smooth mat, bonded surface on air side. Liner shall meet ASTM C1071 with excellent abuse resistance and shall not support mold or fungus growth. Flame spread, fuel contribution, and smoke development ratings shall comply with NFPA Standard 90A and ASTM E84.

B. 'K' Value: 0.26 at 75 Deg. F, ASTM C518.

C. Noise Reduction Coefficient: 0.60 or higher based on "Type A mounting" and tested in accordance to ASTM C423.

D. Air Surface Coating: Acrylic coating treated with EPA registered anti-microbial agent proven to resist microbial growth as determined by ASTM G21 and G22.

E. Maximum Velocity: 5,000 ft/min.

F. Adhesive: Meets ASTM C916.

G. Fasteners: Duct liner galvanized steel pins, welded or mechanically fastened.

2.5 DUCT ACCESS DOORS, PANELS AND SECTIONS:

A. Provide access doors in accordance with NFPA 90A, sized and located for maintenance work, upstream where possible, in the following locations:

1. Each automatic control damper.
2. Each duct mounted smoke detector.
3. Each fire damper and smoke damper.
4. Each apparatus requiring service or inspection.
5. Each kitchen hood exhaust duct elbow and six foot intervals of horizontal grease duct.

B. Openings shall be 15" x 18" unless noted otherwise, except where size of duct will not accommodate this size, they shall be made minimum 12”x12” square. Where 12”x12” square opening is not practical, a flanged, removable duct section shall be utilized in accordance with VMC 607.4.1. Access doors shall be of rigid type and shall be provided with gasket to make air tight. Door shall be provided with galvanized hinges having bronze pins and two approved brass fasteners. Access doors in insulated ducts shall be of the insulated type. Doors shall swing so that fan pressure or suction and direction of air flow holds the door closed.

1. For Rectangular Ducts: Refer to SMACNA and provide lock type 2 (door latch, not sash lock).
2. For Round Ducts: Access sections shall be not less than 20 gage housing welded or riveted to a duct section.

2.6 FLEXIBLE AIR DUCTS:

A. General: Factory fabricated, complying with NFPA 90A for connectors up to 14 feet maximum length and not passing through floors of buildings. Flexible ducts shall not penetrate any fire or smoke barrier as defined in Section 23 00 00, HEATING, VENTILATING AND AIR-CONDITIONING (HVAC). Provide approximate lengths indicated on the drawings. Provide insulated, acoustical air duct connectors in supply air duct systems and elsewhere as shown.

B. Flexible ducts shall be acoustically insulated type as manufactured by Thermaflex or Flexmaster. Duct shall be fabricated with an acoustically transparent CPE inner film, 1" fiberglass insulation, and reinforced metalized vapor barrier. Vapor barrier permeance shall be .05 per ASTM E96, Procedure A. The rated positive pressure shall be 10" water gage and the recommended operating pressure for 90 degree bends shall be 6" water gage for 12" diameter duct. The minimum 'R' value shall be minimum 4.2, except in unconditioned attic type spaces the minimum 'R' value shall be 5.5. Entire assembly shall have maximum Flame-Spread rating of 25, a Smoke Developed Rating less than 50, and shall meet all NFPA 90A requirements. Connections between flexible duct and ductwork fittings or diffusers shall be made with draw bands and sealed with an approved pressure-sensitive tape. Flexible duct shall be UL 181 listed, ETL Class1.

Duct Insertion Loss, dB

Octave Band	2	3	4	5	6
Frequency, Hz	125	250	500	1000	2000
6 inch duct	7	19	34	37	38
8 inch duct	8	13	29	35	36
12 inch duct	20	26	27	33	26

C. All round duct take-offs shall be made with SPIN-IN fittings or pre-manufactured tap fittings with flanged low-loss boot and round connection collar. Units shall have a balancing damper and a factory-installed spring-loaded retractable bearing and a positive locking wing nut for easy readjustment. Provide 2" insulation stand-off for balancing damper handle.

D. Connection between high velocity duct and variable air volume boxes shall be made with high pressure flexible duct runouts unless shown otherwise. Insulation shall be a nominal 1-inch by 1 lb/cf fiberglass sheathed in a seamless vapor barrier jacket. The duct shall be rated for 15 inches of water pressure. Connection between flexible duct and ductwork fittings or variable air volume boxes shall be by manufacturer's recommendations. The duct shall comply with the latest NFPA Bulletin 90A and be listed as Class 1 connector, UL Standard 181.

2.7 FLEXIBLE CONNECTIONS:

A. Where duct connections are made to fans and air handling units, install a non-combustible flexible connection of 29 ounce neoprene coated fiberglass fabric approximately six inches wide. Burning characteristics shall conform to NFPA 90A. Securely fasten flexible connections to round ducts with stainless steel or zinc-coated iron draw bands with worm gear fastener. For rectangular connections, crimp fabric to sheet metal and fasten sheet metal to

ducts by screws two inches on center. Fabric shall not be stressed other than by air pressure. Allow at least one inch slack to ensure that no vibration is transmitted.

2.8 INSTRUMENT TEST FITTINGS:

A. Manufactured type with a minimum two-inch length for insulated duct, and a minimum one-inch length for duct not insulated. Test hole shall have a flat gasket for rectangular ducts and a concave gasket for round ducts at the base, and a screw cap to prevent air leakage.

B. Provide instrument test holes at each duct or casing mounted temperature sensor or transmitter, and at entering and leaving side of each heating coil and cooling coil.

2.9 AIR OUTLETS AND INLETS:

A. Materials:

1. Steel or aluminum as indicated. Provide manufacturer's standard gasket.
2. Exposed Fastenings: The same material as the respective inlet or outlet. Fasteners for aluminum may be stainless steel. Provide concealed method of fastening where available.

B. Performance Test Data: In accordance with Air Diffusion Council Code 1062R4.

C. Finish: White baked enamel for ceiling mounted units. Wall-mounted units shall be primed.

D. Air Supply Outlets and Inlets: Manufacturer shall be Tuttle and Bailey, Price, Titus or Metal-Aire. Tuttle and Bailey model numbers are listed.

1. Square ceiling diffusers shall be Model 1300ALT 24" x 24" adjustable pattern full louver face for lay-in mount for inverted T-bar ceiling without panel extensions or Model 1300ASF surface mount, as applicable for ceiling type. Provide opposed blade manual damper and equalizing deflectors. Construction shall be steel with mitered blade joints.
2. Supply registers shall be Type A54 aluminum double deflection and shall have free area of not less than 75%. Register dampers shall be aluminum opposed blade type, face operated. Sponge rubber gasket shall be provided on frame.
3. Return and exhaust registers and grilles shall be Model A70 fixed blade aluminum construction with 40 degree deflecting vanes on ¾” centers. Units shall have free area not less than 75%. Register dampers shall be aluminum opposed-blade face-operated type. Units on watertight ducts shall be all aluminum including damper, linkage, core, and frame. Sponge rubber gasket shall be provided on frame. Wall-mounted units shall be provided with horizontal face blades.
4. Return air lay-in filter grilles shall be Model A70DFB aluminum construction for nominal 24 x 24 lay-in inverted Tee Bar ceiling. Blades shall be 40 degrees deflection. Grilles shall have hinged frame with MERV 8 filters of standard size.

2.10 LOUVERS:

A. Wall Louvers (4" Aluminum): Louvers shall be Greenheck Model ESD-403, Louvers and Dampers Inc. Model IL-23, or equal stationary drainable blade with 4" deep frame and 0.08" thick extruded aluminum construction. Blades shall be positioned at approximately 37 degree angle and spaced not to exceed 4 inches on center. A channel in each blade shall drain water to downspouts in jambs and mullions to prevent water cascade from blade to blade. Provide complete with 1/2" mesh matching bird screen in removable frame and extended sill. Louver shall be AMCA certified for air performance and water penetration. Water penetration shall not occur while the free area velocity is maintained less than 1,000 feet per minute. Louvers are basically sized at 400 cfm per square feet of louver face area, with a static pressure drop not to exceed 0.10 inches water column for a 48" x 48" louver. Finish shall be (prime coat) (mill finish) (baked enamel) (anodized) (as selected by the Architect).

2.11 FIRE DAMPERS:

A. General - Fire dampers shall be dynamic type. Dampers shall meet local codes and the standards of the National Fire Protection Association contained in Bulletin 90A. Dampers in ductwork shall be sized so that the free air space is not less than the connected duct free air space. (Damper installed behind grilles or registers shall be the same size as the grille or register with blades in the air stream.) Location shall be as shown on drawings or as required by local code. Dampers shall possess a 1-1/2 hour standard fire protection rating in accordance with NFPA No. 555.

B. Material - The frame shall be constructed so as to be unaffected by corrosion or high heat. Mechanical parts shall have bronze non-corrosive pins. Vertical and horizontal dampers shall feature closure spring operation suitable for closure against the installed system air stream. When closed, the dampers shall be held closed by a catch arrangement. Blades installed in regular ductwork will not be accepted.

C. Fuse Links - Fire curtains shall be arranged to close automatically and remain tightly closed upon the operation of an approved fusible link or other approved heat-actuated device, located where readily affected by an abnormal rise of temperature in the duct. Fusible links shall have a temperature rating approximately 50 Deg. F above the maximum temperature that would normally be encountered when the system is in operation or shut down.

D. Access doors shall be provided in accordance with NFPA 90A. Suitable openings shall be provided to make fire dampers accessible for inspection and maintenance.

2.12 SMOKE DAMPERS:

A. General - Dampers shall meet local codes and the standards of the National Fire Protection Association contained in Bulletin 90A. Locations shall be as shown on the drawings.

B. Performance - Each damper shall be classified by Underwriter's Laboratories as a leakage rated damper for use in smoke control systems under the latest version of UL 555S, and shall bear U.L. Label attesting to same. The leakage rating under UL 555S shall be Leakage Class II (10 CFM Sq. Ft. at 1" W.G.). As part of the U.L. qualification, dampers shall have demonstrated a capacity to operate under HVAC system operating conditions, with pressures of at least 4" W.G. in the closed position, and 2000 FPM air velocity in the open position. The dampers and their actuators shall be qualified under UL 555S to an elevated temperature of at least 250 Deg. F.

C. Materials - Damper frames shall be a minimum of 16 gage galvanized steel formed into a structural hat channel shape with tapped corners for reinforcement. The blades shall be single skin 16 gage minimum galvanized with three longitudinal grooves for reinforcement. Bearings shall be stainless steel sleeve turning in an extruded hole in the frame. Blade edge seals shall be silicone rubber designed to withstand 450 Deg. F and jamb seal shall be silicone impregnated fiberglass with stainless steel flexible metal compression type cover. Appropriate electric (120V-1PH) actuators shall be furnished and installed by the damper manufacturer at time of damper fabrication. Damper and actuator shall be supplied as a single entity which meets all applicable UL 555S qualifications for both dampers and actuators. Factory supplied caulked sleeve shall be 20 gage. (.91) for dampers through 84" (2134) wide and 18 gage (1.21) above 84" (2134) wide. Damper and actuator assembly shall be factory cycled 10 times to assure operation. All wiring or piping material required to interconnect the actuator with detection and/or alarm or other systems shall be furnished by others as detailed elsewhere in the specification. Dampers shall be Ruskin Model SD36 or approved equal.

D. Access holes - Suitable hand hole openings with tightly fitted covers shall be provided to make them accessible for inspection and maintenance.

E. Operation - Damper motor shall de-energize to allow spring-loaded damper to close when smoke is detected by a space-mounted smoke detector. Smoke detectors will be provided under the Electrical Specifications.

2.13 FIRE/SMOKE DAMPERS:

A. Fire/smoke dampers shall conform to the requirements of Underwriters' Laboratories standard for smoke dampers UL 555S and for fire dampers UL 555 for 1-1/2 hour rating. Operator shall be 120 VAC/60 Hz, normally closed type.

PART 3: EXECUTION

3.1 INSTALLATION:

A. Comply with provisions of Section 23 00 00, HEATING, VENTILATING AND AIR-CONDITIONING (HVAC), particularly regarding coordination with other trades.

B. Fabricate and install ductwork and accessories in accordance with SMACNA Standards:

1. Duct clearance and lengths shall be established from measurements taken at the job site before any ducts are fabricated. The Contractor will not be allowed any extra costs for ducts fabricated and then found not to fit into the space intended. Duct sizes on the drawings are actual sheet metal dimensions which shall be altered by the Contractor to other dimensions producing the same air handling characteristics where necessary to avoid interferences and clearance difficulties. Acoustically lined duct has been sized to include the lining.
2. Fire damper openings shall be established from measurements taken at the job site before any fire damper is fabricated. The Contractor will not be allowed any extra costs for dampers fabricated and then found not to fit into the space intended. The Contractor shall coordinate clearances for locating the damper blades out of the air stream as required.
3. Provide duct transitions, offsets and connections to dampers, coils, and other equipment in accordance with SMACNA. Weld sheet metal in accordance with SMACNA, Guidelines for Welding Sheet Metal. Repair damaged galvanized areas with galvanizing repair compound.
4. Provide bolted construction and tie-rod reinforcement in accordance with SMACNA.
5. Construct casings and pipe penetrations in accordance with SMACNA. Design casing access doors to swing against air pressure so the pressure helps to maintain a tight seal.

C. Install duct hangers and supports in accordance with SMACNA. Duct supports shall consist of not less than 1" x 16 ga. galvanized steel strap hangers spaced not over 8'-0" on center for ducts with up to 240” perimeter.

D. Duct floor and wall openings - Rectangular and square ducts shall have openings 1" larger than the overall duct dimensions framed in place when the wall is constructed and 1/4" larger when floors are poured. Space between duct and structure shall be filled with duct insulation, except in fire partitions or floors they shall be packed tight with non-combustible fiber rope. Flanges constructed of 22-gauge galvanized sheet metal, not less than 3" wide, shall be installed at each opening in finished areas.

E. Install underfloor ducts in accordance with SMACNA. Sheet steel ducts shall be anchored with wire and stakes located at least 4" away from duct. Bricks and blocks wired to bottom of duct are not acceptable anchors. Ducts shall be sloped as indicated.

F. Flexible Duct Installation: Continuous, single pieces not over fourteen feet long (NFPA 90A), as straight and short as feasible, adequately supported. Centerline radius of bends shall be not less than two duct diameters. Make connections with adhesive and clamps or screws as recommended by the duct manufacturer. Flexible ducts shall not penetrate any chase or partition designated as a fire or smoke barrier, including corridor partitions fire rated one hour or two hours.

G. Where diffusers, registers and grilles cannot be installed to avoid seeing inside the duct, paint the inside of the duct with flat black paint to reduce visibility.

H. Control Damper Installation:

1. Provide necessary blank-off plates required to install dampers that are smaller than duct size. Provide necessary transitions required to install dampers larger than duct size.
2. Assemble multiple section dampers with required interconnecting linkage and extend required number of shafts through duct for external mounting of damper motors.
3. Provide necessary sheet metal baffle plates to eliminate stratification and provide air volumes specified. Locate baffles by experimentation, and affix and seal permanently in place, only after stratification problem has been eliminated.

I. Duct Liner: Install in accordance with SMACNA and NAIMA (North American Insulation Manufacturers Assoc.) Apply in cut-to-size pieces to the entire interior of the duct with approved adhesive and secured with fasteners. Fasteners shall be metal washer type and mechanically secured or welded to the duct. Adhesive type fasteners are not acceptable. Edges, joints, and penetrations shall be coated with adhesive meeting ASTM C916.

J. Protection and Cleaning: Adequately protect equipment and materials against physical damage. Place equipment in first class operating condition, or return to source of supply for repair or replacement. Protect equipment and ducts during construction against entry of foreign matter to the inside and clean both inside and outside before operation and painting.

K. Installation of Diffusers, Registers, and Grilles: Ducts shall be fastened securely to the building construction at each side of opening. Diffuser, register, or grille shall be securely fastened thereto, snug against the wall.

L. Installation of Fire and Smoke Dampers and Fire/Smoke Dampers: Dampers shall be installed so as to provide the positive barrier to passage of air when in a closed position. Dampers shall be located and installed so that destruction of the duct on either side of the damper will not allow the damper to fall away from the opening to be protected. Dampers shall be located in the wall or ceiling, or as close thereto as possible, and securely fastened thereto. Where it is not possible to locate the damper directly adjacent to the wall or ceiling, it shall be located as close as possible and all ductwork between the damper and wall or ceiling shall be fireproofed with plaster or other approved methods to give a rating equal to the rating of the damper. Access doors in the duct and wall or ceiling where applicable shall be sized and located as required for inspection and maintenance of the damper. Damper installation shall be as recommended by the manufacturer for UL compliance and shall meet all requirements of NFPA Standard 90A. Dampers shall be installed with sufficient tension to prevent rattling or vibration. The installation of the dampers shall conform to the requirements of SMACNA.

M. Smoke Detectors shall be provided and installed by the Electrical Contractor, as specified in Division 26.

3.2 DUCT LEAKAGE TESTS AND REPAIR:

A. Low Pressure Ducts: Seal visible openings and seal air leaks audible at operating conditions.

B. High Pressure Duct Leakage Testing (greater than 3 in. w.g.):

1. Perform testing in accordance with SMACNA HVAC Air Duct Leakage Test Manual. Ductwork shall have a rate of air leakage (CL) less than or equal to 4.0 as determined in accordance with the equation:

$$CL = F/P^{0.65}$$

Where F = the measured leakage rate in CFM per 100 square feet of duct surface and P = the static pressure of the test.

Documentation shall be furnished demonstrating that representative sections totaling at least 25 percent of the duct area have been tested and that all tested sections comply with the requirements of this section.

2. Audible Leaks: Test at two inches wg above design operating pressure, up to rated pressure classification of ductwork. Repair significant or noisy leaks.

C. Breeching and chimney shall be tested as recommended by the system manufacturer.

END OF SECTION 233000

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SECTION 233400 - HVAC FANS

PART 1: GENERAL

1.1 CONDITIONS:

A. The applicable provisions of Section 23 00 00, HEATING, VENTILATING AND AIR-CONDITIONING (HVAC), are hereby made a part of this section and the Contractor is cautioned to read Section 23 00 00 carefully as items of work applicable to this section are included in Section 23 00 00.

1.2 DESCRIPTION OF WORK:

A. Fans.

B. Product Definitions: AMCA Publication 99, Standard 1-66.

1.3 RELATED WORK:

A. Section 23 00 00, HEATING, VENTILATING AND AIR-CONDITIONING (HVAC).

B. Section 23 05 93, TESTING, ADJUSTING, AND BALANCING FOR HVAC.

C. Section 23 09 00, INSTRUMENTATION AND CONTROL FOR HVAC.

D. Section 23 21 33, VARIABLE SPEED DRIVES.

E. Section 23 30 00, HVAC AIR DISTRIBUTION.

1.4 QUALITY ASSURANCE:

A. Fans and power ventilators shall be listed in the current edition of AMCA 261, and shall bear the AMCA performance seal.

B. Fans and power ventilators shall comply with the following standards:

1. Testing and Rating: AMCA 210.
2. Sound Rating: AMCA 300.

C. Safety Criteria: Provide manufacturer's standard screen on fan inlet and discharge exposed to operating and maintenance personnel.

1.5 SUBMITTALS:

A. In accordance with Section 23 00 00, HEATING, VENTILATING AND AIR-CONDITIONING (HVAC), furnish the following:

1. Manufacturer's Literature and Data:

a. Prefabricated roof curbs
b. Inline centrifugal fans

2. Sound power levels for each fan.
3. Maintenance and operating manuals in accordance with Section 23 00 00, HEATING, VENTILATING AND AIR-CONDITIONING (HVAC).
4. Fan curves for each fan showing CFM versus static pressure, efficiency, and horsepower for design point of operation and at 110 percent of design static pressure. Include product application data to indicate the effect of capacity control devices such as inlet vane dampers on flow, pressure and horsepower.

1.6 EXTRA MATERIALS:

A. Furnish one set of air filters for each unit.

PART 2: - PRODUCTS

2.1 PREFABRICATED ROOF CURBS:

A. Type: Greenheck Model GPR

B. Construction: Galvanized steel or extruded aluminum, with continuous welded and mitered corner seams, to form a rigid and leak-proof shell. Curb material shall be compatible with the roof materials. Two inch wall thickness, rack or flange to support dampers, treated wood nailer 1-1/2 inch thick, 3 pound density rigid mineral fiberboard insulation with metal liner, built-in cant strip. For surface insulated roof, deck flange shall be recessed so the cant strip starts at the upper surface of the insulation. Curbs shall be built for pitched roof or ridge mounting as required to keep top of curb level.

C. Dimensions: Curb height shall be minimum 12 inches above the top of the roofing system. Perimeter dimensions shall match equipment.

2.2 IN-LINE CENTRIFUGAL FANS:

A. Type: Penn Model as indicated on drawings or equal by Greenheck or Cook, centrifugal fan, backward inclined.

B. Construction: Straight-through blower complete with backward-curved non-overloading aluminum blades, rubber-mounted motor, square steel enclosure, rubber-in-shear vibration isolators, and disconnect switch wired to motor. Unit shall be suitable for mounting at any angle. Power unit shall be accessible without disconnecting ductwork. Housing shall be internally lined with 1" thick fiberglass insulation.

C. Motor and Drive: Refer to Section 23 00 00, HEATING, VENTILATING AND AIR-CONDITIONING (HVAC). Drive shall be direct or belt connected as indicated on the drawings. Bearings shall be pre-lubricated and sealed at the factory.

D. All fans shall bear the AMCA Certified Ratings Seal for both air and sound performance.

E. Finish Painting: Baked-on epoxy paint for entire unit.

PART 3: - EXECUTION

3.1 INSTALLATION:

A. Install fan, motor and drive in accordance with manufacturer's instructions.

B. Align fan and motor sheaves to allow belts to run true and straight.

C. Bolt equipment to curbs with galvanized lag bolts.

D. Coordinate roof openings and locations with structural framing.

3.2 PRE-OPERATION MAINTENANCE:

A. Grease bearings.

B. Rotate impeller by hand and check for shifting during shipment and check all bolts, collars, and other parts for tightness.

3.3 START-UP AND INSTRUCTIONS:

A. Check vibration and correct as necessary for air balance work.

B. Check operation of motorized damper.

END OF SECTION 233400

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SECTION 237000 - CENTRAL HVAC EQUIPMENT

PART 1: GENERAL

1.1 CONDITIONS:

A. The applicable provisions of Section 23 00 00, HEATING, VENTILATING AND AIR-CONDITIONING (HVAC), are hereby made a part of this section and the Contractor is cautioned to read Section 23 00 00 carefully as items of work applicable to this section are included in Section 23 00 00.

1.2 DESCRIPTION OF WORK:

A. Indoor air handling units

1.3 RELATED WORK:

A. Section 23 00 00, HEATING, VENTILATING AND AIR-CONDITIONING (HVAC).

B. Section 23 05 93, TESTING, ADJUSTING, AND BALANCING FOR HVAC.

C. Section 23 09 00, INSTRUMENTATION AND CONTROLS FOR HVAC.

D. Section 23 20 00, HVAC PIPING.

E. Section 23 21 33, VARIABLE SPEED DRIVES.

F. Section 23 30 00, HVAC AIR DISTRIBUTION.

G. Section 23 34 00, HVAC FANS.

1.4 SUBMITTALS:

A. In accordance with Section 23 00 00, HEATING, VENTILATING AND AIR-CONDITIONING (HVAC), furnish the following:

1. Manufacturer's Literature, Data, including Sound Data for Fan Units:

    a. Indoor air handling units

2. Operation and Maintenance Manuals: Submit in accordance with paragraph, INSTRUCTIONS, in Section 23 00 00, HEATING, VENTILATING AND AIR-CONDITIONING (HVAC).

1.5 EXTRA MATERIALS:

A. Furnish one set of air filters for each unit.

PART 2: PRODUCTS

2.1 INDOOR AIR HANDLING UNITS:

A. General - Indoor air handling units shall be Trane, Daikin or York/JCI factory fabricated and assembled modular single-zone draw-through type, complete with air tight double wall insulated casing, horizontal supply air fan section, supply air fan motor, bypass air section downstream of coils and upstream of supply air fan (where noted on the drawings), adjustable V-belt drive, belt guards, access doors, spring-type vibration isolators, drain pan, cooling coil, reheat coil, preheat coil, coil access sections, economizer section, filters, mixing dampers, and mixing box.

B. Casing shall be modular constructed of double-wall bonderized or galvanized steel reinforced with galvanized steel angles or channels. Space between double walls shall be insulated with 1-1/2 pound density insulation and all connecting channels shall be insulated to prevent sweating. Drain pans shall be sloped in two directions and constructed of insulated double wall stainless steel. Provide a trap in the condensate drain piping from the evaporator coil drain pan of sufficient depth to prevent blowout or siphoning of water. Double wall access doors shall be provided in each casing section.

C. Heating and cooling coils standard water coils shall be fin and tube type suitable for water service, constructed of seamless copper tubes mechanically expanded into aluminum fins. Fins shall have a minimum thickness of 0.0095". Casing shall be constructed of insulated, double-wall, galvanized steel panels with flanges and support plates. Coil tubes shall be 1/2 or 5/8 inch OD seamless copper, 0.020" nominal tube wall thickness, expanded into fins, brazed at joints. Tubes shall be staggered, full circulating, and completely drainable. Each coil shall be factory tested and shall be suitable for 175 psi working pressure. Coils shall be mounted for counter-flow service. Where coils are furnished in sections, the return connections to each section shall be provided with a balancing cock. Cooling coil ratings shall be certified in accordance with ARI Standard #410. Coil connections shall extend a minimum of 5" beyond unit casing for ease of installation. Drain and vent connections shall be provided exterior to unit casing. Coil connections must be factory sealed with grommets on interior and exterior and gasket sleeve between outer wall and liner where each pipe extends through the unit casing to minimize air leakage and condensation inside panel assembly. If not factory packaged, Contractor must supply all coil connection grommets and sleeves. Coils shall be removable through side and/or top panels of unit without the need to remove and disassemble the entire section from the unit.

D. Filters shall be UL approved MERV-13 pleated media type 2" thick complete with filter frames, holding racks, and clips. Filters shall be removable from either side of unit. Filter face velocity shall not exceed 350 fpm.

E. Fans shall be double width, double inlet, centrifugal type with blades of the forward curve (FC) or air foil (AF) design as required for stable operation. Fans shall be statically and dynamically balanced after unit is assembled at the factory. Fans shall be mounted on a steel shaft and shall be supported in ball or sleeve type bearings, which shall be provided with lubrication facilities outside of the unit enclosure. Fans shall be driven by a unit-mounted motor and V-belt drive complete with belt guard. Belt drives shall be designed for 150% of the connected motor capacity, and sheaves shall be adjustable to provide at least 20% speed variation. Motors for VAV service shall be inverter duty type suitable for operation with a VFD. Electrical characteristics shall be as shown in schedule. Sheave shall be selected to drive the fan at a speed which will produce the specified capacity when set at its approximate midpoint. Provide fan curves with shop drawing submittals. Each fan and motor shall be internally isolated with spring isolators.

F. Mixing boxes shall be factory fabricated to match the unit, complete with vinyl edged, parallel blade dampers in both the return air and outdoor air sections. Outdoor air damper shall be tracking type with measurement station and modulating damper to control the outside airflow with an accuracy of ∀5%.

G. Economizer section and combination filter-mixing box shall be factory fabricated to match the unit, complete with parallel blade dampers for exhaust air, return air and outdoor air. Damper blades shall be constructed of galvanized steel with neoprene blade seals and stainless steel jamb seals. Damper actuators will be provided by the BAS Contractor.

H. Energy Recovery Section:

1. Energy recovery wheel shall be constructed of corrugated synthetic fibrous media, with a desiccant intimately bound and uniformly and permanently dispersed throughout the matrix structure of the media. Rotors with desiccants coated, bonded, or synthesized onto the media are not acceptable due to delaminating or erosion of the desiccant material. Media shall be synthetic to provide corrosion resistance and resistance against attack from external outdoor air conditions. Coated aluminum is not acceptable. Face flatness of the wheel shall be maximized in order to minimize wear on inner seal surfaces and to minimize cross leakage. Rotor shall be constructed of alternating layers of flat and corrugated media. Wheel layers shall be uniform in construction forming uniform aperture sizes for airflow. Wheel construction shall be fluted or formed honeycomb geometry so as to eliminate internal wheel bypass. Wheel layers that can be separated or spread apart by airflow are unacceptable due to the possibility of channeling and performance degradation. The minimum acceptable performance shall be as specified in the unit schedule.

    a. Desiccant Material: The desiccant material shall be a molecular sieve, and specifically a 4A or smaller molecular sieve to minimize cross contamination.
    b. Wheel Media Support System: The wheel frames shall consist of evenly spaced steel spokes, galvanized steel outer band and rigid center hub. The wheel construction shall allow for post fabrication wheel alignment. The wheel seals shall be full contact nylon brush seals or equivalent. Seals shall be easily adjustable.

c. Wheel cassette: Cassettes shall be fabricated of heavy duty reinforced galvanized steel or welded structural box tubing. Cassettes shall have a built in adjustable purge section minimizing cross contamination of supply air. Bearings shall be inboard, zero maintenance, permanently sealed roller bearings, or alternatively, external flanged or pillow block bearings.
d. Drive systems shall consist of fractional horsepower AC drive motors with multi-link drive belts.
e. Face and bypass dampers shall be furnished.
f. Certification: The wheel shall be ARI certified by the energy recovery wheel supplier to ARI Standard 1060 and must bear the ARI certification stamp. Private independent testing performed "in accordance with" various standards is not a substitute for ARI certification and shall not be accepted. The wheel shall be listed or recognized by UL or equivalent.

2. Recirculation Air Section: Provide a recirculation air section with a recirculation air damper.
3. The unit shall have 2" Merv 13 filters for the outdoor air and the exhaust air before the wheel to help keep the wheel clean and reduce maintenance. Filter access shall be by a hinged access door with ¼ turn latches.

I. Each unit shall be provided with a factory-fabricated bypass air section (where noted on the drawings) to match the unit complete with parallel blade dampers for return air. Damper actuator will be provided by the BAS Contractor.

J. Combination Starter/Disconnects - The combination starter/disconnects shall be properly sized, mounted, and wired by the manufacturer. Each starter/disconnect shall be properly fused and UL listed. Switch arrangement shall be Hand-Off-Auto (H-O-A) with normally open auxiliary contacts, and manual reset overload relays. Controls shall be factory mounted and shall include power wiring and proper transformers for direct digital control. Starter/disconnects shall be with NEMA Type 4 enclosures for outdoor use. Fan motors shall be wired in 'liquid tight' conduit. All wiring shall comply with NEC and NFPA 70. For VAV applications, the air handler manufacturer shall provide and mount variable speed drives as specified in Section 23 21 33 VARIABLE SPEED DRIVES with a bypass switch and fused disconnect for each fan. Electrical characteristics shall be as shown on equipment schedule.

PART 3: EXECUTION

3.1 INSTALLATION:

A. Handle and install units and accessories in accordance with the manufacturer's printed instructions.

B. Mount units for proper condensate drainage.

C. Provide P-traps for each drain.

3.2 TESTS:

A. Perform tests and make reports in accordance with Section 23 00 00, HEATING, VENTILATING AND AIR-CONDITIONING (HVAC), and Section 23 05 93, TESTING, ADJUSTING, AND BALANCING FOR HVAC.

END OF SECTION 237000

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SECTION 238100 - DECENTRALIZED UNITARY HVAC EQUIPMENT

PART 1: GENERAL

1.1 CONDITIONS:

A. The applicable provisions of Section 23 00 00, HEATING, VENTILATING AND AIR-CONDITIONING (HVAC), are hereby made a part of this section and the Contractor is cautioned to read Section 23 00 00 carefully as items of work applicable to this section are included in Section 23 00 00.

1.2 DESCRIPTION OF WORK:

A. Ductless Split System (Heat Pump) Air Conditioners

B. Definitions:

1. Energy Efficiency Ratio (EER): A ratio calculated by dividing the cooling capacity in Btuh by the power input in watts at any given set of rating conditions, expressed in Btuh per watt (Btuh/watt).
2. Unitary (ARI): Consists of one or more factory-made assemblies which normally include an evaporator or cooling coil, a compressor and condenser combination, and may include a heating function.

1.3 RELATED WORK:

A. Section 23 00 00, HEATING, VENTILATING AND AIR-CONDITIONING (HVAC).

B. Section 23 09 00, INSTRUMENTATION AND CONTROLS FOR HVAC.

1.4 QUALITY ASSURANCE:

A. Safety Standards:

1. Design, manufacture and installation of mechanical refrigeration equipment: ANSI B9.1.
2. Machinery Guards: Provide guards as shown in AMCA 410 for belts, chains, couplings, pulleys, sheaves, shafts, gears, and other moving parts regardless of height above the floor. Drive guards may be excluded where motors and drives are inside factory fabricated unit casings.

B. Unit Capacities: When providing a substitution to the basis of design manufacturer for the Variable Refrigerant System, the Contractor shall ensure the system meets the heating and cooling capacities specified in the equipment schedules and is responsible for any additional

materials that include but are not limited to higher capacity outdoor an indoor units, refrigerant piping, and accessories required for proper operation.

1.5 SUBMITTALS:

A. In accordance with Section 23 00 00, HEATING, VENTILATING AND AIR-CONDITIONING (HVAC), furnish the following:

1. Manufacturer's Literature and Data:

a. Unitary Air Conditioners:

(1) Ductless Split System Air Conditioners

2. Submit proof of specified ARI Certification.
3. Performance Rating: Submit catalog selection data showing equipment ratings and compliance with required EER, COP, etc.
4. Operating and Maintenance Manuals: Submit in accordance with paragraph, INSTRUCTIONS, in Section 23 00 00, HEATING, VENTILATING AND AIR-CONDITIONING (HVAC).

1.6 EXTRA MATERIALS:

A. Furnish one set of air filters for each unit.

PART 2: PRODUCTS

2.1 DUCTLESS SPLIT SYSTEM AIR CONDITIONERS:

A. General - Equipment and material specified under this heading shall be Daikin or equal furnished and installed by a certified representative of the unit manufacturer. System shall consist of condensing unit, air unit, refrigerant piping, and system controls. Each system shall be fitted and rated in accordance with ARI Standard 210.

B. Condensing (outdoor) unit shall be single-zone commercial type complete with compressor-motor unit, direct expansion condenser coil, condenser fans, starters, controls, and piping enclosed in a galvanized steel, bonderized and coated paint finish cabinet recommended for outside installation. Condenser fans shall be horizontal or vertical discharge. Intake and discharge opening shall be safely guarded. Condensing unit controls and accessories shall provide automatic capacity modulation and condenser and evaporator pressure control for operation down to 0°F outside air temperature. Crankcase heater shall be provided. Unit shall be supported in accordance with manufacturer’s installation instruction.

C. Fan-coil (indoor) unit shall be wall mounted type complete with cooling coil, fan, fan motor, piping connectors, starters, electrical controls, condensate pump and hanging brackets. Cabinet

shall be constructed of zinc coated steel; full insulated with inlet and discharge grilles. Filters shall be cleanable. Fan shall be direct drive, 3-speed, with adjustable discharge. Cooling coil shall be non-ferrous direct-expansion type. Drip pan under coil shall have a factory installed condensate pump.

D. Special Features, Options, & Accessories. In addition to the above, provide: Compressor cycle delay, high condensing temperature protection, overload protection, high pressure relief, liquid solenoid valve, crankcase heater, condensate pump alarm, low ambient cooling.

E. Refrigerant lines shall be hard-drawn, dehydrated, and sealed copper tubing, sized and connected as recommended by the unit manufacturer. Suction line shall be insulated and effectively vapor sealed. Refrigerant circuit access ports shall be fitted with locking type tamper resistant caps in strict accordance with the IMC.

F. Controls for safe automatic controlled operation of the system shall be provided. Units shall be provided with low-ambient controls for operation down to 0°F. The thermostat shall be wall mounted with 3 speed fan selector switch, and an auto/manual switch. Provide thermostat to limit cooling coil discharge air to 45°F or above.

G. The system shall be completely charged with R-410a refrigerant and oil and shall be guaranteed to be free of leakage for one (1) year.

H. The system shall be tested and checked out for safe, controlled operation. One week before final inspection, a letter from the unit manufacturer's representative shall be submitted to the Engineer certifying that the system is performing safely and satisfactorily. Compressors shall be guaranteed to be free from defective materials or workmanship for five (5) years after final acceptance of the project.

PART 3: EXECUTION

3.1 INSTALLATION:

A. Handle and install units and accessories in accordance with ARI 260 and the manufacturer's printed instructions.

B. Coordinate indoor unit location with lighting and ceiling system.

C. Coordinate roof openings and locations with structural framing.

D. Provide equipment rails as specified in Section 23 34 00, HVAC FANS for outdoor units mounted on the roof.

3.2 TESTS:

A. Perform tests and make reports in accordance with Section 23 00 00, HEATING, VENTILATING AND AIR-CONDITIONING (HVAC), and Section 23 05 93, TESTING, ADJUSTING, AND BALANCING FOR HVAC.

END OF SECTION 238100

SECTION 238200 - CONVECTION HEATING AND COOLING UNITS

PART 1: GENERAL

1.1 CONDITIONS:

A. The applicable provisions of Section 23 00 00, HEATING, VENTILATING AND AIR-CONDITIONING (HVAC), are hereby made a part of this section and the Contractor is cautioned to read Section 23 00 00 carefully as items of work applicable to this section are included in Section 23 00 00.

1.2 DESCRIPTION OF WORK:

A. Shut-off variable terminal boxes.

1.3 RELATED WORK:

A. Section 23 00 00, HEATING, VENTILATING AND AIR-CONDITIONING (HVAC).

B. Section 23 09 00, INSTRUMENTATION AND CONTROLS FOR HVAC.

C. Section 23 20 00, HVAC PIPING.

D. Section 23 21 33, VARIABLE SPEED DRIVES.

E. Section 23 30 00, HVAC AIR DISTRIBUTION.

F. Section 23 34 00, HVAC FANS.

G. Section 23 70 00, CENTRAL HVAC EQUIPMENT.

1.4 SUBMITTALS:

A. In accordance with Section 23 00 00, HEATING, VENTILATING AND AIR-CONDITIONING (HVAC), furnish the following:

1. Manufacturer's Literature and Data:

    a. Shut-Off Variable Terminal Boxes

2. Operation and Maintenance Manuals: Submit in accordance with paragraph, INSTRUCTIONS, in Section 23 00 00, HEATING, VENTILATING AND AIR-CONDITIONING (HVAC).

1.5 EXTRA MATERIALS:

A. Furnish one set of air filters for each unit.

PART 2: PRODUCTS

2.1 SHUT-OFF VARIABLE TERMINAL BOXES:

A. Shut-off variable terminal boxes shall be Trane. See Equipment Notes for applicable terminal boxes.

B. Casing shall be 22-gauge galvanized steel with interior surface of unit casing acoustically and thermally lined with 1", 1.0 lb./cu. ft. matte face insulation with R-value of 3.85 that meets NFPA-90A, UL 181, and bacteriological standard ASTM C1338, G31 and G22. Insulation shall be fully encapsulated with no exposed edges.

C. Primary air valve shall be a heavy gauge galvanized steel cylinder sized to fit standard round duct with integral electric actuator. Maximum leak rate 1 percent at 4 inches wg. inlet static pressure. Integral multiple point, averaging flow sensing ring to provide primary air flow measurement within +/- 5 percent of unit rated airflow with 1-1/2 diameters of straight duct upstream of unit. Integral flow taps and calibration chart provided on each unit. Damper blade shall be constructed of a closed cell foam seal that is mechanically locked between two 22 gauge, galvanized steel disks with permanent damper position indicator on the shaft and mechanical stop to prevent over-stroking.

D. Heating water coil shall be factory mounted on discharge outlet and constructed of seamless copper tubes mechanically expanded into the fin collars. Coils shall be leak tested at 450 psig air pressure under water. Pipe connections shall be sweat type.

E. Outlet connection shall be Integral Outlet sheet metal connection at unit discharge to facilitate ductwork installation. All units shall be U.L. Listed and CSA approved.

F. Boxes shall be provided with 24V transformers factory installed and wired to power damper actuator, fan control, and DDC controller.

PART 3: EXECUTION

3.1 INSTALLATION:

A. Handle and install units in accordance with manufacturer's written instructions.

B. Support units rigidly so they remain stationary at all times. Cross-bracing or other means of stiffening shall be provided as necessary. Method of support shall be such that distortion and malfunction of units cannot occur.

C. Locate variable air volume boxes to provide a straight section of inlet duct for proper functioning of volume controls.

D. Locate concealed equipment above ceilings at elevations suitable for proper drainage of cooling coil condensate where applicable.

3.2 OPERATIONAL TEST:

A. Perform tests and make reports in accordance with Section 23 00 00, HEATING, VENTILATING AND AIR-CONDITIONING (HVAC), and Section 23 05 93, TESTING, ADJUSTING, AND BALANCING FOR HVAC.

END OF SECTION 238200

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SECTION 260100 - BASIC REQUIREMENTS FOR ELECTRICAL SYSTEMS

PART 1: GENERAL

1.1 DESCRIPTION:

A. This Section specifies the basic requirements of electrical installations and includes requirements common to all sections of Divisions 26, 27 and 28. It expands and supplements the requirements specified in sections of Division 1.

B. Division 26 shall provide the electrical equipment, electrical wire, raceways and cable work and connections as required for complete and operable electrical systems as indicated in Division 26 Contract Documents. Refer to all other portions of these Contract Documents and apply to those portions of work relating to Electrical Work the same as if the Electrical Work was repeated herein in its entirety.

C. Other Divisions of these Contract Documents will provide equipment that will require electrical connections - Division 26 shall coordinate with other Divisions and shall provide all necessary items and equipment for complete and code-compliant connections.

1.2 RELATED DOCUMENTS:

A. The Drawings and general provisions of the Contract, including the General and Supplementary Conditions, Instructions to Bidders and sections of Division 1, apply to the work specified in this section.

1.3 SCOPE OF THE WORK:

A. Work included under this section shall include complete electrical systems as shown on the Contract Documents, which includes all of the specifications, drawings, addendums, accepted change orders and the Authority Having Jurisdiction (AHJ) compliances. Provide supervision, labor, material, equipment, machinery, plant, and other items necessary to complete the systems. Items of equipment may be specified in the singular; however, provide the number of items of equipment indicated in the Contract Documents and as required for complete systems.

B. It is the intention of these Contract Documents to call for finished work, tested and ready for operation. Wherever the word "provide" is used, it shall mean "furnish and install complete and ready for use."

C. Minor details necessary for the complete installation and operation of the systems shall be included.

D. Any item that is shown on the drawings but not mentioned in the specifications, or mentioned in the specifications but not shown on the drawings, shall be considered as being both shown on the drawings and mentioned in the specifications and shall be provided.

E. The entire work provided for in the specifications and indicated on the drawings is to be accomplished even though every item and minor detail for the proper installation and successful operation of the entire work may not be mentioned in the specifications or shown on the drawings.

F. All materials and equipment shall be new and listed by Underwriters Laboratories, Inc.

1.4 PERMITS AND FEE:

A. The Contractor shall obtain and pay for all permits, bonds, licenses, and inspection certificates, and shall pay inspection fees and taxes, but permanent electrical utility fees shall be paid by the Owner.

B. The Contractor shall file plans and prepare documents required to obtain approvals of the Authorities Having Jurisdiction (AHJ).

1.5 DRAWINGS:

A. Electrical drawings are diagrammatic and indicate general arrangement of systems and work included. Consult Architectural and Structural drawings for building construction details.

B. Should there be any discrepancy between actual measurements and those indicated, which prevents following good practice or the intent of the drawings and specifications, notify the Architect/Engineer and make modifications as directed.

C. Where variances occur between drawings and specifications or within either document itself, include in the contract price the item or arrangement of better quality, greater quantity, or higher cost.

1.6 ROUGH-IN:

A. Verify final locations for rough-ins with field measurements and with the requirements of the actual equipment to be connected. Refer to equipment specifications in Divisions 2 through 23 for rough-in requirements.

B. Rough-in openings shall align vertically and horizontally with the building structure and shall be plumb.

C. Verify door swings before roughing-in switch outlets.

1.7 ELECTRICAL INSTALLATIONS:

A. In addition to the requirements of the General Conditions, examine areas and conditions for compliance with installation tolerances and other conditions affecting performance of electrical work. Do not proceed with installation until unsatisfactory conditions have been corrected. Verify all dimensions by field measurements.

B. Install material and equipment in accordance with manufacturer's written installation instructions, applicable requirements of the National Electrical Contractors Association (NECA) "Standard of Installation" and applicable requirements of National Electrical Code (NEC).

C. Coordinate electrical equipment and materials installation with other building components.

D. Arrange for chases, slots and openings in other building components to allow for electrical installations.

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

F. Sequence, coordinate and integrate installations of electrical materials and equipment for efficient flow of the Work. Give particular attention to large equipment requiring positioning prior to closing-in the building. Where housekeeping pads are required, they shall be minimum 4” tall and shall meet Division 3 specifications.

G. Where mounting heights are not indicated, detailed or dimensioned, bring to the attention of the Architect immediately for resolution.

H. Install electrical equipment with National Electrical Code (NEC) required clearances to facilitate maintenance and repair or replacement of equipment components. Connect equipment in such a way as to facilitate future maintenance, with minimum of interference with other items in the vicinity. Do not run any conduits across any designated rooftop walkways – if this is unavoidable, provide a removable platform or stairs to safely walk over the conduits.

I. Coordinate the installation of electrical materials and equipment above ceilings with suspension system, mechanical equipment and systems, and structural components. Do not block mechanical equipment access with raceways.

J. Coordinate connection of electrical systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies and controlling agencies. Provide required connection for each service.

K. Tighten connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque tightening values for equipment connectors. Where manufacturer's torqueing requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL Std 486A.

L. All wiring connectors and terminals (including but not limited to wiring devices, breakers, disconnects, fuses, starters, etc.) shall be rated for not less than 75 deg. C. If connectors and terminals are provided that are rated for less than 75 deg. C., the electrical contractor shall incur all costs associated with upsizing conductors and conduits as required by the NEC for lower-temperature conductors.

M. All damages incurred to new or existing electrical installations shall be immediately reported to the general contractor project manager and repaired by the contractor at no cost to Owner.

N. Site-Applied Interior Paints and Coatings: Comply with low-emitting requirements in Division 01 Section "Indoor Air Quality Requirements."

O. See Division 1 for BIM coordination drawing requirements. This must include coordination of cable tray with all above-ceiling elements, ensuring that ceiling tiles can be removed and at least 4” of space is left above trays for cable pulling.

1.8 PROTECTION:

A. Protect work against theft, injury, or damage. Carefully store material and equipment off the ground and under cover. Close open ends of work or equipment with temporary covers or plugs during storage and construction to prevent entry of obstructing material.

1.9 EXCAVATION AND BACKFILLING:

A. Excavate to the depths required for the installation of electrical work. The Contractor shall be responsible for obtaining core drill sample information prior to receipt of bids to determine presence or absence of rock. After receipts of bids, no extras will be allowed for excavation of rock. Remove and properly dispose of excavated materials not required or suitable for backfill. Provide shoring as necessary to protect existing facilities, new work, and the safety of personnel. Make open cut excavation, except for short sections of trench which may be tunneled if conduit or duct can be properly installed and supported.

B. Grade the bottom of trenches to provide uniform bearing and support for each section of conduit on undisturbed soil at every point along its entire length. Backfill trench over depths with sand, fine gravel, or loose, granular, moist earth and thoroughly tamp. Unstable soil that is incapable of properly supporting conduit shall be removed to stable soil and the trench treated as over depth.

C. Existing utility lines to be retained, whether known or unknown, and uncovered during excavation operations shall be protected from damage during excavation and backfilling, and if damaged shall be restored to original condition.

D. Do not backfill until all tests have been performed and the utility systems installed conform to the requirements of the Contract Documents. Carefully backfill trenches with clean

earth, sand, and gravel or soft shale in 6-inch layers and thoroughly tamp until the conduit has a cover of not less than 2 feet. Place the remainder of the backfill in the trench in 1-foot layers and tamp. Grade surface to reasonable uniformity and mound over trenches. Use compacted backfill for excavation under slabs on grade, building structures, concrete or asphalt paving, and driveway or parking areas.

E. Check elevations of utilities entering and leaving building. When such elevations require excavations lower than footing levels, notify Architect and proceed as directed by him. Make excavations at minimum required depths in order not to undercut footings.

1.10 ACCESSIBILITY:

A. Furnish, for installation by others, access doors in every location necessary and as required by Code or equipment manufacturer recommendation, whether indicated or not, to allow working access to concealed electrical items which may require operation, inspection, maintenance, or adjustment. Access doors are not required in lay-in panel systems. See Division 8 for specification and installation requirements.

B. Coordinate the final location of concealed equipment and devices requiring access with final location of access doors. Access unit shall be of adequate size and shall match the wall, floor and ceiling rating and construction type. Allow ample space for removal of all parts that will likely require replacement or servicing during the normal life of equipment.

C. Prior to installation of equipment and materials requiring access doors, prepare, for review by the architect in ample time for proper coordination, one (1) set of architectural prints marked with size and approximate location of all access doors.

1.11 JOINT SEALANTS:

A. See specification 07 92 00 – Joint Sealants for all joint sealants required around conduit and/or cable penetrations through interior and exterior joints.

1.12 PENETRATION FIRESTOPPING SYSTEMS:

A. See specification 07 84 13 – Penetration Firestopping for all penetration firestopping systems required around conduit and/or cable penetrations through fire-rated assemblies.

1.13 CUTTING AND PATCHING:

A. This Article supplements sections of Division 1 for general requirements for cutting and patching and specifies the cutting and patching for electrical equipment, components and materials, to include removal and legal disposal of selected materials, components, and equipment.

B. Do not endanger or damage installed work through procedures and processes of cutting and patching.

C. Arrange for repairs required to restore other work because of damage caused as a result of electrical installations.

D. No additional compensation will be authorized for cutting and patching work that is necessitated by ill-timed, defective, or non-conforming installations.

E. Perform cutting, fitting, and patching of electrical equipment and materials required to:

1. Uncover work to provide for installation of ill-timed work;
2. Remove and replace defective work;
3. Remove and replace work not conforming to requirements of the Contract Documents;
4. Remove samples of installed work as specified for testing;
5. Upon written instructions from the Architect/Engineer, uncover and restore work to provide for Architect/Engineer observation of concealed work.

1.14 SLEEVES:

A. Locate sleeves during normal course of work. Provide sleeves for conduit larger than 1" passing through concrete floor slabs and concrete, masonry, tile, and gypsum wall construction. Sleeves shall not be provided for conduit running embedded in concrete or slab on grade. Sleeves through structural members shall be only as directed by Architect.

B. All conduits passing through fire-rated walls or floors or ceilings shall have sleeve assemblies to maintain the fire rating of the wall or floor or ceiling. Pack between sleeve and conduit with U.L. Listed material to maintain wall or floor or ceiling rating. See Architectural drawings for locations of fire-rated walls, floors and ceilings.

C. Sleeves shall be constructed of 20 gauge galvanized sheet steel with lock seam joints for all sleeves set in concrete floor slabs terminating flush with the floor. All other sleeves shall be constructed of galvanized steel pipe unless otherwise indicated.

D. Fasten sleeves securely in floors or 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 from being forced into the space between pipe and sleeve during construction.

1.15 MOTOR AND ELECTRICAL WIRING:

A. Temperature control wiring, equipment control wiring, and interlock wiring necessary for the proper sequence of operation of mechanical equipment will be provided as part of the Mechanical Work. See Division 23 for instrumentation and control for HVAC, and for the complete definition of control wiring.

B. Power wiring from the power source to the motor or equipment junction box, including wiring through starters, VFD's and safety switches shall be provided as part of the Electrical Work under Division 26.

C. Power wiring from the power source to electric heating equipment, including wiring through contactors, safety switches and line voltage control devices shall be provided as part of the Electrical Work under Division 26.

1.16 QUALITY ASSURANCE:

A. Manufacturers: Where a list of manufacturers or a proprietary item is not specified, use manufacturers whose products have been in satisfactory use in similar service for not less than five (5) years.

B. Installer's Qualifications: Firms with at least three (3) years of successful installation experience on projects utilizing material similar to that required for this project.

C. Codes and Standards: Comply with applicable requirements of the following codes and standards.

1. National Electrical Manufacturers Association (NEMA) Standards.
2. 2020 NFPA 70 - National Electrical Code (NEC)
3. 2019 NFPA 72 – National Fire Alarm and Signaling Code
4. 2021 VUSBC – Virginia Uniform Statewide Building Code (VCC – Virginia Construction Code)
5. 2021 IBC - International Building Code as adopted and modified by the VUSBC (VCC)
6. 2021 IFC – International Fire Code
7. 2021 VECC – Virginia Energy Conservation Code
8. 2010 Americans with Disabilities Act Accessibility Guidelines (ADAAG)
9. 2010 ADA Standards for Accessible Design
10. Institute of Electrical and Electronics Engineers (IEEE) Standards
11. National Electrical Safety Code (NESC)
12. Other applicable ANSI/NFPA & UL Standards as required for the project

D. Provide material and equipment which is listed by Underwriters Laboratories, Inc. (UL) and which bears the UL label. This applies to materials and equipment for which UL Standards have been established and for which label service is regularly furnished. Assemble materials and equipment, for which no UL Product Category exists for the completed unit, with UL-listed components.

1.17 ELECTRICAL REQUESTS FOR INFORMATION (RFI's):

A. Refer to the Conditions of the Contract (General and Supplementary) and Division 1 for RFI definitions, requirements, and procedures. RFI's shall be submitted as a digital file (pdf). Allow 5 business days for review of RFI's, starting from the date LPA, Inc. receives the RFI's.

1.18 ELECTRICAL SUBMITTALS:

A. Refer to the Conditions of the Contract (General and Supplementary) and Division 1 for submittal definitions, requirements, and procedures. Shop drawings shall be submitted per specification section as a digital file (pdf); do not combine equipment from multiple specification sections into a single submittal. O&M manuals with warranties shall be submitted tabulated per specification section combined into a single digital file (pdf). Allow 10 business days for review of shop drawings & O&M manuals, starting from the date LPA, Inc. receives the submittals.

B. Submittal of shop drawings, product data and samples will be accepted only when submitted by the General Contractor. Data submitted from subcontractors and material suppliers directly to the Architect/Engineer will not be processed.

C. Submittals that are not acceptable must be resubmitted until returned as approved by the engineer. If the third submittal is not approved, the contractor will be responsible for paying additional fees for subsequent reviews of submittals at a rate of $200 per hour, and the specified item may be required to be provided at the engineer's discretion at no additional cost to the contract. Submittals will not be returned until payment is received.

1.19 BIDDING INSTRUCTIONS:

A. Products are generally specified by a performance specification and/or by manufacturer's name and model number or trade name.

1. When specified only by a performance specification, the Contractor may use any manufacturer who meets the performance specification and applicable codes.
2. When several products/manufacturers are specified together, then the Contractor has the option of using any product/manufacturer listed. The Contractor shall be subject to the requirements of paragraph 1.18 - ELECTRICAL SUBMITTALS. The Contractor's bid shall be compiled on the use of the listed products without exception. Substitutions will only be considered after the contract has been signed and shall be subject to the requirements of paragraph 1.20 - SUBSTITUTIONS.
3. When several products/manufacturers are specified together and the system design is based on one of the listed products by specific model number(s) or catalog number(s), the Contractor has the option of using the one specific product or any product/manufacturer listed. However, when another listed product/manufacturer is

used, the Contractor shall be responsible for determining that the product(s) are compatible with building design, electrical design, and mechanical design; are equal to the basis-of-design product in quality, appearance, construction and performance (including lamping and lenses for lighting fixtures); and will not necessitate design modifications by the Architect/Engineer. The Contractor's bid shall be compiled on the use of the listed products/manufacturers without exception. Substitutions will only be considered after the Contract has been signed and shall be subject to the requirements of paragraph 1.20 - SUBSTITUTIONS.

4. A request for substitution shall be made in writing from the General Contractor only. Requests by distributors, manufacturers, or manufacturer's representatives will not be considered. Oral requests will not be considered. Request for deviations from product specifications will not be considered.
5. Request for substitutions will not be considered during bidding unless the specified product is discontinued.
6. If approval for a substitution is granted, samples shall be submitted if and as requested by Engineer.
7. Approval of substitutions prior to shop drawing submittal will not be granted.

1.20 SUBSTITUTIONS:

A. Any substitution to the basis of design light fixtures shall require complete photometric point-by-point calculations (at no additional cost to the contract) of all areas (rooms) the substitute light fixtures will be installed. The photometric calculations shall include substitute light fixture(s) and any non-substitute light fixture(s) where they are all in the same area (room). Architect/Engineer shall then review substitution cut sheets and photometric calculations to determine if the light fixtures are equal to the basis of design.

B. Substitutions are understood to mean that the Contractor:

1. Has personally investigated the proposed substitute and has determined that it is equal or superior in all respects, including appearance, to the item specified.
2. Will provide the same guarantee for the substitution that he would for the equipment specified,
3. Has coordinated the installation of the substitute, providing design modifications and changes as required for the work to be complete in all respects.
4. Has coordinated the installation of the substitute with the General Contractor pertaining to changes required for the work to be complete with all trades (all changes shall be provided without additional cost to the contract).
5. All required design modifications and/or changes shall be submitted with the shop drawings for the substitute equipment.
6. Has coordinated with the light controls manufacturer to ensure substitution will work with specified light controls and sequence of operations.
7. Has provided the amount of credit due the Owner if the substitution is accepted.

C. The Architect/Engineer will indicate on which of these items the Contractor may submit shop drawings for review. The acceptance by the Architect/Engineer of any or all of those items listed by the Contractor for review shall not constitute an approval of the substitute

but shall mean that the Contractor may then submit detailed shop drawings for review. When a request for substitution is granted, the Architect/Engineer will review shop drawings as follows:

1. If shop drawings for the substitute equipment are marked "AMEND & RESUBMIT" on first submittal, the Contractor is allowed to resubmit for two additional reviews, unless the Architect/Engineer provides other instructions. If after the third review, the substitute equipment is not accepted, the specified equipment shall be provided without any additional cost to the contract.
2. If shop drawings for the substitute equipment are marked "REJECTED – SEE REMARKS" at any submittal level, the Contractor shall stop any further submittals of any substitute equipment. The Architect/Engineer will not review any additional substitute equipment and the Contractor shall submit and provide the specified equipment without any additional cost to the contract.

1.21 SIMILAR PRODUCTS:

A. When two or more items of same material or equipment are required, they shall be of the same manufacturer. Product manufacturer uniformity does not apply to raw materials, bulk materials, conductors, conduit, fittings, sheet metal, steel bar stock, welding rods, solder, fasteners and similar items used in Work, except as otherwise indicated.

B. Provide products which are compatible within systems and other connected items.

1.22 NAMEPLATE DATA:

A. Provide permanent operational data nameplate on each item of power-operated equipment, indicating manufacturer, product name, model number, serial number, capacity, operating and power characteristics, labels of tested compliances, and similar essential data. Locate nameplates in an accessible location. Provide the manufacturer's nearest authorized servicing agency, address and emergency telephone number.

1.23 DELIVERY, STORAGE AND HANDLING:

A. Deliver products to project properly identified with names, model numbers, types, grades, compliance labels, and similar information needed for distinct identifications. Products shall be adequately packaged and protected to prevent damage during shipment, storage, and handling.

B. Store equipment and materials at the site, unless off-site storage is authorized in writing. Protect stored equipment and materials from damage.

C. Coordinate deliveries of electrical materials and equipment to minimize construction site congestion. Limit each shipment of materials and equipment to the items and quantities needed for the smooth and efficient flow of installations.

1.24 IDENTIFICATION:

A. Coordinate all room number designations with the final room numbers. Use final room numbers for all final documentation and display, including but not limited to, programming, alarm displays, annunciator displays, panelboard schedules, signage, labels, and engraved labels. The room numbers shall be as directed by the Owner and may not be the same as shown on Contract Drawings. Include final room numbers on the drawings for the Record Documents.

1.25 RECORD DOCUMENTS:

A. Refer to the sections of Division 1 for record document requirements. The following paragraphs supplement the requirements of Division 1.

B. Mark Drawings to indicate revisions to lighting fixture and wiring device layout; conduit size and location both exterior and interior; actual equipment locations, dimensioned from column lines; concealed equipment, dimensioned from column lines; distribution and branch electrical circuitry; fuse and circuit breaker sizes and arrangements; support and hanger details; concealed control system devices; panel schedules.

C. Mark Contract Documents to indicate accepted substitutions, Change Orders and actual equipment and material used on the project.

D. Within 30 days after the date of system acceptance, as-built record drawings of the following shall be provided to the Owner in accordance with energy codes

1. Single-line diagram of the building electrical distribution system
2. Floor plans indicating the location and area served for all electrical distribution equipment.

E. Within 90 days after the date of system acceptance, as-built record drawings of the actual lighting and associated controls installations shall be provided to the Owner, including the location, luminaire identifier, and control & circuiting for each piece of lighting equipment, in accordance with energy codes

1.26 OPERATING AND MAINTENANCE DATA:

A. Refer to the sections of Division 1 for procedures and requirements for preparation and submittal of maintenance manuals.

B. In addition to the information required by Division 1 for Maintenance Data, include the following information:

1. Submittal data stating equipment rating and selected options for each piece of equipment requiring maintenance. Include description of function, normal operating characteristics and limitations, performance curves, engineering data and tests, and complete nomenclature and commercial numbers of all replaceable parts.
2. Manufacturer's printed operating procedures to include start-up, break-in, routine and normal operating instructions; regulation, control, stopping, shut-down, and emergency instructions; and summer and winter operating instructions.
3. Operations and maintenance manuals for each piece of equipment requiring maintenance. Include maintenance procedures for routine preventative maintenance and troubleshooting, disassembly, repair and reassembly, aligning and adjusting instructions. Required regular maintenance actions shall be clearly stated and incorporated on a readily accessible label; the label shall include the title or publication number for the operation and maintenance manual for that particular model and type of product.
4. Servicing instructions and lubrication charts and schedules.
5. Names and addresses of at least one qualified service agency for each piece of equipment or system.
6. A complete narrative of how each system is intended to operate.

C. For compliance with energy codes, provide a lighting equipment and controls operations and maintenance manual to the Owner within 90 days after the date of system acceptance. These manuals shall include the following:

1. Submittal data indicating all selected options for each piece of lighting equipment and lighting controls.
2. Operation and maintenance manuals for each piece of lighting equipment and lighting controls with routine maintenance clearly identified, including a recommended re-lamping program and a schedule for inspecting and recalibrating all lighting controls.
3. A complete narrative of how each lighting control system is intended to operate, including recommended settings.

D. Compile and assemble the manuals for Divisions 26, 27 and 28 into a separated set of vinyl covered, three ring binders, tabulated and indexed for easy reference. Only one copy of each manual needs to be submitted for engineer review.

E. For the Owner’s use, provide 2 copies of all O&M manuals, diagnostic tools, software and sufficient training for all electrical systems and their components (generator, fire alarm, lighting controls, etc.).

1.27 WARRANTIES:

A. Refer to the sections of Division 1 for procedures and submittal requirements for warranties. Refer to individual equipment specifications for warranty requirements.

B. Compile and assemble the warranties for Divisions 26, 27 and 28 into a separated set of vinyl covered, three ring binders, tabulated and indexed for easy reference.

C. Provide complete warranty information for each product or piece of equipment, including date of beginning of warranty or bond; duration of warranty or bond; and names, addresses, and telephone numbers and procedures for filing a claim and obtaining warranty services. Only one copy of each warranty needs to be submitted for engineer review.

1.28 CLEANING:

A. Refer to the sections of Division 1 for general requirements for cleaning.

B. Clean all panelboards, lighting fixtures, and lenses prior to final acceptance. Replace all inoperative LED boards and LED drivers.

1.29 SITE VISIT REPORTS:

A. Respond in writing to each item of discrepancy noted on all site visit reports.

1.30 ALTERATIONS TO EXISTING WORK:

A. Refer to the sections of Division 2 for requirements for selective demolition. The following paragraphs supplement the requirements of Division 1.

B. Unless otherwise indicated, all existing electrical work shall be removed in all areas that are indicated to be renovated, unless required for the new installation. Existing work to be removed includes, but is not limited to, conductors and cables, exposed raceways and raceway systems concealed behind accessible construction, raceway systems exposed due to remodeling of existing space, wiring devices, circuit and motor disconnects, supporting devices, motor starters, lighting fixtures, fire alarm equipment, telephone equipment, intercom equipment, sound equipment and television equipment. As used in this paragraph, raceway systems include raceway fittings, boxes and plates. Cut abandoned under-slab raceways off flush with floor and fill with grout. All removed items shall become property of the Contractor and removed from the site unless noted otherwise.

C. Where ceilings or sections of walls or other work is demolished or removed, maintain or alter all existing electrical branch circuits, service(s), feeders, communication and alarm systems to all remaining occupied areas and operational facilities, unless otherwise indicated, or when authorized otherwise in writing by Owner or Architect. Also provide code-compliant supports for existing-to-remain light fixtures, raceways, and cables that are not currently code compliant. Provide temporary service, feeders, connections and branch circuits during interruptions to existing facilities. When necessary, schedule momentary outages for replacing existing wiring systems with new wiring systems. When that "cutting-over" has been successfully accomplished, remove, relocate, or abandon existing wiring as required.

D. Where existing corridor, classroom or office accessible ceilings are removed for the new work, care shall be taken when removing the existing ceiling tiles. Any damaged ceiling tiles shall be replaced with matching tiles.

E. Ceiling replacement: In areas where ceilings are replaced (ceiling tile, tile and grid, gypsum), provide electrical work to accommodate ceiling replacement, including but not limited to, light fixtures, fire alarm devices, light controls, and low-voltage devices. Where existing electrical items can remain in place while replacing the ceilings, protect them from construction damage. Remove existing electrical items where necessary to remove ceiling. Work to remove existing electrical items shall include disconnecting power/controls/wiring/cabling from the existing items; remove, protect, and store the existing items. Reinstall the existing items back in the same locations and reconnect the existing power/controls/wiring/cabling. Provide additional materials and labor required when reinstalling the existing electrical items in the new ceilings to fix any existing NEC violations, this includes but is not limited to, light fixture supports, cable/wiring/junction box supports, connectors, junction boxes and covers, labeling, grounding, etc. After ceiling work is complete, clean all electrical items. See Architectural sheets for extent of ceiling replacement work.

F. GWB or panel veneer: in areas where GWB or paneling is added to existing walls, provide electrical work to accommodate wall. Note all locations and wiring connections and remove existing devices before wall covering is installed. Provide box extenders and re-install devices. After work is complete, clean all electrical items. See Architectural sheets for extent of work.

END OF SECTION 260100

SECTION 260519 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1: GENERAL

1.1 DESCRIPTION:

A. This section specifies the furnishing, installation and connection of the low voltage power and lighting wiring. Extent of electrical wire and cable shall be as indicated and required for complete and operable electrical systems.

1.2 RELATED WORK SPECIFIED ELSEWHERE:

A. The Drawings and general provisions of the Contract, including the General and Supplementary Conditions, Instructions to Bidders and sections of Division 1, apply to the work specified in this section.

B. Refer to other Division 7, Division 26 and Division 31 sections for requirements for penetration firestopping, requirements for electrical installations, grounding and bonding, raceway and boxes and earthwork.

1.3 REFERENCES AND CODES:

A. NEMA WC 70 Standard for Non-shielded Power Cable 2000 volts or Less for the Distribution of Electrical Energy (2009).

B. 2020 NFPA 70 National Electrical Code

1.4 SUBMITTALS:

A. In accordance with sections of Division 1, furnish the manufacturer’s literature and data showing each conductor and cable type and rating.

1.5 QUALITY ASSURANCE:

A. Testing Agency Qualifications: Testing agency as defined by OSHA in 29 CFR 1910.7 or a member company of the International Electrical Testing Association and that is acceptable to Authorities Having Jurisdiction.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70 Article 100 by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with applicable requirements of NFPA 70 (NEC) pertaining to the construction and installation of electrical wires and cables.

1.6 DELIVERY, STORAGE AND HANDLING:

A. Deliver wire and cable properly packaged in factory fabricated containers or wound on NEMA-specified wire and cable reels. Each coil or reel shall contain only one continuous cable without splices.

B. Handle wire and cable carefully to avoid abrading, puncturing or tearing wire and cable insulation and sheathing. Ensure the dielectric resistance integrity of the wire and cable is maintained.

C. Store wire and cable in a clean, dry space in original containers. Protect products from weather, damaging fumes, construction debris and traffic.

PART 2: PRODUCTS

2.1 CONDUCTORS AND CABLES:

A. General: Provide electrical conductors and cables of manufacturer's standard materials, as indicated by published product information, designed and constructed as recommended by manufacturer for a complete installation and for applications indicated.

B. Line Voltage (100 to 600 volts): Provide copper conductors with conductivity of not less than 98% at 20 degrees C (68 degrees F). All indicated conductor sizes in construction documents are based on copper. Provide color-coding of conductors. Use factory applied colored insulation for conductors #6 AWG and smaller. Use colored self-adhesive vinyl tape for #4 AWG and larger at terminations and splices. Match existing color coding for conductors. Provide ground conductor color as required by the NEC.

1. Provide factory-fabricated copper conductors of sizes, ampacity ratings, and materials for applications and services indicated. Provide conductors with Type XHHW or XHHW-2 or THHN or THWN-2 insulation with a minimum rating of 90 degrees C, which are the indicated conductors scheduled.
2. Provide solid conductors for sizes #10 AWG and smaller. Provide stranded conductors for sizes #8 AWG and larger. Provide minimum conductor size of #12 AWG, larger where indicated.
3. For 120-volt 15 amp and 20 amp branch circuits, use minimum 12 AWG up to 60 feet, 10 AWG for 61-95 feet, 8 AWG for 96-155 feet and 6 AWG for branch circuits longer than 155 feet. Conductors shall be same size for entire length of run, except if all outlets are in the same room (1200 square feet or less) the oversized conductors may be run only to the first outlet.
4. For 277-volt 15 amp and 20 amp branch circuits, use minimum 12 AWG up to 140 feet, 10 AWG for 141-220 feet and 8 AWG for branch circuits longer than 220 feet. Conductors shall be same size for entire length of run.

5. Cables: Provide UL-type factory-fabricated cables of materials and jacketing/sheathing as indicated below for services indicated. Re-size cable conductors based on equal to or greater equivalent 75 degree C rated copper conductors as scheduled if cables are used. Select cables with construction features which fulfill project requirements. At Contractor's option, the following cable types are acceptable where indicated:

    a. Type "MC"--METAL-CLAD CABLE
    b. Types “SE” & “USE”--SERVICE AND UNDERGROUND SERVICE
    c. Type "UF"--UNDERGROUND FEEDERS AND BRANCH CIRCUITS

6. Fire Alarm Circuits: Type THHN/THWN or THHN/THWN-2 in full metal raceway system where installed in concealed walls and ceilings or outdoors (above or below grade) in combination with power-limited signaling circuit cables where allowed by code. Where required provide plenum rated or fire-protective signaling circuit cables/assemblies in accordance with the instructions by the manufacturer.

2.2 CONNECTORS:

A. General: Provide proper current-carrying material suitable for conductors used.

B. Line Voltage (100 to 600 volts):

1. Splices: Provide solderless, screw-on, reusable pressure cable type, 600 volt connectors for conductors #10 AWG and smaller constructed of corrosion-resistant steel or copper spring and a vinyl or plastic insulator which is temperature-rated 105 degree C and approved for copper conductors. Provide compression connectors for conductors #8 AWG and larger constructed of copper, copper alloy or aluminum.
2. Terminations: Provide compression-type terminations rated 600V and 105 degree C, constructed of tin-plated copper; serrated barrel; chamfered conductor entry. All compression terminations shall be applied using the manufacturer's recommended compression tool for the size of termination used. The terminations shall be of exact size to fit the conductors and shall be installed to bring uniform pressure on all sides of the joint and assure a permanent high-conductivity connection. Where terminations are supplied as standard material on equipment, contractor may elect to utilize such termination in lieu of those specified herein.

PART 3: EXECUTION

3.1 INSTALLATION OF CONDUCTORS, CABLES AND CONNECTORS:

A. Coordinate conductors/cable installation work, including electrical raceway and equipment installation work, as necessary to properly interface installation of conductors/cables with other work.

B. Unless otherwise indicated, install individual conductors in raceways.

C. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.

D. Support cables according to NEC and cable manufacturer's instructions.

E. Cables penetrating fire-rated elements shall be sealed according to Division 7.

F. Type MC, SE, USE and UF cable may be used in areas where permitted by NEC and local codes, but only for branch circuits above accessible ceilings and in stud walls. Only cables with 75 degree C rated insulation are permitted. Where running into a panel where the ceiling space is inaccessible, conduit shall be run from the panel to a junction box above the nearest accessible ceiling. Cables shall be run neatly in straight parallel runs with proper support and limited sag.

G. Provide cables in plenum spaces in metallic raceways or with cable jackets approved for use in plenum spaces.

H. Provide listed bushing or grommets where non-metallic-sheathed cables pass through openings in metal studs and other metal members in accordance with NEC 300.4. Where cables are installed at roof decking, follow requirements of NEC 300.4(E).

I. Pull conductors simultaneously where more than one is being installed in same raceway.

J. 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.

K. Use pulling means, including fish tape, cable, rope and basket weave conductor/cable grips, which will not damage cables or raceway. Remove and replace all conductors/cables with damaged jacket or insulation.

L. Install splices at accessible outlet or junction boxes. Keep splices in underground junction boxes, hand holes, and manholes to an absolute minimum. Where splices are necessary, arrange to minimize the effects of moisture.

M. Install splices and tapes which possess equivalent-or-better mechanical strength and insulation ratings than conductors being spliced.

N. Where ground conductors are required to be run in same raceway as phase conductors, the ground conductor shall be run continuous throughout each circuit and the ground conductor pigtailed to the device to ensure ground continuity.

O. Do not install a shared neutral on any circuit. Install capped neutral conductors in switch boxes where required by NEC 404.2(C).

P. 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 and UL 486B.

Q. Wiring at Outlets: Install conductors at each outlet with at least 6 inches of slack.

R. AC cable is not allowed to be used.

S. Comply with all emergency system wiring requirements in NEC 700.10.

3.2 INSTALLATION OF CONDUCTORS AND CABLES FOR POWER LIMITED CIRCUITS:

A. Wiring for signaling and power limited circuits may be run exposed in the following locations:

1. Above accessible ceilings where not exposed to view.

B. Provide signaling and wiring for power limited circuits in raceways in the following locations:

1. In all locations not specifically listed above.
2. Where concealed in inaccessible locations.
3. In elevator equipment rooms and hoistways.

C. Install exposed conductors or cable parallel and perpendicular to building surfaces, or exposed structural members, and follow surface contours where possible.

D. Install conductors and cables in a neat and workmanlike manner.

E. Support conductors and cables frequently to prevent excessive sag. Support a minimum of 6" above suspended ceilings. Do not support conductors or cables from conduit or other raceway.

F. Parallel cable runs shall be installed adjacent to each other. Tie adjacent runs in neat bundles.

G. Install conductors and cables without splices. Make connections at terminal strips in cabinets or at equipment terminals.

H. Provide conductors and cables in accordance with requirements of manufacturer.

3.3 FIELD QUALITY CONTROL:

A. Prior to energization of circuitry, check low voltage installed conductors and cables with megohm meter to determine insulation resistance levels to ensure requirements are fulfilled.

B. Prior to energization, test low voltage conductors and cables for electrical continuity, short circuits and grounds. Also, test conductor phase-to-phase and phase-to-ground.

END OF SECTION 260519

SECTION 260526 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1: GENERAL

1.1 DESCRIPTION:

A. This section specifies general grounding and bonding requirements of electrical equipment operations for safety and to provide a low impedance path for possible ground fault currents. Extent of grounding and bonding work is indicated by drawings and schedules and as specified herein. Grounding and bonding work is defined to encompass systems, circuits and equipment.

1.2 RELATED DOCUMENTS:

A. The Drawings and general provisions of the Contract, including the General and Supplementary Conditions, Instructions to Bidders and sections of Division 1, apply to the work specified in this section.

1.3 RELATED WORK SPECIFIED ELSEWHERE:

A. Refer to other Division 26 sections for conductors/cables, electrical raceways, boxes and fittings which are required in conjunction with electrical grounding and bonding work.

1.4 REFERENCES AND CODES:

A. Electrical Code Compliances: Comply with applicable requirements of the 2020 NFPA-70 (NEC) pertaining to electrical grounding and bonding, pertaining to systems, circuits, and equipment. Particular attention is called to Article 250.

B. U.L. Compliance: Comply with applicable requirements of UL Standards Nos. 467, "Electrical Grounding and Bonding Equipment", and 869, "Electrical Service Equipment", pertaining to grounding and bonding of systems, circuits, and equipment. In addition, comply with UL Std. 486A, "Wire Connectors and Soldering Lugs for Use with Copper Conductors." Provide grounding and bonding products which are U.L. Listed and labeled for their intended usage.

C. IEEE Compliance: Comply with applicable requirements and recommended installation practices of IEEE Standards 80, 81, 141, and 142 pertaining to grounding and bonding of systems, circuits, and equipment.

1.5 SUBMITTALS:

A. Submit manufacturer's data on grounding and bonding products and associated accessories.

PART 2: PRODUCTS

2.1 GROUNDING SYSTEMS:

A. General: Except as otherwise indicated, provide electrical grounding and bonding systems in accordance with the NEC, with assembly of materials including, but not limited to: conductors/cables, connectors, terminals (solderless lugs), compression connectors, mechanical connectors and/or exothermic process connections, grounding electrodes and bonding jumpers, and additional accessories needed for complete installation. Where more than one type unit meets indicated requirements, selection is Contractor's option. Where materials or components are not indicated, provide products complying with NEC, UL, IEEE and established industry standards for applications indicated.

B. Conductors: Unless otherwise indicated, provide electrical grounding conductors matching power supply wiring materials and sized according to NEC.

2.2 MISCELLANEOUS MATERIAL:

A. Bonding Jumper Braid: Copper braided tape constructed of 30 gauge bare copper wires and properly sized for indicated applications.

B. Bonding Plates, Connectors, Terminals and Clamps: Provide electrical bonding plates, connectors, terminals and clamps for indicated applications.

C. Ground Busbar: Provide ground busbar of 1/4” thick, tin-plated copper; 15 1/2”L x 4”W; tower mounting with nylon polyamide insulators and stainless steel brackets and bolts for a total stand-off height of 2”; predrilled with 19 pairs of 5/16” holes and 3 pairs of 7/16” holes.

D. Grounding Electrodes (Rods): Steel with copper welded exterior, 3/4 inch diameter and 10 feet length.

E. Electrical Grounding Connection Accessories: Provide electrical insulating tape, heat-shrinkable insulating tubing, welding materials and bonding jumpers, as recommended by accessories manufacturers for type services indicated.

F. Compression Connectors: Compression connectors shall be manufactured from pure, wrought copper in compliance with ASTM B187.

G. Mechanical Connectors: Mechanical cast connectors shall be manufactured from a copper alloy of minimum 80% copper, according to ASTM B30.

H. Field Welding: Comply with AWS Code for procedures, appearance, quality of welds and methods used in correcting welding work. Provide welded connections where grounding conductors connect to underground grounding electrodes. Welds shall utilize the exothermic process.

PART 3: EXECUTION

3.1 EXAMINATION:

A. Examine areas and conditions under which electrical grounding and bonding connections are to be made and notify Contractor in writing of conditions detrimental to proper completion of work. Do not proceed with work until satisfactory conditions have been corrected in a manner acceptable to Installer.

3.2 INSTALLATION OF ELECTRICAL GROUNDING AND BONDING SYSTEMS:

A. General: Install electrical grounding and bonding systems required in accordance with manufacturer's instructions and applicable portions of the NEC, NECA's "Standard of Installation", and in accordance with recognized industry practices to ensure that products comply with requirements.

B. Provide insulated equipment grounding conductors in the same raceway with phase conductors for all feeders (panelboards, control centers and distribution transformers), motor circuits, branch circuits and site lighting. Ground conductors shall be continuous from the equipment to the ground bus of the switchboard, panelboard or control center serving the equipment.

C. Coordinate with other electrical work as necessary to interface installation of electrical grounding and bonding system with other work.

D. Drive each grounding electrode (ground rod) vertically in the soil such that a minimum 8’-0” of length is in contact with the soil with the upper end of the electrode a minimum 2’-0” below finished grade level, but below the permanent moisture level. Utilize an exothermic welding process to connect grounding conductors to the underground grounding electrodes and at other inaccessible or concealed locations.

E. Install standard cable bonding jumpers with ground clamps on water piping to electrically bypass water meters, water heaters, insulated joints and any equipment which is likely to be disconnected for repairs or replacement, refer to NEC 250.53 (D) (1).

F. Install clamp-on connectors only on thoroughly cleaned metal contact surfaces, to ensure electrical conductivity and circuit integrity.

G. Ground electrical service system neutral at service entrance equipment to grounding electrodes. Make ground connections in accordance with NEC and local utility company requirements. Bonding jumpers at the service shall comply with NEC 250.92.

H. Site Lighting: Lighting poles and fixtures shall be grounded to a ground rod in the pole base and to the branch circuit equipment grounding conductor.

I. Ground each separately-derived system neutral to effectively grounded metallic water pipe, effectively grounded structural steel member or separate grounding electrode.

J. Connect together system neutral, service equipment enclosures, exposed non-current carrying metal parts of electrical equipment, metal raceway systems, grounding conductor in raceways and cables, wiring device ground connectors and plumbing systems. Particular attention is called to NEC 250.92, 250.97 and 250.98 for metal raceway bonding requirements. Ground cord-and-plug connected equipment in accordance with NEC 250.114.

K. Provide a ground bar in each communication room and electric room where indicated. Ground bars shall be mounted with long dimension horizontal and with bottom of bar 12" above the finished floor. Ground each bar as noted on drawings.

L. Terminate feeder and branch circuit insulated equipment grounding conductors with grounding lug to ground bar or bus.

M. Connect grounding electrode conductors to metallic cold water pipe and sprinkler main within 5 feet of the entrance point into the building using a suitably sized ground clamp, refer to NEC 250.68 (C) (1). Also bond gas piping, metallic water piping and metal structural members to system ground where applicable in compliance with NEC 250.104.

N. Route grounding connections and conductors to ground and protective devices in shortest and straightest paths as possible to minimize transient voltage rises.

O. Apply corrosion-resistant finish to field-connections, buried metallic grounding and bonding products and places where factory applied protective coatings have been destroyed, which are subjected to corrosive action.

P. All ground connectors shall be designed for fault-duty loading and shall have the fault capacity of the maximum sized conductor for which it is designed.

Q. Bolt hole connectors and in-line splices shall accommodate only one conductor size. All other ground connectors shall be range taking.

R. Structural steel and busbar ground connectors shall accommodate only one rigid member conductor.

S. All ground connectors shall be provided with a corrosion-inhibiting compound preapplied to the contact surfaces. The compound shall be compatible with the conductors accommodated by the connector.

T. All ground connectors shall be capable of being provided with tin plating, if required by the application.

U. Tighten grounding and bonding connectors and terminals, including screws and bolts, in accordance with manufacturer's published torque tightening values for connectors and bolts. Where manufacturer's torqueing requirements are not indicated, tighten connections to comply with tightening torque values specified in UL 486A to assure permanent and effective grounding.

V. Compression and Mechanical Connector Marking:

1. All connectors shall be clearly and permanently marked with the following information:

   a. Manufacturer's inspection symbol
   b. Catalog number
   c. Conductor accommodation(s)
   d. Installation die index or die catalog number (compression)
   e. Underwriters Laboratories Listing Mark
   f. The words "Suitable for Direct Burial," or "Direct Burial," or "Burial" as specified per ANSI/UL467.

2. The smallest unit package shall contain the information listed under V.1 and shall also include installation tooling.

W. Ground Connector Installation Using Compression and Mechanical Connectors:

1. Installation of connectors shall be made in accordance with the manufacturer's recommendations. The instructions typically include conductor preparation (cleaning, pre-crimp), installation tool and die selection, and application of the proper number of crimps.
2. Connectors shall be installable under all types of weather/field conditions without special safety precautions or procedures.
3. Connectors shall be installable without using or producing hazardous materials or by-products.

X. Provide labels on all ground electrode conductors and bonding conductors that indicate what they are connected to.

1. Main Service Ground Buss Bar:

   a. Ground electrode conductor to Metal Underground Water Pipe ground electrode shall be labeled: "Water Main".
   b. Ground electrode conductor to Metal Frame of Building or Structure ground electrode shall be labeled: "Building Steel".
   c. Ground electrode conductor to Concrete-Encased ground electrode shall be labeled: "Concrete Encasement".
   d. Ground electrode conductor to Ground Rod Triad ground electrode shall be labeled: "Ground Rods".
   e. Ground conductor to Telecommunication Systems ground buss bar (located at the telecommunication services) shall be labeled: "Telecommunication Systems".
   f. Ground conductor to Interior Gas Metal Piping shall be labeled: "Gas Piping".
   g. Ground conductor to Interior Sprinkler Metal Piping shall be labeled: "Sprinkler Piping".

3.3 FIELD QUALITY CONTROL:

A. Ground Connector Inspection:

1. Compression dies shall provide embossment of the connector upon successful installation. The embossed index shall match the marking on the installed connector.
2. Connector marking information specified above shall be legible after installation for inspector cross-reference.
3. Closed barrel connectors shall have inspection holes at the appropriate location to verify proper cable insertion.

B. Performance: All system connectors shall be Listed by Underwriters Laboratories for direct burial in earth or embedment in concrete per ANSI/UL467 Standard for Grounding and Bonding Equipment.

C. Upon completion of installation of electrical grounding and bonding systems, test ground resistance of rod, pipe or plate electrodes with ground resistance tester. Where tests show resistance to ground is over 25 ohms, provide additional electrodes as listed by the NEC to reduce resistance to 25 ohms or less. Retest to demonstrate compliance. This test does not apply to supplementary grounding electrodes such as a ground rod provided for exterior lighting fixture poles.

3.4 O&M MANUAL:

A. Provide O&M Manual as specified in specification section 260100. Include both a paper copy and digital pdf copy of the O&M Manual.

END OF SECTION 260526

SECTION 260529 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1: GENERAL

1.1 DESCRIPTION:

A. This section specifies the extent of supports, anchors, sleeves and seals for electrical equipment installations as indicated by drawings and schedules, as specified in the Division 26 sections and as required by the NEC.

1.2 RELATED DOCUMENTS:

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Instructions to Bidders and sections of Division 1, apply to the work specified in this section.

1.3 REFERENCES AND CODES:

A. Electrical Code Compliances: Comply with applicable requirements of the 2020 NFPA-70 (NEC) pertaining to construction and installation of electrical supporting devices.

B. NECA Compliance: Comply with National Electrical Contractors Association's "Standard of Installation" pertaining to anchors, fasteners, hangers, supports, and equipment mounting.

C. U.L. Compliance: Provide electrical components which are U.L. Listed and U.L. Labeled.

1.4 PERFORMANCE REQUIREMENTS:

A. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.

B. Design equipment system supports capable of supporting combined operating weight of supported equipment and connected systems and components.

C. Rated Strength: Adequate in tension, shear and pullout force to resist maximum loads calculated or imposed under this Project, with a structural safety factor of five times the applied force.

PART 2: PRODUCTS

2.1 MANUFACTURERS:

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.
2. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 SUPPORT, ANCHORAGE AND ATTACHMENT COMPONENTS:

A. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.

1. Manufacturers:

a. Cooper B-Line; a division of Cooper Industries.
b. ERICO International Corporation.
c. Allied Support Systems; Power-Strut Unit.
d. GS Metals Corp.
e. Michigan Hanger Co., Inc.; O-Strut Div.
f. National Pipe Hanger Corp.
g. Thomas & Betts Corporation.
h. Unistrut; Tyco International, Ltd.
i. Wesanco, Inc.
j. Bridgeport Fittings, Inc.

2. Finishes:

a. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
b. Nonmetallic Coatings: Manufacturer’s standard PVC, polyurethane, or polyester coating applied according to MFMA-4.
c. Painted Coatings: Manufacturer’s standard painted coating applied according to MFMA-4.

3. Channel Dimensions: Selected for applicable load criteria.

B. Raceway and Cable Supports: As described in NECA 1 and NECA 101.

C. Conduit and Cable Support Devices: Steel and malleable-iron hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.

D. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes and bars; black and galvanized.

E. Support for Conductors in Vertical Conduit: 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 suit individual conductors or cables supported. Body shall be malleable iron.

F. 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 Construction Products.
      (3) MKT Fastening, LLC.
      (4) Simpson Strong-Tie Co. Inc.

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; a division of Cooper Industries.
      (2) Empire Tool and Manufacturing Co., Inc.
      (3) Hilti, Inc.
      (4) ITW Construction Products.
      (5) MKT Fastening, LLC.
      (6) Powers Fasteners.

3. Concrete Inserts: Steel or malleable-iron slotted-support-system units similar to MSS Type 18; complying with MFMA-3 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, high strength. Comply with ASTM A 325.
6. Toggle Bolts: All-steel springhead type.
7. Hanger Rods: Threaded steel.

2.3 FABRICATED METAL 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 5 for steel shapes and plates.

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. Minimum rod size shall be 1/4 inch (6 mm) in diameter.

C. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted or other support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.

1. Secure raceways and cables to these supports with two-bolt conduit clamps or single-bolt conduit clamps.

D. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2 inch (38 mm) 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 this Article.

B. 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 (90 kg).

C. 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 required 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 inches (100 mm)

thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches (100 mm) thick.

6. To Steel: Beam clamps or Spring-tension 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.

D. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

3.3 INSTALLATION OF FABRICATED METAL SUPPORTS:

A. Comply with installation requirements in Division 5 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 INSTALLATION OF SUPPORTING DEVICES:

A. Install hangers, anchors, sleeves and seals as required, in accordance with manufacturer's written instructions and with recognized industry practices to ensure supporting devices comply with requirements. Comply with requirements of NECA and NEC for installation of supporting devices.

B. Coordinate with other electrical work, including raceway and wiring work, as necessary to interface installation of supporting devices with other work.

C. Install hangers, supports, clamps, and attachments to support conduit properly from building structure. Arrange for grouping of parallel runs of horizontal conduits to be supported together on trapeze type hangers where possible. Install supports in compliance with NEC requirements.

END OF SECTION 260529

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SECTION 260533 - RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS

PART 1: GENERAL

1.1 DESCRIPTION:

A. This section specifies the furnishing, installation and connection of conduit, fittings and boxes to form complete, coordinated, grounded raceway systems. Raceways are required for all wiring unless shown or specified otherwise. Extent of raceway work is indicated by drawings and schedules and as required by the NEC.

1.2 RELATED DIVISIONS AND SECTIONS:

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Instructions to Bidders and sections of Division 1, apply to the work specified in this section.

B. Refer to other Division 7 and Division 26 sections for requirements for penetration firestopping, requirements for electrical installations, grounding and bonding and wiring devices and miscellaneous equipment.

1.3 REFERENCES AND CODES:

A. NEMA Compliance: Comply with applicable requirements of NEMA Standards Publication pertaining to raceways.

B. U.L. Compliance and Labeling: Comply with applicable requirements of U.L. Safety Standards pertaining to electrical raceway systems. Provide raceway products and components which have been U.L. Listed and labeled.

C. Electrical Code Compliance: Comply with applicable requirements of the 2020 NFPA-70 (NEC) pertaining to the construction and installation of raceway systems.

1.4 SUBMITTALS:

A. Product Data: Submit manufacturer's data on raceways, surface metal raceways and thru-wall/floor firestop devices.

B. Samples: Submit 6” length of metal type surface raceways, with required finish, when requested by Architect.

PART 2: PRODUCTS

2.1 ALL RACEWAYS:

A. General: Provide complete assembly of all raceways, including but not limited to fittings, couplings, conduit bodies, underground raceway seals, service heads, expansion fittings, straps, hangers and other components and accessories as required to complete raceway system.

2.2 METAL RACEWAYS:

A. Rigid Aluminum Conduit: Rigid aluminum 6063 Alloy, T41 temper, conforming to ANSI C80.5. Provide factory-applied, closed-end thread protectors.

B. Rigid Steel Conduit: Rigid steel, zinc-coated, threaded type conforming to ANSI C80.1. Provide zinc coating fused to inside and outside walls.

C. Intermediate Metal Conduit (IMC): Rigid intermediate grade steel, hot-dip galvanized conforming to ANSI C80.6.

D. Electrical Metallic Tubing (EMT): ANSI C80.3. The Contractor has the option of using aluminum EMT where sizes 2" through 4" are required, except where UL firestop assemblies require steel.

E. Flexible Metal Conduit: Formed from continuous length of spirally wound, interlocked zinc-coated strip steel conforming to UL 1.

F. Liquid-Tight Flexible Metal Conduit: Constructed of single strip, flexible, continuous, interlocked, and double-wrapped steel; galvanized inside and outside; coated with liquid-tight jacket of flexible polyvinyl chloride (PVC).

G. Rigid Metal Conduit Fittings: Cast malleable iron, galvanized or cadmium plated, compatible with conduit materials conforming to NEMA FB-1.

H. Flexible Metal Conduit Fittings: Provide conduit fittings for use with flexible steel conduit of threadless hinged clamp type.

1. Straight Terminal Connectors: One piece body, female end with clamp and deep slotted machine screw for securing conduit, and male threaded end provided with locknut.
2. 45° or 90° Terminal Angle Connectors: Two-piece body construction with removable upper section, female end with clamp and deep slotted machine screw for securing conduit, and male threaded end provided with locknut.

I. Liquid-Tight Flexible Metal Conduit Fittings: Cadmium plated, malleable iron fittings with compression type steel ferrule and neoprene gasket sealing rings, with insulated throat.

J. EMT Fittings: Galvanized steel fittings, set screw or compression watertight type, except where aluminum EMT is used provide UL listed fittings for use with aluminum EMT.

K. Conduit Bodies: Provide galvanized cast-metal conduit bodies of types, shapes and sizes as required to fulfill job requirements and NEC requirements. Construct conduit bodies with threaded-conduit-entrance ends, removable covers, either cast or of aluminum or galvanized steel, and corrosion-resistant screws.

2.3 NON-METALLIC RACEWAYS:

A. Pliable Electrical Nonmetallic Tubing (ENT): ENT shall be UL listed, conforming to NEMA TC-13 and installed as required by NEC where concealed inside walls for the installation of telecom wiring. Yellow colored ENT shall be used for telecommunication wiring.

B. Electrical Plastic Conduit:

1. Heavy Wall Conduit: Schedule 40, 90 deg. C, UL-rated, constructed of polyvinyl chloride and conforming to NEMA TC-2, for direct burial, or normal above ground use, UL-listed and in conformity with NEC Article 352.
2. Extra Heavy Wall Conduit: Schedule 80, UL-rated, constructed of polyvinyl chloride compound C-200 PVC conforming to NEMA TC-2, and UL-listed in accordance with NEC Article 352 for direct burial, or above ground use.

C. PVC Conduit and Tubing Fittings: NEMA TC 3, mate and match to conduit or tubing type and material.

D. Conduit and Tubing Accessories: Provide conduit, tubing and duct accessories of types, sizes, and materials complying with manufacturer's published product information, which mate and match conduit and tubing.

E. Conduit and Fitting Bonding: Use only manufacturer's recommended sealing compounds to produce watertight joints.

2.4 SURFACE METAL RACEWAYS:

A. Type SR1 Raceway: One-piece type with single compartment, lengths as indicated. Provide nominal 3/4" wide, depth as required.

B. Type SR2 Raceway: Two-piece type with single compartment, length as indicated. Provide nominal 1-1/4" x 7/8" with flush, snap-on cover. Install devices as indicated in raceway.

2.5 SURFACE RACEWAY ADDITIONAL REQUIREMENTS:

A. Provide all boxes, fittings and mounting accessories required for surface raceways; designed, manufactured and supplied by raceway manufacturer for use with specified raceway.

B. Manufacturers: Provide surface raceways of one of the following:

1. Panduit Corp.
2. Wiremold Company.
3. Monosystems.

C. Submit color samples for selection with shop drawings. Provide all standard colors – shall offer a minimum of three (3) choices.

2.6 OUTLET BOXES:

A. Provide galvanized coated flat rolled sheet-steel non-gangable outlet boxes, of shapes, cubic inch capacities, and sizes suitable for installation at respective locations. Provide one piece multiple-gang boxes, not built-up. Construct outlet boxes with mounting holes and with cable and conduit-size knockout openings in bottom, ends and sides. Provide boxes with threaded screw holes, with corrosion-resistant cover, and with grounding screws for fastening surface and device type box covers, and for equipment type grounding.

B. Outlet Box Accessories:

1. Provide outlet box accessories as required for each installation, including box supports, mounting ears and brackets, wallboard hangers, box extension rings, fixture studs, cable clamps and metal straps for supporting outlet boxes, which are compatible with outlet boxes being used to fulfill installation requirements for individual wiring situations. Choice of accessories is Contractor's code-compliant option. Provide Erico #RBS16 or RBS24 box mounting plate in metal or wood stud partition walls as required where two or three devices are shown mounted side by side such as a receptacle, telecom or other device as indicated.
2. Provide outlet box extension rings of the square-cut tile-type for use in GWB, tile, and wood-paneled walls. Provide standard plaster rings for use in plaster walls.

C. Raintight Outlet Boxes: Provide corrosion-resistant cast-metal raintight outlet boxes, of types, shapes and sizes suitable for installation at respective locations, with threaded conduit holes for fastening electrical conduit, complete with NEMA 3R covers.

2.7 INTERIOR AND ABOVE-GRADE EXTERIOR JUNCTION AND PULL BOXES:

A. Provide galvanized code-gauge sheet steel junction and pull boxes, with screw-on covers; of types, shapes and sizes to suit each respective location and installation. For exterior above-grade locations, provide NEMA 3R boxes with welded seams and equipped with stainless

steel nuts, bolts, screws and washers. If knockouts are provided on the sides of the box for conduit entry, use watertight conduit hubs. Large pullboxes with any dimension over 6 feet shall be complete with built-in wire support systems to prevent wire from pressing on connectors or other wire to prevent damage to insulation. Pullboxes in high-rise installations shall be complete with insulating wedge type connectors to provide proper support of conductors. The number and locations of pullboxes shall be as required by NEC to provide proper support of conductors, where required due to the number of bends in the raceway and where required due to length of raceway to not exceed the maximum pulling tension recommended by the cable manufacturer. Exterior exposed pullboxes shall be provided with screened raintight openings to allow heat to escape.

2.8 EXTERIOR BELOW-GRADE JUNCTION AND PULL BOXES:

A. Provide exterior below-grade junction and pull boxes at locations indicated and as required. Top of boxes shall be set flush with existing grade. Boxes shall be constructed of polymer concrete and fiber reinforced polyester 3 to 4 times the compressive strength of concrete and having the tensile strength of steel. Boxes shall have full size covers secured to the box with stainless steel pentahead hardware. Covers shall have the logo "ELECTRIC" or “TELECOM” as required. Boxes and covers shall have a heavy duty rating. Boxes shall be sized in accordance with NEC requirements for number of conduits entering and leaving box.

2.9 GENERAL FLOOR BOXES:

A. Stamped Steel Flush Service Floor Boxes: Provide stamped steel, concrete tight floor boxes, 3-7/16” deep, fully adjustable before and after the concrete pour, one, two or three-gang combinations, as noted below, where indicated on the drawings. Provide boxes with rectangular opening(s) and complete with vertical adjusting rings, gaskets, aluminum cover plate with cover screws to match plates. Provide cover plate with combination carpet and tile flange where carpet or tile is indicated on finish schedule. Boxes shall accept industry standard and proprietary telecom connectivity devices. Wiring devices shall be as specified in Section 26 27 26.

1. Single-Gang Receptacle Floor Box: Provide a single-gang floor box complete with duplex receptacle and duplex flap cover plate.
2. Single-Gang Telecom Floor Box: Provide a single-gang floor box complete with a communication cover plate to allow up to four communication devices.
3. Combination Receptacle/Telecom Two-Gang Floor Box: Provide a two-gang floor box complete with a duplex receptacle, duplex flap cover plate, barrier between gangs and a communication cover plate to allow up to four communication devices.
4. Combination Receptacle/Telecom/Audio Three-Gang Floor Box: Provide a three-gang floor box complete with a duplex receptacle, duplex flap cover plate, barriers between each gang, a communication cover plate to allow up to four communication devices and a communication cover plate suitable for A/V devices.

B. Corrosion-Resistant Recessed Service Floor Boxes: Provide corrosion-resistant, for use in concrete, watertight floor boxes, 3-3/4" deep, fully adjustable before and after the concrete pour. two or four-gang combinations, as noted below, where indicated on the drawings. Provide boxes with rectangular covers, and complete with threaded conduit entrances, vertical adjusting rings, gaskets, aluminum (color finish to be selected by architect) cover plate with cover screws to match plates. Provide rectangular cover plate with two large cable egress doors and access 180 degree opening with combination carpet and tile flange where carpet or tile is indicated on finish schedule. Boxes shall accept industry standard and proprietary telecom connectivity devices. Wiring devices shall be as specified in Section 26 27 26.

1. Two-Gang Receptacle Floor Box: Provide a two-gang floor box complete with two duplex receptacles.
2. Two-Gang Communication Floor Box: Provide a two-gang floor box complete with one 6-port keystone jack and one blank plate.
3. Combination Receptacle/Telecom Four-Gang Floor Box: Provide a four-gang floor box complete with two duplex receptacles, barrier between power and communications sections, one 6-port keystone jack and one blank plate.

C. Manufacturers: Provide floor boxes of one of the following:

1. Hubbell
2. Steel City
3. Wiremold Company

2.10 COMBINATION RECEPTACLE/TELECOM MULTI-SERVICE BOXES:

A. Floor Box--Type 1: Provide a stamped steel concrete tight, fully adjustable, flush-mounted floor box, 12"L x 10"W x 6"D. Boxes shall be complete with a minimum of eight 3/4" knockouts and twelve concentric knockouts of 1.00"/1.25"/1.5", internal plates and brackets for mounting receptacle and telecom device, removable gang plate, compartment and center dividers. Provide UL scrub water rated floor box cover with flanged frame suitable for carpet or tile and of material as directed by the Architect. Provide pour pan accessory where the floor box is installed on grade and may rest on soil, rock, gravel, etc.

B. Manufacturers: Provide floor multi-service boxes of one of the following:

1. FSR Metal Products Group
2. Hubbell
3. Steel City
4. Wiremold Company
5. Raceway Components, Inc.
6. Arlington Industries

2.11 MISCELLANEOUS CABINETS:

A. Provide flat-rolled sheet-steel cabinets, flush or surface mounted as indicated, hinged door with flush latch and lock. Provide a framed directory with clear plastic protective cover on inside of door; trim clamps; gaskets where required by atmospheric conditions; single point latching for doors under 36"; 3 point latching for doors 36" and larger. Door and trim shall have factory applied finish to match panelboard cabinets.

B. Manufacturers: Provide cabinets of one of the following:

1. Anchor
2. Austin
3. Keystone
4. Electromate
5. Hoffman
6. Westinghouse
7. General Electric
8. Square D

2.12 THRU-WALL/FLOOR FIRESTOP DEVICE:

A. The firestop device shall meet UL1479 (ASTM E 814) and bear the U.S. UL Classification Mark. The device shall be classified for use in one-, two-, three-, and four-hour rated gypsum, concrete and block walls. The device shall also have been listed by Underwriters Laboratories Inc. To UL2043 and determined to be suitable for use in air handling spaces. The firestop device shall stop or inhibit the spread of both fire and smoke as required by the VCC for fire and smoke rated partitions and barriers.

B. Sizes: The firestop device shall be for 2” and 4” trade size EMT conduit.

C. At each location where conduits and/or sleeves penetrate a fire or smoke rated partition or barrier for a pathway for I.T. cables, provide sufficient quantity of units to completely cover and properly seal all conduits and sleeves.

D. Installation shall be in strict accordance with

1. Manufacturer’s installation instructions.
2. All written and graphic requirements in the test assembly documentation published by the listing agency.

E. The firestop device shall be by Wiremold FlameStopper, Hilti Speed Sleeve, or STI EZ-Path.

PART 3: EXECUTION

3.1 INSTALLATION OF RACEWAYS:

A. Install raceways level and plumb, and maintain manufacturer's recommended clearances.

B. Coordinate with other work including wires/cables, boxes and panel work as necessary to interface installation of electrical raceways and components with other work.

3.2 INSTALLATION OF CONDUITS:

A. Conduit runs are not shown on floor plans unless specifically noted or indicated otherwise.

B. Applications:

1. Use rigid steel conduit in moist or damp locations, in hazardous or refrigerated areas, in poured concrete, underground, beneath slab-on-grade and where exposed outdoors.
2. Steel IMC may be used in lieu of rigid steel conduit where permitted by the NEC, except IMC may not be used below-grade, below slab or in slab.
3. EMT may be used for all installations not requiring rigid or IMC conduit. Aluminum EMT may be used at Contractor’s option for size 2" through 4", except do not use aluminum EMT or aluminum products in cast-in-place concrete installation or where UL firestop assemblies require steel.
4. Rigid conduit may be steel or aluminum at Contractor’s option, except do not use aluminum conduit or aluminum products in cast-in-place concrete installations or where UL firestop assemblies require steel.
5. Rigid PVC conduit may be used in lieu of rigid steel for conduits installed in poured concrete, underground or beneath slab-on-grade. Convert to metallic conduit at no more than 48” above ground or slab if concealed in wall; otherwise, convert to metallic conduit before exiting ground or slab. Do not use PVC conduit above-grade unless specifically indicated otherwise.
6. Use flexible conduit in movable partitions, from outlet boxes to recessed lighting fixtures, and in cells of precast concrete panels.
7. Use liquid-tight flexible conduit in exterior exposed locations; in moist or humid atmosphere where condensate can be expected to accumulate; in corrosive atmosphere; where subjected to water spray or dripping oil, water or grease; and for connection of motors, transformers and equipment subject to movement and vibration. Wherever liquid-tight flexible conduit is used, it may only be for the final 6 feet (maximum) of a connection to a motor, transformer or piece of equipment subject to movement or vibration.
8. Do not install any EMT conduit outside of the exterior walls within the exterior brick cavity. All EMT conduits shall be routed within exterior walls.

C. General:

1. Install conduits concealed in new construction work, either in walls, slabs or above hung ceiling, except in mechanical or electrical equipment rooms in which they may

be exposed. Install conduits concealed in stairs, except in stairs without suspended ceilings a short horizontal section conduit to feed each light fixture mounted to underside of landing may be exposed. Run conduits concealed in existing work where practicable. Where conduits cannot be concealed in finished areas, notify the Architect for permission to use surface raceways. Where installed at roof decking, follow requirements of NEC 300.4(E).

2. Provide penetration firestopping systems in smoke barriers and fire-resistance-rated walls, floors and ceilings for electrical raceway penetrations in accordance with specification 07 84 13 – Penetration Firestopping.
3. Mechanically fasten together metal conduits, enclosures, and raceways for conductors to form continuous electrical conductor. Connect to electrical boxes, fittings and cabinets to provide electrical continuity and firm mechanical assembly.
4. Avoid use of dissimilar metals throughout systems to eliminate possibility of electrolysis. Where dissimilar metals are in contact, coat surfaces with corrosion inhibiting compound before assembling.
5. Install miscellaneous fittings such as reducers, chase nipples, 3-piece unions, split couplings, and plugs that have been specifically designed and manufactured for their particular application. Install expansion/deflection fittings in raceways every 200' linear run or wherever structural expansion joints are crossed, per NEC 300.4(H).
6. Provide polypropylene or monofilament plastic or pull cord with not less than 200-lb tensile strength in empty conduits, tied off at both ends. Test conduits required to be installed, but left empty, with ball mandrel. Clear any conduit which rejects ball mandrel. Pay costs involved for restoration of conduit and surrounding surfaces to original condition.
7. Cut conduits straight, properly ream, and cut threads for heavy wall conduit deep and clean.
8. Use factory-made elbows or field-bend conduit with benders designed for purpose so as not to distort nor vary internal diameter.
9. Size conduits to meet NEC, except no conduit smaller than 3/4 inch shall be used unless noted otherwise. Conduits below-grade and in-slab shall be minimum 1 inch.
10. Fasten conduit terminations in sheet metal enclosures by 2 locknuts, and terminate with bushing. Install locknuts inside and outside enclosure.
11. Conduits shall not touch sprinkler pipes, or cross pipe shafts or ventilating duct openings.
12. Keep conduits a minimum distance of 6" from parallel runs of flues, hot water pipes and other sources of heat. Wherever possible, install raceway runs below hot water and steam piping where necessary to cross piping.
13. Use of running threads at conduit joints and terminations is prohibited. Where required, use 3-piece union or split coupling.
14. Complete installation of electrical raceways before starting installation of cables/wire within raceways.
15. Install conduits so as not to damage the integrity of the structural members. Avoid horizontal or cross runs in building partitions or side walls.
16. Install temporary closures to prevent foreign matter from entering raceways.
17. Protect stub-ups from damage where conduits rise through floor slabs. Arrange so curved portions of bends are not visible above the finished slab.
18. Provide bushings on all conduit stubs.

D. Concealed Conduits:

1. Metallic raceways installed underground, in floors, below-grade or outside shall have conduit threads painted with corrosion inhibiting compound before couplings are assembled. Draw up coupling and conduit sufficiently tight to ensure watertightness.
2. Install underground conduits minimum of 24" below finished grade, except where NEC requires deeper burial.
3. Mark Record Documents with conduit size and location.

E. Conduits in Concrete Slabs:

1. Install conduits in concrete slabs only under the following conditions:

   a. In slab-on-grade.
   b. In structural concrete deck.
   c. In concrete-on-metal deck for short runs to isolated floor outlets.

2. Place conduits between bottom reinforcing steel and top reinforcing steel in middle 1/3 of slab thickness. Secure raceways to reinforcing rods to prevent sagging or shifting during concrete placement. Separate conduits by not less than diameter of largest conduit to ensure proper concrete bond. Conduits crossing in slab must be reviewed for proper cover by Architect. Minimum finished cover of conduit in slabs shall not be less than one inch. Embedded conduit diameter is not to exceed 1/3 of slab thickness at cross-overs, if any. For locations where a large “swath” of conduits will be in or below slab, coordinate requirements with Structural Engineer before rough-in.
3. Mark Record Documents with conduit size and location.

F. Exposed Conduits:

1. Install exposed conduits and extensions from concealed conduit systems parallel with or at right angles to walls and floors of building. Conduits shall be run tight to the wall and ceiling or structure and as neatly and inconspicuously as possible.
2. Exposed conduits may be used in finished spaces only when conduits cannot be concealed and surface raceway is not practical, and only with the specific approval of the Architect. The Contractor shall submit a detailed proposal for the area and the routing of the exposed conduit to the Architect before installation. Exposed conduits in finished areas shall be painted to match the surface on which they are installed.
3. Install exposed conduit work so as not to interfere with ceiling inserts, lights, ventilation ducts, HVAC unit clearances, or outlets.
4. Support exposed conduits by use of hangers, clamps, or clips. Support conduits on each side of bends and on spacing not to exceed the requirements of the NEC. Support multiple runs of conduit from trapeze hangers.
5. Set anchors in waterproof cement for the support of conduits where run on waterproof walls.
6. Above requirements for exposed conduits also apply to conduits installed in space above hung ceilings and in crawl spaces.

G. Non-metallic Conduits: Make solvent cemented joints in accordance with recommendations of manufacturer.

H. Conduit Fittings:

1. Use locknuts for securing conduit to metal enclosure with sharp edge for digging into metal, and ridged outside circumference for proper fastening.
2. Bushings for terminating conduit smaller than 1-1/4" shall have flared bottom and ribbed sides, with smooth upper edges to prevent injury to cable insulation.
3. Install insulated type bushings for terminating conduits 1-1/4" and larger. Bushings shall have flared bottom and ribbed sides. Upper edge shall have phenolic insulating ring molded into bushing.
4. Bushings of standard or insulated type shall have screw type grounding terminal where required by the NEC.
5. Miscellaneous fittings such as reducers, chase nipples, 3-piece unions, split couplings, and plugs shall be specifically designed for their particular application.
6. Install raceway sealing fittings at suitable, approved, and accessible locations and fill them with U.L. Listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings at the following points:

    a. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
    b. Where otherwise required by NFPA 70, such as in 225.27 and 300.5(G).

3.3 INSTALLATION OF SURFACE METAL RACEWAYS:

A. Mechanically assemble metal enclosures and raceways for conductors to form continuous electrical conductor, and connect to electrical boxes, fittings and cabinets in order to provide effective electrical continuity and rigid mechanical assembly.

B. Avoid use of dissimilar metals throughout system to eliminate possibility of electrolysis. Where dissimilar metals are in contact, coat all surfaces with corrosion inhibiting compound before assembling.

C. Install expansion fittings in all wireways and raceways wherever structural expansion joints are crossed.

D. Make changes in direction of raceway run with proper fittings, supplied by raceway manufacturer. No field bends of raceway sections will be permitted.

E. Properly support and anchor raceways for their entire length by structural materials. Raceways shall not span any space unsupported.

F. Use boxes as supplied by raceway manufacturer wherever junction, pull or devices boxes are required. Standard electrical "handy" boxes, etc. shall not be permitted for use with surface raceway installations.

3.4 INSTALLATION OF ELECTRICAL BOXES AND FITTINGS:

A. All wall-mounted wiring device boxes shall be mounted with long dimension vertically unless otherwise noted.

B. Coordinate installation of electrical boxes and fittings with conductors/cable, wiring devices, raceway installation work, and equipment requiring electrical connections.

C. Provide raintight outlets for interior and exterior locations exposed to weather or moisture.

D. Provide surface mounted boxes only where recessed mounting is not possible.

E. Provide knockout closures to cap unused knockout holes where blanks have been removed in new and existing boxes and fittings.

F. Install electrical boxes in those locations which ensure ready accessibility to enclosed electrical wiring.

G. Do not install boxes back-to-back in walls.

H. Provide not less than 6" separation between sides of boxes in opposite sides of acoustic walls, unless “putty pads” are provided for sound attenuation.

I. Provide membrane protection for penetrations of fire horizontal assemblies:

1. Through penetrations shall be protected using systems installed as tested in the approved fire-resistance-rated assembly, or
2. Through penetrations shall be protected by an approved through-penetration firestop system installed and tested in accordance with ASTM E814 or UL 1479, with a minimum positive pressure differential of 0.01 inch (2.49 Pa) of water and shall have an F rating of not less than the required fire-resistant rating of the wall penetrated.

J. Provide membrane protection for penetrations of fire rated ceiling assemblies:

1. Through penetrations shall be protected using systems installed as tested in the approved fire-resistance-rated assembly, or
2. Through penetrations shall be protected by an approved through-penetration firestop system installed and tested in accordance with ASTM E814 or UL 1479, with a minimum positive pressure differential of 0.01 inch of water (2.49 Pa). The system shall have an F rating/T rating of not less than 1 hour but not less than the required rating of the floor penetrated.

K. Do not install aluminum products in concrete.

L. Position recessed outlet boxes accurately in order that boxes will not be installed with front edge of box at a greater depth in wall than permitted by NEC. Provide extension rings for existing outlet boxes with new wall covering so face of box is flush with the finished wall surface and finished plate is tight to wall on all sides.

M. Set floor boxes level and flush with finish flooring material. Trim as necessary after installation to fit flush with finished floor surface.

N. Fasten electrical boxes firmly and rigidly to substrates or structural surfaces to which attached, or solidly embed electrical boxes in concrete or masonry. Box support shall be independent of conduit.

O. Subsequent to installation of boxes, protect boxes from construction debris and damage.

P. Install power and communications outlets for televisions so as to be concealed by the television. Coordinate location with the bracing for wall or ceiling brackets and with furniture as recommended by manufacturer.

3.5 O&M MANUAL:

A. Provide O&M Manual as specified in specification section 260100. Include both a paper copy and digital pdf copy of the O&M Manual.

END OF SECTION 260533

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SECTION 260553 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1: GENERAL

1.1 DESCRIPTION:

A. Extent of electrical identification work is as herein specified.

B. Types of electrical identification work specified in this section include the following:

1. Electrical power, control, fire alarm and communication conductors and/or conduits.
2. Operational instructions and warnings.
3. Danger signs.
4. Equipment/system identification signs.

1.2 RELATED DOCUMENTS:

A. The Drawings and general provisions of the Contract, including the General and Supplementary Conditions, Instructions to Bidders and sections of Division 1, apply to the work specified in this section.

1.3 REFERENCES AND CODES:

A. Electrical Code Compliances: Comply with applicable requirements of the 2020 NFPA-70 (NEC) pertaining to installation of identifying labels and markers for wiring and equipment.

B. U.L. Compliance: Comply with applicable requirements of UL Std. 969, "Marking and Labeling Systems", pertaining to electrical identification systems.

C. NEMA Compliance: Comply with applicable requirements of NEMA Std. Nos. WC-1 and WC-2 pertaining to identification of power and control conductors.

1.4 COORDINATION:

A. Coordinate identification names, abbreviations, colors, and other features with requirements in the Contract Documents, Shop Drawings, manufacturer’s wiring diagrams and the manuals, 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 the installation of acoustical ceilings and similar concealment.

1.5 SUBMITTALS:

A. Product Data: Submit manufacturer's data on electrical identification materials and products.

PART 2: PRODUCTS

2.1 ELECTRICAL IDENTIFICATION MATERIALS:

A. General: Except as otherwise indicated, provide manufacturer's standard products of categories and types required for each application. Where more than single type is specified for an application, selection is Contractor’s option, but provide single selection for each application.

B. Color-Coded Plastic Tape: Provide manufacturer's standard self-adhesive vinyl tape not less than 3 mils thick by 1/2" wide.

C. Detectable Underground-Type Plastic Line Marker: Manufacturer's standard permanent, bright-colored, continuous-printed detectable plastic tape, intended for direct-burial service; not less than 6" wide x 4 mils thick. Provide tape with printing which most accurately indicates type of service of buried cable.

D. Self-Adhesive Plastic Signs:

1. General: Provide manufacturer's standard self-adhesive or pressure-sensitive, pre-printed, flexible vinyl signs for operational instructions or warnings, of sizes suitable for application areas and adequate for visibility, with proper wording for each application, e.g., 208V, EXHAUST FAN, RECTIFIER.
2. Colors: Unless otherwise indicated, or required by governing regulations, provide black signs with white lettering.

E. Baked Enamel Danger Signs: Provide manufacturer's standard "DANGER" signs of baked enamel finish on 20 gage steel with standard red, black and white graphics. Provide following minimum sizes: 20" x 14", 14" x 10", or 10" x 7", where signs are sized according to the largest size which can be applied where needed, or where a larger size is needed for adequate vision. Provide signs with recognized standard explanation wording, e.g., HIGH VOLTAGE, KEEP AWAY, BURIED CABLE, DO NOT TOUCH SWITCH.

F. Cable/Conductor Identification Bands: Provide manufacturer's standard vinyl-cloth self-adhesive cable/conductor markers of wrap-around type, either pre-numbered plastic coated type, or write-on type with clear plastic self-adhesive cover flap, numbered to show circuit identification.

G. Engraved Plastic-Laminate Signs:

1. General: Provide engraving stock melamine plastic laminate, complying with FS L-P-387, in sizes and thickness indicated, engraved with engraver's standard lettering style of sizes and wording indicated, punched for mechanical fastening except where adhesive mounting is necessary because of substrate, and color codes as indicated below:

   a. Normal Power Systems: Black face with White lettering.
   b. Life Safety Power Systems: Yellow face with Black lettering.
   c. Equipment Power Systems: Red face with White lettering.

2. Thickness: 1/16", for units up to 20 sq. in. or 8" length; 1/8" for larger units.
3. Fasteners: Self-tapping stainless steel screws, except contact-type permanent adhesive where screws cannot or should not penetrate substrate.

2.2 LETTERING AND GRAPHICS:

A. Coordinate names, abbreviations and other designations used in electrical identification work, with corresponding designations shown, specified or scheduled. Provide numbers, lettering and wording as indicated or, if not otherwise indicated, as recommended by manufacturer or as required for proper identification and operations/maintenance of electrical systems and equipment.

PART 3: EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS:

A. Install electrical identification products as specified in accordance with the manufacturer’s written instructions and the requirements of the NEC.

B. Coordination: Where identification is to be applied to surfaces which require finish, install identification after completion of finish work.

C. Regulations: Comply with governing regulations and requests of governing authorities for identification of electrical work.

D. Identification: Coordinate all room number designations with the final room numbers. Use final room numbers for all final documentation and display, including but not limited to, programming, alarm displays, annunciator displays, panelboard schedules, signage, labels and engraved labels. The room numbers shall be as directed by the Owner and may not be the same as shown on Contract Drawings. Include final room numbers on the drawings for the Record Documents.

3.2 CONDUIT IDENTIFICATION:

A. Where conduit is concealed above accessible ceilings or exposed, apply color-coded identification at equipment termination, at outlet boxes, pull boxes and junction boxes, within each room, and at 20' on-center within an area.

1. Color-code conduit using plastic tape with the following band colors between orange background bands.

SERVICE	COLOR BAND
240 or 208/120 Volt Normal Circuits	Black
240 or 208/120 Volt Life Safety Emergency Circuits	Black/Yellow
240 or 208/120 Volt Equipment Emergency Circuits	Black/Red
480/277 Volt Circuits	Blue
480/277 Volt Life Safety Emergency Circuits	Blue/Yellow
480/277 Volt Equipment Emergency Circuits	Blue/Red
Grounding Electrode	Green
Fire Alarm	Red
Sound/Intercommunication	Purple
Television	Brown
Telephone	Yellow
Telecom	Brown/Yellow
Security	White/Red

3.3 UNDERGROUND CABLE IDENTIFICATION:

A. During backfilling/top-soiling of each exterior underground electrical, signal or communication cable, install a continuous detectable underground-type plastic line marker, located directly over buried line at 6" to 8" below finished grade. Where multiple small lines are buried in a common trench and do not exceed an overall width of 16", install a single line marker. Install line marker for every buried cable or group of buried cables, regardless of whether direct-buried or protected in conduit.

3.4 CONDUCTOR/CABLE COLOR CODING:

A. See Division 26 for color-coding of line voltage conductors and cables. Provide means of identification per NEC 200.6(D).

3.5 CONDUCTOR/CABLE CIRCUIT IDENTIFICATION:

A. Apply cable/conductor identification, including panelboard and circuit number on power wiring, on each cable/conductor in each box/enclosure/cabinet. Match identification with marking system used in panelboards, shop drawings, contract documents, and similar previously established identification for project's electrical work.

3.6 IDENTIFICATION OF UNGROUNDED CONDUCTORS:

A. Where more than one nominal voltage system exists in a building, each ungrounded conductor of a multi-wire branch circuit, where accessible, shall be identified by phase and system. This means of identification shall be permitted to be by separate color coding, marking tape, tagging, or other approved means and shall be permanently posted at each panelboard and switchboard or readily available in accordance with NEC 210.5.

3.7 OPERATIONAL IDENTIFICATION AND WARNINGS:

A. Operational Identification and Warnings: Wherever reasonably required to ensure safe and efficient operation and maintenance of electrical systems and electrically connected mechanical systems and general systems and equipment, including prevention of misuse of electrical facilities by unauthorized personnel, install self-adhesive plastic signs or similar equivalent identification, instruction or warnings on switches, outlets, and other controls, devices and covers of electrical enclosures. Where detailed instructions or explanations are needed, provide plasticized tags with clearly written messages adequate for intended purposes.

3.8 DANGER SIGNS:

A. General: In addition to installation of danger signs required by governing regulations and authorities, install appropriate danger signs at locations identified by Installer of electrical work as constituting similar dangers for persons in or about project.

B. High Voltage: Install danger signs wherever it is possible, under any circumstances, for persons to come into contact with electrical power of voltages higher than 110-120 volts.

C. Critical Switches/Controls: Install danger signs on switches and similar controls, regardless of whether concealed or locked up, where untimely or inadvertent operation (by anyone) could result in significant danger of persons, or damage to or loss of property.

3.9 EQUIPMENT/SYSTEM IDENTIFICATION:

A. Signs: Install engraved plastic-laminate sign on outside of each major unit of electrical equipment in building, including central or master unit of each electrical system, including communication/control/signal systems, unless unit is specified with its own self-explanatory

identification or signal system. Provide three (3) lines of text, with 1/2" high lettering for first line and 1/4" high lettering for other lines; first line of text shall indicate name of unit, second line of text shall indicate voltage and phase and number of wires, and third line of text shall indicate origin of feeder. Provide text matching terminology and numbering of the contract documents and shop drawings. Provide signs for each unit of the following categories of electrical work:

1. Panelboards, control panels, relay panels, electrical cabinets, and enclosures.
2. Access panel/doors for concealed electrical items.
3. Major electrical switchgear and switchboards (including individual breakers, i.e. main breakers, sub-breakers, etc.).
4. Enclosed switches (safety switches) and circuit breakers.
5. Motor starters (magnetic and manual starters).
6. Variable frequency drives.
7. Automatic transfer switches.
8. Transformers.
9. Push-button stations.
10. Time clocks and lighting contactors.
11. Power generating units.
12. Provide permanent SERVICE ENTRANCE label for all service entrance equipment.

B. Provide identification, labeling and signs for emergency and standby systems as required by 700.7, 700.10, 701.7 and 702.7 of NEC.

C. Install signs at locations indicated and, where not otherwise indicated, at locations for best convenience of viewing without interference with operation and maintenance of equipment.

D. Provide labeling in accordance with all requirements in NEC 110.21 and 110.22.

E. Provide fault current labeling on service equipment per NEC 110.24(A).

F. Provide enclosure type labeling as required in NEC 110.28.

G. Where transformer disconnecting means are remote from the transformer, the disconnect location shall be permanently marked on the transformer.

H. Provide label on each fire alarm control panel and power supply clearly indicating the branch circuit feeding it. Provide another label on each fire alarm control panel and power supply that indicates the room location of the panelboard that is powering the fire alarm control panel and power supply.

I. Provide labeling on all wiring devices (receptacles and lighting controls) with the panel and circuit number feeding them. Place the label on the cover plate. For all floor boxes, locate the label within the floor box next to the device, do not install on the top of the coverplate, they will get worn off.

3.10 O&M MANUAL:

A. Provide O&M Manual as specified in specification section 260100. Include both a paper copy and digital pdf copy of the O&M Manual.

END OF SECTION 260553

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SECTION 260583 - WIRING CONNECTIONS FOR ELECTRICAL SYSTEMS

PART 1: GENERAL

1.1 DESCRIPTION:

A. This section specifies the basic requirements of electrical connections for equipment specified in Division 8, 10, 11, 12, 13, 21, 22 and 23 sections and Division 26, 27 and 28 sections making reference to electrical connections for equipment specified herein.

B. Extent of electrical connections for equipment is indicated by drawings and schedules. Electrical connections are hereby defined to include connections used for providing electrical power to equipment.

1.2 RELATED DOCUMENTS:

A. The Drawings and general provisions of the Contract, including the General and Supplementary Conditions, Instructions to Bidders and sections of Division 1, apply to the work specified in this section.

1.3 REFERENCES AND CODES:

A. Refer to other Division 26 sections for motor starters, controllers and disconnects not furnished as integral part of equipment.

B. Refer to sections of other Divisions for motor starters, controllers, VFD’s and disconnects furnished integrally with equipment and for specific individual equipment power requirements.

C. Refer to other Division 26 sections for junction boxes, raceways and conductors/cables required for connecting motors and other electrical units of equipment.

PART 2: PRODUCTS

2.1 MANUFACTURERS:

A. Refer to other Division 26 sections for manufacturers of electrical connection products.

2.2 MATERIALS AND COMPONENTS:

A. General: For each electrical connection indicated, provide complete assembly of materials, including but not necessarily limited to, junction boxes, raceways, conductors/cables, disconnect switches, starters, controllers, pressure connectors, terminals (lugs), electrical

insulating tape, cable ties, solderless wirenuts, and other items and accessories as needed to complete splices, terminations, and connections.

B. Connectors and Terminals: Provide electrical connectors and terminals which mate and match, including sizes and ratings, with equipment terminals as recommended by equipment manufacturer for intended applications.

PART 3: EXECUTION

3.1 INSPECTION:

A. Inspect area and conditions under which electrical connections for equipment are to be installed and notify Contractor in writing of conditions detrimental to proper completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected in a manner acceptable to Installer.

3.2 INSTALLATION OF ELECTRICAL CONNECTIONS:

A. Connect electrical power supply conductors to equipment conductors or terminals in accordance with equipment manufacturer's written instructions and wiring diagrams. Mate and match conductors of electrical connections for proper interface between electrical power supplies and installed equipment.

B. Cover splices with electrical insulating material equivalent to or greater than electrical insulation rating of those conductors being spliced.

C. Prepare cables and conductors by cutting and stripping covering armor, jacket, and insulation properly to ensure uniform and neat appearance where cables and wires are terminated. Exercise care to avoid cutting through tapes which will remain on conductors. Also avoid "ringing" conductors while stripping wire.

D. Trim cables and wires as short as practicable and arrange routing to facilitate inspection, testing and maintenance.

E. Tighten connectors and terminals, including screws and bolts, in accordance with the equipment manufacturer’s published torque tightening values for equipment connectors.

F. Fasten identification markers to each electrical power supply conductor/cable conductor which indicates their voltage, phase and feeder number in accordance with Division 26. Affix markers on each terminal conductor, as close as possible to the point of connection.

3.3 CONNECTIONS TO EQUIPMENT:

A. Final electrical connections to equipment furnished under other sections of these specifications or specified to be furnished by the Owner shall be provided as required for

the individual item of equipment. Provide the conduit, outlet boxes, and power wiring from the power source to the motor or equipment junction box, wiring devices, transformers, relays, starters, VFD's, disconnect switches or circuit breakers, including wiring through starters, VFD's or safety switches, in accordance with the manufacturer's installation instructions. The presumed location of all presently envisioned equipment having electrical connections is shown or scheduled, but these locations are for estimating purposes only and the contractor shall prepare the bid to allow for any possible rearrangement of the equipment listed or as shown or scheduled. Prior to roughing in conduit, receptacles, or other outlets or equipment, verify the locations and characteristics of equipment and verify heights and locations of required connections from an approved shop drawing or roughing-in drawing. Use roughing-in dimensions of electrically operated units furnished by the supplier.

B. Provide connections for, but not limited to, the following equipment as specified:

1. Laboratory Equipment: Provide the required NEMA rated outlet for laboratory equipment provided or specified with cord-and-plug connection. Provide direct connections by extending conduit and wiring to equipment requiring direct electrical connections and make all final connections. All electrical connections to the laboratory equipment shall be furnished and installed as required by the laboratory equipment manufacturer. Outlets and connections to equipment shall be made from walls, except where special floor or ceiling outlets are indicated. Provide a flush junction box in wall beneath the operating level of the equipment for outlets and direct connections, and coordinate final mounting heights with equipment installer. All direct connections to equipment shall be with flexible liquid tight conduit. Plugs and cords on the equipment shall be completely wired, shortened, or lengthened as required to suit the outlets furnished. Provide a separate ground conductor for equipment.
2. Architectural Motorized Doors: Install electrical wiring for motorized doors. Door controls shall be furnished by door manufacturer. Wiring and accessories shall be provided as required and the doors completely wired in accordance with the manufacturer's instructions.
3. Mechanical and Plumbing Equipment: See Divisions 21, 22 and 23 for any type or item of equipment requiring electrical connections. Provide all power wiring and control wiring of 110 volts and greater for controlling all equipment as described therein even though control wiring may not be shown on Electrical Drawings. See Mechanical Drawings for exact locations of equipment and Mechanical Specifications for control of equipment.

3.4 FIELD QUALITY CONTROL:

A. Final connections and proper operation of equipment connected under this contract shall be supervised by the equipment supplier. This Contractor shall certify in writing to the Architect that the connected equipment is properly connected and the equipment is operating properly in accordance with these contract specifications, the equipment manufacturer's wiring diagrams, and instructions of the equipment supplier or manufacturer.

END OF SECTION 260583

SECTION 260943 - LIGHTING CONTROLS

PART 1: GENERAL

1.1 DESCRIPTION:

A. This section specifies the furnishing, installation and connection of automatic and manual lighting controls (except for line-voltage toggle switches). The extent of the lighting controls work is indicated by drawings and schedules and as specified herein.

1.2 RELATED DOCUMENTS:

A. The Drawings and general provisions of the Contract, including the General and Supplementary Conditions, Instructions to Bidders and sections of Division 1, apply to the work specified in this section.

1.3 RELATED WORK SPECIFIED ELSEWHERE:

A. Refer to other Division 26 sections for conductors / cables, grounding, raceways, electrical boxes and fittings and wiring devices required in connection with lighting controls.

B. Refer to Section 26 27 26 for line-voltage toggle switches.

1.4 REFERENCES AND CODES:

A. Electrical Code Compliances: Comply with applicable requirements of the 2020 NFPA-70 (NEC) pertaining to installation and construction of lighting controls

B. Underwriters Laboratories (UL):

1. 508 – Standard for Industrial Control Equipment.
2. 924 – Emergency Lighting and Power Equipment.
3. 1008 – Transfer Switch Equipment
4. 1472 – Standard for Solid–State Dimming Controls.

1.5 SUBMITTALS:

A. Submit manufacturer’s standard catalog data for each of the products specified. Include data on features, components, ratings and performance, including coverage patterns for each type of sensor. Include dimensioned drawings with isometric projections of components and enclosures.

B. Provide samples of the equipment, devices and device wall plates for color selection and evaluation of technical features, if required by the Architect.

C. Provide wiring diagrams detailing internal and interconnecting wiring for power, signal and control that distinguishes between field-installed and factory-installed wiring.

1.6 QUALITY ASSURANCE:

A. Manufacturer shall be regularly engaged in manufacturing of lighting control equipment and ancillary equipment, of types and capacities required, whose products have been in satisfactory use in similar service for not less than 5 years.

B. All devices shall be U.L. and CSA Listed specifically for the required loads.

C. Lighting controls shall be listed, approved and comply with all national, state and local energy codes, including but not limited to the 2021 VECC. Transfer devices and lighting control panels controlling emergency circuits shall be ETL listed to UL 924 and UL 1008.

D. Comply with NEC and all local and state codes as applicable to electrical wiring work. Control wiring shall be in accordance with the NEC requirements for Class 2 remote control systems and manufacturer specifications.

E. Manufacturer shall maintain ISO 9001-2000 quality standard certification, including in-house engineering for product design activities.

1.7 WARRANTY:

A. The manufacturer shall provide a full one-year warranty (minimum) on all equipment provided and installed under this section.

B. Warranty information and documentation shall be included in Submittals and Operation and Maintenance manuals turned over to owner at end of project.

PART 2: PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS:

A. Transfer Device based on Philips Bodine; acceptable equals by Philips Chloride and Hubbell Dual-Lite. Pay particular attention to functionality needed in 0-10V dimming emergency lighting applications and UL 924 and UL 1008 Listings. Other manufacturers will be considered if they meet the specifications of the basis of design product.

B. Interior low-voltage wired sensors and switches based on Acuity nLight; acceptable equals by Hubbell, Wattstopper, Lutron, Eaton Greengate and Crestron.

2.2 TRANSFER DEVICES:

A. Automatic Load Control Relay (ALCR): A device used to set normally dimmed or normally-off switched emergency lighting equipment to full power illumination levels in the event of a loss of the normal supply by bypassing the dimming/switching controls, and to return the emergency lighting equipment to normal status when the device senses the normal supply has been restored. The device shall consist of relay switching circuitry and fusing contained in one steel enclosure; shall operate at 120/277 VAC 60 HZ and shall have all inputs fused to 3A max. The device shall be UL 924 listed and listed for installation inside, on top of, or remote from the lighting fixture.

1. Do not use this ALCR to transfer light fixtures from normal power to emergency power.

B. Branch Circuit Emergency Lighting Transfer Switch (BCELTS) or Automatic Transfer Switch (ATS): A device used in conjunction with an auxiliary generator or central inverter system to transfer power to designated lighting loads. The device senses the loss of normal power and, in response, transfers the lighting load to a designated emergency power source. The device will then bypass the dimming/switching controls and bring the light fixtures to full power illumination levels. When normal power is restored the device will transfer the light loads back to normal power and restore the lights to their last controlled state. The device shall consist of relay switching circuitry, a test switch, normal and alternate power indicator lights contained in one steel enclosure; shall sense normal power at 120/277 VAC 60 HZ and shall be rated for 120/277 VAC 20A lighting load. The device shall be UL 924 and UL1008 listed and listed for installation indoor or damp locations.

C. Note that for 0-10V dimming fixtures on emergency, the transfer device for multiple fixtures or for intelligent control systems must be used. Bypass the 0-10V signal to automatically bring fixture to full brightness when normal power is lost. Follow manufacturer's wiring diagrams carefully.

2.3 INTERIOR LOW-VOLTAGE WIRED SENSORS AND SWITCHES:

A. See schedule on drawings for interior ceiling and/or wall mounted low-voltage sensors, manual switches and load controllers. Connect per manufacturer's recommendations for individual room/area operation (lighting zoned per the floor plans). Controls shall be standalone, and not networked as a total building system; provide all programming tools needed for Owner to be able to re-program standalone rooms in the future; basis of design is Acuity nComKit and nIO BT, with acceptable equal manufacturers as indicated on the drawings.

B. For manual switches, match wall mounted switch color and wallplate color/material to wiring devices and wallplates as specified in Section 26 27 26 or as directed by Architect or Engineer. Wall plates shall be by the same manufacturer as the wiring devices wall plates.

2.4 VARIOUS:

A. For all low-voltage and relay panel controls, provide what is necessary for the Owner to make programming changes to the system after all initial programming has been performed by the manufacturer. This may be accomplished by a PC, a handheld programmer, or other means, as long as the Owner can easily make programming/setting changes at any time after initial programming without needing to contact a manufacturer's representative.

B. For all 0-10V dimming controls, the performance curves for the 0-10V control and the 0-10V drivers shall not both be logarithmic. All 0-10V dimming controls shall include a relay in order to turn the circuit completely off.

PART 3: EXECUTION

3.1 GENERAL INSTALLATION:

A. The Lighting Control equipment shall be installed and connected as indicated on the drawings and as directed by the manufacturer. The Contractor shall complete all electrical connections to all control circuits, sensors, devices, etc.

B. All wiring shall be in accordance with the manufacturer's specifications. Wiring shall meet all local and state codes. All wiring shall be ground and short tested.

C. Low-Voltage Cabling (including 0-10V): All low-voltage wiring/cabling shall be wired as Class 2 or Class 3 as applicable, following all requirements in NEC 725 for Class 2 or Class 3 circuits as applicable. Low-voltage wiring/cabling shall not share raceways with line-voltage wiring except where allowed by NEC 725.136(I), and all low-voltage wiring/cabling sharing a raceway shall have the same insulation rating. Cables shall be exposed where above A.C.T. ceilings - provide J-hooks spaced 6'-0" apart down corridor walls and D-rings spaced 6'-0" apart on structure where cables run from one side of the corridor to the other. Where J-hooks and D-rings are not required, cables shall be neatly and properly supported from the structure (not ductwork, piping or conduit) in such a way that they will not be strained as the building settles. Where cables are not above A.C.T. ceilings, provide raceways for cables according to Division 26 raceway requirements. Where cables must pass through partitions (such as floors or walls), provide conduit sleeves sized as required and bushed at both ends - cables are not allowed to poke through partitions. No conduit or sleeve shall be smaller than 3/4". Install wires and cables without splices. Make connections at terminal strips in cabinets or at equipment terminals.

3.2 SENSOR INSTALLATION:

A. Install and aim occupancy/vacancy 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. Contractor shall install sensors (occupancy/vacancy and photo) in locations and quantities as recommended by manufacturer. Regardless of quantities and locations of sensors shown on drawings, contractor shall provide sensors in quantities and locations to sufficiently

cover areas in which sensors are located. If the engineer deems during a field inspection that there is not sufficient coverage or that photosensors are not properly reading the natural light in the space, the contractor will be responsible for adding and/or relocating sensors at no cost to the owner.

3.3 FIELD QUALITY CONTROL:

A. The contractor or manufacturer's representative shall perform the following functional testing in the presence of the Engineer (notify the Engineer at least 10 days in advance of the start of testing, and certify in writing that the system is fully functional and operating correctly at least 10 days before the functional testing begins):

1. Ensure that control hardware is calibrated, adjusted, programmed and in proper working condition in accordance with the construction documents and manufacturer's installation instructions.
2. Confirm that the placement, sensitivity and time-out adjustments for occupancy/vacancy sensors yield acceptable performance, and that lights turn off only after space is vacated (or are manually turned off) and do not turn on unless the space is occupied (and are manually turned on for vacancy sensors).
3. Confirm that the placement and sensitivity adjustments for photosensor controls reduce electric light based on the amount of usable daylight in the space.

3.4 O&M MANUAL:

A. Provide O&M Manual as specified in specification section 260100. Include both a paper copy and digital pdf copy of the O&M Manual.

END OF SECTION 260943

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SECTION 262213 - LOW-VOLTAGE DISTRIBUTION TRANSFORMERS

PART 1: GENERAL

1.1 DESCRIPTION:

A. This section specifies the furnishing, installation and connection of the low-voltage distribution transformers as indicated by drawings and schedules and as specified herein.

1.2 RELATED DOCUMENTS:

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Instructions to Bidders and sections of Division 1, apply to the work specified in this section.

1.3 REFERENCES AND CODES:

A. Electrical Code Compliances: Comply with applicable requirements of the 2020 NFPA-70 (NEC) pertaining to low-voltage distribution transformers.

B. NFPA Compliance: Comply with applicable requirements of NFPA 70E, "Standard for Electrical Safety Requirements for Employee Workplaces."

C. NEMA Compliance: Comply with applicable portions of NEMA St. 1 and St. 20.

D. ANSI Compliance: Comply with applicable requirements of ANSI Standards C57-Series pertaining to power/distribution transformers.

E. NETA Compliance: Comply with ATS, Acceptance Testing Specifications for Electrical Power Distribution Equipment.

F. U.L. Compliance: Comply with applicable requirements of ANSI/UL 506 and 1561.

G. IEEE Compliance: 519

1.4 SUBMITTALS:

A. Submit manufacturer's technical product data including dimensions, wiring and connection diagrams, rated KVA, frequency, primary and secondary voltages, percent taps, polarity, X/R ratio and impedance. Furnish factory certification for each size transformer to be installed of the following:

1. Transformer performance efficiency at indicated loads
2. Percentage regulation at 100% and 80% power factor

3. No-load and full-load losses in watts
4. Percent impedance at 75 degrees C
5. Hot-spot and average temperature rise above 40 Deg. C ambient temperature
6. Sound level in decibels, including standard and low noise transformers

PART 2: PRODUCT

2.1 MANUFACTURERS:

A. Transformers shall be manufactured by one of the following:

1. Acme Electric.
2. General Electric Company.
3. Eaton Corporation/Cutler-Hammer.
4. Siemens Energy & Automation, Inc.
5. Square D/Schneider Electric.

2.2 TRANSFORMERS:

A. General Distribution Dry Type: Provide factory-assembled, general-purpose, dry-type distribution transformers; of sizes, characteristics, and rated capacities indicated. Provide terminal board with crimp type connectors. Limit terminal compartment temperature to 75 degrees C when transformer is operating continuously at rated load with ambient temperature of 40 degrees C. Windings shall be copper. Provide wiring connections suitable for copper or aluminum wiring. Integrally mount vibration isolation supports between core and coil assembly and transformer enclosure; electrically ground core and coils to transformer enclosure by means of flexible metal grounding strap. Do not exceed maximum sound-level ratings as determined in accordance with ANSI/NEMA standards. Provide transformers with fully-enclosed sheet steel enclosures and lifting lugs. Coat interior and exterior surfaces of transformer, including bolted joints, with manufacturer's standard color baked-on enamel. Efficiency shall meet US Department of Energy (DOE) 10 CRF 431.

1. Provide ventilated NEMA 250, Type 2 transformers. Provide primary windings with 6 taps; (2) 2-1/2% increments above and (4) 2-1/2% increments below full-rated voltage for de-energized tap-changing operation. Insulate with Class 220 insulation and limit temperature rise to 150 degrees C when operating in an ambient temperature of 40 degrees C.
2. Low Noise Transformers: Transformers indicated as "low noise" shall have a factory-certified noise level at least 3 dB below the NEMA standard sound level for equal size transformers.

B. Control and Signal Transformers:

1. Description: Self-cooled, two winding dry type, rated for continuous duty, complying with NEMA ST 1, and listed and labeled as complying with UL 506.
2. Ratings: Continuous duty. If rating is not indicated, provide at least 50 percent spare capacity above connected peak load.

PART 3: EXECUTION

3.1 INSTALLATION:

A. Provide a concrete pad for each floor-mounted transformer that is 4” high and 4” larger than the respective transformer on all sides. Install each transformer on 1/2" thick rubber isolation pads between transformer and concrete pad. Transformers shall have minimum 6” clearance on back and sides and the NEC 110.26 required clearance on the front.

B. Install wall-mounted transformers level and plumb with 1/4" thick rubber washers at each mounting bolt between transformer and wall or mounting frame. Provide wall mounted bracket from the same manufacturer as the transformer.

C. Install pendant-mounted transformers level and plumb from anti-vibration hangers by Amber/Booth or Kinetics. Provide pendant mounted bracket from the same manufacturer as the transformer.

D. Connect dry-type transformers to wiring system with liquid-tight flexible metal conduit in lengths not exceeding 6 feet.

E. Provide equipment identification name plates complying with Division 26 for identification for electrical systems.

3.2 CLEANING:

A. Prior to energization:

1. Upon completion of installation, inspect interior and exterior of transformer.
2. Remove paint splatters and other spots inside and outside of the transformer enclosure. Repair exposed surfaces to match original finish.
3. Remove all wrenches, packing materials, and construction debris from inside the transformer.
4. Use vacuum (with non-metallic attachments) to collect loose dust, dirt, and particles from inside the transformer enclosure and around the exterior of the transformer enclosure.
5. Do not use compressed air to assist in cleaning. Using compressed air is likely to spread contamination and damage insulation.
6. Accumulated dirt, oil, or grease might require a solvent to be removed. Solvents used for cleaning of electrical equipment shall be selected carefully to ensure compatibility with materials being cleaned. Do not use any liquid cleaners, include spray cleaners, unless specified by the transformer manufacturer, because of the risk of residues causing damage, interfering with electrical or mechanical functions, or compromising the integrity of the insulation surfaces. Allow sufficient time for drying after cleaning transformer with solvents. Wear the required PPE when working with potential hazardous solvents; refer to solvent material data sheets.

3.3 FIELD QUALITY CONTROL:

A. Prior to energization:

1. Prior to energization of transformer, check all accessible connections to manufacturer's tightening torque specifications.
2. Prior to energization of transformer, check with ground resistance tester phase-to-phase and phase-to-ground insulation resistance levels to ensure requirements are fulfilled.
3. Prior to energization of transformer, check for electrical continuity of circuits and for short-circuits.

B. Certification: This Contractor shall certify in writing to the Architect that the above checks were made, including date of the checks and results.

C. Upon completion of installation, energize transformer and demonstrate capability and compliance with requirements. Where possible, correct malfunctioning units at project site, then retest to demonstrate compliance, otherwise remove and replace with new units and retest.

END OF SECTION 262213

SECTION 262416 - PANELBOARDS

PART 1: GENERAL

1.1 DESCRIPTION:

A. This section specifies the furnishing, installation and connection of the panelboards. Extent of panelboard work is indicated by drawings and schedules and as specified herein.

1.2 RELATED DOCUMENTS:

A. The Drawings and general provisions of the Contract, including the General and Supplementary Conditions, Instructions to Bidders and sections of Division 1, apply to the work specified in this section.

1.3 RELATED WORK SPECIFIED ELSEWHERE:

A. Refer to Division 26 for requirements of panelboards used as service entrance equipment.

1.4 REFERENCES AND CODES:

A. Electrical Code Compliances: Comply with applicable requirements of the 2020 NFPA-70 (NEC) pertaining to installation, and construction of electrical panelboards and enclosures.

B. NFPA Compliance: Comply with applicable requirements of NFPA 70E, "Standard for Electrical Safety Requirements for Employee Workplaces."

C. U.L Compliance: Comply with applicable requirements of UL 67, "Electrical Panelboards," and UL's 50, 869, 486A, 486B, and 1053 pertaining to panelboards, accessories and enclosures. Provide units which are U.L. Listed and labeled.

D. Special-Use Markings: Provide panelboards, constructed for special-use, with appropriate UL listing for service entrance equipment, if panelboard is used as service entrance equipment.

E. NEMA Compliance: Comply with NEMA Stds. Pub. No. 250, "Enclosures for Electrical Equipment (1000 Volts Maximum)," Pub. No. PB 1, "Panelboards," and Pub. No. PB 1.1, "Instructions for Safe Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less."

1.5 SUBMITTALS:

A. Product Data: Submit manufacturer's data on panelboards.

B. Shop Drawings: Submit manufacturer's drawings indicating the following:

1. Dimensional data, including gutter dimensions.
2. Circuit protective device schedule indicating type, frame, trip, interrupting rating; circuit numbering and arrangement to match that indicated on contract drawings as much as possible.
3. Bus rating and bracing.
4. Lug location and capacity.
5. Provisions for future, breakers or switches.
6. Caution Label in Panelboards with Ground Fault and/or Arc Fault circuit breakers to read “DO NOT INSTALL SHARED NEUTRALS ON GROUND FAULT OR ARC FAULT CIRCUIT BREAKERS”.

PART 2: PRODUCTS

2.1 MANUFACTURERS:

A. Subject to compliance with all requirements, panelboards shall be manufactured by one of the following:

1. Eaton Corporation/Cutler-Hammer.
2. Siemens Energy & Automation, Inc.
3. Square D/Schneider Electric.
4. General Electric Company

2.2 PANELBOARDS:

A. General: Except as otherwise indicated, provide panelboards, enclosures and ancillary components, of types, sizes, and ratings indicated, which comply with manufacturer's standard materials; designed and constructed in accordance with published product information; equipped with proper number of unit panelboard devices as required for complete installation. Where types, sizes, or ratings are not indicated, comply with NEC, UL and established industry standards for those applications indicated. Panelboards and circuit protective devices shall be marked to indicate that terminal provisions are based on the use of 75 degrees C rated, insulated conductors for all terminations.

B. Panelboards: Provide dead-front safety type panelboards as indicated, with switching and protective devices in quantities, ratings, types and arrangements shown; with anti-turn solderless mechanical type lug connectors suitable for copper or aluminum conductors. Provide copper phase bus bars and full-sized neutral bus bars, unless noted otherwise. Ground bus bars shall be un-insulated and bolted to the inside of the enclosure. All bus bars (phase, neutral and ground) shall be of the same material. Only a single neutral or ground conductor is

permitted to be connected to a lug screw in the respective neutral or ground bus bar within a panelboard. Provide additional or larger capacity neutral or ground bus bars for each panelboard where indicated. Provide spaces with all studs, bussing, and hardware for future circuit breakers without the necessity of installing additional parts or changing bussing.

C. Panelboard Enclosures: Unless noted otherwise, provide galvanized sheet steel cabinet type enclosures, code-gauge, minimum 16-gauge thickness, minimum size 5-3/4" deep x 20" wide. Construct with multiple knockouts and wiring gutters. Provide front with hinged trim constructed of piano hinge down one side and adjustable trim clamps. Front shall have an integral door with keyed flush lock/latch and concealed hinges to provide access to the dead front portion of the circuit breakers and screws to release entire trim. Removing screws shall allow entire front to open along with integral door to provide full access to all wiring gutters without removing front. All panelboard enclosures shall be keyed alike. Equip with interior circuit-directory frames and cards with clear plastic covering. Fronts for flush mounted panelboards shall overlap cabinet by 3/4" all around; fronts for surface mounted panels shall be the same size as the cabinet. Provide baked gray enamel finish over rust inhibitor covering, except panels in all finished areas shall have a prime finish, ready for paint finish to match adjacent surface. Provide enclosures which are fabricated by same manufacturer as panelboards, which mate properly with panelboards to be enclosed.

D. Circuit Protective Devices:

1. Molded-Case Circuit Breaker: UL 489, with interrupting capacity to meet available fault currents.

   a. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
   b. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
   c. Electronic trip-unit circuit breakers shall have RMS sensing, field-replaceable rating plug, and the following field-adjustable settings:

      (1) Instantaneous trip.
      (2) Long- and short-time pickup levels.
      (3) Long- and short-time time adjustments.
      (4) Ground-fault pickup level (only where specifically indicated), time delay, and I2t response.

   d. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.
   e. Ground Fault Circuit Breakers (GFCI): Single-pole and two-pole configurations with a nominal 5 mA trip threshold and 0.025 sec trip time.
   f. Ground Fault Equipment Protector (GFEP): Single-pole, two-pole and three-pole configurations with a nominal 30 to 300 mA trip threshold.
   g. Arc Fault Circuit Breaker (combination type per NEC): Single pole and two-pole configurations with detection of line-to-neutral arcing at 75A and above and line-to-ground arcing at 5A and above.

2. Molded-Case Circuit-Breaker Features and Accessories: Standard frame sizes, trip ratings, and number of poles.

    a. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor materials.
    b. Ground Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature and ground-fault indicator.
    c. Arc Fault Protection: Combination type AFCI breaker, push-to-test feature and arc-fault indicator.
    d. Shunt Trip: 120V or 277V trip coil energized from separate circuit.
    e. Multipole units enclosed in a single housing or factory-assembled shall operate as a single unit.
    f. Fused Switch: NEMA KS 1, Type HD; clips shall accommodate specified fuses; lockable handle. Fuses are specified in Division 26 Section "Fuses".

E. Short Circuit Current Ratings: This Contractor shall contact the local utility company to determine the available fault current at the pad mounted transformer. Utilize components which are individually rated not less than the short circuit current rating as determined from data received from the local utility company. Series rating is not acceptable. Short circuit current rating shall be as required above and shall be a minimum of 10,000 amps on 208/120 or 240 panels and 14,000 amps on 480/277 panels unless noted otherwise.

F. Circuit Breaker Lock: Provide approved circuit breaker lock-on device for the following equipment:

1. All Fire Alarm System equipment, including but not limited to Fire Alarm Control Panel and remote (NAC) panels. Breakers shall be red and identified as "FIRE ALARM CIRCUIT".
2. Sprinkler System: Dry-pipe air compressor.
3. Exit signs.
4. Egress lighting fixtures.
5. Other equipment as shown on the Drawings or as required.

G. Panelboard Surge Protective Device (SPD): See specification section 26 43 13 SURGE PROTECTIVE DEVICES (SPD) for SPD requirements.

PART 3: EXECUTION

3.1 INSTALLATION OF PANELBOARDS:

A. Coordinate installation of panelboards and enclosures with cable and raceway installation work.

B. Anchor enclosures firmly to walls and structural surfaces, ensuring that they are permanently and mechanically secure and plumb. Mount recessed panelboards with front uniformly flush with wall finish.

C. Provide properly wired electrical connections within enclosures.

D. Type panelboard's circuit directory card upon completion of installation work. Indicate panel designation, phase, voltage, and (for each circuit) type of load and location on the directory. Use Owner's room numbers, not those on the construction documents.

E. Unless noted otherwise on the drawings, all adjustable trip breakers shall have their long-time pick-up set to 100%. For breakers that have long-time pick-up set to less than 100%, provide label indicating what the setting is and that the wiring has been sized for this; also provide restricted access per NEC 240.6(C). A factory-authorized representative shall perform field adjustment of protective devices as required to place the equipment in final operating condition. Contractor shall notify Design Engineer once all breakers have been adjusted for field verification approval.

F. Install filler plates in unused, open circuit breaker spaces.

G. For flush mounted panelboards, stub four 1-inch empty conduits from panelboard up into accessible ceiling space or space designated to be ceiling space in the future. Also, stub four 1-inch empty conduits down into raised floor space or below slab when not on grade. Bush the ends of the conduits.

H. Arrange conductors in gutters into groups and bundle and wrap with wire ties.

I. Apply sealant around all exterior mounted panelboards to provide weatherproofing and pest control; refer to sections of Division 7.

J. Provide equipment/system identification nameplates complying with Division 26 in accordance with panelboard schedules on drawings. Inside each panelboard, the voltage, system, amperage and AIC ratings must be clearly labeled.

K. Provide field marking to warn qualified persons of potential electric arc flash hazards. The marking shall be located so as to be clearly visible to qualified persons before examination, adjustment, servicing or maintenance of the equipment. Provide arc flash warning label made of high performance polyester, 3-1/2"H X 5"W, Brady Cat. No. 94913 or approved equal.

3.2 ADJUSTING AND CLEANING:

A. Adjust operating mechanisms for free mechanical movement.

B. Prior to energization:

1. Upon completion of installation, inspect interior and exterior of panelboard.
2. Remove paint splatters and other spots inside and outside of the panelboard enclosure. Repair exposed surfaces to match original finish.
3. Remove all wrenches, packing materials, and construction debris from inside the panelboard.

4. Use vacuum (with non-metallic attachments) to collect loose dust, dirt, and particles from inside the panelboard enclosure and around the exterior of the panelboard enclosure.
5. Do not use compressed air to assist in cleaning. Using compressed air is likely to spread contamination and damage insulation.
6. Accumulated dirt, oil, or grease might require a solvent to be removed. Solvents used for cleaning of electrical equipment shall be selected carefully to ensure compatibility with materials being cleaned. Do not use any liquid cleaners, include spray cleaners, unless specified by the panelboard manufacturer, because of the risk of residues causing damage, interfering with electrical or mechanical functions, or compromising the integrity of the insulation surfaces. Allow sufficient time for drying after cleaning panelboard with solvents. Wear the required PPE when working with potential hazardous solvents; refer to solvent material data sheets.

3.3 FIELD QUALITY CONTROL:

A. Prior to energization:

1. Prior to energization of panelboard, check all accessible connections to manufacturer's tightening torque specifications.
2. Prior to energization of panelboard, check with ground resistance tester phase-to-phase and phase-to-ground insulation resistance levels to ensure requirements are fulfilled.
3. Prior to energization of panelboard, check for electrical continuity of circuits and for short-circuits.

B. Certification: This Contractor shall certify in writing to the Architect that the above checks were made, including date of the checks and results.

C. Upon completion of installation, energize panelboard and demonstrate capability and compliance with requirements. Where possible, correct malfunctioning units at project site, then retest to demonstrate compliance, otherwise remove and replace with new units and retest.

END OF SECTION 262416

SECTION 262726 - WIRING DEVICES AND MISCELLANEOUS EQUIPMENT

PART 1: GENERAL

1.1 DESCRIPTION:

A. This section specifies the furnishing, installation and connection of wiring devices and miscellaneous equipment. The extent of this work is indicated by drawings and in these specifications

1.2 RELATED WORK SPECIFIED ELSEWHERE:

A. Refer to other Division 26 sections for requirements for electrical installations, conductors and cables, grounding and bonding, and raceway and boxes which are required in conjunction with wiring devices and miscellaneous equipment.

1.3 REFERENCES AND CODES:

A. Electrical Code Compliance: Comply with applicable requirements of the 2020 NFPA-70 (NEC) pertaining to installation and wiring of electrical wiring devices.

B. U.L. Compliance: Comply with applicable requirements of UL 20, 486A, 498 and 943 pertaining to installation and wiring devices. Provide wiring devices which are U.L. Listed and U.L. Labeled.

C. IEEE Compliance: Comply with applicable requirements of IEEE Std. 241, “Recommended Practice for Electric Power Systems in Commercial Buildings”, pertaining to electrical wiring systems.

D. NEMA Compliance: Comply with applicable portions of NEMA Stds. Pub. Nos. WD 1, “General Purpose Wiring Devices”, and WD 5, “Specific Purpose Wiring Devices”.

1.4 SUBMITTALS:

A. Product Data: Submit manufacturer's data on wiring devices and miscellaneous equipment, including manufacturer's standard colors, descriptive literature and recommended installation instructions on each electrical item specified. Mark wiring device cut sheets for applicable NEMA, U.L. and Federal Specification compliance.

B. Samples: Submit samples of the following items as requested by Architect or Engineer:

1. Decora duplex receptacle and cover plate.
2. Decora ground fault duplex receptacle and cover plate.
3. Toggle switch, SPST and cover plate.

4. Weatherproof receptacle cover plate.
5. Weatherproof switch cover plate.
6. Tamper-resistant duplex receptacle.
7. Foam gasket.
8. Manufacturer color samples for each wiring device and each cover plate.

PART 2: PRODUCTS

2.1 MANUFACTURERS:

A. Provide wiring devices of one of the following:

1. Receptacles and Switches: Bryant, Eaton Arrow/Hart, Hubbell, Leviton, Pass & Seymour.
2. Wallplates: Bryant, Eaton Arrow/Hart, Hubbell, Leviton, Pass & Seymour.

2.2 WIRING DEVICES:

A. General:

1. Provide factory-fabricated wiring devices, of types and electrical ratings for applications indicated. Color selections for all wiring devices and plates shall be from manufacturer's standard white, ivory, light almond, gray, red, brown or black colors, verified with the Architect by the Contractor (except where colors are noted below) before device order is released. The selected color or colors may not be the same in all spaces in the project.
2. Wiring devices shall be grounding type and shall be industrial specification grade, construction specification grade or heavy-duty specification grade. Switches shall comply with Federal Specification Standard WS-896 and receptacles shall comply with U.L. Standard 498 and Federal Specification WC-596.
3. When used in this specification section, the term "unfinished" refers to mechanical rooms, electrical rooms, I.T. rooms, shops and janitor's closets. Unless otherwise indicated, all other interior spaces shall be considered "finished".

B. Receptacles:

1. Duplex: Provide duplex receptacles with non-tracking thermoplastic polyester and/or nylon case; color as selected by Architect in finished and unfinished spaces; red for receptacles connected on emergency circuits; blue for surge suppression receptacles; triple-wipe power contacts .031 in. nominal; break-off tab for split wiring; auto-grounding clip; metal plaster ears; side wiring with spring-loaded, screw-activated pressure plate; NEMA configuration 5-20R, unless otherwise indicated. Receptacles shall be straight blade style.
2. Controlled Duplex: Same as duplex receptacles except the receptacles must include the text “CONTROLLED” permanently marked on the face of the device along with the NEMA-approved controlled receptacle marking symbol per NEC 406.3 (E). Virginia Energy Conservation Code requires either providing a split wired controlled

receptacle with top half of receptacle controlled and bottom half is uncontrolled, or a full duplex controlled receptacle to be located within 12 inches of an uncontrolled duplex receptacle. Controlled receptacles are noted by the letter "C" on the drawings. Where drawings only show one receptacle on the wall with a "C" next to it then provide split wired controlled receptacles. Where drawings show two duplex receptacles with one duplex having a "C" next to it then provide that duplex with a "C" as a controlled receptacle and the other duplex as an uncontrolled receptacle. Where drawings show a quad receptacle with a "C" next to it then provide the right duplex receptacle as a controlled receptacle and the left duplex as an uncontrolled receptacle.

3. Ground Fault Duplex: Provide ground fault duplex receptacles with non-tracking thermoplastic polyester and/or nylon case; color to match duplex receptacles in same area; red for receptacles connected on emergency circuits; side wiring with spring-loaded, screw-activated pressure plate; "feed-through" type capable of protecting connected downstream outlets; grounding type UL-rated Class A, Group 1; solid-state ground fault sensing and signaling with 5 milliamperes ground-fault trip level; NEMA configuration 5-20R, unless otherwise indicated. Receptacles shall be straight blade decorator style.
4. Tamper Resistant Duplex: Provide duplex receptacles with mechanical shutter mechanism to prevent access to contacts unless a two-pronged plug is inserted; non-tracking plastic or nylon case; face locked into base; "TR" symbol stamped on receptacle face; color to match duplex receptacles in same space type, except red where on emergency circuit; metal plaster ears; side wiring with spring-loaded, screw-activated pressure plate; NEMA configuration 5-20R, unless otherwise indicated. Receptacles shall be straight blade style.
5. Surge Protective (Suppression) Duplex: Provide receptacles which are U.L. Listed to Standards 1449 and 498 and are suitable for ANSI/IEEE C62.41 installation category "A". Provide pilot light to indicate when power is available and suppression circuit is fully functional. Ground terminal shall be isolated from mounting strap and shall require a dedicated copper equipment grounding connection. Face color of receptacle shall be blue. Receptacles shall be straight blade style.
6. Provide receptacles requiring current, voltage or configuration different from duplex receptacles as indicated. Provide with quality, material and workmanship at least equal to that specified for duplex receptacles.

C. Plugs: Provide plugs where noted or required, grounding-type, adjustable cord clamp, NEMA configuration and blades to match receptacle where noted.

D. Connectors: Provide connectors where noted, grounding-type, double wipe contacts, adjustable cord clamp, NEMA configuration to match mating plug where noted.

E. General Use Switches:

1. Provide toggle switches in all spaces. Switches shall be 120/277 volts AC; quiet-type; color as selected by the Architect in finished and unfinished spaces; red for switches connected on emergency circuits; side wired; non-tracking case; undercut binder head screws; silver/cadmium alloy contacts with bronze spring arm; 20 ampere rating; SPST, DPST, 3 or 4-way, maintained or momentary contacts, or key

operated as indicated. Key-operated switches shall be P&S #20AC1-KL Series, or approved equal.

2. Provide toggle switches mounted in mullions suitable for side wiring; rated 15 amperes; single pole or three-way as indicated; quiet type; color to match other switches in same space type.

F. Wallplates: Provide wallplates for single and combination wiring devices, of types, sizes, and ganging as required and cutouts as required for specified devices. Select wall plates of style which mate and match wiring devices to which attached. Unless stainless steel, color shall match associated wiring device except in unfinished spaces. All plates shall be by the same manufacturer unless specifically noted otherwise. Construct with metal screws for securing plates to devices; screw heads shall match finish of plates. Provide plates possessing the following additional construction features:

1. Steel plate, Type 302 stainless, 0.032" thick. Where installed on 2” wide mullions, wall plate shall be 1-3/4” wide.
2. Weatherproof Duplex Receptacle Wallplates: Wallplates for weatherproof receptacles with the designation “WP” where indicated on drawings or where required by NEC shall be UL listed and NEMA 3R rated while outlet is in use or not used. The receptacle shall also be listed as weather-resistant type. The cover shall be single-gang or double-gang for two devices and shall not protrude over 4.5” from wall surface. Each cover shall be complete with required sealing gaskets, and stainless steel mounting screws. Covers shall capability to allow the passage of two flexible cords. Mount wallplates with long dimension vertical, unless noted otherwise. Wallplates shall be identified as “extra heavy duty” where required by NEC 406.9(B)(1). Wallplate cover units shall be as manufactured by Arlington Industries, Inc. or Taymac Corporation, or approved equal. Where mounted on mechanical equipment, provide “bubble” type weatherproof-while-in-use cover. Architect to select color finishes.
3. Weatherproof Switch Wallplates: Wallplates for weatherproof switches with the designation “WP” where indicated on drawings or where required by NEC shall be single or double gang as required for number of switches indicated and shall not protrude over 5/8” from wall surface. Each cover shall be complete with required sealing gaskets and stainless steel mounting screws. Wallplates shall be as manufactured by Taymac Corporation. Architect to select color finishes.

G. Foam Gaskets: Provide fire-retardant plastic foam sealer sheets for all wiring devices installed on the interior of exterior building walls. Install to form a seal between the wallplate and the wall. Sealer sheets shall be "Frost King" as manufactured by Therm-well Products Co., Inc., Paterson, NJ., or “Gasket 1” as manufactured by Pass & Seymour.

PART 3: EXECUTION

3.1 INSTALLATION OF WIRING DEVICES:

A. Coordinate with other work, including painting, electrical boxes and wiring work, as necessary to interface installation of wiring devices with other work.

B. Install wiring devices only in electrical boxes which are set in wall at depth not greater than permitted by NEC, and which are clean and free from excess building materials, dirt and debris.

C. Install tamper-resistant receptacles in all locations specified in NEC 406.12, 406.13 and 406.14.

D. Install foam gaskets on all wiring devices installed on inside of exterior building walls.

E. Install stainless steel wallplates in finished and unfinished spaces.

F. Install wall plates square and plumb with building lines.

G. Mount all duplex receptacles vertically, with ground slot up, at mounting height as indicated in the Electrical Legend, unless noted otherwise. All receptacles shown at counter locations shall be mounted at height as indicated by an asterisk, unless noted otherwise. Only where there is a conflict with a mirror or medicine cabinet in Bathroom or Toilet counter locations the receptacle(s) shown shall be mounted horizontal with ground slot to the left. Center these receptacles between top of backsplash and bottom of mirror or cabinet.

H. GFCI receptacles shall be readily accessible in locations required by NEC 210.8.

I. Install wiring devices after wiring work is completed. Provide protective cover over each wiring device installed prior to painting operations.

J. Install wallplates after painting work is completed and remove all protective covers.

K. Apply sealant around all exterior mounted electrical devices (receptacles, photocells, switches, etc.) to provide weatherproofing and pest control; refer to Division 7 for joint sealers.

3.2 PROTECTION OF WALL PLATES AND RECEPTACLES:

A. Upon installation of wallplates and receptacles, make proper and cautious use of convenience outlets. At time of Substantial Completion, replace those items which have been damaged, including those burned and scored by faulty or overloaded plugs.

3.3 TESTING:

A. Prior to energizing circuitry, test wiring for electrical continuity and for short-circuits. Ensure proper polarity of connections is maintained. Subsequent to energizing, test wiring devices to demonstrate compliance with requirements. Following energizing, a polarity test shall be made on all receptacles to determine that all receptacles have been properly connected and that grounding conductors are continuous throughout all outlets. This

Contractor shall certify in writing to the Architect that the testing has been completed and all receptacles are wired properly.

END OF SECTION 262726

SECTION 262813 - FUSES

PART 1: GENERAL

1.1 DESCRIPTION:

A. This section specifies the furnishing and installation of low voltage circuit protective devices or fuses. Extent of the work is indicated on drawings and as required by the NEC.

1.2 RELATED DOCUMENTS:

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Instructions to Bidders and sections of Division 1, apply to the work specified in this section.

1.3 REFERENCES AND CODES:

A. UL Compliance and Labeling: Comply with applicable provisions of UL 198D, "High-Interrupting-Capacity Class K Fuses". Provide overcurrent protective devices which are U.L. Listed and Labeled.

B. NEC Compliance: Comply with 2020 NFPA-70 (NEC) as applicable to construction and installation of fusible devices.

C. NFPA Compliance: Comply with applicable requirements of NFPA 70E, "Standard for Electrical Safety Requirements for Employee Workplaces."

D. ANSI Compliance: Comply with applicable requirements of ANSI C97.1 "Low-Voltage Cartridge Fuses 600 Volts or Less".

1.4 SUBMITTALS:

A. Product Data: Submit manufacturer's technical product data on fuses used on this project, including specifications and electrical characteristics. In addition, include voltages and current ratings, interrupting ratings, current limitation ratings, and time-current trip characteristics curves.

PART 2: PRODUCTS

2.1 MANUFACTURERS:

A. Obtain all fuses used on the project from a single manufacturer. Provide fuses by Cooper Bussmann, Mersen or Littelfuse.

2.2 FUSES:

A. General: Except as otherwise indicated, provide NEMA FU 1 nonrenewable cartridge fuses of types, sizes, ratings, and average time-current and peak let-through current characteristics as indicated or required to suit the equipment served, which comply with manufacturer's standard design and materials, and constructed in accordance with published product information and with industry standards and configurations.

B. Extra Materials: For all types and ratings required, furnish additional fuses amounting to one unit for every 10 installed units, but not less than one set of 3 of each size and type. Provide a metal cabinet with lockable door to house all extra fuses, plus 25% spare capacity and fuse pullers for each size of fuse.

C. Class RK1 Time-Delay Fuses: Provide UL Class RK1 time-delay fuses rated 250 or 600 volts as applicable, 60 Hz, with 200,000 RMS symmetrical interrupting current rating, Bussmann "Low Peak", LPN/LPS, or equal.

2.3 CABLE LIMITERS:

A. Provide cable limiters rated 250 or 600 volts as required by secondary service voltage rating, 60 Hz with terminals type and size as indicated or required.

PART 3: EXECUTION

3.1 INSTALLATION OF FUSES:

A. Provide fuses in all fusible devices. Size of fuses shall be as noted or in accordance with fuse manufacturer's tables for back-up motor running protection. Install fuses so rating information is readable without removing fuses. Install labels indicating fuse replacement information on inside door of each fused switch.

END OF SECTION 262813

SECTION 262816 - ENCLOSED SWITCHES

PART 1: GENERAL

1.1 DESCRIPTION:

A. This section specifies the furnishing; installation and connection of low voltage disconnect switches. Extent of the work is indicated on drawings and schedules and as required by the NEC.

1.2 RELATED DOCUMENTS:

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Instructions to Bidders and sections of Division 1, apply to the work specified in this section.

1.3 RELATED WORK SPECIFIED ELSEWHERE

A. Refer to Division 26 for requirements of safety/disconnect switches used as service entrance equipment.

1.4 REFERENCES AND CODES:

A. Electrical Code Compliances: Comply with applicable requirements of the 2020 NFPA-70 (NEC) pertaining to construction and installation of disconnect switches.

B. NFPA Compliance: Comply with applicable requirements of NFPA 70E, "Standard for Electrical Safety Requirements for Employee Workplaces."

C. U.L. Compliance: Provide with requirements of UL 98, “Enclosed and Dead-Front Switches”. Provide switches which are U.L. Listed and U.L. Labeled.

D. NEMA Compliance: Comply with applicable requirements of NEMA Stds. Pub. No. KS 1, “Enclosed Switches”, and 250, “Enclosures for Electrical Equipment (1000 Volts Maximum)”.

1.5 SUBMITTALS:

A. Submit manufacturer's descriptive literature and recommended installation instructions on enclosed switches.

PART 2: PRODUCTS

2.1 MANUFACTURERS:

A. Provide enclosed switches by one of the following:

1. Square D /Schneider Electric Co.
2. Cutler-Hammer, Inc./Eaton Corporation
3. General Electric Co.
4. Siemens Energy & Automation, Inc.

2.2 SAFETY SWITCHES:

A. Surface-mounted, general-duty or heavy-duty as applicable, horsepower-rated, fusible or non-fusible as indicated, safety switches with lugs suitable for copper or aluminum conductors and electro-silver plated current carrying parts, and with equipment ground bus with appropriate lugs. Fusible switches shall be provided with spring-reinforced fuse clips to reject all fuses except Class R current limiting type; fuse each phase. Switches shall have hinged door with defeatable interlock to prevent door from being opened in "ON" position; operating lever arranged for padlocking in the "OFF" position; arc quenchers; capacity and characteristics as required; non-teasable quick-make and quick-break mechanism; dead front; line side shield.

B. Provide Service Entrance Rated safety/disconnect switches that are listed and labeled for service entrance applications where applicable.

C. Provide a set of auxiliary contacts for disconnects serving VFD’s, to send a “disable” signal to the VFD when the disconnect is opened.

D. As a Contractor-option for equipment rated below 1/2 horsepower, provide horsepower-rated, fusible or non-fusible as indicated, toggle-type switches with provisions for padlocking in the "OFF" position, and with number of poles and voltage as indicated.

2.3 ENCLOSURES:

A. Listed for environmental conditions of installed locations, including:

1. Indoor General Locations, except where noted below: NEMA Standard 250, Type 1 surface mounted, except where noted as flush.
2. Indoor Damp or Wet Locations: NEMA Standard 250, Type 4, surface mounted.
3. Outdoor Locations: NEMA Standard 250, Type 3R, surface mounted.
4. Food Service Areas: NEMA Standard 250, Type 4X, stainless steel, surface mounted.
5. Elevator Equipment Rooms: NEMA Standard 250, Type 12 surface mounted.

PART 3: EXECUTION

3.1 INSTALLATION OF ENCLOSED SWITCHES:

A. Provide safety switches for all motor appliances for the project where indicated and required by the NEC.

B. Coordinate enclosed switch installation work with electrical raceway and cable work, as necessary for proper interface.

C. Anchor enclosures firmly to walls and structural surfaces, ensuring that they are permanently and mechanically secure.

D. Install safety switches for use with motor-driven appliances, motors and controllers within sight of controller position, unless otherwise indicated, on a nearby wall, on the equipment served, or on an adequately constructed metallic framework. Where safety switches and maintenance receptacles are located on equipment served, the switches and/or maintenance receptacles shall be located where directed by the manufacturer of equipment or at a location that will not interfere with access panels or louvers.

E. Provide labels indicating size and type of replacement fuses, glued to inside of door on all fusible switches.

F. Apply sealant around all exterior mounted safety switches and enclosures to provide weatherproofing and pest control; refer to Division 7 for joint sealers.

G. Provide equipment identification name plates complying with Division 26 for identification for electrical systems.

H. Provide field marking to warn qualified persons of potential electric arc flash hazards. The marking shall be located so as to be clearly visible to qualified persons before examination, adjustment, servicing or maintenance of the equipment. Provide arc flash warning label made of high performance polyester, 3-1/2”H X 5”W, Brady Cat. No. 94913 or approved equal.

3.2 ADJUSTING AND CLEANING:

A. Adjust operating mechanisms for free mechanical movement.

B. Prior to energization:

1. Upon completion of installation, inspect interior and exterior of enclosed switches.
2. Remove paint splatters and other spots inside and outside of the enclosed switches enclosure. Repair exposed surfaces to match original finish.
3. Remove all wrenches, packing materials, and construction debris from inside the enclosed switches.

4. Use vacuum (with non-metallic attachments) to collect loose dust, dirt, and particles from inside the enclosed switches enclosure and around the exterior of the enclosed switches enclosure.
5. Do not use compressed air to assist in cleaning. Using compressed air is likely to spread contamination and damage insulation.
6. Accumulated dirt, oil, or grease might require a solvent to be removed. Solvents used for cleaning of electrical equipment shall be selected carefully to ensure compatibility with materials being cleaned. Do not use any liquid cleaners, include spray cleaners, unless specified by the enclosed switches manufacturer, because of the risk of residues causing damage, interfering with electrical or mechanical functions, or compromising the integrity of the insulation surfaces. Allow sufficient time for drying after cleaning enclosed switches with solvents. Wear the required PPE when working with potential hazardous solvents; refer to solvent material data sheets.

3.3 FIELD QUALITY CONTROL:

A. Prior to energization:

1. Prior to energization of enclosed switches, check all accessible connections to manufacturer's tightening torque specifications.
2. Prior to energization of enclosed switches, check with ground resistance tester phase-to-phase and phase-to-ground insulation resistance levels to ensure requirements are fulfilled.
3. Prior to energization of enclosed switches, check for electrical continuity of circuits and for short-circuits.

B. Certification: This Contractor shall certify in writing to the Architect that the above checks were made, including date of the checks and results.

C. Upon completion of installation, energize enclosed switches and demonstrate capability and compliance with requirements. Where possible, correct malfunctioning units at project site, then retest to demonstrate compliance, otherwise remove and replace with new units and retest.

END OF SECTION 262816

SECTION 263213.13 - DIESEL-ENGINE DRIVEN PACKAGED GENERATOR SET

PART 1: GENERAL

1.1 DESCRIPTION:

A. This section specifies the furnishing, complete installation, connection and testing of the engine generator system. The engine generator system shall be fully automatic and shall constitute a unified and coordinated system ready for operation.

1.2 RELATED DOCUMENTS:

A. The Drawings and general provisions of the Contract, including the General and Supplementary Conditions, Instructions to Bidders and Division 1 sections, apply to the work specified in this section.

1.3 REFERENCES AND CODES:

A. Refer to Division 3 sections for concrete and grout work required in connection with generator unit.

B. Refer to other Division 26 sections for wires/cables, electrical boxes and fittings, and wiring devices which are required in conjunction with generator work.

C. Electrical Code Compliance: Comply with applicable local code requirements of the authority having jurisdiction and 2020 NFPA-70 Article 702 pertaining to construction and installation of emergency and standby systems, as well as Article 445.

D. NFPA Compliance: Comply with applicable requirements of NFPA 70E, "Standard for Electrical Safety Requirements for Employee Workplaces."

E. NFPA Compliance: Comply with applicable requirements of, and install in accordance with, NFPA 37 "Installation and Use of Stationary Combustion Engines and Gas Turbines," NFPA 101 "Code for Safety to Life from Fire in Buildings and Structures", and NFPA 110 "Emergency and Standby Power Systems".

F. UL Compliance: Provide generator set listed in accordance with ANSI/UL 2200, "Stationary Engine Generator Assemblies." Provide all required UL testing for any changes to the generator set made in the field after shipped from the factory. This includes, but is not limited to, changes to the enclosure, sub-base fuel tank, circuit breakers, and all other components within the generator enclosure. Automatic transfer switches shall be listed per UL 1008.

1.4 SUBMITTALS:

A. Product Data: Submit manufacturer's data on generator set(s), generator components, and transfer switch(es). Include manufacturer's standard product warranty, for duration of not less than two years. Warranty shall include parts, labor, and travel (transportation, lodging, and meals) for the entire length of the warranty for replacement of materials and equipment used in generator systems.

B. Shop Drawings:

1. Submit layout drawings of generator unit and accessories including, but not limited to, manufacturer and model of engine and generator, automatic transfer switches, exhaust piping, weather protective/sound attenuating housing, remote start-stop stations, and instrumentation. In addition, show generator set units and their spatial relationship to associated equipment. Allow adequate clearance space for removal of generator elements for maintenance purposes.
2. Submit wiring diagrams for generator units showing connections to automatic transfer switches and ancillary equipment. Differentiate between portions of wiring that are manufacturer installed and portions that are field installed.

C. Agreement to Maintain: Prior to time of final acceptance, the Installer shall submit 4 copies of an agreement for continued service and maintenance of generator sets, for Owner's possible acceptance. Offer terms and conditions for furnishing parts and providing continued testing and servicing, including replacement of materials and equipment, for one-year period with option for renewal of Agreement by Owner.

D. Certifications: Prior to generator set being shipped from factory to project location, provide certified test record of the following final production testing:

1. Single-step load pickup.
2. Transient and steady-state governing.
3. Safety shutdown device testing.
4. Voltage regulation.
5. Rated power.

E. Operating and Maintenance Data: Submit operating and maintenance data.

1.5 QUALITY ASSURANCE:

A. Design Criteria:

1. The unit shall be manufactured in the USA, shall be the product of a firm regularly engaged in the manufacture of engines and generator sets, and shall meet the requirements of specifications set forth herein. It shall be a standard model in regular production at the manufacturer's place of business.

2. Provide unit capable of producing the minimum continuous rating as specified while operating as a standby power source and without producing any overloading or overheating of the engine, alternator, or any of the components at any time.
3. Provide unit capable of attaining full speed, voltage and frequency, and capable of accepting load within elapsed time of 10 seconds from initial starting signal received from the automatic transfer switch.

B. Supplier/Installer's Qualifications: Engage supplier/installer who is willing to execute with the Owner an agreement for continued maintenance of generator units (Owner's option). It is essential that the engine-generator supplier/installer maintain a local parts and service facility within 100 miles of the project. In addition, in order not to penalize the Owner for unnecessary or prolonged periods of time for service or repairs to the emergency system, the bidding generator set supplier must have no less than 60 percent of all engine replacement parts in his stock at all times. Certified proof of this requirement shall be available from the dealer, and a personal inspection of the dealer's facilities may be made by the designing engineer or his appointed representative to substantiate claims made by the generator set supplier. The supplier shall furnish all installation and test supervision necessary for final approval and acceptance.

1.6 DELIVERY, STORAGE AND HANDLING:

A. Deliver generators properly packaged and mounted on pallets or skids to facilitate handling. Utilize factory-fabricated type containers or wrappings for engine-generator and components which protect equipment from damage.

B. Store generator equipment in original packaging and protect from weather and construction traffic. Wherever possible, store indoors; where necessary to store outdoors, store above grade and enclose with watertight wrapping.

PART 2: PRODUCTS

2.1 MANUFACTURERS:

A. Provide generators and associated equipment of one of the following: Generac Corp., Caterpillar Corp., Cummins/Onan Corp., Kohler Power Systems, or MTU Onsite Energy.

B. Provide transfer switches of one of the following: ASCO, Eaton Corp., or Caterpillar Corp.

2.2 PACKAGED GENERATOR SET:

A. Provide NFPA 110 Type 10, Level 2, Class 24 packaged diesel engine-driven generator assembly unit with nominal ratings as indicated, at a governed speed of 1800 RPM, and rated 80 percent power factor for continuous operation, 60 Hz. Equip generator with four-stroke cycle, 1800 RPM, diesel engine, and fueled with No. 2 diesel. Unit shall be liquid cooled for operation in an ambient temperature of 110 degrees F. Complete unit shall comply with ASME

B15.1 safety standard. Ratings of the diesel electric set shall be based on operation of the unit at rated generator RPM when equipped with all necessary operating accessories, such as air cleaners, lubricating oil pump, fuel transfer pump, fuel injection pumps, jacket water pump, alternating current generator, exciter, unit-mounted radiator, and fan. The generator shall be capable of rated emergency power for the duration of the power outage. Provide all required lubricating fluids in accordance with generator manufacturer's instructions. The engine shall be provided with antifreeze (a solution of 50% ethylene glycol) and suitable electric-immersion type jacket coolant heater factory installed in coolant system, and shall comply with NFPA 110 requirements for Level 2 equipment for heater capacity. Connect engine drive directly to 4-pole PMG revolving-field type single, maintenance-free, bearing generator through semi-flexible steel disk coupling. Provide control equipment and wiring to automatically start engine, transfer load to standby power upon failure of normal power source, transfer load back to normal power upon normal power restoration, and stop engine. Initiation signal shall come from all automatic transfer switches. Cushion-mount engine-generator on heavy steel base with spring vibration isolators to reduce possibility of torsional vibration. Equip engine with low-oil pressure, high-water temperature, and automatic over-speed safety shutdown devices. Equip generator with exciter and voltage regulator to maintain voltage within 5 percent of rated value. Provide unit capable of voltage recovery, within regulated range, of 7 seconds following sudden load increase from 0 to 100 percent of rated load, with voltage dip not to exceed 20 percent upon application of rated load at rated power factor. Engine and generator shall be treated and painted standard manufacturer’s color to resist corrosion. Construct unit in compliance with applicable standards and with additional construction features as indicated.

B. Starting Battery and Charger System: The automatic start/stop system shall be electrically operated through a 12 or 24 volt battery system. A lead acid battery set of required ampere-hour capacity as recommended by the generator unit manufacturer shall be furnished with suitable battery rack with acid-resistant finish, securely mounted within the enclosure. When the generator is located in a protective enclosure, the battery rack shall have thermal insulation and thermostatically controlled heater arranged and sized to maintain battery above 10 degrees C (50 degrees F) regardless of external ambient temperature. The battery charger shall be 10 ampere, current-limiting, automatic-equalizing and float type complying with UL 1236, and shall be securely mounted within the generator set enclosure. Provide contact for battery charger malfunction alarm. Mount the charger on the interior side of the generator enclosure wall.

C. Instrument Control Panel:

1. Provide unit-mounted control panel with engine oil-pressure and coolant-temperature indicators, battery charge-rate ammeter, START - STOP switch for manual operation of unit, static voltage regulator, voltage-adjusting rheostat, voltmeter, ammeter with phase selector switch with an OFF position, panel illumination light and switch, and running time indicator and frequency meters. Provide circuitry of plug-in design capable of quick replacement, and capable of accepting a plug-in device which allows maintenance to test control panel performance without operating the engine.
2. Provide unit-mounted main circuit breaker or breakers (quantity and size as indicated). Circuit breaker enclosure(s) shall be U.L. listed and labeled for service entrance. Each circuit breaker shall be separately enclosed per NEC 700.10(B)(5).

3. Provide those safety devices and audible and visual warning devices required by NFPA 110 5.6.5 – Control Functions.

D. Genset Disconnecting Means and Overcurrent Protection:

1. The STOP switch on the Instrument Control Panel shall meet the requirements of NEC 445.18 for disconnecting means.
2. Alternator shall be protected per the requirements of NEC 445.12. Protection provided shall be coordinated with the thermal damage curve of the alternator; submit damage and protection curves to verify performance. Protection shall allow genset to operate continuously at its rated output. Protection shall be 3rd party certified to verify performance.
3. All generator disconnecting means shall be service entrance rated.

E. Sound Attenuated, Weather Protective Enclosure: The engine-generator supplier shall furnish in their package a sound attenuated, weather protective enclosure to contain the engine-generator set and silencer. The engine-generator set with enclosure shall be sound rated for 75 dBA at 23 feet under full load. Enclosure shall have piano hinged lockable doors on each side and rear, fixed intake louvers, and wire mesh screen on radiator end. Enclosure shall be minimum 14-gauge sheet metal treated and painted the standard manufacturer's color to resist corrosion. Enclosure shall fully enclose and protect the generator set, control panel, batteries, battery charger, and silencer. The enclosure shall be listed as part of the UL2200 testing.

2.3 ACCESSORIES:

A. Automatic Transfer Switch, Open Transition: Provide electrically operated, mechanically held, and electrically and mechanically interlocked, wall-mounted automatic transfer switch, of types and capacities indicated with fully-rated withstand rating, rated to carry 100% of rated current continuously, to automatically start emergency generator unit when line voltage drops to 85 percent normal value, transfer load to generator, and transfer load back to normal source when voltage is restored to 90 percent normal. Provide switch with switched neutral contact (4-pole). Equip transfer switch with limiter which opens starting circuit after 45 seconds when engine fails to start. Also provide time-delay features to prevent excessive transfer and retransfer operation during momentary line voltage dips, load retransfer, and engine shutdown. NPFA 110 8.4 requires the generator to be exercised at least once a month for a minimum of 30 minutes with the switch. Equip switch with time-clock exerciser for automatic exercise of emergency generator unit. Equip switch with test switch for manual simulation of power outages, including unit operation and load transfer. Provide NEMA Type 1 enclosure with door locks. Coat enclosure with manufacturer's standard color, acrylic, enamel finish over a corrosion resistive primer.

1. The ATS control pad shall be provided with the following features:

(a) Utility voltage by phase.
(b) Emergency voltage by phase.
(c) Frequency by phase.

2. Provide a dry contact in each transfer switch that will close when the switch is in the emergency position. The Building Automation System (BAS) contractor will wire these contacts to report emergency status to the BAS.

B. Heaters: Provide engine jacket coolant heater of wattage required and voltage indicated, with thermostatic controls to maintain engine coolant at proper temperature to fulfill start-up requirements of NFPA 99.

C. Remote Annunciator: Provide a flush remote annunciator with visual and audible alarms in accordance with NFPA 110. In addition to required visual alarms, the annunciator shall have a "GENERATOR RUNNING - NOT ON LINE" lamp and "GENERATOR RUNNING - UNDER LOAD" lamp.

D. Fuel Tank: Provide a sub-base mounted, UL listed, double wall fuel tank that is a maximum of 30" high and has a basis of design volumetric capacity of 132 gallons or as required by the approved manufacturer to provide fuel for the generator to operate at 133% of full load for 24 hours, per NFPA 110 5.5.3. Provide flexible fuel supply and return fuel connections to engine and a full-flow fuel filter with replaceable elements. Provide tank level indicator and vandal-resistant fill cap. Also provide low level switch, leak detection switch, a maximum of 2.5 psi emergency relief vents, 2" mushroom vent and 1/2" NIT drain to exterior of tank. The fuel tank shall be factory installed between the rails and shipped as an integral part of the generator package. The fuel tank design shall comply with the local and Commonwealth of Virginia regulations, NFPA, UL 142 and EPA codes and regulations, etc. for above ground installation. The complete sub-base tank shall be treated and painted standard manufacturer's color to resist corrosion and shall be as manufactured by the generator manufacturer to comply with the UL 2200 listing.

E. Provide remote generator emergency stop station as is required by NFPA 110 5.6.5.6. Emergency stop station shall be located within sight of the exterior generator on the wall of a nearby structure. Provide any necessary kendorf structural materials where required. The station shall be installed in a vandal resistant, weatherproof enclosure with breakable glass. Provide a sign above the station that reads, "Generator Emergency Stop".

F. Provide an easily-accessible means of connecting a portable load bank via a full load circuit breaker.

G. Provide generator with capability of communicating warnings and critical alarms to the Building Automation System (BAS).

H. Generator Load Center: Provide a 208Y/120 Volt, 100 Amp MLO, 1-phase, 12-pole, 22 KAIC, with surface mounted NEMA-1 enclosure to be installed within the generator enclosure and provide with the required breakers (qty and size) to power all the generator accessories. Provide conduit and wiring between the generator load center and generator accessories as required by manufacturer wiring diagram installation instructions.

PART 3: EXECUTION

3.1 INSTALLATION OF EMERGENCY GENERATOR:

A. Install emergency generator unit as indicated, in accordance with the equipment manufacturer's written instructions and with recognized industry practices, to ensure that emergency generator unit fulfills requirements. Comply with NFPA and NEMA standards pertaining to installation of emergency generator sets and accessories.

B. Coordinate with other work, including concrete base, raceways, wiring, electrical boxes and fittings, fuel tanks, piping and accessories, as necessary to interface installation of emergency generator equipment work with other work.

C. Install units on vibration isolators and comply with manufacturer's indicated method of installation.

D. Connect fuel oil piping to emergency generator equipment as required, and comply with manufacturer's installation instructions.

E. Provide the initial fill of the fuel tank to its capacity. At Substantial Completion, and after successful completion of all test, the Contractor shall return the fuel tank to its capacity. Supply documentation from a fuel analysis performed prior to start-up, testing the following parameters:

1. Cetane Index
2. Water
3. Water and Sediment
4. ISO Cleanliness
5. API Gravity
6. Distillation
7. Micro-organisms (both bacteria and fungi)

F. Provide equipment identification name plates complying with Division 26 for identification for electrical systems.

G. Provide field marking to warn qualified persons of potential electric arc flash hazards for circuit breakers and transfer switches. The marking shall be located so as to be clearly visible to qualified persons before examination, adjustment, servicing or maintenance of the equipment. Provide arc flash warning label made of high performance polyester, 3-1/2”H X 5”W, Brady Cat. No. 94913 or approved equal.

3.2 GROUNDING:

A. Provide equipment grounding connections for emergency generator units as required by the NEC. See generator grounding schematic on drawings.

3.3 ADJUSTING AND CLEANING:

A. Adjust operating mechanisms for free mechanical movement.

B. Prior to energization:

1. Upon completion of installation, inspect generator and switch.
2. Remove paint splatters and other spots on the generator enclosure and switch enclosure. Repair exposed surfaces to match original finish.
3. Remove all wrenches, packing materials, and construction debris from inside the generator enclosure and switch enclosure.
4. Use vacuum (with non-metallic attachments) to collect loose dust, dirt, and particles from inside and around the exterior of the generator enclosure and switch enclosure.
5. Do not use compressed air to assist in cleaning. Using compressed air is likely to spread contamination and damage insulation.
6. Accumulated dirt, oil, or grease might require a solvent to be removed. Solvents used for cleaning of electrical equipment shall be selected carefully to ensure compatibility with materials being cleaned. Do not use any liquid cleaners, include spray cleaners, unless specified by the generator and switch manufacturers, because of the risk of residues causing damage, interfering with electrical or mechanical functions, or compromising the integrity of the insulation surfaces. Allow sufficient time for drying after cleaning generator with solvents. Wear the required PPE when working with potential hazardous solvents; refer to solvent material data sheets.

3.4 FIELD QUALITY CONTROL:

A. Prior to energization:

1. Prior to energization of generator and switch, check all accessible connections to manufacturer's tightening torque specifications.
2. Prior to energization of generator and switch, check with ground resistance tester phase-to-phase and phase-to-ground insulation resistance levels to ensure requirements are fulfilled.
3. Prior to energization of generator and switch, check for electrical continuity of circuits and for short-circuits.

B. Certification: This Contractor shall certify in writing to the Architect that the above checks were made, including date of the checks and results.

C. Upon completion of installation, energize generator and switch and demonstrate capability and compliance with requirements. Where possible, correct malfunctioning units at project site, then retest to demonstrate compliance, otherwise remove and replace with new units and retest.

3.5 FIELD TESTING:

A. Engage local equipment manufacturer's factory-authorized service representative to perform start-up and building load tests upon completion of installation. Prior to acceptance of the installation, equipment shall be tested to show it is free of any defects; unit shall start automatically and be subjected to a full load test at the job site. Test shall be for a minimum of two hours and shall be witnessed by the Owner's representative. Provide certified test record. Perform tests required by NFPA 110 for both the Generator and the Automatic Transfer Switch, including, but not limited to, the following:

1. Full load test shall be performed by the generator set supplier's service technician utilizing load banks to obtain full rated KW load at 1.0 power factor. Strip chart recordings of both voltage and frequency shall be made continuously during the two-hour test to demonstrate voltage and frequency stability. Measurements of amperage, jacket water temperature, oil pressure, fuel pressure, exhaust temperature, and ambient temperature shall be recorded at fifteen-minute intervals during this test. All data shall be recorded on standard field test forms which shall be signed by the supplier's technician and by the Owner's representative. Certified copies of field test report shall be furnished for the Owner's records.
2. Certification of the full-load test at 0.8 power factor performed at the factory shall be provided.
3. Check fuel, lubricating oil, and antifreeze in liquid-cooled models for conformity to the manufacturer's recommendations under environmental conditions present.
4. Prior to cranking engine, test for proper operation of accessories that normally function while the set is in a standby mode. Accessories include, but are not limited to, engine heaters, battery charger, and remote annunciator.
5. Check, during start-up test mode, for exhaust leaks, path of exhaust gases outside the building, cooling air flow, movement during starting and stopping, vibration during running, normal and emergency line-to-line voltage and phase rotation.
6. Test, by means of simulated power outage and restoration, automatic start-up by remote-automatic starting, transfer of load, and automatic shut-down. Prior to this test adjust, for proper system coordination, transfer switch timers. Monitor throughout the test engine temperature, oil pressure, battery charge level, generator voltage, amperes, and frequency.
7. Test remote emergency stop button for proper operation and provide corrective measures as necessary.

3.6 PERSONNEL TRAINING:

A. Provide services of factory-authorized service representative to train Owner's building personnel in procedures for starting-up, testing and operating emergency generator set and transfer switches for a period of one-half day (4 hours). In addition, train Owner's personnel in periodic maintenance of batteries. Schedule instruction with Owner; provide at least 7-day notice to Architect of training date.

END OF SECTION 263213.13

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SECTION 264313 - SURGE PROTECTIVE DEVICES (SPD)

PART 1: GENERAL

1.1 DESCRIPTION:

A. This section specifies the requirements of surge protection devices (SPD) for low voltage power systems. SPDs intended for Service Entrance equipment installation shall apply to IEEE C62.41, Category C3 waveforms. Extent of surge protective devices work is indicated by drawings and as specified herein.

1.2 RELATED DOCUMENTS:

A. The Drawings and general provisions of the Contract, including the General and Supplementary Conditions, Instructions to Bidders and sections of Division 1, apply to the work specified in this section.

1.3 RELATED WORK SPECIFIED ELSEWHERE:

A. Refer to other Division 26 sections for conductors/cables, electrical raceways, boxes and fittings which are required in conjunction with installation of SPD units.

1.4 REFERENCES AND CODES:

A. Source Limitations: Obtain surge protective devices and accessories through one source from a single manufacturer.

B. Electrical Components, Devices and Accessories: Listed and labeled as defined in NFPA 70, Article 100 by a testing agency acceptable to authorities having jurisdiction and marked for the intended use.

C. Comply with applicable requirements of the 2020 NFPA-70 (NEC), Article 285 pertaining to surge protective devices.

D. Comply with applicable requirements of the 2020 NFPA-780 – Standards for the Installation of Lightning Protection Systems, Section 4.20 pertaining to surge protective devices.

E. NFPA Compliance: Comply with applicable requirements of NFPA 70E, "Standard for Electrical Safety Requirements for Employee Workplaces."

F. Comply with IEEE C62.41, "IEEE Guide for surge voltages in Low Voltage AC Power Circuits," and test devices according to IEEE C62.45, "IEEE Guide on Surge Testing for Equipment Connected to Low-Voltage AC Power Circuits."

G. Comply with UL 1283, "Electromagnetic Interference Filters," and UL 1449 4th Edition, "UL Standard for Surge Protective Devices."

1.5 SUBMITTALS:

A. Product Data: For each type of product indicated, include physical characteristics, rated capacities, peak-surge current ratings per mode and per phase, operating characteristics, MCOV and any furnished specialties and accessories.

B. Product Certificates: Certificate from manufacturer certifying products furnished comply with UL 1283 and UL 1449 listing and classification.

C. Furnish independent certified test reports.

D. Furnish operational and maintenance data.

1.6 SURGE PROTECTIVE DEVICE LOCATIONS:

A. Provide surge protective devices within or at the building service entrance switchgear and switchboards. Also provide surge protective devices within or at secondary switchgear, switchboards and panelboards as indicated on the drawings or schedules.

1.7 MANUFACTURER QUALIFICATIONS:

A. All surge protective devices shall be manufactured by an ISO 9001-2001 certified company normally engaged in the design, development, and manufacture of such equipment. The certified company shall have been engaged in the commercial design and manufacture of SPD units for a minimum of ten (10) years. The manufacturer shall be represented by a firm that is located within 250 miles of the jobsite and has represented the manufacturer of the SPD units for a minimum of five (5) years.

B. The surge protective device manufacturer shall provide unlimited free replacement of the entire SPD for all inoperable SPD units during the warranty period.

1.8 WARRANTY:

A. The manufacturer of the SPD units shall provide a ten year limited warranty from the date of substantial completion against failure when installed in compliance with applicable national/local electrical codes and the manufacturer's installation, operation, and maintenance instructions. The warranty shall cover events that damaged the SPD, when they should not have damaged it. The warranty shall cover all parts, labor, and material to return the unit to serviceable condition. A factory trained local representative located within 250 miles of the jobsite shall provide on-site labor and system testing, if required, during the warranty period. The local representative shall own and operate test equipment capable of determining the

clamping voltages of the systems provided on the project as well as ground measurement test equipment.

PART 2: PRODUCTS

2.1 MANUFACTURERS:

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Square D; Schneider Electric.
2. DITECK Surge Protection
3. General Electric Co.
4. Cutler-Hammer, Inc.; Eaton Corporation.
5. Current Technology, Inc.
6. Liebert Corporation; a division of Emerson.

2.2 SURGE PROTECTIVE DEVICES:

A. Type 2 Surge Protective Device with the following features and accessories:

1. 20kA nominal discharge current.
2. 100kA short circuit current rating (SCCR).
3. AC Sine wave True Tracking Filter with EMI/RFI Filtering.
4. Phase Loss Monitoring with visual status indicators.
5. Thermal protective MOVs.
6. Audible Alarm, Silencing Switch and Form C Dry Contacts.
7. 10 Protection Modes: (3) line-to-line (L-L), (3) line-to-neutral (L-N), (3) line-to-ground (L-G), and neutral-to-ground (N-G).
8. Surge Counter with reset button.
9. Fuses rated at 200-kA interrupting capacity.
10. Nominal Discharge Current and Measured Limiting Voltage Tests.
11. Connection Means: Permanently wired.
12. Integral disconnect where in a switchboard.

B. Type 3 Point-Of-Use Surge Protective Device: Refer to Division 26 for receptacles rated as surge protective devices.

C. Type 4: Provide component surge protective devices and component assemblies for Type 1, Type 2 and Type 3 surge protective devices as required.

D. Required Ratings:

Minimum surge current capacity based on ANSI / IEEE C62.41 location category			
CATEGORY	Application	Per Phase	Per Mode
C	Service Entrance Locations (Switchboards, Switchgear, Main Entrance)	300 kA	150 kA
B	Exterior Locations, Distribution Panelboards, MCCs, Large Mechanical Equipment Panelboards, Panelboards Serving Exterior Equipment	200 kA	100 kA
A	Branch Locations (Panelboards, Busway)	100 kA	50 kA

E. 2020 NFPA 780 Table 4.20.4 Maximum Allowed Voltage Protection Rating (VPR) of Mode of Protection Provided for Different Power Distribution Systems to Which SPD Can Be Connected. The maximum VPR for the device shall not exceed the following:

MODES	208Y/120	480Y/277	600Y/347
L-N; L-G; N-G	700V	1200V	1800V
L-L	1200V	1800V	4000V

F. The listed Maximum Continuous Operating Voltage (MCOV) must be a tested value (minimum 115% of nominal for 480Y/277V, and minimum 125% of nominal for 208Y/120V).

PART 3: EXECUTION

3.1 INSTALLATION:

A. Surge protective device units shall be installed in strict accordance with the manufacturer's recommendations.

B. Electrical Service, Distribution Panels and Panelboards:

1. Provide SPD units at each building service entrance switchgear or switchboards and at other primary or secondary panelboard locations as indicated on the drawings or schedules. When provided, the SPD units shall be located integrally or immediately adjacent to the switchgear, switchboard or panelboard being protected.
2. Where SPD's are indicated on the drawings as being integral to a piece of electrical gear, it shall be the contractor's option to provide an external SPD instead, located as closely as possible to the gear being protected and in a NEMA enclosure appropriate for the installation environment. The contractor shall be fully responsible to ensure that there is sufficient wall space for the external SPD, as the external SPD is his option – change orders will not be approved due to the contractor not coordinating this.
3. SPD units (except those in switchboards) shall be served with a dedicated 3-pole 60-amp circuit breaker in the gear being served and (5) #6 AWG minimum stranded low impedance connection cable to the breaker, unless the manufacturer recommends differently. The conductors serving SPD units shall be twisted together to reduce the

SPD system input impedance, and shall be kept at the minimum length. SPD units shall be installed in strict accordance with the manufacturer's recommended practices and in compliance with NEC requirements. Measured impedance shall not be higher than 5 ohms on the ground for the service entrance SPD device. Where external, close nipple the SPD to the respective gear being protected.

3.2 GROUNDING CONNECTORS:

A. Connectors, splicers, and other fittings used to interconnect ground conductors, bond to equipment or grounding bars, shall be in accordance with NEC and U.L. requirements.

B. All connectors and fittings shall be of the press crimp or compression set screw type.

C. Special treatment to fittings, lugs, or other connectors of dissimilar material shall be applied to prevent electro-galvanic action.

3.3 FINAL INSPECTION:

A. Each SPD installation shall be inspected by a licensed electrician to verify proper installation and operation in accordance with all applicable codes. Any deficiencies shall be corrected by the contractor. Provide written documentation of this inspection as part of the closeout documents/manual.

3.4 PLACING SYSTEM INTO SERVICE:

A. Do not energize or connect service entrance equipment, panelboards, control terminals, or data terminals to their sources until surge protective devices are installed and connected.

END OF SECTION 264313

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SECTION 265000 - LIGHTING – INTERIOR, EXTERIOR AND EMERGENCY

PART 1: GENERAL

1.1 DESCRIPTION:

A. This section specifies the furnishing, installation and connection of the interior, exterior and emergency luminaries, as well as battery-based emergency lighting equipment. Extent of the lighting systems work is indicated by drawings and schedules and as specified herein.

1.2 RELATED DOCUMENTS:

A. The Drawings and general provisions of the Contract, including the General and Supplementary Conditions, Instructions to Bidders and sections of Division 1, apply to the work specified in this section.

1.3 RELATED WORK SPECIFIED ELSEWHERE:

A. Refer to Division 31 for excavation and backfilling work required in connection with luminaires.

B. Refer to Division 3 for concrete work required in connection with luminaires.

C. Refer to other Division 26 sections for transfer devices, contactors, photocells, conductors / cables, raceways, electrical boxes and fittings required in connection with luminaires.

1.4 REFERENCES AND CODES:

A. Codes and Standards:

1. Electrical Code Compliances: Comply with applicable requirements of the 2020 NFPA-70 (NEC) pertaining to installation and construction of lighting fixtures.
2. NEMA Compliance: Comply with applicable requirements of NEMA Stds. Pub. Nos. LE 1 and LE 2 pertaining to lighting equipment, as well as NEMA std. Pub. Nos. 1B, 4, 5 and FA 1 pertaining to emergency lighting.
3. UL Compliance: Comply with UL standards, including Stds. 486A and B, pertaining to lighting fixtures. Provide lighting fixtures and components which are UL-listed and labeled.
4. All drivers shall comply with NEMA 410 for inrush current.

B. Lamp Requirements: All lamps shall meet or exceed the requirements of the National Energy Policy Act where applicable.

C. All drivers shall meet or exceed ANSI end-of-life requirements.

D. In addition to the above requirements, LED fixtures shall comply with the latest applicable editions of the following:

1. UL Standard 8750 “Light Emitting Diode Equipment for Use in Lighting Products”.
2. IES Standard LM-79 “Electrical and Photometric Measurements of Solid-State Lighting Products”.
3. IES Standard LM-80 “Measuring Lumen Maintenance of LED Light Sources”.
4. IES Standard TM-21 “Projecting Long Term Lumen Maintenance of LED Light Sources”.
5. ANSI C78.377 “Specifications for the Chromaticity of Solid State Lighting Products”.
6. NEMA SSL 1 “Electronic Drivers for LED Devices, Arrays or Systems”.
7. ANSI C62.41.2 “Recommended Practice on Characterization of Surges in Low-Voltage (1000V and Less) AC Power Circuits”.

1.5 DELIVERY, STORAGE, AND HANDLING:

A. Deliver lighting fixtures in factory-fabricated containers of wrappings which properly protect fixtures from damage.

B. Store lighting fixtures in original packaging. Store inside well-ventilated area protected from weather, moisture, soiling, extreme temperature and humidity, laid flat and blocked off ground.

C. Handle lighting fixtures carefully to prevent damage, breaking, and scoring of finishes. Do not install damaged units or components; replace with new.

1.6 SUBMITTALS:

A. Product Data: Submit manufacturer's technical product data in booklet form with separate sheet for each light fixture type, assembled in "light fixture type" numerical or alphabetical order matching contract documents, with dimensional data and accessories for proposed light fixtures. The booklet shall also contain manufacturer's technical product data for each light fixture’s driver that will be provided with that light fixture type. Driver’s product data shall be marked-up (highlighted or red-line) to show compliance with Driver requirements below.

B. Maintenance Data: Submit manufacturer's technical product data for each luminaire, pole and accessory, including a copy of the installation instructions for each type of luminaire installed. Include data in maintenance manual in accordance with requirements of Division 1.

C. Extra Materials: For LED fixtures with replaceable LED modules/arrays, furnish one (1) spare of each type of module/array. Furnish one (1) spare driver of each light fixture type used. Label and deliver replacement stock as directed to Owner's storage space.

D. Also submit product and maintenance data for all emergency drivers.

1.7 WARRANTY:

A. All drivers (including emergency) shall have a minimum 5-year manufacturer's warranty.

B. All LED luminaires shall have a limited minimum 5-year manufacturer's warranty for the light engine(s) or array(s) and driver.

C. All other items in this section shall have a minimum 1-year manufacturer's warranty.

1.8 PRODUCT OPTIONS AND SUBSTITUTIONS:

A. Refer to Division 1 for requirements in selecting products and requesting substitutions. ALL requests for substitutions, including value engineering, shall include catalog cuts for each luminaire type.

PART 2: PRODUCTS

2.1 MANUFACTURERS:

A. Luminaires: Manufacturer's names and catalog numbers are indicated on the luminaire schedule on the drawings. Alternate luminaires will only be considered if submitted in accordance with the requirements of the supplementary instructions to bidders. Provide product data and catalog cuts or shop drawings as required above for each proposed alternate luminaire type.

B. Individual Emergency Battery Drivers: Philips Bodine, Lithonia, Iota or approved equal.

2.2 LUMINAIRES:

A. General: Provide luminaires of sizes, types and ratings indicated, complete with but not limited to housings, poles, lamps, lamp holders, reflectors, drivers, starters and wiring. Ship luminaires factory-assembled with parts required for a complete installation. Design luminaires with concealed hinges and catches, with metal parts grounded as a common unit and constructed so as to dampen driver-generated sounds. Provide thermal protection for recessed luminaires. Provide luminaires which are identified as suitable for installation in direct contact with thermal insulation where such installations occur.

B. Wiring: All wiring within luminaires shall have a minimum temperature rating of 90 degrees C and shall be sized in accordance with NEC.

C. Lens: Provide nominal minimum 0.125" thick 7.8 oz./sq.ft. 100 percent virgin acrylic Type 12 pattern, plastic, UV stabilized lens for standard lensed 1'x4', 2'x4' and 2'x2' luminaires, unless noted otherwise.

D. Pendants: All pendant mounting means, whether cable, chain, rod or stem, shall be provided in lengths as required to provide luminaire mounting heights as indicated.

E. Additional requirements for LED luminaires:

1. Color temperature shall be 4000K with minimum CRI of 80, unless indicated otherwise. Confirm LED color temperature with architect prior to ordering light fixtures.
2. LED's shall be binned within a maximum three-step MacAdam Ellipse to ensure color consistency amongst luminaires of the same type.
3. Mercury-free, lead-free, RoHS compliant.
4. Compliant with FCC 47 CFR Part 15 non-consumer RFI/EMI standards.
5. Light output shall be measured using the absolute photometry method following IES LM-79 and LM-80 requirements and guidelines.
6. Luminaires shall maintain at least 70% lumen output (L70) for a minimum of 50,000 hours.
7. Lumen output shall not depreciate more than 20% after 20,000 hours of use.
8. Thermally designed to not exceed the maximum junction temperature of the LED for the ambient temperature of the location in which the luminaire is to be installed. Rated case temperature shall be suitable for operation in the ambient temperatures typically found in the intended installation. Exterior luminaires shall be capable of operating in ambient temperatures of -20 deg. F to 122 deg F (-29 deg. C to 50 deg. C).
9. Luminaires shall operate normally for input voltage fluctuations of plus or minus 10%.
10. Maximum Total Harmonic Distortion (THD) of 20% at full input power and across specified voltage range.
11. All connections to luminaires shall be reverse-polarity protected and provide high voltage protection in the event that connections are reversed or shorted during installation.
12. The failure of one individual LED shall not affect the operation of the remaining LED's in the luminaire.

2.3 DRIVERS:

A. LED Drivers:

1. Unless specifically indicated otherwise, shall be of the 0-10V dimming type down to 10% light level. The performance curves for the 0-10V control and the 0-10V drivers shall both be linear, not logarithmic. Dimming shall occur down to the minimum level with no visible flicker or "popcorn effect". "Popcorn effect" is when the luminaire is on a preset dimmed level, and the LED's go to 100% prior to returning to the preset level when power is returned to the fixture.

2. Shall have rated life of minimum 50,000 hours.
3. Shall have minimum power factor of 0.9 and maximum crest factor of 1.5 at full input power and across specified voltage range.
4. Shall operate normally for input voltage fluctuations of plus or minus 10%.
5. Shall have maximum Total Harmonic Distortion (THD) of 20% at full input power and across specified voltage range.
6. Shall have polarized quick-disconnects for wiring connections for field maintenance.
7. Shall have built-in fuse protection, with all power supply outputs either fuse protected or Polymeric Positive Temperature Coefficient (PTC)-protected per Class 2 UL Listing.
8. Shall demonstrate no visible change in light output with a variation of plus or minus 10% change in line-voltage input.
9. All dimmable LED drivers of the same manufacturer family/series shall track evenly across multiple light fixtures at all light levels.
    a. Example: Say light fixture Type A is a 2'x4' light fixture with a dimmable driver that is used throughout an office building in multiple rooms. The Type A light fixture shall be provided from the approved manufacturer with the exact same dimmable LED driver in all the Type A light fixtures shipped/installed in the building. These drivers shall all be alike, so the low end and high end of the dimming ranges are all identical. These drivers shall all be alike, so the dimming curves dim at the same levels through the dimming range. Where any dimmable drivers are provided/shipped from the manufacturer that do not meet this requirement then the manufacturer shall replace the dimmable drivers (material and labor) at no cost to the owner.

B. Other Dimmer Controls: Refer to Division 26 for Lighting Control Devices specification sections for dimming systems associated with local dimmer controlled luminaires.

C. Voltages: Drivers shall be coordinated with circuit voltages as indicated on drawings. Some luminaire types may be connected on multiple voltages when utilized in different areas of the project.

D. Reference the associated lighting control specification section for specialized drivers, such as addressable dimming drivers, required for a lighting control system where indicated on the drawings.

2.4 INDIVIDUAL EMERGENCY BATTERY INVERTER UNITS:

A. Emergency lighting shall be provided by using a standard luminaire equipped with a UL listed, self-contained, modular, battery inverter unit complying with UL 924. The unit shall be mounted within the lighting fixture body or listed for installation on top of or remote from the fixture. The battery inverter unit shall consist of a high-temperature, maintenance-free, nickel cadmium battery, charger and electronic circuitry. The AC driver operation shall be delayed for approximately 3 seconds by the circuitry to prevent false tripping of AC driver. A solid-state charging LED indicator light to monitor the charger and battery and a single-pole test switch shall be provided and mounted such that the light and switch are visible and accessible within the fixture without entering the ceiling space. Where units are

mounted outside the building envelope, provide cold-weather rated units. Provide battery inverter unit with self-testing and self-diagnostic electronic circuitry. The electronic circuitry shall be self-testing and shall automatically test the associated emergency lighting fixture for a minimum of 30 seconds every 30 days and 90 minutes once a year. Test failure shall be annunciated by an integral audible alarm and flashing LED indicator light.

B. Emergency LED drivers shall have lumen outputs as indicated in the lighting fixture schedule for a minimum of 90 minutes.

2.5 FIRE PROTECTIVE ENCLOSURES:

A. Fire Protective Enclosures: Enclosures shall be fire rated light covers, U.L. listed, preformed, flexible, intumescent, 2'x2' or 2'x4' troffer shaped or dome shaped. Provide one-hour or two-hour rating as required by the ceiling rating. Provide products by Tenmat Inc. or equal.

PART 3: EXECUTION

3.1 INSPECTION:

A. Verify ceiling construction in all areas prior to ordering luminaires to determine if luminaire type called for is correct to fit ceiling encountered. Notify Architect if any discrepancies are found.

3.2 INSTALLATION OF LUMINAIRES:

A. Coordinate the location of luminaires with other installations (i.e. diffusers, registers, grilles, speakers, sprinklers, finish ceiling height, structural components, fire rating, etc.) located in the same space.

B. Locate ceiling-mounted luminaires where indicated on reflected ceiling plans.

C. Luminaires in mechanical and electrical rooms are shown for quantity and approximate location only. Coordinate final location with other work in the space to clear piping, ducts, valves and equipment. Some units may be required to be wall-mounted.

D. Support all ceiling mounted luminaires that match the size of the layout of the ceiling grid from the building structural framing members or the ceiling framing system utilizing conduit stems, fixture studs, support clips, steel rods or bar hangers. If the ceiling framing system is used for support, install a minimum of two ceiling support system rods or wires for each luminaire (on diagonally opposite corners of the fixture). Locate not more than 6 inches from fixture corners.

E. Fixtures of Sizes Less than Ceiling Grid: Install as indicated on reflected ceiling plans or center in acoustical panel, and support fixtures independently with at least two 3/4-inch metal channels spanning and secured to ceiling tees.

F. Fasten luminaires securely to structural supports, and ensure that pendant luminaires are plumb, level and square with ceiling and walls unless indicated otherwise. Provide individually mounted pendant luminaires longer than 24" with twin stem hangers, unless noted otherwise; provide stem hanger with ball aligners and provisions for minimum 1" vertical adjustment. Mount continuous rows of luminaires with one additional stem hanger more than the quantity of luminaires in the row.

G. Fasten recessed luminaires mounted in lay-in ceilings to the adjacent T-bars by approved fasteners or clips that are UL listed for the application.

H. Submit design of hangers for review by Architect if method of fastening is other than indicated or specified herein.

I. Install recessed luminaires in plaster ceiling areas in rolled metal plaster frames.

J. Where luminaires are provided with integral emergency power supplies, connect the battery charger on the indicated branch circuit on the line side of the local switch so that the battery/inverter circuit will remain energized when the lighting luminaire is extinguished.

K. Support surface mounted luminaires greater than 24" in length at a point in addition to the outlet box fixture stud.

L. Apply sealant around all exterior mounted light fixtures to provide weatherproofing and pest control; refer to Division 7 for joint sealants.

M. Fire Protective Enclosures: Provide fire protective enclosures for all luminaires which penetrate a fire rated membrane. Install enclosure in accordance with manufacturer's instructions and U.L. listing requirements. If the luminaire maintains the fire rating, then the additional fire protective enclosure is not required.

3.3 ADJUSTING AND CLEANING:

A. Clean luminaires of dirt, fingerprints, paint, dust and other debris upon completion of installation. Protect installed luminaires from damage during remainder of construction period.

3.4 FIELD QUALITY CONTROL:

A. At Date of Substantial Completion, for LED fixtures with built-in LED boards, replace boards or fixtures in which at least 5% of the individual LED's will not illuminate.

B. Refer to sections of Division 1 for the replacement/restoration of lamps in interior luminaires, where used for temporary lighting prior to Date of Substantial Completion.

END OF SECTION 265000

SECTION 271013 - INFRASTRUCTURE FOR BUILDING TELECOMMUNICATIONS CABLING SYSTEM

PART 1: GENERAL

1.1 DESCRIPTION:

A. This section specifies the furnishing and installation of an empty conduit system for the building telecommunications cabling system. The building telecommunications system includes, but is not limited to, telephone, cable television and data (computer) systems.

B. The work of this section includes, but is not limited to, providing the main conduits from the service entrance point to the distribution rooms within the building, branch conduits, outlet boxes, equipment panels and pull cords/strings.

C. Unless otherwise noted, the Owner will contract directly with local installers for module frames, module jacks, faceplates, terminations, cables, and all head-end equipment including but not limited to racks, switches, routers, splitters, amplifiers, modulators, etc. required for a complete and operating telecommunications system.

1.2 RELATED DOCUMENTS:

A. The Drawings and general provisions of the Contract, including the General and Supplementary Conditions, Instructions to Bidders and Division 1 and Division 26 specification sections, apply to the work specified in this section.

1.3 RELATED WORK SPECIFIED ELSEWHERE:

A. Refer to Division 26 sections for work including, but not limited to, electrical raceways, electrical boxes and fittings, electrical wiring devices, wallplates and cabinets required in conjunction with installation of the infrastructure for the telecommunications systems.

1.4 REFERENCES AND CODES:

A. 2020 NFPA-70--National Electrical Code

B. ANSI/IEEE C-2--National Electrical Safety Code

C. OSHA Standards and Regulations

D. Pertinent Local Codes and Standards

1.5 COORDINATION:

A. Coordinate work of this section with requirements of the local telephone, data and/or cable television service providers.

PART 2: PRODUCTS

2.1 SYSTEM MATERIALS:

A. Provide wall outlets of standard 4-11/16" square (double-gang) by 2-1/8" deep outlet boxes, unless indicated otherwise on drawings, with 4” square by 3/4” mud ring or tile wall cover as applicable for single gang device. Face of mud ring or tile wall cover shall be flush with finished wall surface.

B. Provide blank single gang wall plates of color and type of material to match adjacent wiring devices. The Owner will contract directly with a local contractor to remove blank fillers/plates as required and install desired telephone, television and/or data jacks, faceplates, equipment, connectors and cables.

C. Provide equipment panels of 3/4" thick, FRT AC grade fire-retardant plywood of 4' x 8' size unless indicated otherwise on drawings. Paint with two coats of medium gray paint.

PART 3: EXECUTION

3.1 INSTALLATION:

A. General:

1. Follow all raceway requirements specified in Division 26.
2. Label pull cords with outlet served.
3. Apply sealant around all exterior mounted telecom outlets to provide weatherproofing and pest control; refer to Division 7 for joint sealants.
4. Provide all conduit raceway runs of size and quantity as indicated on drawings and as specified below. Provide empty conduit raceways with nylon pull cord. The minimum size of any conduit not indicated shall be 1”. All bends shall be long radius ells. ENT conduit may be used where concealed inside walls and above ceilings as specified in Division 26 and where permitted by codes.
5. Outlet locations indicated are for estimating purposes only. Coordinate final location with other installations and refer all conflicts to the Architect for resolution.

B. Telecom Outlets:

1. Install one 1” conduit from each telecom outlet to the area above the accessible ceiling of room in which the outlet is located, or to the area above the nearest accessible corridor ceiling. Terminate conduits with bushing. If an accessible ceiling is not available, extend the conduits to the nearest telecommunication panel serving the respective floor. At

equipment panels, terminate conduits with bushings at 0'-8" or 5'-10" above finished floors.

2. Where specifically noted to be “hard-piped” to an IT room, no more than 270 degrees of bends are allowed between pull boxes.

C. Wireless Access Points:

1. Install one 1” conduit from each wireless access point to the area above the accessible ceiling of room in which the wireless access point is located, or to the area above the nearest accessible corridor ceiling. Terminate conduits with bushing. If an accessible ceiling is not available, extend the conduits to the nearest telecommunication panel serving the respective floor. At equipment panels, terminate conduits with bushings at 0'-8" or 5'-10" above finished floors.
2. Where specifically noted to be “hard-piped” to an IT room, no more than 270 degrees of bends are allowed between pull boxes.

D. CCTV Security Cameras:

1. Install one 1” conduit from each security camera to the area above the accessible ceiling of room in which the security camera is located, or to the area above the nearest accessible corridor ceiling. Terminate conduits with bushing. If an accessible ceiling is not available, extend the conduits to the nearest telecommunication panel serving the respective floor. At equipment panels, terminate conduits with bushings at 0'-8" or 5'-10" above finished floors.
2. Where the security camera is mounted to the exterior of the building, install one 1” conduit through the exterior wall to the area above the nearest accessible corridor ceiling, sealing the penetration weather tight.
3. Where specifically noted to be “hard-piped” to an IT room, no more than 270 degrees of bends are allowed between pull boxes.

E. Feeder and Service:

1. Install empty service and feeder raceways as indicated on drawings. At equipment panels, terminate service and feeder raceways with bushings at 0'-8" and 7-10" above finished floors.
2. Securely mount equipment panels to wall, level and plumb. Mount plywood equipment panels at 6’-6” AFF to top and mount data/communication cabinets at 6’-0” AFF to top, unless noted otherwise.

END OF SECTION 271013

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SECTION 312000 - EARTHWORK

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. The provisions of the Contract Documents apply to the work of this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Excavation, filling, backfilling, and grading indicated and necessary for proper completion of the work.

2. Preparing of subgrade for walks and pavements.

3. Excavating and backfilling of trenches.

1.3 UNIT PRICES.

A. Work of this Section is affected by unit prices for earth moving specified in Section 012200 "Unit Prices."

B. Rock Measurement: Volume of rock actually removed, measured in original position, but not to exceed the following. Unit prices for rock excavation include replacement with approved materials.

1. 24 inches outside of concrete forms

2. 6 inches outside of minimum required dimensions of concrete cast against grade.

3. 6 inches beneath pipe in trenches, and the greater of 24 inches wider than pipe or 42 inches wide.

1.4 SUBMITTALS

A. VDOT approved Job Mixes for stone.

B. Borrow Soil (if required): Submit location of borrow pit and a sample of the soil for approval to the Owner’s Geotechnical Engineer a minimum of fourteen (14) working days prior to use.

C. Geotextile Fabric.

1.5 DEFINITIONS

A. Backfill: Soil material or controlled low-strength material used to fill an excavation.

1. Initial Backfill: Backfill placed beside and over pipe in a trench, including haunches to support sides of pipe.

2. Final Backfill: Backfill placed over initial backfill to fill a trench.

B. Base Course: Aggregate layer placed between the subbase course and hot-mix asphalt paving.

C. Bedding Course: Aggregate layer placed over the excavated subgrade in a trench before laying pipe.

D. Borrow Soil: Satisfactory soil imported from off-site for use as fill or backfill.

E. Excavation: Removal of material encountered above subgrade elevations and to lines and dimensions indicated.

1. Authorized Additional Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions as directed by the Owner's Geotechnical Engineer and the Engineer. Authorized additional excavation and replacement material will be paid for according to Contract provisions for changes in the Work.

2. Unauthorized Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions without direction by the Owner's Geotechnical Engineer. Unauthorized excavation, as well as remedial work directed by Architect, shall be without additional compensation.

F. Fill: Soil materials used to raise existing grades.

G. Rock: Rock material in beds, ledges, unstratified masses, conglomerate deposits, and boulders of rock material that exceed 1 cu. yd. for bulk excavation or 3/4 cu. yd. for footing, trench, and pit excavation that cannot be removed by rock-excavating equipment equivalent to the following in size and performance ratings, without systematic drilling, ram hammering, or ripping:

1. Equipment for Trench, and Pit Excavation: Late-model, track-mounted hydraulic excavator; equipped with a 42-inch-maximum-width, short-tip-radius rock bucket; rated at not less than 138-hp flywheel power with bucket-curling force of not less than 28,700 lbf and stick-crowd force of not less than 18,400 lbf with extra-long reach boom.

2. Equipment for Bulk Excavation: Late-model, track-mounted loader; rated at not less than 230-hp flywheel power and developing a minimum of 47,992-lbf breakout force with a general-purpose bare bucket.

H. Structural Landscape Soil: Soil to be used under walks in the immediate vicinity of tree roots.

I. Subbase Course: Aggregate layer placed between the subgrade and base course for hot-mix asphalt pavement, or aggregate layer placed between the subgrade and a cement concrete pavement or a cement concrete or hot-mix asphalt walk.

J. Subgrade: Uppermost surface of an excavation or the top surface of a fill or backfill immediately below subbase, drainage fill, drainage course, or topsoil materials.

K. Utilities: On-site underground pipes, conduits, ducts, and cables as well as underground services within buildings.

1.6 EARTHWORK BALANCE ADJUSTMENTS

A. No adjustments of grades are allowed.

B. Importation of any required material shall be a Contract responsibility. No additional payment will be made for the importation of this material.

C. Excavation and disposal of any required material off-site in a legal manner shall be a Contract responsibility. No additional payment will be made for the export and disposal of this material.

1.7 QUALITY ASSURANCE

A. Codes and Standards: Perform excavation work in compliance with applicable requirements of authorities having jurisdiction.

B. Environmental Compliance:

1. Comply with the requirements of the latest edition of the Virginia Stormwater Management Handbook Chapter 7.

C. Testing and Inspection Service: Owner will employ and pay for an independent Geotechnical testing and inspection laboratory to perform soil testing and inspection service during earthwork operations. Cooperate with Owner's Geotechnical Engineer as required for testing and inspection of work. These services do not relieve the responsibility for compliance with Contract Document requirements.

1.8 PROJECT CONDITIONS

A. Existing Utilities: Do not interrupt existing utilities serving occupied facilities except when permitted under the following conditions and then only after arranging to provide acceptable temporary utility services.

1.9 SAFETY

A. Protection of Persons and Property: Barricade open excavations occurring as part of this work and post with warning lights.

1. Operate warning lights as recommended by authorities having jurisdiction and governing regulations and standards.

2. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earthwork operations.

B. Work within the road right-of-way shall meet all requirements of the latest edition of the Virginia Department of Transportation Work Area Protection Manual.

PART 2 - PRODUCTS

2.1 SOIL MATERIALS

A. General: Provide borrow soil materials when sufficient satisfactory soil materials are not available from excavations.

B. Satisfactory Soils: Soil Classification Groups GW, GP, GM, SW, SP, and SM according to ASTM D2487 or a combination of these groups; free of rock or gravel larger than 3 inches (75 mm) in any dimension, debris, waste, frozen materials, vegetation, and other deleterious matter.

C. Unsatisfactory Soils: Soil Classification Groups GC, SC, CL, ML, OL, CH, MH, OH, and PT according to ASTM D2487, or a combination of these groups.

1. Unsatisfactory soils also include satisfactory soils not maintained within 2 percent of optimum moisture content at time of compaction.

D. Subbase Material: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D2940/D2940M; with at least 90 percent passing a 1-1/2-inch (37.5-mm) sieve and not more than 12 percent passing a No. 200 (0.075-mm) sieve.

E. Base Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D2940/D2940M; with at least 95 percent passing a 1-1/2-inch (37.5-mm) sieve and not more than 8 percent passing a No. 200 (0.075-mm) sieve.

F. Engineered Fill: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D2940/D2940M; with at least 90 percent passing a 1-1/2-inch (37.5-mm) sieve and not more than 12 percent passing a No. 200 (0.075-mm) sieve.

G. Bedding Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D2940/D2940M; except with 100 percent passing a 1-inch (25-mm) sieve and not more than 8 percent passing a No. 200 (0.075-mm) sieve.

H. Drainage Course: Narrowly graded mixture of crushed stone, or crushed or uncrushed gravel; ASTM D448; coarse-aggregate grading Size 57; with 100 percent passing a 1-1/2-inch (37.5-mm) sieve and zero to 5 percent passing a No. 8 (2.36-mm) sieve.

2.2 GEOTEXTILES

A. Subsurface Drainage Geotextile: Nonwoven needle-punched geotextile, manufactured for subsurface drainage applications, made from polyolefins or polyesters; with elongation greater than 50 percent; complying with AASHTO M 288 and the following, measured per test methods referenced:

1. Survivability: Class 2; AASHTO M 288.

2. Apparent Opening Size: No. 60 sieve, maximum; ASTM D4751.

3. Permittivity: 0.2 per second, minimum; ASTM D4491.

4. UV Stability: 50 percent after 500 hours' exposure; ASTM D4355.

B. Separation Geotextile: Woven geotextile fabric, manufactured for separation applications, made from polyolefins or polyesters; with elongation less than 50 percent; complying with AASHTO M 288 and the following, measured per test methods referenced:

1. Survivability: Class 2; AASHTO M 288.

2. Apparent Opening Size: No. 60 sieve, maximum; ASTM D4751.

3. Permittivity: 0.02 per second, minimum; ASTM D4491.

4. UV Stability: 50 percent after 500 hours' exposure; ASTM D4355.

2.3 CONTROLLED LOW-STRENGTH MATERIAL

A. Controlled Low-Strength Material: Self-compacting, flowable concrete material produced from the following:

1. Portland Cement: ASTM C150, Type I.

2. Fly Ash: ASTM C618, Class C or F.

3. Normal-Weight Aggregate: ASTM C33, 3/4-inch nominal maximum aggregate size.

PART 3 – EXECUTION

3.1 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earthwork operations.

B. Preparation of subgrade for earthwork operations including removal of vegetation, topsoil, debris, obstructions, and deleterious materials from ground surface is specified in Section 311000 "Site Clearing."

C. Protect and maintain erosion and sedimentation controls during earthwork operations.

3.2 DEWATERING

A. Prevent surface water and subsurface or groundwater from flowing into excavations and from flooding project site and surrounding area.

1. Do not allow water to accumulate in excavations. Remove water to prevent softening of foundation bottoms, undercutting footings, and soil changes detrimental to stability of subgrade and foundations. Provide and maintain pumps, well points, sumps, suction and discharge lines, and other dewatering system components necessary to convey water away from excavations.

2. Establish and maintain temporary drainage ditches and other diversions outside excavation limits to convey rainwater and water removed from excavations to collecting or runoff areas. Do not use utility trench excavations as temporary drainage ditches.

B. Should any springs or running water be encountered in the excavation, notify the Engineer/Site Inspector and provide discharge by trenches (or other acceptable means) and drain to an appropriate point of disposal. Provide temporary drainage facilities to minimize the flow of rainwater onto adjacent property. Repair any damage to property or to subgrade as a result of construction and/or dewatering (or lack thereof) operations at no additional cost to the Contract. If permanent provision must be made for disposal of water other than as indicated, the Contract price shall be adjusted.

3.3 EXPLOSIVES

A. Blasting is not permitted.

3.4 EXCAVATION

A. Excavation consists of removal, placement and disposal of material encountered when establishing required subgrade or finish grade elevations.

1. Excavation includes removal and disposal of pavements and other obstructions visible on ground surface; underground structures, utilities and other items indicated to be demolished and removed; together with earth and other materials encountered that are not classified as rock or unauthorized excavation.

B. Classified Excavation: Excavate to subgrade elevations. Material to be excavated will be classified as earth and rock. Do not excavate rock until it has been classified and cross sectioned by the Owner's Geotechnical Engineer. The Contract Sum will be adjusted for rock excavation according to unit prices included in the Contract Documents. Changes in the Contract Time may be authorized for rock excavation.

1. Earth excavation includes excavating pavements and obstructions visible on surface; underground structures, utilities, and other items indicated to be removed; and soil, boulders, and other materials not classified as rock or unauthorized excavation.

    a. Intermittent drilling, ram hammering, or ripping of material not classified as rock excavation is earth excavation.

2. Rock excavation includes removal and disposal of rock. Remove rock to lines and subgrade elevations indicated to permit installation of permanent construction without exceeding the following dimensions:

    a. 24 inches outside of concrete forms
    b. 6 inches outside of minimum required dimensions of concrete cast against grade.
    c. 6 inches beneath pipe in trenches, and the greater of 24 inches wider than pipe or 42 inches wide.

3.5 EXCAVATION FOR WALKS AND PAVEMENTS

A. Cut surface under pavements to comply with cross-sections, elevations and grades as indicated.

3.6 EXCAVATION FOR UTILITY TRENCHES

A. Excavate trenches to uniform width, sufficiently wide to provide ample working room and a minimum of 12 inches of clearance on both sides of pipe or conduit.

B. Trench Bottoms: Excavate to depth indicated or required to establish indicated slope and invert elevations and allow for the appropriating bedding. Excavate and shape trench bottoms to provide uniform bearing and support of pipes and conduit. Shape subgrade to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits. Remove projecting stones and sharp objects along trench subgrade. Refer to plan details for additional information.

3.7 EXCAVATION STABILITY

A. General: Comply with local codes, ordinances, and requirements of agencies having jurisdiction.

B. Slope sides of excavations to comply with local codes, ordinances, and requirements of agencies having jurisdiction. Shore and brace where sloping is not possible because of space restrictions or stability of material excavated. Maintain sides and slopes of excavations in safe condition until completion of backfilling.

C. Shoring and Bracing: Provide materials for shoring and bracing, such as sheet piling, uprights, stringers, and cross braces, in good serviceable condition. Maintain shoring and bracing in excavations regardless of time period excavations will be open. Extend shoring and bracing as excavation progresses.

3.8 SUBGRADE INSPECTION

A. Proof-roll subgrade below the pavement with heavy pneumatic-tired equipment to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades.

1. Completely proof-roll subgrade in one direction, repeating proof-rolling in direction perpendicular to first direction. Limit vehicle speed to 3 mph.

2. Proof-roll with a loaded 10-wheel, tandem-axle dump truck weighing not less than 15 tons.

3. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by the Owner's Geotechnical Engineer, and replace with compacted backfill or fill as directed.

B. Reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities, as directed by Owner's Geotechnical Engineer, without additional compensation.

3.9 UNAUTHORIZED EXCAVATION

A. Correct Unauthorized Excavation as follows:

1. Backfill and compact unauthorized excavations as indicated for authorized excavations of same classification unless otherwise directed.

3.10 STORAGE OF EXCAVATED MATERIALS

A. Temporarily stockpile excavated materials acceptable for use as backfill and fill. Place, grade, and shape stockpiles for proper drainage. Cover to prevent windblown dust.

1. Stockpile excavated materials away from edge of excavations. Do not store within the drip line of trees to remain.

3.11 UTILITY TRENCH BACKFILL

A. Place backfill on subgrades free of mud, frost, snow, or ice.

B. All material specifications and dimensions for bedding and backfill shall be in accordance with:

1. Sanitary Sewer: VDOT specifications and Martinsville Public Works

C. Place and compact bedding course on trench bottoms and where indicated. Shape bedding course to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits.

D. Place and compact initial backfill over the utility pipe or conduit.

1. Carefully compact initial backfill under pipe haunches and compact evenly up on both sides and along the full length of utility piping or conduit to avoid damage or displacement of piping or conduit. Coordinate backfilling with utilities testing.

E. Place and compact final backfill over initial backfill to final subgrade elevation. The final backfill material shall generally be classified as suitable fill in grass areas and VDOT 21A stone in pavement areas.

F. Backfill voids with satisfactory soil while installing and removing shoring and bracing.

G. Under piping and conduit and equipment, use crushed stone where required over rock bearing surface and for correction of unauthorized excavation. Shape excavation bottom to fit bottom 90 degrees of cylinder.

H. Place backfill and fill materials evenly adjacent to structures, piping, or conduit to required elevations. Prevent wedging action of backfill against structures or displacement of piping or conduit by carrying material uniformly around structure, piping, or conduit to approximately same elevation in each lift.

3.12 SOIL MOISTURE CONTROL

A. Uniformly moisten or aerate subgrade and each subsequent fill or backfill soil layer before compaction to within 3 percentage points of optimum moisture content.

1. Do not place backfill or fill soil material on surfaces that are muddy, frozen, or contain frost or ice.

2. Remove and replace or scarify and air dry otherwise satisfactory soil material that exceeds optimum moisture content by 3 percentage points and is too wet to compact to specified dry unit weight.

B. Moisture Control: Where subgrade or layer of soil material must be moisture conditioned before compaction, uniformly apply water to surface of subgrade or layer of soil material. Apply water in minimum quantity as necessary to prevent free water from appearing on surface during or subsequent to compaction operations. Maintain the moisture content of the structural fill materials to within 3 percentage points of the optimum moisture content until permanently covered.

C. Remove and replace, or scarify and air dry, otherwise satisfactory soil material that exceed optimum moisture content by 2 percent and is too wet to compact to specified dry unit weight.

3.13 COMPACTION OF SOIL BACKFILL AND FILLS

A. Place backfill and fill materials in layers not more than 8 inches in loose depth for material compacted by heavy compaction equipment, and not more than 4 inches in loose depth for material compacted by hand-operated tampers.

B. Before compaction, moisten or aerate each layer as necessary to provide optimum moisture content. Compact each layer to required percentage of maximum dry density or relative dry

density for each area classification. Do not place backfill or fill material on surfaces that are muddy, frozen, or contain frost or ice.

C. Control soil and fill compaction, providing minimum percentage of density indicated for each area classification indicated below. Correct improperly compacted areas if soil density tests indicate inadequate compaction.

D. Percentage of Maximum Density Requirements: Compact soil to not less than the following percentages of maximum density at a moisture content within 3 percentage points of optimum in accordance with ASTM D698:

1. Under pavements and sidewalks, compact each layer of backfill or fill material at 95 percent maximum density.

2. Under grass or unpaved areas, compact each layer of backfill or fill material at 90 percent maximum density.

E. Seal all fill areas at the end of each working day, utilizing a smooth drum roller.

3.14 GRADING

A. General: Rough grading of areas within the Project, including cut and fill sections and adjacent transition areas, shall be reasonably smooth, compacted and free from irregular surface changes. The degree of finish shall be that ordinarily obtainable from either blade-grader or motor patrol except as otherwise indicated. The finished subgrade surface from the grassed areas generally shall be not more than 0.2 feet above or below the final grade or approved cross section, with due allowance for topsoil.

B. The tolerance for areas within 10 feet of walks and all areas to be paved shall not exceed 0.10 feet above or below the established subgrade. Finish all ditches, swales and gutters to drain readily. Unless otherwise indicated, evenly slope the subgrade to provide drainage away from buildings in all directions at a grade not less than ¼ inch per foot. Provide rounding at top and bottom of cut and fill slopes and at other breaks in grade.

C. Protection of Graded Areas: Protect newly graded areas and areas of cut, fill and design/subgrade elevations from the actions of the elements and from deterioration as a result of construction operations and weather conditions (frost, rains, snow, sleet, hail, etc.). Repair any settlement or washing that occurs prior to or after acceptance of the work. Fill to required subgrade levels any areas where settlement occurs. Protect trees to remain, and, at all areas of the Site where construction operations are in progress, provide protection for the safety of occupants of the existing facilities.

D. General: Uniformly grade areas to a smooth surface, free of irregular surface changes. Comply with compaction requirements and grade to cross sections, lines, and elevations indicated.

1. Provide a smooth transition between adjacent existing grades and new grades.

2. Cut out soft spots, fill low spots, and trim high spots to comply with required surface tolerances.

E. Site Grading: Slope grades to direct water away from buildings and to prevent ponding. Finish subgrades to required elevations within the following tolerances:

1. Lawn or Unpaved Areas: Plus or minus 1 inch.

2. Walks: Plus or minus 1/2 inch; but never outside ADA guidelines.

3. Pavements: Plus or minus 1/2 inch; but never outside ADA guidelines.

3.15 PAVEMENT SUBBASE COURSE:

A. General: Place subbase material, in layers of indicated thickness, over subgrade surface to support a pavement base course.

B. Grade Control: During construction, maintain lines and grades including crown and cross-slope of subbase course.

C. Shoulders: Place shoulders along edges of subbase course to prevent lateral movement. Construct shoulders of acceptable soil materials placed in such quantity to compact to thickness of each subbase course layer. Compact and roll at least at 12” width of shoulder simultaneously with compacting and rolling each layer of subbase course.

D. Placing: Place subbase course material on prepared subgrade in layers of uniform thickness, conforming to indicated cross-section and thickness. Maintain optimum moisture content for compacting subbase material during placement operations.

E. When a compacted subbase course is 6” thick or less, place material in a single layer. When more than 6” thick, place material in equal layers, except no single layer more than 6” or less than 3” in thickness when compacted.

F. Place subbase and base course on subgrades free of mud, frost, snow, or ice.

G. On prepared subgrade, place subbase and base course under pavements and walks as follows:

1. Place base course material over subbase course under hot-mix asphalt pavement.

2. Shape subbase and base course to required crown elevations and cross-slope grades.

3. Place subbase and base course 6 inches or less in compacted thickness in a single layer.

4. Place subbase and base course that exceeds 6 inches in compacted thickness in layers of equal thickness, with no compacted layer more than 6 inches thick or less than 3 inches thick.

5. Compact subbase and base course at optimum moisture content to required grades, lines, cross sections, and thickness to not less than 95 percent of maximum dry unit weight according to ASTM D 698.

3.16 FIELD QUALITY CONTROL

A. Quality Control Testing During Construction: Allow the Owner's inspector to inspect and approve each subgrade and fill layer before further backfill or construction work is performed.

B. The Owner will engage, and pay for, the services of a Geotechnical Engineer whose function shall be to afford complete engineering control by testing of the conditions of all footing subgrades, the placement of all structural fills under structures, building pad and pavement areas, and all compaction where required, and to observe the proof rolling of the building pad and pavement areas.

C. The Owner's Geotechnical Engineer will be present as deemed necessary during all phases of the Work requiring filling, compaction operations or testing. The Geotechnical Engineer will provide the Engineer with written certification that fill and compaction was completed with accepted materials in accordance with the Documents, and give a professional opinion regarding shrinkage or settlement of fill and safe load bearing capacity of fill.

D. Site Preparation and Proofrolling: The Owner's Geotechnical Engineer will determine if any additional excavation or in-place densification is necessary to prepare a subgrade for fill placement for slab or pavement support.

E. Fill Placement and Compaction: The Owner's Geotechnical Engineer will witness all fill operations and take sufficient in-place density tests to verify that the indicated degree of fill compaction is achieved. The Owner's Geotechnical Engineer will observe and approve borrow materials used and shall determine if their existing moisture contents are suitable/acceptable.

F. The Owner's Geotechnical Engineer will submit copies each of his reports, recommendations and/or opinions to the Engineer and the Owner. Pertinent information will be provided to the Contractor as required.

3.17 PROTECTION

A. Repair and reestablish grades in settled, eroded, and rutted areas to indicated tolerances.

B. Reconditioning Compacted Areas: Where subsequent construction operations or adverse weather disturbs completed compacted areas, scarify surface, reshape, and compact to required density prior to further construction.

C. Settling: Where settling is measurable or observable at excavated areas during general project warranty period, remove surface (pavement, lawn, or other finish), add backfill material, compact, and replace surface treatment. Restore appearance, quality, and condition of surface or finish to match adjacent work and eliminate evidence of restoration to greatest extent possible.

D. Protect excavation bottoms against freezing when atmospheric temperature is less than 35 degrees F.

3.18 DISPOSAL OF WASTE MATERIALS

A. Removal from Owner's Property: Remove excess and/or waste materials, including trash and debris, and dispose of it off Owner's property in a legal manner.

B. Dispose of excess material and materials not acceptable for use as backfill or fill legally offsite.

C. Do not remove topsoil from site until it has been demonstrated to the Owner’s satisfaction that it is excess.

END OF SECTION 312000

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SECTION 321216 - ASPHALT PAVEMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. The provisions of the Contract Documents apply to the work of this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Hot-mix asphalt paving over prepared subbase.
2. Hot-mix asphalt patching.
3. Hot-mix asphalt overlays.
4. Asphalt surface treatments.

1.3 SUBMITTALS

A. Job-Mix Designs: VDOT certifications for each job mix proposed for the Work.

B. Material Certification: Certification signed by Contractor certifying that each material complies with requirements.

C. Traffic maintenance and Work Area Protection Plan: Submit a plan indicating sequencing and measures to be used for the maintenance and protection of traffic during operations within or immediately adjacent to existing roadways open to vehicular traffic.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Engage an experienced installer who has completed hot-mix asphalt paving similar in material, design, and extent to that indicated for this Project and with a record of successful in-service performance.

B. Asphalt paving materials and installation shall conform to the requirements of the latest edition of the Virginia Department of Transportation (VDOT) Road and Bridge Specifications and Road and Bridge Standards.

1.5 PROJECT CONDITIONS

A. Environmental Limitations: Do not apply asphalt materials if substrate is wet or excessively damp or if the following conditions are not met:

1. Prime and Tack Coats: Minimum ambient temperature of 50 deg F, and when temperature has not been below 35 deg F for 12 hours immediately prior to application.

2. Asphalt Base Course: Minimum surface temperature of 40 deg F and rising at time of placement.

3. Asphalt Surface Course: Minimum surface temperature of 40 deg F and rising at time of placement.

1.6 TESTING AND INSPECTION

A. The Owner's Geotechnical Engineer shall observe the asphalt placement.

PART 2 - PRODUCTS

2.1 ASPHALT-AGGREGATE MIXTURE

A. General: Provide plant-mixed, hot-laid asphalt-aggregate mixtures complying with the requirements of the VDOT Road and Bridge Specifications.

2.2 ASPHALT MATERIALS

A. Tack Coat: ASTM D 977, emulsified asphalt or ASTM D 2397, cationic emulsified asphalt, slow setting, factory diluted in water, of suitable grade and consistency for application.

B. Prime Coat: Asphalt emulsion prime conforming to VDOT requirements.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that subgrade is dry and in suitable condition to support paving and imposed loads.

B. Proof-roll subbase using heavy, pneumatic-tired rollers to locate areas that are unstable or that require further compaction as determined by the Owner's Geotechnical Engineer.

C. Notify Owner and Engineer in writing of any unsatisfactory conditions. Do not begin paving installation until these conditions have been satisfactorily corrected.

3.2 MAINTENANCE AND PROTECTION OF TRAFFIC

A. Utilize flagmen, barricades, warning signs and warning lights as required by the Virginia Work Area Protection Manual.

3.3 PATCHING AND REPAIRS

A. Patching: Saw cut perimeter of patch and excavate existing pavement section to sound base. Recompact new subgrade. Excavate rectangular or trapezoidal patches, extending 12 inches into adjacent sound pavement, unless otherwise indicated. Cut excavation faces vertically.

1. Tack coat faces of excavation and allow to cure before paving.

2. Fill excavation with dense-graded, hot-mix asphalt base mix and, while still hot, compact flush with adjacent surface.

B. Leveling Course: Install and compact leveling course consisting of dense-graded, hot-mix asphalt surface course to level sags and fill depressions deeper than 1 inch in existing pavements.

1. Install leveling wedges in compacted lifts not exceeding 3 inches thick.

C. Crack and Joint Filling: Remove existing filler material from cracks or joints to a depth of 1/4 inch. Refill with asphalt joint-filling material to restore watertight condition. Remove excess filler that has accumulated near cracks or joints.

D. Tack Coat: Apply uniformly to existing surfaces of previously constructed asphalt or Portland cement concrete paving and to surfaces abutting or projecting into new, hot-mix asphalt pavement. Apply at a uniform rate of 0.05 to 0.15 gal./sq. yd. of surface.

1. Allow tack coat to cure undisturbed before paving.

2. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillage and clean affected surfaces.

3.4 SURFACE PREPARATION

A. General: Immediately before placing asphalt materials, remove loose and deleterious material from substrate surfaces. Ensure that prepared subgrade is ready to receive paving.

B. Sweep loose granular particles from surface of unbound-aggregate base course. Do not dislodge or disturb aggregate embedded in compacted surface of base course.

C. Prime Coat: For asphalt sections less than 4” thick, apply uniformly over surface of compacted-aggregate base at a rate of 0.15 to 0.50 gal./sq. yd. Apply enough material to penetrate and seal, but not flood, surface. Allow prime coat to cure for 24 hours minimum.

1. If prime coat is not entirely absorbed within 24 hours after application, spread sand over surface to blot excess asphalt. Use just enough sand to prevent pickup under traffic. Remove loose sand by sweeping before pavement is placed and after volatiles have evaporated.

2. Protect primed substrate from damage until ready to receive paving.

3.5 HOT-MIX ASPHALT PLACING

A. Machine place hot-mix asphalt mix on prepared surface, spread uniformly, and strike off. Place asphalt mix by hand to areas inaccessible to equipment in a manner that prevents segregation of mix. Place each course to required grade, cross section, and thickness, when compacted.

1. Place hot-mix asphalt base course in number of lifts and thickness indicated.

2. Spread mix at minimum temperature of 225 deg F.

B. Place paving in consecutive strips not less than 10 feet wide, except where infill edge strips of a lesser width are required.

1. After first strip has been placed and rolled, place succeeding strips and extend rolling to overlap previous strips. Complete asphalt base course for a section before placing intermediate or surface courses.

C. Promptly correct surface irregularities in paving course behind paver. Use suitable hand tools to remove excess material forming high spots. Fill depressions with hot-mix asphalt to prevent segregation of mix; use suitable hand tools to smooth surface.

3.6 JOINTS

A. Construct joints between old and new pavement, or between successive days work, to ensure continuous bond between adjoining paving sections. Construct joints free of depressions with same texture and smoothness as other sections of hot-mix asphalt course.

1. Clean contact surfaces and apply tack coat.

2. Offset longitudinal joints in successive courses a minimum of 6 inches.

3. Offset transverse joints in successive courses a minimum of 24 inches.

4. Construct transverse joints as required by the VDOT Road and Bridge Specifications.

5. Compact joints as soon as hot-mix asphalt will bear roller weight without excessive displacement.

3.7 COMPACTION

A. General: Begin compaction as soon as placed hot-mix paving will bear roller weight without excessive displacement. Compact hot-mix paving with hot, hand tampers or vibratory-plate compactors in areas inaccessible to rollers.

1. Complete compaction before mix temperature cools to 185 deg F.

B. Breakdown Rolling: Accomplish breakdown or initial rolling immediately after rolling joints and outside edge. Examine surface immediately after breakdown rolling for indicated crown, grade, and smoothness. Repair surfaces by loosening displaced material, filling with hot-mix asphalt, and rerolling to required elevations.

C. Intermediate Rolling: Begin intermediate rolling immediately after breakdown rolling, while hot-mix asphalt is still hot enough to achieve indicated density. Continue rolling until hot-mix asphalt course has been uniformly compacted to the following density:

1. Average Density: 95 percent of reference laboratory density according to ASTM D 1559.

D. Finish Rolling: Finish roll paved surfaces to remove roller marks while hot-mix asphalt is still warm. Surface course average density shall be 95 percent of reference laboratory density.

E. Edge Shaping: While surface is being compacted and finished, trim edges of pavement to proper alignment. Bevel edges while still hot, with back of rake or smooth iron. Compact thoroughly using tamper or other satisfactory method. Edges adjacent to curbs and curb and gutter sections shall be flush with the edge of concrete.

F. Repairs: Remove paved areas that are defective or contaminated with foreign materials. Remove paving course over area affected and replace with fresh, hot-mix asphalt. Compact by rolling to specified density and surface smoothness.

G. Protection: After final rolling, do not permit vehicular traffic on pavement until it has cooled and hardened.

H. Erect barricades to protect paving from traffic until mixture has cooled enough not to become marked.

3.8 INSTALLATION TOLERANCES

A. Thickness: Compact each course to produce the thickness indicated within the following tolerances:

1. Base Course: Plus or minus 1/2 inch.

2. Surface Course: Plus 1/4 inch, no minus.

B. Surface Smoothness: Compact each course to produce a surface smoothness within the following tolerances as determined by using a 10-foot straightedge applied transversely or longitudinally to paved areas:

1. Base Course: 1/4 inch.

2. Surface Course: 3/16 inch.

3. Crowned Surfaces: Test with crowned template centered and at right angle to crown. Maximum allowable variance from template is 1/4 inch.

3.9 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified independent testing agency (Geotechnical Engineer) to perform field inspections and tests and to prepare test reports.

1. Testing agency will conduct and interpret tests as required to demonstrate for general compliance with the project documents. Reports shall be provided documenting whether tested Work complies with or deviates from requirements.

B. Additional testing, at Contractor's expense, will be performed to determine compliance of corrected Work with requirements.

C. Remove and replace or install additional hot-mix asphalt where test results or measurements indicate that it does not comply with requirements.

END OF SECTION 321216

SECTION 321313 - SITE CONCRETE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. The provisions of the Contract Documents apply to the work of this Section.

1.2 DESCRIPTION OF WORK:

A. Extent of Portland cement concrete paving is shown on drawings, including:

1. Curbs
2. Dumpster Pad
3. Sidewalk
4. ADA parking stalls and access aisles

1.3 SUBMITTALS

A. Job-Mix Designs: VDOT Certification of approval of each job mix proposed for the Work.

B. Material Certification: Certification signed by Contractor certifying that each material complies with requirements.

1.4 JOB CONDITIONS

A. Traffic Control: Maintain access for vehicular and pedestrian traffic as required for other construction activities.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Forms: Steel, wood, or other suitable material of size and strength to resist movement during concrete placement and to retain horizontal and vertical alignment until removal. Use straight forms, free of distortion and defects.

1. Use flexible spring steel forms or laminated boards to form radius bends as required.
2. Coat forms with a nonstaining form release agent that will not discolor or deface surface of concrete.

B. Welded Wire Mesh: Welded plain cold-drawn steel wire fabric, ASTM A 185.

C. Reinforcing Steel: ASTM A 615, Grade 60, deformed

D. Concrete Materials: Comply with requirements of applicable VDOT Road and Bridge Specifications.

1. Cementitious Materials: Use the following cementitious materials, of same type, brand, and source throughout Project:

   a) Portland Cement: ASTM C150, Portland cement, Type I.
   b) Fly Ash: ASTM C618, Class C or Class F.

2. Normal-Weight Aggregates: ASTM C33, uniformly graded. Provide aggregates from a single source.

3. Air-Entraining Admixture: ASTM C260.

4. Chemical Admixtures: Admixtures certified by manufacturer to be compatible with other admixtures and to contain not more than 0.1 percent water-soluble chloride ions by mass of cementitious material.

5. Water: Potable and complying with ASTM C94.

E. Expansion Joint Materials: Sealant shall be Multicomponent, Self Leveling, Urethane, Elastomeric Joint Sealant: ASTM C920, Type M, Grade P, Class 25, for Use T in combination with a compatible backer material.

2.2 CONCRETE MIX, DESIGN, AND TESTING

A. Comply with requirements of VDOT Road and Bridge Specifications.

B. Design mix to produce normal-weight concrete consisting of Portland cement, aggregate, water-reducing or high-range water-reducing admixture (superplasticizer), air-entraining admixture, and water to produce the following properties:

1. Comply with the requirements of VDOT Std. Class A3 Concrete, unless otherwise indicated.

PART 3 - EXECUTION

3.1 SURFACE PREPARATION

A. Remove loose material from compacted subbase surface immediately before placing concrete.

B. Proof-roll prepared subbase surface to check for unstable areas and need for additional compaction. Do not begin paving work until such conditions have been corrected and are ready to receive paving,

3.2 FORM CONSTRUCTION

A. Set forms to required grades and lines, braced and secured. Install forms to allow continuous progress of work and so that forms can remain in place at least 24 hours after concrete placement.

B. Check completed formwork for grade and alignment to following tolerances:

1. Top of forms not more than 1/8 inch in 10 feet.

2. Vertical face on longitudinal axis, not more than 1/4 inches in 10 feet.

C. Clean forms after each use and coat with form release agent as required to ensure separation from concrete without damage.

3.3 REINFORCEMENT

A. Comply with CRSI's "Manual of Standard Practice" for fabricating, placing and supporting reinforcement.

3.4 CONCRETE PLACEMENT

A. General: Comply with requirements of applicable VDOT Road and Bridge Specifications.

B. Do not place concrete until subbase and forms have been checked for line and grade. Moisten subbase if required to provide a uniform dampened condition at time concrete is placed. Do not place concrete around manholes or other structures until they are at required finish elevation and alignment.

C. Place concrete by methods that prevent segregation of mix. Consolidate concrete along face of forms and adjacent to transverse joints with internal vibrator. Keep vibrator away from joint assemblies, reinforcement, or side forms. Use only square-faced shovels for hand spreading and consolidation. Consolidate with care to prevent dislocation of reinforcing, dowels, and joint devices.

D. Deposit and spread concrete in a continuous operation between transverse joints as far as possible. If interrupted for more than 1/2 hour, place a construction joint.

E. Fabricated Bar Mats: Keep mats clean and free from excessive rust, and handle units to keep them flat and free of distortions. Straighten bends, kinks, and other irregularities or replace units as required before placement. Set mats for a minimum 2-inch overlap to adjacent mats.

F. Place concrete in 2 operations; strike off initial pour for entire width of placement and to the required depth below finish surface. Lay fabricated bar mats immediately in final position. Place top layer of concrete, strike off, and screed.

G. Remove and replace portions of bottom layer of concrete that have been placed more than 15 minutes without being covered by top layer or use bonding agent if acceptable to Architect.

H. Curbs: Automatic machine may be used for curb placement. If machine placement is to be used, submit revised mix design and laboratory test results that meet or exceed minimums indicated. Machine placement must produce curbs and gutters to required cross-section, lines, grades, finish, and jointing as indicated for formed concrete. If results are not acceptable, remove and replace with formed concrete meeting requirements.

3.5 JOINTS

A. General: Construct expansion, weakened-plane (contraction), and construction joints true to line with face perpendicular to surface of concrete. Construct transverse joints at right angles to the centerline, unless otherwise indicated.

B. Weakened-Plane (Contraction) Joints: Provide weakened-plane (contraction) joints in sidewalk at a spacing to match the width of the sidewalk, or as detailed on the plans. Construct weakened-plane joints for a depth equal to at least 1/4 concrete thickness, as follows:

1. Tooled Joints: Form weakened-plane joints in fresh concrete by grooving top portion with a recommended cutting tool and finishing edges with a jointer.

2. Sawed Joints: Form weakened-plane joints with powered saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut joints into hardened concrete as soon as surface will not be torn, abraded, or otherwise damaged by cutting action.

C. Construction Joints: Place construction joints at end of placements and at locations where placement operations are stopped for more than 1/2 hour, except where such placements terminate at expansion joints.

1. Construct joints as indicated using standard metal keyway-section forms.

D. Expansion Joints: Provide premolded joint filler for expansion joints abutting concrete curbs, catch basins, manholes, inlets, structures, walks, and other fixed objects, unless otherwise indicated.

1. Locate expansion joints at 30 feet o.c. for each pavement lane unless otherwise indicated.

E. Extend joint fillers full width and depth of joint, not less than 1/2 inch or more than 1 inch below finished surface with joint sealer.

F. Provide joint fillers in one-piece lengths for full width being placed wherever possible. Where more than one length is required, lace or clip joint filler sections together.

G. Protect top edge of joint filler during concrete placement with a metal cap or other temporary material. Remove protection after concrete has been placed on both sides of joint.

H. Fillers and Sealants: Comply with VDOT requirements.

3.6 CONCRETE FINISHING

A. After striking-off and consolidating concrete, smooth surface by screeding and floating. Use hand methods only where mechanical floating is not possible. Adjust floating to compact surface and produce uniform texture.

B. After floating, test surface for trueness with a 10-ft. straightedge. Distribute concrete as required to remove surface irregularities and refloat repaired areas to provide a continuous smooth finish.

C. Work edges of slabs, gutters, back top edge of curb, and formed joints with an edging tool, and round to 1/2-inch radius, unless otherwise indicated. Eliminate tool marks on concrete surface.

D. After completion of floating and when excess moisture or surface sheen has disappeared, complete troweling and finish surface as follows:

1. Broom finish by drawing a fine-hair broom across concrete surface perpendicular to line of traffic. Repeat operation if required to provide a fine line texture acceptable to Owner.

2. Crosswalks to have an 18” square scoring and 12” boarder.

E. Do not remove forms for 24 hours after concrete has been placed. After form removal, clean ends of joints and point-up any minor honeycombed areas. Remove and replace areas or sections with major defects, as directed by Architect.

3.7 CURING

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.

B. Comply with ACI 306.1 for cold-weather protection

C. Begin curing after finishing concrete but not before free water has disappeared from concrete surface.

D. Curing Methods: Cure concrete by moisture curing, moisture-retaining cover curing, curing compound or a combination of these.

3.8 REPAIRS AND PROTECTIONS

A. Repair or replace cracked, broken or defective concrete curbs, sidewalk, and pavements as directed by Engineer or Owner.

B. Drill test cores where directed by Engineer when necessary to determine magnitude of cracks or defective areas. Fill drilled core holes in satisfactory pavement areas with Portland cement concrete bonded to pavement with epoxy adhesive.

C. Protect concrete from damage until acceptance of work. Exclude traffic from pavement for at least 14 days after placement. When construction traffic is permitted, maintain pavement as clean as possible by removing surface stains and spillage of materials as they occur.

D. Sweep concrete pavement and wash free of stains, discolorations, dirt, and other foreign material just before final inspection.

END OF SECTION 321313

SECTION 321700 - PAVEMENT MARKINGS, SIGNS AND SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. The provisions of the Contract Documents apply to the work of this Section.

1.2 SUMMARY

A. This Section includes, but is not limited to, the following:

1. Establishing the location of pavement markings and applying pavement markings for parking space lines, traffic control, fire lane and accessible spaces.

2. Installation of signs for traffic control and accessible spaces.

1.3 QUALITY ASSURANCE

A. All work and materials shall conform to the requirements of the latest edition of the Virginia Department of Transportation (VDOT) Road and Bridge Specifications and Road and Bridge Standards.

B. All materials for signs shall conform to the requirements of the latest edition of the Virginia Department of Transportation (VDOT) Road and Bridge Specifications and Road and Bridge Standards and to the requirements of the latest edition of the Manual of Uniform Traffic Control Devices for traffic signs.

C. Installer Qualifications: Engage an experienced installer, who has successfully completed striping and signage projects similar in size and complexity to this project. The installer's primary business (defined as a minimum of 60% of total billings) shall be striping and signage.

1.4 SUBMITTALS

A. Product Data and written confirmation that the following materials are included on VDOT's list of approved construction materials:

1. Pavement marking material

2. Signs

3. Posts

PART 2 - PRODUCTS

2.1 PAVEMENT MARKINGS

A. Markings shall be VDOT Type B, Class 1 thermoplastic pavement markings conforming to the requirements of Section 246 and 704 of the VDOT Road and Bridge Specifications.

2.2 SIGNS AND POSTS

A. Signs shall conform to the requirements of Section 701 of the VDOT Road and Bridge Specifications. Signs shall be fabricated with encapsulated lens sheeting.

B. Signposts shall be square tube sign post conforming to the requirements of STP-1 of the VDOT Road and Bridge Standards.

2.3 CONCRETE

A. Concrete shall be Class A3, General concrete, conforming to the requirements of Section 217 of the VDOT Road and Bridge Specifications, unless otherwise noted.

PART 3 - EXECUTION

3.1 SURFACE PREPARATION FOR PAVEMENT MARKING

A. Prepare surfaces in accordance paint in accordance with the requirements of Section 704 of the VDOT Road and Bridge Specifications and the manufacturer's recommendations.

B. Apply pavement markings only when the ambient temperatures is above 50°F and less than 95°F, unless otherwise approved.

C. Allow pavement to cure for a period recommended by the manufacturer before applying pavement marking.

D. Clean surfaces thoroughly before application of paint. Remove, dust, dirt and other granular surface deposits by sweeping, blowing with compressed air, rinsing with water, or a combination of these methods as required.

E. Remove existing pavement markings, residual curing compounds and other coating adhering to the pavement with scrapers, wire brushes, waterblasting, sandblasting or mechanical abrasion as required. Areas of existing pavement affected by oil or grease shall be scrubbed with an approved chemical and rinsed thoroughly. Seal oil-soaked areas with shellac or primer after cleaning.

F. Pavement surfaces shall be dry and clean prior to painting. Pavement markings shall not be applied within 24 hours following rain or other inclement weather or when rain is imminent.

G. Apply seal coat across the existing pavement to provide a uniform surface appearance.

3.2 APPLICATION OF PAVEMENT MARKING

A. Apply paint in accordance with the requirements of Section 704 of the VDOT Road and Bridge Specifications and the manufacturer's recommendations.

B. Lay out lines and markings to the width and length as indicated. All parking space lines shall be 4 inches wide.

C. Apply markings with an approved applicator.

D. Apply markings at manufacturer recommended rates.

3.3 INSTALLATION OF SIGNS

A. Install signs on signposts in accordance with the requirements of Section 701 of the VDOT Road and Bridge Specifications and STP-1 of the VDOT Road and Bridge Standards.

END OF SECTION 321700

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SECTION 333000 - SANITARY SEWER

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. The provisions of the Contract Documents apply to the work of this Section.

1.2 SUMMARY

A. This Section includes sanitary sewerage system piping and appurtenances from a point 5 feet outside the building to the point of disposal.

1.3 SUBMITTALS

A. Product data for sewer piping and associates materials.

B. Inspection and test reports, including video recordings.

1.4 QUALITY ASSURANCE

A. Environmental Compliance: Comply with applicable portions of the Virginia Department of Health pertaining to sanitary sewerage systems.

B. Utility Compliance: Comply with the requirements of the latest edition of Martinsville Public Works Design Manual

1.5 DELIVERY, STORAGE, AND HANDLING

1. Do not store plastic structures in direct sunlight.

2. Do not store plastic pipe or fittings in direct sunlight.

3. Protect pipe, pipe fittings, and seals from dirt and damage.

4. Handle precast concrete manholes and other structures according to manufacturer's rigging instructions.

1.6 PROJECT CONDITIONS

A. Site Information: Perform site surveys, research public utility records, and verify existing utility locations. Verify that sanitary sewerage system piping may be installed in compliance with original design and referenced standards.

B. Locate existing structures and piping to be closed and abandoned.

C. Remove and/or abandon the existing septic system and drainfield in accordance with Virginia Department of Health requirements.

D. Existing Utilities: Locate and coordinate with the owner in accordance with Section 312000.

1.7 SEQUENCING AND SCHEDULING

A. Coordinate with interior building sanitary drainage piping.

B. Coordinate with other utility work.

PART 2 - PRODUCTS

2.1 PIPE AND FITTINGS

A. General: Provide pipe and pipe fitting materials compatible with each other. All materials shall comply with the requirements of the latest edition of the Locality's Design Guidelines. Pipe material may be PVC, DI, or HDPE meeting the requirements below, but shall all be one consistent material throughout the project.

B. Polyvinylchloride (PVC) Sewer:

1. Polyvinylchloride (PVC) non-pressure pipe shall be solvent weld jointed Schedule 40 PVC meeting the requirements of ASTM D1785 and ASTM D2665.

C. Ductile Iron (DI) Sewer:

1. Ductile iron pipe shall be asphalt coated, cement lined, Class 52 or higher in accordance with ANSI/AWWA C150/A21.50 and ANSI/AWWA C151/A21.51

2. Ductile iron pipe shall have flexible restrained joints.

3. All hardware for ductile iron piping shall be epoxy coated.

D. HDPE Pipe and Fittings

1. HDPE Dimension Ratio (DR)11 piping in accordance with ASTM D3350.

2. All fittings for HDPE shall be molded fittings. If fabricated fittings are used the DR must increase to maintain the pressure rating.

E. Flexible Pipe Connections: Provide flexible pipe connections to manholes.

1. Materials shall be resistant to water, sewage, acids, ozone, weathering and aging. Connectors shall conform to the requirements of ASTM C923. Use neoprene conforming to ASTM C443 and stainless steel, Series 300.

2. Cast or core drill openings in manholes to receive connectors. Connectors shall be suitable for field repair or replacement.

3. At existing structures install sleeve prior to connection. Use flexible, mechanical clamps, grout and water stop for a leak- proof connection.

2.2 CLEANOUTS

A. General: Provide cleanout plug with round cast-iron access frame and heavy-duty, secured, scoriated cast-iron cover in accordance with the requirements of the latest edition of the Locality's Design Guidelines.

B. Sewer pipe fitting and riser to cleanout: 4" or 6" dia. PVC.

PART 3 - EXECUTION

3.1 PREPARATION OF FOUNDATION FOR BURIED SANITARY SEWERAGE SYSTEMS

A. Grade trench bottom to provide a smooth, firm, stable, and rock-free foundation, throughout the length of the pipe.

B. Remove unstable, soft, and unsuitable materials at the surface upon which pipes are to be laid and backfill with clean sand or pea gravel to indicated level.

C. Install pipe bedding as required by the latest edition of the Locality's Design Guidelines or VDOT.

3.2 PIPE INSTALLATION

A. Install the sanitary sewerage system in accordance with the latest edition of the Locality's Design Guidelines or VDOT.

B. Install piping beginning at low point of systems, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings in accordance with manufacturer's recommendations for use of lubricants, cements, and other installation requirements. Maintain swab or drag in line and pull past each joint as it is completed.

C. Use manholes for changes in direction, except where a fitting is indicated. Use fittings for branch connections, except where direct tap into existing sewer is indicated.

D. Use proper size increasers, reducers, and couplings, where different size or material of pipes and fittings are connected. Reduction of the size of piping in the direction of flow is prohibited.

E. Install piping pitched down in direction of flow, at minimum slope of 2 percent, except where indicated otherwise.

F. Extend sanitary sewerage system piping to connect to building sanitary drains, of sizes and in locations indicated.

3.3 PIPE JOINT CONSTRUCTION AND INSTALLATION

A. Join pipe with standard manufactured couplings and fittings intended for that purpose.

3.4 CLEANOUTS

A. Provide cleanouts as indicated on the plans, and as required by the Locality's Design Guidelines or VDOT.

3.5 FIELD QUALITY CONTROL

A. Cleaning: Clear interior of piping and structures of dirt and other superfluous material as work progresses. Maintain swab or drag in piping and pull past each joint as it is completed.

1. In large, accessible piping, brushes and brooms may be used for cleaning.

2. Place plugs in ends of uncompleted pipe at end of day or whenever work stops.

3. Flush piping between manholes, if required by local authority, to remove collected debris.

B. Interior Inspection: Inspect piping with a crawler style camera, or approved equal, to provide sufficient video quality to determine whether line displacement or other damage has occurred. It is the contractor's responsibility to coordinate, complete, and pay for the inspections.

1. Make inspections after pipe between manholes and manhole locations has been installed and approximately 2 feet of backfill is in place, and again at completion of project.

2. If inspection indicates poor alignment, debris, displaced pipe, infiltration or other defects correct such defects, and reinspect.

3. Provide video recordings to Owner/Engineer for review.

C. Test new piping systems and parts of existing systems that have been altered, extended, or repaired for leaks and defects.

1. Do not enclose, cover, or put into service before inspection and approval.

2. Test all completed piping systems (public and private) as required by Martinsville Public Works.

3. Schedule tests and inspections at least 24 hours' advance notice.

4. All concrete sanitary structures shall be vacuum tested at 10 inches of mercury for 60 seconds. The vacuum test method shall be in accordance with ASTM C1244-05a, except as specified otherwise.

5. Submit separate reports for each test.

END OF SECTION 333000

APPENDIX A

Available Asbestos Reports

June 8, 2026

Mr. Jay Eanes **Via Email**
Martinsville City Schools

Re: **Hazardous Materials Inspection Report**
Albert Harris ES Clinic
200 Hospital Drive; Martinsville, Virginia 24112
Hurt & Proffitt Project Number: 20261262

Mr. Eanes:

The employee-owners of Hurt & Proffitt, Inc. (H&P) are pleased to provide this document and enclosures as the *Hazardous Materials Inspection Report* associated with the *Albert Harris ES Clinic* located at 200 Hospital Drive in Martinsville, Virginia 24112.

1.0 Asbestos-Containing Material (ACM) Survey and Laboratory Procedures

Inspection / assessment activities were performed in compliance with United States Occupational Safety and Health Administration (US OSHA) and United States Environmental Protection Agency (US EPA) National Emission Standards for Hazardous Air Pollutants (NESHAPs) on May 27th, 2026, by Hurt & Proffitt representative, Kenric K. Hundley (Virginia Asbestos Inspector: 3303001516). A copy of Mr. Hundley's Virginia Department of Professional and Occupational Regulation (VA DPOR) Asbestos Inspector License is enclosed for your review.

Physical inspection/assessment was performed throughout the area designated by the client to determine the extent and locations of suspect asbestos-containing materials and potential degree of abatement activities to take place for the proposed renovation activities.

Suspect bulk samples were collected and logged on chain-of-custody forms as representative of suspect homogenous materials (based on material type, color, texture, etc.), from the functional spaces as they were determined by visual observations in the field.

Sixteen (16) suspect asbestos-containing bulk material samples, including duplicate sets, were submitted for analysis by EPA Method No. 600/R-93/116 and 600/M4-82-020 (polarized light microscopy (PLM)). All samples were analyzed by SanAir Technologies Laboratory of Powhatan, Virginia, a NVLAP accredited laboratory licensed to perform asbestos bulk analysis within the State of Virginia under positive stop protocol. Under microscopy, an additional ten (10) layers were identified. Therefore, a total of twenty-six (26) samples were analyzed to complete this report.

The following table illustrates the sample identification, location, and analytical results as received from the laboratory. A copy of the laboratory results and sample chain-of-custody are additionally enclosed for your review.

Table I
Asbestos-Containing Bulk Material Sample Analysis Summary
Albert Harris ES Clinic

Sample ID	Material Description	Location	Estimated Quantity	Lab Results (% Asbestos)	Condition/ Friable Y/N
001-CLPL-ABC	HARD PLASTER CEILING WITH TEXTURE	THROUGHOUT	N/A	NONE DETECTED	N/A
002-PI-ABC	PINK PIPE INSULATION MASTIC	THROUGHOUT	N/A	NONE DETECTED	N/A
003-DM-AB	GRAY DUCT MASTIC	THROUGHOUT	N/A	NONE DETECTED	N/A
004-WLPL-ABC	HARD WALL PLASTER WITH SKIM COAT	THROUGHOUT	N/A	NONE DETECTED	N/A
005-WLSH-ABC	WALLBOARD WITH JOINT COMPOUND	THROUGHOUT	N/A	NONE DETECTED	N/A
006-DM-AB	WHITE DUCT MASTIC	THROUGHOUT	N/A	NONE DETECTED	N/A

Table Notes:

1. (AB) following sample identification denotes multiple samples collected of the same homogenous material from various functional spaces of the structure.

A copy of the laboratory report of analysis, along with drawing(s) illustrating sample collection location(s) is enclosed for your review.

Discussion and Recommendations

Based upon the materials identified and sampled within the above referenced structure, asbestos abatement is not necessary prior to planned building material replacement activities. However, during the conduct of this assessment, bulk material sample collection was limited to those materials which were readily and safely accessible. **As such, should any other/additional materials not represented in this survey be discovered during demolition activities, all work on the site must cease and the newly discovered materials be sampled by a Virginia Department of Professional and Occupational Regulation (VA DPOR) licensed asbestos inspector and evaluated for asbestos content by a NVLAP-accredited laboratory.**

2.0 Lead-Based Paint Assessment

Sample collection was performed by collecting paint chip samples from components identified during the site inspection. The paint chip sample(s) were collected utilizing a manual paint scraper. The removed paint chips were collected in a piece of clean construction paper for transfer into plastic sample collection bags. Each container was sealed and labeled with a unique sample identification number. Pertinent information for each sample including date of collection, location, color, and condition of the surface coatings was recorded on a sampling log form. After sample collection, each sample location was cleaned of extraneous debris.

Four (4) paint-chip samples were collected during the assessment and logged onto chain-of-custody form(s), packaged with custody seals, and delivered by UPS to the analytical laboratory, SanAir Technologies Laboratory, Inc. of Richmond, Virginia. SanAir is licensed by the Commonwealth of Virginia for Lead analysis. SanAir analyzed the paint chip samples for Lead content following EPA's Method SW 846/3051A/6010B (preparation by microwave-assisted acid digestion followed by analysis via inductively coupled plasma). Analytical results were reported as parts per million (ppm, ug/g) and converted to per-cent Lead by weight. A copy of the analytical laboratory report is enclosed for your review.

The following table (Table No. III) illustrates the analytical results and details regarding the paint chip sample(s) collected during the assessment:

Table II
Paint Chip Sample Analytical Summary
Albert Harris ES Clinic

Sample Number	Building Component / Room	Color	Substrate	Condition	Lead Content (% Weight)
L-01	*Interior Wall*	*Tan*	*Wallboard*	*Intact*	*0.263%*
L-02	***Exterior Door Frame***	***Gray***	***Metal***	***Intact***	***2.504%***
L-03	*Interior Door Frame*	*Burgundy*	*Metal*	*Intact*	*0.012%*
L-04	*Mechanical Room*	*White*	*Metal*	*Intact*	*<0.009%*

Based upon the results of the laboratory analytical methods, the following paint/surface coatings were identified as **lead-based: Exterior Door Frames painted Gray.**

Discussion and Recommendations

Hurt & Proffitt recommends that the contractor adhere to all applicable United States Environmental Protection Agency (US EPA) regulations regarding disposal requirements and United States Occupational Safety and Health administration (US OSHA) regulations for employee exposure.

Where components tested below the designated action level of 1.0 mg/cm² for classifying the material as lead based paint, it is important to note that **any** painted or coated surface may contain concentrations of lead, which when disturbed, could generate lead in dust greater than the action level exposure concentration of 30 ug/m^3 established by the OSHA "*Lead Exposure in Construction Rule*" (29 CFR 1926.62).

The OSHA standard gives no guidance on acceptable levels of lead in coatings at which no exposure to airborne lead (above the action level) would be expected; however, OSHA defines airborne concentrations and lists specific work practices which may create a lead hazard. Therefore, personnel exposure monitoring should be performed during any removal or demolition process to establish worker exposure levels which can be used to determine appropriate personnel protection and environmental controls for the specific work practice and material type. In accordance with OSHA requirements, the Contractor performing the work will be required to conduct this monitoring. The primary route of exposure OSHA regulations are concerned with is the inhalation of Lead-containing dust generated by demolition operations within the building. These hazards are assessed by measuring the Lead concentration in air when demolition operations are initiated; a procedure called a *negative exposure assessment*. The OSHA defined Permissible Exposure Limit (PEL) for Lead is 50 micro-grams (ug) of Lead per cubic-meter (m^3) air.

Building demolition and/or renovation activities where LBP is present must comply with the OSHA regulation 29 CFR 1926.62, Lead in Construction; and US EPA waste disposal regulations found in 40 CFR Part 261. OSHA regulations are designed to limit exposure of the construction workforce to Lead, which is a well-documented toxic element.

It would be prudent for the Building Owner to implement and document the following in response to the likely presence of Lead-dust hazards and documented Lead-based paint hazards in the building:

- Prior to any large-scale effort to remove the contents of the building or disturb/demolish building surfaces where LBP is known or suspected to be present, conduct a negative exposure assessment using trained workers wearing respiratory protection and protective clothing in compliance with 29CFR1926.62.
- Notify any person employed by the Owner to work in the building about the potential Lead-dust hazard and the LBP hazards. Instruct such worker in the importance of the use of proper personal hygiene practices and work practices (use of wet methods and HEPA vacuums) by providing them with the EPA-approved pamphlet *Renovate Right: Important Lead Hazard Information for Families, Child Care Providers and Schools.*
- The US OSHA regulation 29 CFR 1910.1200-Hazard Communication, requires that employers must inform employees about chemical hazards in the workplace. Construction contractors employed to demolish the building components within the site must be furnished a copy of this report.

Waste disposal for concentrated LBP debris (paint chips and scrapings, HEPA vacuum contents, protective suits, drop cloths, etc.) and for building components coated with LBP is regulated under 40 CFR Part 261 and/or 29 CFR 1910.1200. For disposal of construction/demolition debris that contain Lead, the United States Environmental Protection Agency (US EPA) requires the generator perform testing for lead content of the waste stream to determine proper disposal in accordance with the requirements of 40 CFR 261.11, Criteria for Listing Hazardous Waste.

3.0 Limitations

This report summarizes the results of Hurt & Proffitt's Hazardous Materials Inspection located at the above referenced project based upon our understanding of the requested scope of services. The findings prepared by Hurt & Proffitt are based upon our observations and the analytical analysis of the suspect bulk samples collected at the time of our field inspection. The services performed were provided in accordance with generally accepted environmental industry standard practices. No warranty, expressed or implied, are made. Our observations, conclusions, and recommendations are based upon conditions readily visible at the time of our field inspection, the results of analytical testing, and information provided to us by others.

Our conclusions and recommendations are based upon the guidelines presented to us by the United States Environmental Protection Agency (US EPA), United States Occupational Safety and Health Administration (US OSHA), and the Commonwealth of Virginia. Any conditions which deviate from the data contained within this report should be presented to Hurt & Proffitt for our evaluation and comment.

During Hurt & Proffitt's non-invasive inspection, accessible areas were visually surveyed for the presence of suspect asbestos-containing materials and lead-based paints. Locations and areas reviewed were limited to those identified by the Client and those that could be readily and safely accessed. Our conclusions and recommendations are based on the results of our sampling and analysis activities and cannot be used to form a professional opinion of conditions in others area beyond those from which the bulk material samples were collected. It is possible that inaccessible areas, such as behind walls or above ceilings, may not have been surveyed and therefore, conditions in these areas are unknown.

During this inspection, suspect asbestos-containing material samples were submitted for analysis at an NVLAP-accredited laboratory via polarized light microscopy (PLM) while suspect lead-based paint samples were analyzed via laboratory analysis. As with any similar survey of this nature, actual conditions exist only at the precise locations from which the bulk material samples were collected. Certain inferences are based on the results of this sampling and related testing to form a professional opinion of conditions in areas beyond those from which the samples were collected.

Hurt & Proffitt assumes no responsibility regarding response actions initiated as a result of our findings, nor liability for the duties and responsibilities of the Client or Building Owner with respect to compliance with applicable regulations. Compliance with local, state, and/or federal requirements / regulations are the responsibility of the Client or Building Owner.

4.0 Closing

Thank you for allowing Hurt & Proffitt the opportunity to be of service to you. Should you have any questions and/or concerns, please do not hesitate to contact the undersigned via email or by telephone at 434.847.7796.

Respectfully,
Hurt & Proffitt, Inc.

Jacob T. Jennings
Environmental/Industrial Hygiene
Project Manager
jjennings@handp.com

W. Chris Nixon, Vice President
Director of Environmental Services
cnixon@handp.com

Enclosures:

Asbestos Inspector License(s)
Laboratory Report of Analysis – Suspect Bulk Material Samples

DPOR License Lookup License Number 3303001516

License Details

Name	HUNDLEY, KENRIC KERWYNN
License Number	3303001516
License Description	Asbestos Inspector License
Rank	Asbestos Inspector
Address	GALAX, VA 24333
Initial Certification Date	1992-10-07
Expiration Date	2026-10-31

The data located on this website are not the public records of the Department of Professional and Occupational Regulation (DPOR). All public records are physically located at DPOR's Public Records Section: 9960 Mayland Drive, Suite 400, Richmond, VA 23233. While DPOR works to ensure the accuracy of the data provided online, the data available on these pages are updated routinely but may not be up to date at all times (due to document processing delays, technical maintenance, etc.).

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DPOR License Lookup build 1,524 (built 2025-04-18 11:59:26).

DPOR License Lookup License Number 3356000777

License Details

Name	HUNDLEY, KENRIC KERWYNN
License Number	3356000777
License Description	Lead Risk Assessor License
Rank	Lead Abatement Risk Assessor
Address	GALAX, VA 24333
Initial Certification Date	2005-05-03
Expiration Date	2019-12-31

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DPOR License Lookup build 1,524 (built 2025-04-18 11:59:26).

SanAir Technologies Laboratory

The Identification Specialists

Analysis Report prepared for Hurt & Proffitt, Inc.

Report Date: 6/4/2026

Project Name: Albert Harris ES Clinic

Project #: 20261262

SanAir ID#: 26031223

NVLAP TESTING

NVLAP LAB CODE 200870-0

10501 Trade Court, North Chesterfield, Virginia 23236
888.895.1177 | 804.897.1177 | fax: 804.897.0070 | LabReports@SanAir.com | SanAir.com

SanAir Technologies Laboratory

SanAir ID Number
26031223
FINAL REPORT
6/4/2026 3:05:01 PM

Name: Hurt & Proffitt, Inc.
Address: 2524 Langhorne Road
Lynchburg, VA 24501
Phone: 434-841-3893 (c)

Project Number: 20261262
P.O. Number:
Project Name: Albert Harris ES Clinic
Collected Date: 5/27/2026
Received Date: 5/28/2026 10:15:00 AM

Dear Ken Hundley,

We at SanAir would like to thank you for the work you recently submitted. The 16 sample(s) were received on Thursday, May 28, 2026 via FedEx. The final report(s) is enclosed for the following sample(s): 001-CLPL-A, 001-CLPL-B, 001-CLPL-C, 002-PI-A, 002-PI-B, 002-PI-C, 003-DM-A, 003-DM-B, 004-WLPL-A, 004-WLPL-B, 004-WLPL-C, 005-WLSH-A, 005-WLSH-B, 005-WLSH-C, 006-DM-A, 006-DM-B.

These results only pertain to this job and should not be used in the interpretation of any other job. This report is only complete in its entirety. Refer to the listing below of the pages included in a complete final report.

Sincerely,

Sandra Sobrino
Asbestos & Materials Laboratory Manager
SanAir Technologies Laboratory

Final Report Includes:
- Cover Letter
- Analysis Pages
- Disclaimers and Additional Information

Sample conditions:
- 16 samples in Good condition.

SanAir Technologies Laboratory

SanAir ID Number
26031223
FINAL REPORT
6/4/2026 3:05:01 PM

Name: Hurt & Proffitt, Inc.
Address: 2524 Langhorne Road
Lynchburg, VA 24501
Phone: 434-841-3893 (c)

Project Number: 20261262
P.O. Number:
Project Name: Albert Harris ES Clinic
Collected Date: 5/27/2026
Received Date: 5/28/2026 10:15:00 AM

Analyst: Williams, Darien

Asbestos Bulk PLM EPA 600/R-93/116

	Stereoscopic	Components		
SanAir ID / Description	Appearance	% Fibrous	% Non-fibrous	Asbestos Fibers
001-CLPL-A / 26031223-001 Hard Plaster Ceiling, Plaster	Gray Non-Fibrous Heterogeneous		100% Other	None Detected
001-CLPL-A / 26031223-001 Hard Plaster Ceiling, Texture	White Non-Fibrous Homogeneous		100% Other	None Detected
001-CLPL-B / 26031223-002 Hard Plaster Ceiling, Plaster	Gray Non-Fibrous Heterogeneous		100% Other	None Detected
001-CLPL-B / 26031223-002 Hard Plaster Ceiling, Texture	White Non-Fibrous Homogeneous		100% Other	None Detected
001-CLPL-C / 26031223-003 Hard Plaster Ceiling, Plaster	Tan Non-Fibrous Heterogeneous		100% Other	None Detected
001-CLPL-C / 26031223-003 Hard Plaster Ceiling, Plaster	Gray Non-Fibrous Heterogeneous		100% Other	None Detected
001-CLPL-C / 26031223-003 Hard Plaster Ceiling, Texture	White Non-Fibrous Homogeneous		100% Other	None Detected
002-PI-A / 26031223-004 Pipe Insulation (Mastic) Mech Rm	Pink Non-Fibrous Homogeneous		100% Other	None Detected
002-PI-B / 26031223-005 Pipe Insulation (Mastic) Mech Rm	Pink Non-Fibrous Homogeneous		100% Other	None Detected
002-PI-C / 26031223-006 Pipe Insulation (Mastic) Mech Rm	Pink Non-Fibrous Homogeneous		100% Other	None Detected

Analyst: Darien Williams
Analysis Date: 6/4/2026

Approved Signatory: Ronald A. Wren
Date: 6/4/2026

SanAir Technologies Laboratory

SanAir ID Number
26031223
FINAL REPORT
6/4/2026 3:05:01 PM

Name: Hurt & Proffitt, Inc.
Address: 2524 Langhorne Road
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Project Number: 20261262
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Project Name: Albert Harris ES Clinic
Collected Date: 5/27/2026
Received Date: 5/28/2026 10:15:00 AM

Analyst: Williams, Darien

Asbestos Bulk PLM EPA 600/R-93/116

	Stereoscopic	Components		
SanAir ID / Description	Appearance	% Fibrous	% Non-fibrous	Asbestos Fibers
003-DM-A / 26031223-007 Duct Mastic	Gray Non-Fibrous Homogeneous		100% Other	None Detected
003-DM-B / 26031223-008 Duct Mastic	Gray Non-Fibrous Homogeneous		100% Other	None Detected
004-WLPL-A / 26031223-009 Hard Wall Plaster - Ext Walls, Plaster	Gray Non-Fibrous Homogeneous		100% Other	None Detected
004-WLPL-A / 26031223-009 Hard Wall Plaster - Ext Walls, Skim Coat	White Non-Fibrous Homogeneous		100% Other	None Detected
004-WLPL-B / 26031223-010 Hard Wall Plaster - Ext Walls, Plaster	Gray Non-Fibrous Homogeneous		100% Other	None Detected
004-WLPL-B / 26031223-010 Hard Wall Plaster - Ext Walls, Skim Coat	White Non-Fibrous Homogeneous		100% Other	None Detected
004-WLPL-C / 26031223-011 Hard Wall Plaster - Ext Walls, Plaster	Gray Non-Fibrous Homogeneous		100% Other	None Detected
004-WLPL-C / 26031223-011 Hard Wall Plaster - Ext Walls, Skim Coat	White Non-Fibrous Homogeneous		100% Other	None Detected
005-WLSH-A / 26031223-012 Wallboard/JC - Int Walls, Wallboard	White Non-Fibrous Heterogeneous	5% Cellulose	95% Other	None Detected
005-WLSH-A / 26031223-012 Wallboard/JC - Int Walls, Joint Compound	White Non-Fibrous Homogeneous		100% Other	None Detected

Analyst: Darien Williams
Analysis Date: 6/4/2026

Approved Signatory: Ronald A. Peluso
Date: 6/4/2026

SanAir Technologies Laboratory

SanAir ID Number
26031223
FINAL REPORT
6/4/2026 3:05:01 PM

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P.O. Number:
Project Name: Albert Harris ES Clinic
Collected Date: 5/27/2026
Received Date: 5/28/2026 10:15:00 AM

Analyst: Williams, Darien

Asbestos Bulk PLM EPA 600/R-93/116

	Stereoscopic	Components		
SanAir ID / Description	Appearance	% Fibrous	% Non-fibrous	Asbestos Fibers
005-WLSH-B / 26031223-013 Wallboard/JC - Int Walls, Wallboard	White Non-Fibrous Heterogeneous	5% Cellulose	95% Other	None Detected
005-WLSH-B / 26031223-013 Wallboard/JC - Int Walls, Joint Compound	White Non-Fibrous Homogeneous		100% Other	None Detected
005-WLSH-C / 26031223-014 Wallboard/JC - Int Walls, Wallboard	White Non-Fibrous Heterogeneous	5% Cellulose	95% Other	None Detected
005-WLSH-C / 26031223-014 Wallboard/JC - Int Walls, Joint Compound	White Non-Fibrous Homogeneous		100% Other	None Detected
006-DM-A / 26031223-015 Duct Mastic	White Non-Fibrous Homogeneous		100% Other	None Detected
006-DM-B / 26031223-016 Duct Mastic	White Non-Fibrous Homogeneous		100% Other	None Detected

Analyst: Darien Williams
Analysis Date: 6/4/2026

Approved Signatory: Ronald A. Peak
Date: 6/4/2026

Disclaimer and Additional Information:
Asbestos Bulk PLM EPA 600/R-93/116

This report is the sole property of the client named on the chain-of-custody (COC) submitted to SanAir Technologies Laboratory, Inc. (SanAir). Results in the report are confidential information intended only for the use by the customer listed on the COC. Neither results nor reports will be discussed with or released to any third party without our client's written permission. The final report shall not be reproduced, except in full, without written approval of the laboratory to assure that parts of the report are not taken out of context. This report and any information contained within shall not be edited, altered, or modified in any way by any persons or agencies receiving, viewing, distributing, or otherwise possessing a copy of this final report. The laboratory reserves the right to perform amendments to any finalized report, of which shall supersede and make obsolete any previous editions. Such changes, modifications, additions, or deletions shall be effective immediately upon notice thereof, which may be given by means including but not limited to posting on the SanAir client portal website, electronic or conventional mail, or by any other means.

The information provided in this report applies only to the samples submitted and is relevant only for the date, time, and location of sampling. The accuracy of the results is dependent upon the client's sampling procedure and information provided to the laboratory by the client on the COC. SanAir assumes no responsibility for the sampling procedure and will provide evaluation reports based solely on the sample(s) in the condition received at the laboratory and information provided by the client on the COC, such as: project number, project name, collection dates, P.O. number, special instructions, samples collected by, sample numbers, sample identifications, sample type, selected analysis type, flow rate, total volume or area, and start-stop times that may affect the validity of the results in this report. Samples were received in good condition unless otherwise noted on the report. When the client requires samples to be tested that deviates from a specific method or condition, all reported results may be affected by the deviation. SanAir assumes no responsibility or liability for the manner in which the results are used or interpreted.

This report does not constitute nor shall not be used by the client to claim product, process, system, or person certification, approval, or endorsement by NVLAP, NIST, NELAC, AIHA LAP, LLC or any other U.S. governmental agencies; all or somet tests contained in this report may not be accredited by every local, state, and federal regulatory agencies. Refer to the SanAir website at www.sanair.com for copies of current certificates and scopes of various accreditations, certifications, and licenses or contact the laboratory for inquiries regarding the status or scope of an accreditation or certification.

Samples are held for a period of 60 days. Fibers smaller than 5 microns cannot be seen with this method due to scope limitations. For NY state samples, method EPA 600/M4-82-020 is performed.

NYELAP Disclaimer:
Polarized-light microscopy is not consistently reliable in detecting asbestos in floor covering and similar non-friable organically bound materials. Quantitative transmission electron microscopy is currently the only method that can be used to determine if this material can be considered or treated as non-asbestos containing.

Asbestos Accreditations, Certifications, and Licenses
National Voluntary Laboratory Accreditation Program (NVLAP) Lab Code 200870-0
City of Philadelphia Department of Public Health Air Management Services, Certification#ALL-460
Commonwealth of Pennsylvania Department of Environmental Protection Number 68-05397
California State Environmental Laboratory Accreditation Program Certificate Number 2915
Colorado Department of Public Health and Environment Registration Number AL-23143
Connecticut Department of Public Health Environmental Laboratory Registration Number PH-0105
Massachusetts Department of Labor Standards Asbestos Analytical Services License Number: AA000222
State of Maine Department of Environmental Protection License Number: LB-0075
New York State Department of Health Laboratory ID: 11983
State of Rhode Island Department of Health Certification No.: PLM00126
Texas Department of State Health Services License Number: 300440
Commonwealth of Virginia Department of Professional and Occupational Regulation Number: 3333000323
State of Washington Department of Ecology Laboratory ID: C989
State of West Virginia Bureau for Public Health Analytical Laboratory Number: LT000616
Vermont Department of Health License Number: Asb-Co-An-000006
Louisiana Department of Environmental Quality AI Number 212253, LELAP Lab ID #05088

SanAir Technologies Laboratory

1551 Oakbridge Dr. STE B
Powhatan, VA 23139
804.897.1177 / 888.895.1177
Fax 804.897.0070
sanair.com

Asbestos Chain of Custody

Form 140, Rev 1, 1/20/2017

SanAir ID Number
26031223

Received by MN on 5/28/26 at 10:15 AM

Company: HURT & PROFFITT INC	Project #: 20261262	Collect by: K HUDDLEY
Address: 2524 LANGHORNE RD	Project Name: ALBERT HARRIS ES CLINIC	Phone #: 274-413-6225
City, St., Zip: LYNCHBURG VA 24501	Date Collected: 5/27/26	Fax #:
State of Collection: VA Account#:	P.O. Number:	Email: khuddley@HANDP.com

Bulk

ABB	PLM EPA 600/R-93/116	X
	Positive Stop X	
ABEPA	PLM EPA 400 Point Count	☐
ABB1K	PLM EPA 1000 Point Count	☐
ABBEN	PLM EPA NOB**	☐
ABBCH	TEM Chatfield**	☐
ABBTM	TEM EPA NOB**	☐
ABQ	PLM Qualitative	☐

** Available on 24-hr. to 5-day TAT

Water

ABHE	EPA 100.2	☐

Air

ABA	PCM NIOSH 7400	☐
ABA-2	OSHA w/ TWA*	☐
ABTEM	TEM AHERA	☐
ABATN	TEM NIOSH 7402	☐
ABT2	TEM Level II	☐
Other:		☐

New York ELAP

PLM NY	PLM EPA 600/M4-82-020	☐
ABEPA2	NY ELAP 198.1	☐
ABENY	NY ELAP 198.6 PLM NOB	☐
ABBNY	NY ELAP 198.4 TEM NOB	☐

Soil

ABSE	PLM EPA 600/R-93/116 (Qual.)	

Vermiculite

ABSP	PLM CARB 435 (LOD <1%)	
ABSP1	PLM CARB 435 (LOD 0.25%)	
ABSP2	PLM CARB 435 (LOD 0.1%)	

Dust

ABWA	TEM Wipe ASTM D-6480	
ABDMV	TEM Microvac ASTM D-5755	

Matrix	Other	

Turn Around Times	3 HR (4 HR TEM) ☐	6 HR (8HR TEM) ☐	12 HR ☐	24 HR ☐
	☐ 2 Days	☐ 3 Days	☐ 4 Days	X 5 Days

Special Instructions

Sample #	Sample Identification/Location	Volume or Area	Sample Date	Flow Rate*	Start – Stop Time*	
001-CLPL-ABC	HARD PLASTER CEILING	6500SF	5/27/26			
002-PI- "	PIPE INSULATION (MASTIC) MECH RM	50SF				
003-DM-AB	DUCT MASTIC - GRAY	3000LF				
004-WLPL-ABC	HARD WALL PLASTER - EXT WALLS	3000SF				
005-WLSH- "	WALLBOARD/JC - INT "	5000SF				
006-DM-AB	DUCT MASTIC - WHITE	500LF				

Relinquished by	Date	Time	Received by	Date	Time
K HUDDLEY	5/27/26	PM			

If no technician is provided, then the primary contact for your account will be selected. Unless scheduled, the turnaround time for all samples received after 3 pm EST Friday will begin at 8 am Monday morning. Weekend or holiday work must be scheduled ahead of time and is charged for rush turnaround time. SanAir covers Standard Overnight FedEx shipping. Shipments billed to SanAir with a faster shipping rate will result in additional charges.

SanAir Technologies Laboratory

The Identification Specialists

Analysis Report prepared for Hurt & Proffitt, Inc.

Report Date: 6/4/2026

Project Name: Albert Harris ES Classic

Project #: 20261262

SanAir ID#: 26031222

10501 Trade Court, North Chesterfield, Virginia 23236
888.895.1177 | 804.897.1177 | fax: 804.897.0070 | LabReports@SanAir.com | SanAir.com

SanAir ID Number
26031222
FINAL REPORT
6/4/2026 4:41:39 PM

Name: Hurt & Proffitt, Inc.
Address: 2524 Langhorne Road
Lynchburg, VA 24501
Phone: 434-841-3893 (c)

Project Number: 20261262
P.O. Number:
Project Name: Albert Harris ES Classic
Collected Date: 5/27/2026
Received Date: 5/28/2026 10:15:00 AM

Dear Ken Hundley,

We at SanAir would like to thank you for the work you recently submitted. The 4 sample(s) were received on Thursday, May 28, 2026 via FedEx. The final report(s) is enclosed for the following sample(s): L-01, L-02, L-03, L-04.

These results only pertain to this job and should not be used in the interpretation of any other job. This report is only complete in its entirety. Refer to the listing below of the pages included in a complete final report.

Sincerely,

Abisola Kasali
Metals Laboratory Director
SanAir Technologies Laboratory

Final Report Includes:
- Cover Letter
- Chemistry Analysis
- Disclaimers and Additional Information

Sample conditions:
- 4 samples in Good condition.

SanAir Technologies Laboratory

SanAir ID Number
26031222
FINAL REPORT
6/4/2026 4:41:39 PM

Name: Hurt & Proffitt, Inc.
Address: 2524 Langhorne Road
Lynchburg, VA 24501
Phone: 434-841-3893 (c)

Project Number: 20261262
P.O. Number:
Project Name: Albert Harris ES Classic
Collected Date: 5/27/2026
Received Date: 5/28/2026 10:15:00 AM

Analyst: Runkle, Maya
Test Method: SW846/M3050B/7000B

Lead Paint Analysis

PAINT Sample	Description	µg Pb In Sample	Sample Size (grams)	Calculated RL	Sample Results	Sample Results
26031222 - 1	L-01	299	0.1139	87.8	2629	0.263 %
	Tan - Interior Walls				µg/g (ppm)	By Weight
26031222 - 2	L-02	2962	0.1183	84.5	25040	2.504 %
	Gray - Ext Door Frames				µg/g (ppm)	By Weight
26031222 - 3	L-03	13	0.1072	93.3	120.4	0.012 %
	Burgundy - Int Door Frames				µg/g (ppm)	By Weight
26031222 - 4	L-04	< 10.0	0.1178	84.9	<84.9	<0.009 %
	White - Mech Rm				µg/g (ppm)	By Weight

Method Reporting Limit <10 µg/0.1 g paint

Signature: Maya Runkle
Date: 5/29/2026

Reviewed: Charles Beach
Date: 5/29/2026

Lead in Paint Disclaimer

This report is the sole property of the client account named on the chain-of-custody (COC) submitted to SanAir Technologies Laboratory, Inc. (SanAir). Results in the report are confidential information intended only for the use by the customer listed on the chain of custody. Neither results nor reports will be discussed with or released to any third party without our client's written permission. Final reports cannot be reproduced, except in full, without written approval from SanAir to assure that parts of the report are not taken out of context. This report and any information contained within shall not be edited, altered, or modified in any way by any persons or agencies receiving, viewing, distributing, or otherwise possessing a copy of this final report. The laboratory reserves the right to perform amendments to any finalized report, of which shall supersede and make obsolete any previous editions. Such changes, modifications, additions, or deletions shall be effective immediately upon notice thereof, which may be given by means including but not limited to posting on the SanAir client portal website, electronic or conventional mail, or by any other means.

The information provided in this report applies only to the samples submitted and is relevant only for the date, time, and location of sampling. The accuracy of the results of the analysis is dependent upon the method of sample procurement and information provided by the client on the COC. SanAir is not responsible for the method of sample procurement. SanAir assumes no responsibility for information provided by the client on the COC such as project number, project name, collection dates, po number, special instructions, samples collected by, sample numbers, sample identifications, sample type, selected analysis type, flow rate, total volume or area, and start stop times that may affect the validity of the results in this report. SanAir only assures the precision and accuracy of the data it generates and assumes no responsibility for errors or biasing that occur during collection prior to SanAir's receipt of the sample(s). Evaluation reports are based solely on the sample(s) in the condition in which they are received at the laboratory and on the information provided by the client on the COC. Sample(s) were received in good condition unless otherwise noted on the report. All quality control results are acceptable unless otherwise noted. SanAir does not make contamination corrections to reports based upon analysis of laboratory and/or field blanks. When the client requires samples to be tested that deviate from a specific method or condition, all reported results may be affected by the deviation. SanAir assumes no responsibility or liability for the manner in which the results are used or interpreted. SanAir's Method Detection Limits (MDL) and Reporting Limits (RL) have been derived using various materials meeting each accrediting agencies' standards. Measurement uncertainty has been evaluated for this test method and is available upon request. All samples are disposed of after 60 days unless otherwise requested by the client.

SanAir Technologies Laboratory, Inc. participates in the Environmental Lead Accreditation Program (ELAP) administered by AIHA LAP, LLC (Laboratory ID LAP-162952), and has met the EPA's NLLAP program standards. SanAir also participates in the State of New York's DOH-ELAP program (NY Lab Id No. 11983) for lead in paint. This report does not constitute nor shall be used by the client to claim product, process, system, or person certification, approval, or endorsement by AIHA LAP, LLC, NELAC, NIST, and/or any other U.S. governmental agencies. All or some test results contained in this report may not be accredited by every local, state or federal regulatory agency. Refer to the SanAir website at www.sanair.com for copies of current certificates and scopes of various accreditations, certifications, and licenses or contact the laboratory for inquiries regarding the status or scope of an accreditation or certification.

AIHA LAP, LLC Lab ID: LAP-162952
New York State Department of Health Laboratory ID No: 11983
State of Connecticut Department of Public Health Environmental Laboratory Registration Number: PH-0105
Ohio Department of Health Environmental Lead Laboratory Approval Number E10049
State of Rhode Island Department of Health Environmental Lead Laboratory No LAO00371

Revision Date 4/6/2026

SanAir Technologies Laboratory
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Powhatan, VA 23139
804.897.1177 / 888.895.1177
Fax 804.897.0070
sanair.com

Metals & Lead Chain of Custody

SanAir ID Number
26031222

Received by MN on 5/28/26 at 10:15 AM

Company: HURT & PROFFITT INC	Project #: 20261262	Phone #: 276-613-4775
Address: 2524 LANGHORNE RD	Project Name: ALBERT HARRIS ES CLINIC	Phone #:
City, St., Zip: LYNCHBURG VA 24501	Date Collected: 5/27/26	Fax #:
Samples Collected By: K HUNDLEY	P.O. Number:	Email: khundley@HAPP.com
Account #:		Email:

Matrix Types

☐ Air ☐ Aqueous ☐ Bulk		
☒ Paint ☐ Sludge ☐ Soil		
☐ Dust ☐ Wipe ☐ Water, DW		
☐ Wastewater		
☐ Other:		

Metals Analysis Types

Total Concentration of Lead ☒		☐ ICP-total concentration of metals (please list metals):
Total Concentration of RCRA 8 Metals ☐		
TCLP for Lead ☐		
TCLP for RCRA 8 Metals ☐		☐ Other:
TCLP Full (w/ Organics) ☐		

*Turn Around Times				
	Same Day ☐	1 Day ☐	2 days ☐	3 Days ☐
	☒ Standard (5 day)	☐ Full TCLP (10d)		

***Courier charge for same day and 1 day TAT for offsite work.**

Sample #	Sample Identification/Location	Flow Rate	Start Time	Stop Time	Volume (L) or Area (Sq ft)
L-01	TAN - INTERIOR WALLS				10,000 SF
L-02	GRAY - EXT DOOR FRAMES				2 UNITS
L-03	BURGANDY - INT " "				12 UNITS
L-04	WHITE - MECH RM				2500 SF

Special Instructions	

Relinquished by	Date	Time	Received by	Date	Time
K HUNDLEY	5/27/26	PM			

Unless scheduled, the turn around time for all samples received after 3 pm will begin at 8 am the next business morning.
Weekend or Holiday work must be scheduled ahead of time and is charged at 150% of the Rush TAT rate
There is a minimum charge of $100 for weekend work. SanAir covers Standard Overnight FedEx shipping. Shipments billed to SanAir with a faster shipping rate will result in additional charges.

Page 1 of 1