

CITY OF BALTIMORE
Brandon M. Scott
Mayor

DEPARTMENT OF GENERAL SERVICES
Berke Attila
Director

CONTRACT NO. PRJ001888

FOREST PARK LIBRARY ADDITION AND RENOVATION

BOOK 2 OF 2

3023 GARRISON BLVD
BROOKLYN, MD 21216

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Chief
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(app).

2.10 HALL STATIONS

- A. Hall Stations, General: Buttons shall illuminate to indicate call has been registered at that floor for the indicated direction.
- B. Provide one pushbutton riser with faceplates having a brushed stainless steel finish.
- C. Phase 1 firefighter's service key switch, with instructions, shall be incorporated into the hall station at the designated level.
- D. Floor Identification Pads: Provide door jamb pads at each floor. Jamb pads shall comply with Americans with Disabilities Act (ADA) requirements.

2.11 MISCELLANEOUS ELEVATOR COMPONENTS

- A. Oil Hydraulic Silencer: Install multiple oil hydraulic silencers (muffler device) at the power unit location. The silencers shall contain pulsation absorbing material inserted in a blowout proof housing.
- B. Lockable three phase circuit breaker with auxiliary contact with shunt trip capability to be provided. Circuit breaker to be located behind locked panel (Group 2 security access) at controller landing entrance jamb and should be sized according to the National Electrical Code.
- C. Lockable single phase 110V circuit breaker for cab light and fan to be provided. Circuit breaker to be located behind locked panel (Group 2 security access) at controller landing entrance jamb should be sized according to the National Electrical Code

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Sound Isolation: Mount rotating and vibrating equipment on vibration-isolating mounts to minimize vibration transmission to structure and structure-borne noise due to elevator system.
- B. Lubricate operating parts of systems, including ropes, as recommended by manufacturers.
- C. Leveling Tolerance: 1/8 inch, up or down, regardless of load and travel direction.
- D. Set sills flush with finished floor surface at landing. Fill space under sill solidly with nonshrink, nonmetallic grout.
- E. Locate hall signal equipment for elevators as follows unless otherwise indicated:
 - 1. Mount hall lanterns at a minimum of 72 inches above finished floor.

SECTION 093013 - CERAMIC TILING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. The Drawings and general provisions of the Contract, including the City of Baltimore Department of Public Works Specifications (the “Green Book”) and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Porcelain tile.
 - 2. Crack isolation membranes.
 - 3. Setting material.
 - 4. Grout materials.
 - 5. Ceramic tile Accessories.

1.3 ACTION SUBMITTALS

- A. Product Data:
 - 1. Porcelain tile.
 - 2. Crack isolation membranes.
 - 3. Setting material.
 - 4. Grout materials.
 - 5. Ceramic tile Accessories.
- B. Samples:
 - 1. Full-size units of each type and composition of tile and for each color and finish required.
 - 2. Assembled samples mounted on a rigid panel, with grouted joints, for each type and composition of tile and for each color and finish required. Make samples at least 12 inches square, but not fewer than four tiles. Use grout of type and in color or colors approved for completed Work.
 - 3. Full-size units of each type of trim and accessory for each color and finish required.
 - 4. Ceramic tile Accessories in 6-inch lengths

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.

1.5 MAINTENANCE MATERIAL SUBMITTALS

- A. Extra Stock Material: Furnish extra materials, from the same production run, to Owner that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Tile and Trim Units: Furnish quantity of full-size units equal to 3 percent of amount installed for each type, composition, color, pattern, and size indicated.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications:
 - 1. Installer is a Five-Star member of the National Tile Contractors Association or a Trowel of Excellence member of the Tile Contractors' Association of America.
 - 2. Installer's supervisor for Project holds the International Masonry Institute's Supervisor Certification.

PART 2 - PRODUCTS

2.1 PRODUCTS, GENERAL

- A. ANSI Standards for Tile Installation Materials: Provide materials complying with ANSI A108.02, ANSI standards referenced in other Part 2 articles, ANSI standards referenced by TCNA installation methods specified in tile installation schedules, and other requirements specified.

2.2 PORCELAIN TILE

- A. Porcelain Tile Type CT-1, CT-2, CT-3
 - 1. Certification: Tile certified by the Porcelain Tile Certification Agency.
 - 2. Face Size: See Finish Schedule.
 - 3. Product Use Classification: Interior, Wet (IW).
 - 4. Physical Properties: Chemical resistant when tested with indicated chemicals in accordance with ASTM C650.
 - a. ANSI / ISO Class A.
 - 5. Tile Color, Glaze, and Pattern: See Finish Schedule.
 - 6. Grout Color: As selected by Architect from manufacturer's full range>.

2.3 CRACK ISOLATION MEMBRANES

- A. General: Manufacturer's standard product,] that complies with ANSI A118.12 for high performance and is recommended by manufacturer for application indicated. Include reinforcement and accessories recommended by manufacturer.

- B. Crack Isolation Membrane, Fluid Applied: Liquid-latex rubber or elastomeric polymer.

2.4 SETTING MATERIALS

- A. Standard Dry-Set Mortar (Thinset): ANSI A118.1.
 - 1. For wall applications, provide mortar that complies with requirements for nonsagging mortar in addition to other requirements in ANSI A118.1.
- B. Modified Dry-Set Mortar (Thinset): ANSI A118.4.
 - 1. Provide prepackaged, dry-mortar mix containing dry, redispersible, vinyl acetate or acrylic additive to which only water must be added at Project site.
 - 2. For wall applications, provide mortar that complies with requirements for nonsagging mortar in addition to other requirements in ANSI A118.4.

2.5 GROUT MATERIALS

- A. Standard Cement Grout: ANSI A118.6.

2.6 MISCELLANEOUS MATERIALS

- A. Top trim, Outside Corners and Cove Base metal trim: Profile designed specifically for wall and flooring applications; height to match tile and setting-bed thickness.
 - 1. Description: See Finish Schedule.
 - 2. Material and Finish: See Finish Schedule.
- B. Temporary Protective Coating: Formulated to protect exposed surfaces of tile against adherence of mortar and grout; compatible with tile, mortar, and grout products and easily removable after grouting is completed without damaging grout or tile.
- C. Tile Cleaner: A neutral cleaner capable of removing soil and residue without harming tile and grout surfaces, specifically approved for materials and installations indicated by tile and grout manufacturers.
- D. Grout Sealer: Grout manufacturer's standard product for sealing grout joints that does not change color or appearance of grout.

2.7 FLOORING TRANSITION TR-4

- 1. Basis of Design; Schluter®-RENO-TK
 - a. Stainless Steel 304

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions where tile will be installed, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
 - 1. Verify that substrates for setting tile are firm; dry; clean; free of coatings that are incompatible with tile-setting materials, including curing compounds and other substances that contain soap, wax, oil, or silicone; and comply with flatness tolerances required by ANSI A108.01 for installations indicated.
 - 2. Verify that concrete substrates for tile floors installed with thinset mortar comply with surface finish requirements in ANSI A108.01 for installations indicated.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Remove coatings, including curing compounds or other coatings, that are incompatible with tile-setting materials.
- B. Fill cracks, holes, and depressions in concrete substrates for tile floors installed with thinset mortar with trowelable leveling and patching compound specifically recommended by tile-setting material manufacturer.
- C. Where indicated, prepare substrates to receive waterproof membrane by applying a reinforced mortar bed that complies with ANSI A108.1 and is sloped 1/4 inch per foot toward drains.
- D. Blending: For tile exhibiting color variations, verify that tile has been factory blended and packaged so tile units taken from one package show same range of colors as those taken from other packages and match approved Samples. If not factory blended, either return to manufacturer or blend tiles at Project site before installing.
- E. Substrate Flatness:
 - 1. For tile shorter than 15 inches, confirm that structure or substrate is limited to variation of 1/4 inch in 10 ft. from the required plane, and no more than 1/16 inch in 12 inches when measured from tile surface high points.
 - 2. For large format tile, tile with at least one edge 15 inches or longer, confirm that structure or substrate is limited to 1/8 inch in 10 ft. from the required plane, and no more than 1/16 inch in 24 inches when measured from tile surface high points.

3.3 INSTALLATION OF CERAMIC TILE SYSTEM

- A. Install tile backing panels and treat joints in accordance with ANSI A108.11 and manufacturer's written instructions for type of application indicated.

- B. Install crack isolation membrane to comply with ANSI A108.17 and manufacturer's written instructions to produce membrane of uniform thickness that is bonded securely to substrate.
 - 1. Allow crack isolation membrane to cure before installing tile or setting materials over it.
- C. Install tile in accordance with TCNA's "Handbook for Ceramic, Glass, and Stone Tile Installation" for TCNA installation methods specified in tile installation schedules. Comply with parts of ANSI A108 series that are referenced in TCNA installation methods and specified in tile installation schedules and apply to types of setting and grouting materials used.
- D. Extend tile work into recesses and under or behind equipment and fixtures to form complete covering without interruptions unless otherwise indicated. Terminate work neatly at obstructions, edges, and corners without disrupting pattern or joint alignments.
- E. Accurately form intersections and returns. Perform cutting and drilling of tile without marring visible surfaces. Carefully grind cut edges of tile abutting trim, finish, or built-in items for straight aligned joints. Fit tile closely to electrical outlets, piping, fixtures, and other penetrations so plates, collars, or covers overlap tile.
- F. Where accent tile differs in thickness from field tile, vary setting-bed thickness so that tiles are flush.
- G. Jointing Pattern: Lay tile in grid pattern unless otherwise indicated. Lay out tile work and center tile fields in both directions in each space or on each wall area. Lay out tile work to minimize use of pieces that are less than half of a tile. Provide uniform joint widths unless otherwise indicated.
- H. Lay out tile wainscots to dimensions indicated or to next full tile beyond dimensions indicated.
- I. Movement Joints: Provide movement joints and other sealant-filled joints, including control, contraction, and isolation joints, where indicated on Drawings. Form joints during installation of setting materials, mortar beds, and tile. Keep joints free of dirt, debris, and setting materials prior to filling with sealants. Do not saw-cut joints after installing tiles.
 - 1. Where joints occur in concrete substrates, locate joints in tile surfaces directly above them.
- J. Metal Flooring Transitions: Install at locations indicated.
- K. Grout Sealer: Apply grout sealer to cementitious grout joints in tile floors in accordance with manufacturer's written instructions. As soon as sealer has penetrated grout joints, remove excess sealer and sealer from tile faces by wiping with soft cloth.

3.4 INTERIOR CERAMIC TILE INSTALLATION SCHEDULE

- 1. TCNA W242: Organic adhesive on gypsum board.
 - a. Ceramic Tile Type: CT-1, CT-2, CT-3.
 - b. Grout: Standard unsanded cement grout.
 - c. Joint Width: 1/8 inch.

- d. Movement Joints: Types located on Drawings.

END OF SECTION 093013

SECTION 095123 - ACOUSTICAL TILE CEILINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. The Drawings and general provisions of the Contract, including the City of Baltimore Department of Public Works Specifications (the "Green Book") and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Acoustical tiles.
 - 2. Metal suspension system.
 - 3. Accessories.

1.3 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

1.4 ACTION SUBMITTAL

- A. Product Data: For each type of product.
- B. Samples: For each exposed product and for each color and texture specified.

1.5 INFORMATIONAL SUBMITTALS

- A. Product test reports.
- B. Research reports.
- C. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

- A. Maintenance data.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Surface-Burning Characteristics: Comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - 1. Flame-Spread Index: Class A in accordance with ASTM E1264.

2.2 ACOUSTICAL TILES ACT-1, ACT-2

- A. Acoustical Tile Standard: Manufacturer's standard tiles of configuration indicated that comply with ASTM E1264.
- B. Classification: See Finish Schedule.
- C. Color: White.
- D. Light Reflectance (LR): 85%
- E. Ceiling Attenuation Class (CAC): 38.
- F. Noise Reduction Coefficient (NRC): .60.
- G. Edge/Joint Detail: Beveled tegular.
- H. Thickness: As indicated in a schedule.
- I. Modular Size: As indicated in a schedule.

2.3 METAL SUSPENSION SYSTEM

- A. Metal Suspension-System Standard: Manufacturer's standard, direct-hung, fully concealed, metal suspension system that complies with applicable requirements in ASTM C635/C635M.
- B. Direct-Hung, Double-Web Suspension System: Main and cross runners roll formed from and capped with cold-rolled steel sheet, prepainted, electrolytically zinc coated, or hot-dip galvanized, G30 coating designation.
 - 1. Structural Classification: Intermediate-duty system.
 - 2. Access: Upward, with initial access openings of size indicated below and located throughout ceiling within each module formed by main and cross runners, with additional access available by progressively removing remaining acoustical tiles.
 - a. Initial Access Opening: In each module, 24 by 24 inches.

2.4 ACCESSORIES

- A. Attachment Devices: Size for five times the design load indicated in ASTM C635/C635M, Table 1, "Direct Hung," unless otherwise indicated. Comply with seismic design requirements.
- B. Seismic Clips: Manufacturer's standard seismic clips designed to secure acoustical tiles in-place during a seismic event.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Measure each ceiling area and establish layout of acoustical tiles to balance border widths at opposite edges of each ceiling. Avoid using less-than-half-width tiles at borders unless otherwise indicated.
- B. Layout openings for penetrations centered on the penetrating items.

3.2 INSTALLATION OF SUSPENDED ACOUSTICAL TILE CEILINGS

- A. Install suspended acoustical tile ceilings in accordance with ASTM C636/C636M and manufacturer's written instructions.
- B. Install edge moldings and trim of type indicated at perimeter of acoustical ceiling area and where necessary to conceal edges of acoustical tiles.
 - 1. Apply acoustical sealant in a continuous ribbon concealed on back of vertical legs of moldings before they are installed.
 - 2. Do not use exposed fasteners, including pop rivets, on moldings and trim.
- C. Arrange directionally patterned acoustical tiles as indicated on reflected ceiling plans.

END OF SECTION 095123

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SECTION 096513 - RESILIENT BASE AND ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. The Drawings and general provisions of the Contract, including the City of Baltimore Department of Public Works Specifications (the "Green Book") and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Thermoplastic-rubber base.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Samples: For each exposed product and for each color and texture specified.

PART 2 - PRODUCTS

2.1 THERMOPLASTIC-RUBBER BASE RB-1, RB-2

- A. Product Standard: ASTM F1861, Type TP (rubber, thermoplastic).
 - 1. Group: I (solid, homogeneous).
 - 2. Style and Location:
 - a. Style A, Straight: Provide in areas with carpet.
 - b. Style B, Cove: Provide in areas with resilient floor coverings.
- B. Thickness: 0.125 inch.
- C. Height: 4 inches.
- D. Lengths: Coils in manufacturer's standard length.
- E. Outside Corners: Preformed.
- F. Inside Corners: Preformed.
- G. Colors: As selected from manufacturer's standard colors.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Prepare substrates according to manufacturer's written instructions to ensure adhesion of resilient products.
- B. Fill cracks, holes, and depressions in substrates with trowelable leveling and patching compound; remove bumps and ridges to produce a uniform and smooth substrate.
- C. Do not install resilient products until materials are the same temperature as space where they are to be installed.
- D. Immediately before installation, sweep and vacuum clean substrates to be covered by resilient products.

3.2 RESILIENT BASE INSTALLATION

- A. Comply with manufacturer's written instructions for installing resilient base.
- B. Apply resilient base to walls, columns, pilasters, casework and cabinets in toe spaces, and other permanent fixtures in rooms and areas where base is required.
- C. Install resilient base in lengths as long as practical without gaps at seams and with tops of adjacent pieces aligned.
- D. Tightly adhere resilient base to substrate throughout length of each piece, with base in continuous contact with horizontal and vertical substrates.
- E. Do not stretch resilient base during installation.
- F. On masonry surfaces or other similar irregular substrates, fill voids along top edge of resilient base with manufacturer's recommended adhesive filler material.
- G. Preformed Corners: Install preformed corners before installing straight pieces.

3.3 CLEANING AND PROTECTION

- A. Comply with manufacturer's written instructions for cleaning and protecting resilient products.

END OF SECTION 096513

SECTION 096519 - RESILIENT TILE FLOORING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. The Drawings and general provisions of the Contract, including the City of Baltimore Department of Public Works Specifications (the “Green Book”) and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. High performance luxury vinyl floor tile.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Samples: For each exposed product and for each color and pattern specified.

1.4 CLOSEOUT SUBMITTALS

- A. Maintenance data.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: An entity that employs installers and supervisors who are competent in techniques required by manufacturer for floor tile installation.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Fire-Test-Response Characteristics: For resilient floor tile, as determined by testing identical products according to ASTM F1700 by a qualified testing agency.
 - 1. Class III printed vinyl plank

2.2 HIGH PERFORMANCE VINYL FLOOR TILE RES-1

- A. Tile Standard: ASTM F1700.
 - 1. Class: Class III, Printed Film Vinyl Tile.
 - 2. Type: A, Smooth Surface.
- B. Thickness: 4.5 mm.
- C. Size: 25 by 1000 mm.
- D. Colors and Patterns: As indicated on finish schedule.

2.3 FLOORING TRANSITIONS

- A. Wheel Traffic Transitional Mouldings
 - 1. Manufactured from a homogeneous composition of polyvinyl chloride (PVC), high quality additives, and colorants. All Wheel Traffic Transitional Mouldings to comply with A.D.A. requirements of Section 4.5.2 Changes of Level. Thickness: 4.5 mm.
 - 2. Size: 12 foot lengths minimum.
 - 3. Colors and Patterns: As indicated on finish schedule.
 - 4. Hardness: ASTM D 2240 - Not less than 85 Shore A
 - 5. Abrasion Resistance: ASTM D 3389 - 0.22 mg/cycle.
 - 6. Slip Resistance: ASTM D 2047 - Exceed Federal Standards and ADA recommendations of .5 for flat surfaces.
 - 7. Fire Resistance: ASTM E 648/NFPA 253 (Critical Radiant Flux) - Class 1.

2.4 INSTALLATION MATERIALS

- A. Trowelable Leveling and Patching Compounds: Latex-modified, portland-cement-based or blended hydraulic-cement-based formulation provided or approved by floor tile manufacturer for applications indicated.
- B. Adhesives: Water-resistant type recommended by floor tile and adhesive manufacturers to suit floor tile and substrate conditions indicated.
- C. Floor Polish: Provide protective, liquid floor-polish products recommended by floor tile manufacturer.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Prepare substrates according to floor tile manufacturer's written instructions to ensure adhesion of resilient products.
- B. Concrete Substrates: Prepare according to ASTM F710.

1. Verify that substrates are dry and free of curing compounds, sealers, and hardeners.
 2. Remove substrate coatings and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, using mechanical methods recommended by floor tile manufacturer. Do not use solvents.
 3. Alkalinity and Adhesion Testing: Perform tests recommended by floor tile manufacturer. Proceed with installation only after substrate alkalinity falls within range on pH scale recommended by manufacturer in writing, but not less than 5 or more than 9 pH.
 4. Moisture Testing: Perform tests so that each test area does not exceed 200 sq. ft. and perform no fewer than three tests in each installation area and with test areas evenly spaced in installation areas.
 - a. Relative Humidity Test: Using in-situ probes, ASTM F2170. Proceed with installation only after substrates have a maximum 85 percent relative humidity level measurement.
- C. Immediately before installation, sweep and vacuum clean substrates to be covered by resilient floor tile.

3.2 FLOOR TILE INSTALLATION

- A. Comply with manufacturer's written instructions for installing floor tile.
- B. Lay out floor tiles from center marks established with principal walls, discounting minor offsets, so tiles at opposite edges of room are of equal width. Adjust as necessary to avoid using cut widths that equal less than one-half tile at perimeter.
 1. Lay tiles in pattern indicated.
- C. Match floor tiles for color and pattern by selecting tiles from cartons in the same sequence as manufactured and packaged, if so numbered. Discard broken, cracked, chipped, or deformed tiles.
 1. Lay tiles in pattern of colors and sizes indicated.
- D. Scribe, cut, and fit floor tiles to butt neatly and tightly to vertical surfaces and permanent fixtures including built-in furniture, cabinets, pipes, outlets, and door frames.
- E. Extend floor tiles into toe spaces, door reveals, closets, and similar openings. Extend floor tiles to center of door openings.
- F. Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating on floor tiles as marked on substrates. Use chalk or other nonpermanent marking device.
- G. Adhere floor tiles to substrates using a full spread of adhesive applied to substrate to produce a completed installation without open cracks, voids, raising and puckering at joints, telegraphing of adhesive spreader marks, and other surface imperfections.

END OF SECTION 096519

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SECTION 096813 - TILE CARPETING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. The Drawings and general provisions of the Contract, including the City of Baltimore Department of Public Works Specifications (the "Green Book") and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Carpet tile.
 - 2. Walk off mat.

1.3 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

1.4 ACTION SUBMITTALS

- A. Product data.
- B. Shop Drawings: For carpet tile installation.
- C. Samples: Manufacturer's standard color sheets, showing full range of available colors for each type of carpet tile.

1.5 INFORMATIONAL SUBMITTALS

- A. Product test reports.
- B. Sample warranties.

1.6 CLOSEOUT SUBMITTALS

- A. Maintenance data.

1.7 QUALITY ASSURANCE

- A. Installer Qualifications: An authorized representative who is certified by the International Certified Floorcovering Installers Association at the Commercial II certification level.

1.8 WARRANTY

- A. Special Warranty for Carpet Tiles: Manufacturer agrees to repair or replace components of carpet tile installation that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: 15 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 CARPET TILE CPT-1

- A. Color: As indicated on Finish Schedule.
- B. Pattern: As indicated on Finish Schedule.
- C. Fiber Content: 100% Recycled Content Nylon.
- D. Pile Characteristic: Engaged Tufted Pattern Loop.
- E. Density: 8,780 oz/yd³.
- F. Pile Thickness: .12 inches for finished carpet tile].
- G. Stitches: 7.5 inch.
- H. Gage: 1/10 inch.
- I. Backing System: Manufacturers standard vinyl backing system, GlasBac.
- J. Size: As indicated on Finish Schedule.
- K. Applied Treatments:
 - 1. Soil-Resistance Treatment: Protekt²®.
 - 2. Antimicrobial Treatment: Manufacturer's standard treatment that protects carpet tiles as follows:
 - a. Antimicrobial Activity: Not less than 2 mm halo of inhibition for gram-positive bacteria, not less than 1 mm halo of inhibition for gram-negative bacteria, and no fungal growth, in accordance with AATCC 174.
- L. Performance Characteristics:

1. Texture Appearance Retention Rating (TARR): Heavy traffic, 3.0 minimum in accordance with ASTM D7330.
2. Critical Radiant Flux Classification: Not less than 0.45 W/sq. cm in accordance with NFPA 253.
3. Dimensional Tolerance: Within .10% of specified size dimensions, as determined by physical measurement.
4. Colorfastness to Crocking: Not less than 4, wet and dry, in accordance with AATCC 165.
5. Colorfastness to Light: Not less than 4 after 60 AFU (AATCC fading units) in accordance with AATCC 16.3 Option 3.
6. Electrostatic Propensity: Less than 3 kV in accordance with AATCC 134.

2.2 CARPET TILE CPT-2

- A. Color: As indicated on Finish Schedule.
- B. Pattern: As indicated on Finish Schedule.
- C. Fiber Content: 100% Recycled Content Nylon.
- D. Pile Characteristic: Tufted Textured Loop.
- E. Density: 7,962 oz/yd³.
- F. Pile Thickness: .10 inches for finished carpet tile].
- G. Stitches: 9.8 inch.
- H. Gage: 1/12 inch.
- I. Backing System: Manufacturers standard vinyl backing system, GlasBac.
- J. Size: As indicated on Finish Schedule.
- K. Applied Treatments:
 1. Soil-Resistance Treatment: Protekt²®.
 2. Antimicrobial Treatment: Manufacturer's standard treatment that protects carpet tiles as follows:
 - a. Antimicrobial Activity: Not less than 2 mm halo of inhibition for gram-positive bacteria, not less than 1 mm halo of inhibition for gram-negative bacteria, and no fungal growth, in accordance with AATCC 174.
- L. Performance Characteristics:
 1. Texture Appearance Retention Rating (TARR): Heavy traffic, 3.0 minimum in accordance with ASTM D7330.
 2. Critical Radiant Flux Classification: Not less than 0.45 W/sq. cm in accordance with NFPA 253.

3. Dimensional Tolerance: Within .10% of specified size dimensions, as determined by physical measurement.
4. Colorfastness to Crocking: Not less than 4, wet and dry, in accordance with AATCC 165.
5. Colorfastness to Light: Not less than 4 after 60 AFU (AATCC fading units) in accordance with AATCC 16.3 Option 3.
6. Electrostatic Propensity: Less than 3 kV in accordance with AATCC 134.

2.3 CARPET TILE CPT-3

- A. Color: As indicated on Finish Schedule.
- B. Pattern: As indicated on Finish Schedule.
- C. Fiber Content: 100% Recycled Content Nylon.
- D. Pile Characteristic: Tufted Textured Loop.
- E. Density: 6,968 oz/yd³.
- F. Pile Thickness: .09 inches for finished carpet tile].
- G. Stitches: 8.3 inch.
- H. Gage: 1/12 inch.
- I. Backing System: Manufacturers standard vinyl backing system, GlasBac.
- J. Size: As indicated on Finish Schedule.
- K. Applied Treatments:
 1. Soil-Resistance Treatment: Protekt²®.
 2. Antimicrobial Treatment: Manufacturer's standard treatment that protects carpet tiles as follows:
 - a. Antimicrobial Activity: Not less than 2 mm halo of inhibition for gram-positive bacteria, not less than 1 mm halo of inhibition for gram-negative bacteria, and no fungal growth, in accordance with AATCC 174.
- L. Performance Characteristics:
 1. Texture Appearance Retention Rating (TARR): Heavy traffic, 3.0 minimum in accordance with ASTM D7330.
 2. Critical Radiant Flux Classification: Not less than 0.45 W/sq. cm in accordance with NFPA 253.
 3. Dimensional Tolerance: Within .10% of specified size dimensions, as determined by physical measurement.
 4. Colorfastness to Crocking: Not less than 4, wet and dry, in accordance with AATCC 165.
 5. Colorfastness to Light: Not less than 4 after 60 AFU (AATCC fading units) in accordance with AATCC 16.3 Option 3.

6. Electrostatic Propensity: Less than 3 kV in accordance with AATCC 134.

2.4 CARPET TILE WOM-1

- A. Color: As indicated on Finish Schedule.
- B. Pattern: As indicated on Finish Schedule.
- C. Fiber Content: Ecosolution Q100™ Nylon.
- D. Pile Characteristic: Multi-Level Pattern Loop.
- E. Density: 7,814 oz/yd³.
- F. Pile Thickness: .25 inches for finished carpet tile].
- G. Stitches: 8.5 inch.
- H. Gage: 1/12 inch.
- I. Primary Backing/Backcoating: Manufacturer's standard composite materials.
- J. Secondary Backing System: Ecoworx® Tile
- K. Size: As indicated on Finish Schedule.
- L. Applied Treatments:
 1. Soil-Resistance Treatment: SSP® Shaw Soil Protection
 2. Antimicrobial Treatment: Manufacturer's standard treatment that protects carpet tiles as follows:
 - a. Antimicrobial Activity: Not less than 2 mm halo of inhibition for gram-positive bacteria, not less than 1 mm halo of inhibition for gram-negative bacteria, and no fungal growth, in accordance with AATCC 174.
- M. Performance Characteristics:
 1. Texture Appearance Retention Rating (TARR): Heavy traffic, 3.0 minimum in accordance with ASTM D7330.
 2. Critical Radiant Flux Classification: Not less than 0.45 W/sq. cm in accordance with NFPA 253.
 3. Dimensional Tolerance: Within .10% of specified size dimensions, as determined by physical measurement.
 4. Colorfastness to Crocking: Not less than 4, wet and dry, in accordance with AATCC 165.
 5. Colorfastness to Light: Not less than 4 after 60 AFU (AATCC fading units) in accordance with AATCC 16.3 Option 3.
 6. Electrostatic Propensity: Less than 3 kV in accordance with AATCC 134.

2.5 INSTALLATION ACCESSORIES

- A. Trowelable Leveling and Patching Compounds: Latex-modified, hydraulic-cement-based formulation provided or recommended in writing by carpet tile manufacturer.
- B. Adhesives: Water-resistant, mildew-resistant, nonstaining, pressure-sensitive types to suit products and subfloor conditions indicated, that comply with flammability requirements for installed carpet tile, and that are recommended in writing by carpet tile manufacturer for releasable installation.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for maximum moisture content, alkalinity range, installation tolerances, and other conditions affecting carpet tile performance.
- B. Examine carpet tile for type, color, pattern, and potential defects.
- C. Concrete Slabs: Verify that finishes comply with requirements specified in Section 033000 "Cast-in-Place Concrete" and that surfaces are free of cracks, ridges, depressions, scale, and foreign deposits.
 - 1. Moisture Testing: Perform tests so that each test area does not exceed 200 sq. ft. (and perform no fewer than three tests in each installation area and with test areas evenly spaced in installation areas.
 - a. Relative Humidity Test: Using in situ probes, ASTM F2170. Proceed with installation only after substrates have a maximum 75 percent relative humidity level measurement.
 - b. Perform additional moisture tests recommended in writing by adhesive and carpet tile manufacturers. Proceed with installation only after substrates pass testing.
- D. Wood Subfloors: Verify the following:
 - 1. Underlayment over subfloor complies with requirements specified in Section 061600 "Sheathing."
 - 2. Underlayment surface is free of irregularities and substances that may interfere with adhesive bond or show through surface.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. General: Comply with CRI 104 and with carpet tile manufacturer's written installation instructions for preparing substrates.

- B. Use trowelable leveling and patching compounds, in accordance with manufacturer's written instructions, to fill cracks, holes, depressions, and protrusions in substrates. Fill or level cracks, holes and depressions 1/8 inch wide or wider, and protrusions more than 1/32 inch unless more stringent requirements are required by manufacturer's written instructions.
- C. Concrete Substrates: Remove coatings, including curing compounds, and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, without using solvents. Use mechanical methods recommended in writing by adhesive and carpet tile manufacturers.
- D. Metal Substrates: Clean grease, oil, soil and rust, and prime if recommended in writing by adhesive manufacturer. Rough sand painted metal surfaces and remove loose paint. Sand aluminum surfaces, to remove metal oxides, immediately before applying adhesive.
- E. Broom and vacuum clean substrates to be covered immediately before installing carpet tile.

3.3 INSTALLATION

- A. General: Comply with CRI 104, Section 10, "Carpet Tile," and with carpet tile manufacturer's written installation instructions.
- B. Installation Method: Glue down; install every tile with full-spread, releasable, pressure-sensitive adhesive.
- C. Maintain dye-lot integrity. Do not mix dye lots in same area.
- D. Maintain pile-direction patterns indicated on Drawings.
- E. Cut and fit carpet tile to butt tightly to vertical surfaces, permanent fixtures, and built-in furniture including cabinets, pipes, outlets, edgings, thresholds, and nosings. Bind or seal cut edges as recommended in writing by carpet tile manufacturer.
- F. Extend carpet tile into toe spaces, door reveals, closets, open-bottomed obstructions, removable flanges, alcoves, and similar openings.
- G. Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating on carpet tile as marked on subfloor. Use nonpermanent, nonstaining marking device.
- H. Install pattern parallel to walls and borders.

3.4 CLEANING AND PROTECTION

- A. Perform the following operations immediately after installing carpet tile:
 - 1. Remove excess adhesive and other surface blemishes using cleaner recommended by carpet tile manufacturer.
 - 2. Remove yarns that protrude from carpet tile surface.
 - 3. Vacuum carpet tile using commercial machine with face-beater element.

- B. Protect carpet tile against damage from construction operations and placement of equipment and fixtures during the remainder of construction period. Use protection methods indicated or recommended in writing by carpet tile manufacturer.

END OF SECTION 096813

SECTION 099114 - EXTERIOR PAINTING (MPI STANDARDS)

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. The Drawings and general provisions of the Contract, including the City of Baltimore Department of Public Works Specifications (the "Green Book") and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:

- 1. Surface preparation and application of paint systems on the following exterior substrates:
 - a. Steel and iron.
 - b. Galvanized metal.
 - c. Wood.
 - d. Fiberglass.
 - e. Gypsum soffit board.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include printout of current "MPI Approved Products List" for each product category specified, with the proposed product highlighted.
- B. Samples: For each type of topcoat product.
- C. Product List: Cross-reference to paint system and locations of application areas. Use same designations indicated on Drawings and in the Exterior Painting Schedule to cross-reference paint systems specified in this Section. Include color designations.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, products listed in the Exterior Painting Schedule for the paint category indicated.

2.2 PAINT PRODUCTS

- A. MPI Standards: Provide products complying with MPI standards indicated and listed in its "MPI Approved Products List."
- B. Material Compatibility:
 - 1. Provide materials for use within each paint system that are compatible with one another, and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
 - 2. For each coat in a paint system, provide products recommended in writing by topcoat manufacturers for use in paint system and on substrate indicated.
- C. Colors: As indicated in a color schedule or match existing color.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify suitability of substrates, including surface conditions and compatibility, with existing finishes and primers.
- B. Proceed with coating application only after unsatisfactory conditions have been corrected.
 - 1. Application of coating indicates acceptance of surfaces and conditions.

3.2 PREPARATION

- A. Comply with manufacturer's written instructions and recommendations in "MPI Manual" applicable to substrates and paint systems indicated.
- B. Remove hardware, covers, plates, and similar items already in place that are removable and are not to be painted. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and painting.
 - 1. After completing painting operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection.

3.3 INSTALLATION

- A. Apply paints in accordance with manufacturer's written instructions and recommendations in "MPI Manual."
- B. Apply paints to produce surface films without cloudiness, spotting, holidays, laps, brush marks, roller tracking, runs, sags, ropiness, or other surface imperfections. Cut in sharp lines and color breaks.

3.4 CLEANING AND PROTECTION

- A. After completing paint application, clean spattered surfaces. Remove spattered paints by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.
- B. Protect work of other trades against damage from paint application. Correct damage to work of other trades by cleaning, repairing, replacing, and refinishing, as approved by Architect, and leave in an undamaged condition.
- C. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

3.5 EXTERIOR PAINTING SCHEDULE

- A. Steel and Iron Substrates:
 - 1. Water-Based Light Industrial Coating System MPI EXT 5.1B:
 - a. Zinc-Rich Prime Coat: Primer, zinc rich, inorganic, MPI #19.
 - b. Intermediate Coat: Light industrial coating, exterior, water based, matching topcoat.
 - c. Semigloss Topcoat: Light industrial coating, exterior, water based, semigloss (MPI Gloss Level 5), MPI #163.
- B. Galvanized-Metal Substrates:
 - 1. Latex System MPI EXT 5.3H:
 - a. Water-Based Prime Coat: Primer, galvanized, water based, MPI #134.
 - b. Intermediate Coat: Latex, exterior, matching topcoat.
 - c. Semigloss Topcoat: Latex, exterior, semigloss (MPI Gloss Level 5), MPI #11.
- C. Wood Substrates: Wood trim, Architectural woodwork, and Doors.
 - 1. Latex System MPI EXT 6.3A:
 - a. Prime Coat: Primer, alkyd for exterior wood, MPI #5.
 - b. Intermediate Coat: Latex, exterior, matching topcoat.
 - c. Semigloss Topcoat: Latex, exterior, semigloss (MPI Gloss Level 5), MPI #11.
- D. Fiberglass Substrates:
 - 1. Latex System MPI EXT 6.7A:
 - a. Prime Coat: Primer, bonding, solvent based, MPI #69.

- b. Intermediate Coat: Latex, exterior, matching topcoat.
 - c. Semigloss Topcoat: Latex, exterior, semigloss (MPI Gloss Level 5), MPI #11.
- E. Exterior Gypsum Board Substrates:
- 1. Latex System MPI EXT 9.2A:
 - a. Prime Coat: Primer, latex for exterior wood (reduced), MPI #6.
 - b. Intermediate Coat: Latex, exterior, matching topcoat.
 - c. Semigloss Topcoat: Latex, exterior, semigloss (MPI Gloss Level 5), MPI #11.

END OF SECTION 099114

SECTION 099124 - INTERIOR PAINTING (MPI STANDARDS)

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. The Drawings and general provisions of the Contract, including the City of Baltimore Department of Public Works Specifications (the "Green Book") and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes surface preparation and the application of paint systems on interior substrates.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product. Include preparation requirements and application instructions.
 - 1. Include printout of current "MPI Approved Products List" for each product category specified, with the proposed product highlighted.
- B. Samples: For each type of topcoat product.
- C. Product List: Use same designations indicated on Drawings and in the Interior Painting Schedule to cross-reference paint systems specified in this Section. Include color designations.

1.4 QUALITY ASSURANCE

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to products listed in the Interior Painting Schedule for the paint category indicated.

2.2 PAINT, GENERAL

- A. MPI Standards: Products shall comply with MPI standards indicated and shall be listed in its "MPI Approved Products List."
- B. Material Compatibility:

1. Materials for use within each paint system shall be compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
 2. For each coat in a paint system, products shall be recommended in writing by topcoat manufacturers for use in paint system and on substrate indicated.
- C. Colors: As indicated in a color schedule.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify suitability of substrates, including surface conditions and compatibility, with existing finishes and primers.
- B. Proceed with coating application only after unsatisfactory conditions have been corrected.
 1. Application of coating indicates acceptance of surfaces and conditions.

3.2 PREPARATION

- A. Comply with manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual" applicable to substrates and paint systems indicated.
- B. Remove hardware, covers, plates, and similar items already in place that are removable and are not to be painted. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and painting.
- C. After completing painting operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection if any.

3.3 INSTALLATION

- A. Apply paints according to manufacturer's written instructions and to recommendations in "MPI Manual."
- B. Apply paints to produce surface films without cloudiness, spotting, holidays, laps, brush marks, roller tracking, runs, sags, ropiness, or other surface imperfections. Cut in sharp lines and color breaks.
- C. Painting Fire-Suppression, Plumbing, HVAC, Electrical, Communication, and Electronic Safety and Security Work:
 1. Paint the following work where exposed in equipment rooms:
 - a. Uninsulated metal piping.
 - b. Uninsulated plastic piping.
 - c. Pipe hangers and supports.

2. Paint portions of internal surfaces of metal ducts, without liner, behind air inlets and outlets that are visible from occupied spaces.

3.4 FIELD QUALITY CONTROL

- A. Dry-Film Thickness Testing: Owner may engage the services of a qualified testing and inspecting agency to inspect and test paint for dry-film thickness.
 1. Contractor shall touch up and restore painted surfaces damaged by testing.
 2. If test results show that dry-film thickness of applied paint does not comply with paint manufacturer's written recommendations, Contractor shall pay for testing and apply additional coats as needed to provide dry-film thickness that complies with paint manufacturer's written recommendations.

3.5 CLEANING AND PROTECTION

- A. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.
- B. After completing paint application, clean spattered surfaces. Remove spattered paints by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.
- C. Protect work of other trades against damage from paint application. Correct damage to work of other trades by cleaning, repairing, replacing, and refinishing, as approved by Architect, and leave in an undamaged condition.
- D. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

3.6 INTERIOR PAINTING SCHEDULE

- A. Concrete Substrates, Traffic Surfaces:
 1. Solvent-Based Concrete Floor Sealer System, MPI INT 3.2F:
 - a. First Coat: Sealer, solvent based, for concrete floors, matching topcoat.
 - b. Topcoat: Sealer, solvent based, for concrete floors, MPI #104.
- B. CMU Substrates:
 1. Institutional Low-Odor/VOC Latex System, MPI INT 4.2E:
 - a. Block Filler: Block filler, latex, interior/exterior, MPI #4.
 - b. Intermediate Coat: Latex, interior, institutional low odor/VOC, matching topcoat.
 - c. Topcoat: Latex, interior, institutional low odor/VOC (MPI Gloss Level 3), MPI #145.

C. Steel Substrates:

1. Institutional Low-Odor/VOC Latex System, MPI INT 5.1S:
 - a. Prime Coat: Primer, rust inhibitive, water based MPI #107.
 - b. Intermediate Coat: Latex, interior, institutional low odor/VOC, matching topcoat.
 - c. Topcoat: Latex, interior, institutional low odor/VOC, semigloss (MPI Gloss Level 5), MPI #147.

D. Galvanized-Metal Substrates:

1. Institutional Low-Odor/VOC Latex System, MPI INT 5.3N:
 - a. Prime Coat: Primer, galvanized, water based, MPI #134.
 - b. Intermediate Coat: Latex, interior, institutional low odor/VOC, matching topcoat.
 - c. Topcoat: Latex, interior, institutional low odor/VOC (MPI Gloss Level 2), MPI #144.

E. Aluminum (Not Anodized or Otherwise Coated) Substrates:

1. Institutional Low-Odor/VOC Latex System, MPI INT 5.4G:
 - a. Prime Coat: Primer, quick dry, for aluminum, MPI #95.
 - b. Intermediate Coat: Latex, interior, institutional low odor/VOC, matching topcoat.
 - c. Topcoat: Latex, interior, institutional low odor/VOC, gloss (MPI Gloss Level 6), MPI #148.

F. Wood Substrates: Wood trim, Architectural woodwork, Doors.

1. Institutional Low-Odor/VOC Latex System, MPI INT 6.3V:
 - a. Prime Coat: Primer, latex, for interior wood, MPI #39.
 - b. Intermediate Coat: Latex, interior, institutional low odor/VOC, matching topcoat.
 - c. Topcoat: Latex, interior, institutional low odor/VOC, semigloss (MPI Gloss Level 5), MPI #147.

G. Wood Substrates: Wood paneling and casework.

1. Institutional Low-Odor/VOC Latex System, MPI INT 6.4T:
 - a. Prime Coat: Primer, latex, for interior wood, MPI #39.
 - b. Intermediate Coat: Latex, interior, institutional low odor/VOC, matching topcoat.

- c. Topcoat: Latex, interior, institutional low odor/VOC, semigloss (MPI Gloss Level 5), MPI #147.

H. Gypsum Board and Plaster Substrates:

- 1. Institutional Low-Odor/VOC Latex System, MPI INT 9.2M:
 - a. Prime Coat: Primer sealer, interior, institutional low odor/VOC, MPI #149.
 - b. Intermediate Coat: Latex, interior, institutional low odor/VOC, matching topcoat.
 - c. Topcoat: Latex, interior, institutional low odor/VOC (MPI Gloss Level 3), MPI #145.

END OF SECTION 099124

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SECTION 099600 - HIGH-PERFORMANCE COATINGS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes surface preparation and the application of high-performance coating systems on the following substrates:
 - 1. Exterior Substrates:
 - a. Concrete, vertical surfaces.
 - b. Clay masonry.
 - c. Concrete masonry units (CMUs).
 - d. Steel.
 - e. Galvanized metal.
 - f. Aluminum (not anodized or otherwise coated).
 - g. Wood.

1.2 DEFINITIONS

- A. MPI Gloss Level 5: 35 to 70 units at 60 degrees, according to ASTM D523.
- B. MPI Gloss Level 6: 70 to 85 units at 60 degrees, according to ASTM D523.
- C. MPI Gloss Level 7: More than 85 units at 60 degrees, according to ASTM D523.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product. Include preparation requirements and application instructions.
 - 1. Include printout of current "MPI Approved Products List" for each product category specified, with the proposed product highlighted.
- B. Samples: For each type of coating system and in each color and gloss of topcoat indicated.

1.4 QUALITY ASSURANCE

- A. Mockups: Apply mockups of each coating system indicated to verify preliminary selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
 - 1. Architect will select one surface to represent surfaces and conditions for application of each coating system.

- a. Other Items: Architect will designate items or areas required.
2. Final approval of color selections will be based on mockups.
 - a. If preliminary color selections are not approved, apply additional mockups of additional colors selected by Architect at no added cost to Owner.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to products listed in the Exterior High-Performance Coating Schedule or Interior High-Performance Coating Schedule for the coating category indicated.

2.2 HIGH-PERFORMANCE COATINGS, GENERAL

- A. MPI Standards: Products shall comply with MPI standards indicated and shall be listed in its "MPI Approved Products Lists."
- B. Material Compatibility:
 1. Materials for use within each paint system shall be compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
 2. For each coat in a paint system, products shall be recommended in writing by topcoat manufacturers for use in paint system and on substrate indicated.
- C. Colors: As selected by Architect from manufacturer's full range.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.
- B. Maximum Moisture Content of Substrates: When measured with an electronic moisture meter as follows:
 1. Concrete: 12 percent.
 2. Fiber-Cement Board: 12 percent.
 3. Masonry (Clay and CMUs): 12 percent.
 4. Wood: 15 percent.
 5. Gypsum Board: 12 percent.
 6. Plaster: 12 percent.

- C. Verify suitability of substrates, including surface conditions and compatibility with existing finishes and primers.
- D. Proceed with coating application only after unsatisfactory conditions have been corrected.
 - 1. Application of coating indicates acceptance of surfaces and conditions.

3.2 PREPARATION

- A. Comply with manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual" applicable to substrates and coating systems indicated.
- B. Remove hardware, covers, plates, and similar items already in place that are removable and are not to be painted. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and painting.
 - 1. After completing painting operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection if any.
- C. Clean substrates of substances that could impair bond of coatings, including dust, dirt, oil, grease, and incompatible paints and encapsulants.
 - 1. Remove incompatible primers and reprime substrate with compatible primers or apply tie coat as required to produce coating systems indicated.

3.3 APPLICATION

- A. Apply high-performance coatings according to manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual."
- B. Apply coatings to produce surface films without cloudiness, spotting, holidays, laps, brush marks, runs, sags, ropiness, or other surface imperfections. Produce sharp glass lines and color breaks.

3.4 EXTERIOR HIGH-PERFORMANCE COATING SCHEDULE

- A. Concrete Substrates, Vertical Surfaces:
 - 1. Epoxy-Modified Latex System MPI EXT 3.1E:
 - a. Prime Coat: Epoxy-modified latex, matching topcoat.
 - b. Intermediate Coat: Epoxy-modified latex, matching topcoat.
 - c. Topcoat: Epoxy-modified latex, semi-gloss (MPI Gloss Level 5).
- B. Concrete Substrates, Horizontal Surfaces:
 - 1. Epoxy Non-Slip Deck Coating System MPI EXT 3.2C:
 - a. Prime Coat: As recommended in writing by topcoat manufacturer.

- b. Intermediate Coat: As recommended in writing by topcoat manufacturer.
- c. Topcoat: Epoxy deck coating (slip resistant), MPI #82.

C. CMU Substrates:

- 1. Epoxy System MPI EXT 4.2E:
 - a. Block Filler: Block filler, epoxy, MPI #116.
 - b. Intermediate Coat: Epoxy, matching topcoat.
 - c. Topcoat: Epoxy, gloss, MPI #77.

D. Steel Substrates:

- 1. Epoxy System MPI EXT 5.1F:
 - a. Prime Coat: Primer, epoxy, anti-corrosive, for metal, MPI #101.
 - b. Intermediate Coat: Epoxy, high build, low gloss, MPI #108.
 - c. Topcoat: Epoxy, gloss, MPI #77.

E. Galvanized-Metal Substrates:

- 1. Epoxy System MPI EXT 5.3C:
 - a. Prime Coat: Primer, epoxy, anti-corrosive, for metal, MPI #101.
 - b. Intermediate Coat: Epoxy, matching topcoat.
 - c. Topcoat: Epoxy, gloss, MPI #77.

F. Aluminum (Not Anodized or Otherwise Coated) Substrates:

- 1. Epoxy System MPI EXT 5.4E:
 - a. Prime Coat: Primer, vinyl wash, MPI #80.
 - b. Intermediate Coat: Epoxy, matching topcoat.
 - c. Topcoat: Epoxy, gloss, MPI #77.

END OF SECTION 099600

SECTION 080314 - HISTORIC TREATMENT OF WOOD DOORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. The Drawings and general provisions of the Contract, including the City of Baltimore Department of Public Works Specifications (the “Green Book”) and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Historic treatment of wood doors in the form of the following:
 - a. Repairing wood doors and trim.
 - b. Reglazing.
 - c. Repairing, refinishing, and replacing hardware.

1.3 DEFINITIONS

- A. Door: Generally, this term includes door frame, leaves, hardware, side panels or lights, fan light, transom, storm and screen doors, and storm vestibule unless otherwise indicated by context.
- B. Glazing: Includes glass, glazing points, glazing tapes, glazing sealants, and glazing compounds.
- C. Wood Door Component Terminology: Wood door components for historic treatment work include the following classifications:
 - 1. Frame Components: Head, jambs, stop, and threshold or sill.
 - 2. Leaf Components: Stiles, rails, and muntins.
 - 3. Exterior Trim: Exterior casing, brick mold, and cornice or drip cap.
 - 4. Interior Trim: Casing.

1.4 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.
 - 1. Review methods and procedures related to historic treatment of wood doors.

1.5 ACTION SUBMITTALS

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

- B. Samples: For each type of exposed wood and finish.

1.6 QUALITY ASSURANCE

- A. Wood-Repair-Material Manufacturer Qualifications: A firm regularly engaged in producing wood consolidant and wood-patching compound that have been used for similar historic wood-treatment applications with successful results, and with factory-authorized service representatives who are available for consultation and Project-site inspection and on-site assistance.

PART 2 - PRODUCTS

2.1 HISTORIC TREATMENT OF WOOD DOORS QUALITY STANDARD

- A. Quality Standard: Comply with applicable requirements in Section 12, "Historic Restoration Work," and related requirements in AWMAC/WI's "North American Architectural Woodwork Standards" for construction, finishes, grades of wood doors, and other requirements unless otherwise indicated.
 - 1. Exception: Industry practices cited in Section 12, Paragraph 6, "Industry Practices," under Article 12.1, "Basic Considerations," of AWMAC/WI's "North American Architectural Woodwork Standards" do not apply to the Work of this Section.

2.2 WOOD-REPAIR MATERIALS

- A. Wood Consolidant: Ready-to-use product designed to penetrate, consolidate, and strengthen soft fibers of wood materials that have deteriorated because of weathering and decay and designed specifically to enhance the bond of wood-patching compound to existing wood.
- B. Wood-Patching Compound: Two-part, epoxy-resin, wood-patching compound; knife-grade formulation as recommended in writing by manufacturer for type of wood repair indicated, tooling time required for the detail of work, and site conditions. Compound to be designed for filling voids in damaged wood materials that have deteriorated because of weathering and decay. Compound to be capable of filling deep holes and spreading to feather edge.

2.3 GLAZING MATERIALS

- A. Glass: See Section 088000 "Glazing."
- B. Glazing Systems:
 - 1. Traditional Glazing Products: Glazing points and oil-based glazing putty or latex glazing compound. Tint to required color in accordance with manufacturer's written instructions.

2. Modern Glazing Products: Glazing points and single-component polyurethane glazing compound; struck to match taper of existing glazing putty (removed); colored as required to match painted sash.
3. Primers and Cleaners for Glazing: As recommended in writing by glazing material manufacturer.

2.4 HARDWARE

- A. Primary Door Hardware, General: Remove, clean and repair and reinstall existing hardware except for new hardware where specified. Typically deadbolts.
- B. Replacement Hardware: Replace existing damaged or missing hardware with new hardware.
- C. Material and Design:
 1. Material: Match existing unless otherwise indicated.
 2. Design: Match type and appearance of existing hardware with architect's approval.
- D. Hardware Finishes: Comply with BHMA A156.18 for base material and finish requirements indicated.

2.5 MISCELLANEOUS MATERIALS

- A. Borate Preservative Treatment: Inorganic, borate-based solution, with disodium octaborate tetrahydrate as the primary ingredient; manufactured for preserving weathered and decayed wood from further damage by decay fungi and wood-boring insects; containing no boric acid.
- B. Cleaning Materials:
 1. Detergent Solution: Solution prepared by mixing 2 cups of tetrasodium pyrophosphate, 1/2 cup of laundry detergent that contains no ammonia, 5 quarts of 5 percent sodium hypochlorite bleach, and 15 quarts of warm water for each 5 gal. of solution required.
 2. Mildewcide: Commercial, proprietary mildewcide or a solution prepared by mixing 1/3 cup of household detergent that contains no ammonia, 1 quart of 5 percent sodium hypochlorite bleach, and 3 quarts of warm water.
- C. Adhesives: Wood adhesives with minimum 15- to 45-minute cure at 70 deg F, in gunnable and liquid formulations as recommended in writing by adhesive manufacturer for each type of repair and exposure conditions.
- D. Fasteners: Use fastener metals that are noncorrosive and compatible with each material joined.
 1. Match existing fasteners in material and type of fastener unless otherwise indicated.
 2. Use concealed fasteners for interconnecting wood components.
 3. Use concealed fasteners for attaching items to other work unless exposed fasteners are unavoidable or the existing fastening method.
 4. For fastening metals, use fasteners of same basic metal as fastened metal unless otherwise indicated.

5. For exposed fasteners, use Phillips-type machine screws of head profile flush with metal surface unless otherwise indicated.
 6. Finish exposed fasteners to match finish of metal fastened unless otherwise indicated.
- E. Anchors, Clips, and Accessories: Fabricate anchors, clips, and door accessories of aluminum, nonmagnetic stainless steel, or hot-dip zinc-coated steel complying with requirements in ASTM B633 for SC 3 (Severe) service condition.

2.6 WOOD DOOR FINISHES

- A. Factory-Finished Units: Alkyd finish system consisting of primer and two finish coats on exposed interior wood surfaces.
1. Finish Coats: Manufacturer's standard.
 2. Color and Gloss: Match existing.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Clean wood doors and trim of mildew, algae, moss, plant material, loose paint, grease, dirt, and other debris by scrubbing with bristle brush or sponge and detergent solution. Scrub mildewed areas with mildewcide. After cleaning, rinse thoroughly with fresh water. Allow to dry before repairing or painting.
- B. Condition replacement wood members and replacement units to prevailing conditions at installation areas before installing.

3.2 HISTORIC TREATMENT OF WOOD DOORS, GENERAL

- A. General: In treating historic items, disturb them as minimally as possible and as follows:
1. Stabilize and repair wood doors to reestablish structural integrity and weather resistance while maintaining the existing form of each item.
 2. Remove coatings and apply borate preservative treatment before repair. Remove coatings in accordance with Section 090391 "Historic Treatment of Plain Painting" unless otherwise indicated.
 3. Repair items in place where possible.
 4. Install temporary protective measures to protect wood door work that is indicated to be completed later.
 5. Refinish historic wood doors in accordance with Section 090391 "Historic Treatment of Plain Painting" unless otherwise indicated.
- B. Mechanical Abrasion: Where mechanical abrasion is needed for the Work, use only the gentlest mechanical methods, such as scraping and natural-fiber bristle brushing, that will not abrade wood substrate, reducing clarity of detail. Do not use abrasive methods such as sanding, wire brushing, or power tools except as approved by Architect.

- C. Repair and Refinish Existing Hardware: Dismantle door hardware; strip paint, repair, and refinish it to match finish Samples; and lubricate moving parts just enough to function smoothly.
- D. Repair Wood Doors: Match existing materials and features, retaining as much original material as possible to perform repairs.
 - 1. Unless otherwise indicated, repair wood doors by consolidating, patching, splicing, or otherwise reinforcing wood with new wood matching existing wood or with salvaged, sound, original wood.
 - 2. Where indicated, repair wood doors by limited replacement matching existing material.
- E. Protection of Openings: Where doors are indicated for removal, cover resultant openings with temporary enclosures so that openings are weathertight during repair period.
- F. Identify removed doors, frames, leaves, trim, and members with numbering system corresponding to door locations to ensure reinstallation in same location.

3.3 WOOD DOOR PATCH-TYPE REPAIR

- A. General: Patch wood members that exhibit depressions, holes, or similar voids and that have limited amounts of rotted or decayed wood.
 - 1. Treat wood members with wood consolidant before applying patching compound. Coat wood surfaces by brushing, applying multiple coats until wood is saturated and unable to absorb more. Allow treatment to harden before filling void with patching compound.
 - 2. Remove rotted or decayed wood down to sound wood.
- B. Apply borate preservative treatment to accessible surfaces either before applying wood consolidant or after removing rotted or decayed wood.
- C. Apply wood-patching compound to fill depressions, nicks, cracks, and other voids created by removed or missing wood.
 - 1. Prime patch area with application of wood consolidant or manufacturer's recommended primer.
 - 2. Apply patching compound in layers as recommended in writing by manufacturer until the void is completely filled.
 - 3. Sand patch surface smooth and flush with adjacent wood, without voids in patch material, and matching contour of wood member.

3.4 GLAZING

- A. Comply with combined written instructions of glass, glazing system, and glazing material manufacturers, unless more stringent requirements are indicated.
- B. Remove cracked and damaged glass and glazing materials from openings and prepare surfaces for reglazing.

- C. Size glass as required by Project conditions to provide necessary bite on glass, minimum edge and face clearances, with reasonable tolerances.
- D. Apply primers to joint surfaces where required for adhesion of glazing system, as determined by preconstruction testing.
- E. Install setting bead, side beads, and back bead against stop in glazing rabbets before setting glass.
- F. Install glass with proper orientation so that coatings, if any, face exterior or interior as required.
- G. Disposal of Removed Glass: Remove from Owner's property and legally dispose of it unless otherwise indicated.

END OF SECTION 080314

SECTION 081113 - HOLLOW METAL DOORS AND FRAMES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. The Drawings and general provisions of the Contract, including the City of Baltimore Department of Public Works Specifications (the "Green Book") and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

- 1. Standard and custom hollow metal doors and frames.
- 2. Light frames and glazing installed in hollow metal doors.

B. Related Sections:

- 1. Division 01 Section "General Conditions".
- 2. Division 04 Section "Unit Masonry" for embedding anchors for hollow metal work into masonry construction.
- 3. Division 08 Section "Flush Wood Doors".
- 4. Division 08 Section "Glazing" for glass view panels in hollow metal doors.
- 5. Division 09 Sections "Exterior Painting" and "Interior Painting" for field painting hollow metal doors and frames.

C. Codes and References: Comply with the version year adopted by the Authority Having Jurisdiction.

- 1. ANSI/SDI A250.8 - Recommended Specifications for Standard Steel Doors and Frames.
- 2. ANSI/SDI A250.4 - Test Procedure and Acceptance Criteria for Physical Endurance for Steel Doors, Frames, Frames Anchors and Hardware Reinforcing.
- 3. ANSI/SDI A250.6 - Recommended Practice for Hardware Reinforcing on Standard Steel Doors and Frames.
- 4. ANSI/SDI A250.10 - Test Procedure and Acceptance Criteria for Prime Painted Steel Surfaces for Steel Doors and Frames.
- 5. ANSI/SDI A250.11 - Recommended Erection Instructions for Steel Frames.
- 6. ASTM A1008 - Standard Specification for Steel Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability.
- 7. ASTM A653 - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
- 8. ASTM A924 - Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process.
- 9. ASTM C 1363 - Standard Test Method for Thermal Performance of Building Assemblies by Means of a Hot Box Apparatus.

10. ANSI/BHMA A156.115 - Hardware Preparation in Steel Doors and Frames.
11. ANSI/SDI 122 - Installation and Troubleshooting Guide for Standard Steel Doors and Frames.
12. ANSI/NFPA 80 - Standard for Fire Doors and Fire Windows; National Fire Protection Association.
13. ANSI/NFPA 105: Standard for the Installation of Smoke Door Assemblies.
14. NFPA 252 - Standard Methods of Fire Tests of Door Assemblies; National Fire Protection Association.
15. UL 10C - Positive Pressure Fire Tests of Door Assemblies.
16. UL 1784 - Standard for Air Leakage Tests of Door Assemblies.

1.3 QUALITY ASSURANCE

- A. Source Limitations: Obtain hollow metal doors and frames through one source from a single manufacturer wherever possible.
- B. Quality Standard: In addition to requirements specified, furnish SDI-Certified manufacturer products that comply with ANSI/SDI A250.8, latest edition, "Recommended Specifications for Standard Steel Doors and Frames".
- C. Fire-Rated Door Assemblies: Assemblies complying with NFPA 80 that are listed and labeled by a qualified testing agency, for fire-protection ratings indicated, based on testing at positive pressure according to UL10C (neutral pressure at 40" above sill) or UL 10C.
 1. Oversize Fire-Rated Door Assemblies Construction: For units exceeding sizes of tested assemblies, attach construction label certifying doors are built to standard construction requirements for tested and labeled fire rated door assemblies except for size.
 2. Temperature-Rise Limit: Where indicated and at vertical exit enclosures (stairwell openings) and exit passageways, provide doors that have a maximum transmitted temperature end point of not more than 450 deg F (250 deg C) above ambient after 30 minutes of standard fire-test exposure.
 3. Smoke Control Door Assemblies: Comply with NFPA 105.
 - a. Smoke "S" Label: Doors to bear "S" label, and include smoke and draft control gasketing applied to frame and on meeting stiles of pair doors.
- D. Fire-Rated, Borrowed-Light Frame Assemblies: Assemblies complying with NFPA 80 that are listed and labeled, by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire-protection ratings indicated, based on testing according to NFPA 257. Provide labeled glazing material.
- E. Pre-Submittal Conference: Conduct conference in compliance with requirements in Division 01 Section "Project Meetings" with attendance by representatives of Supplier, Installer, and Contractor to review proper methods and procedures for installing hollow metal doors and frames and to verify installation of electrical knockout boxes and conduit at frames with electrified or access control hardware.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Deliver hollow metal work palletized, wrapped, or crated to provide protection during transit and Project site storage. Do not use non-vented plastic.
- B. Deliver welded frames with two removable spreader bars across bottom of frames, tack welded to jambs and mullions.
- C. Store hollow metal work under cover at Project site. Place in stacks of five units maximum in a vertical position with heads up, spaced by blocking, on minimum 4-inch high wood blocking. Do not store in a manner that traps excess humidity.
 - 1. Provide minimum 1/4-inch space between each stacked door to permit air circulation. Door and frames to be stacked in a vertical upright position.

1.5 PROJECT CONDITIONS

- A. Field Measurements: Verify actual dimensions of openings by field measurements before fabrication.

1.6 COORDINATION

- A. Coordinate installation of anchorages for hollow metal frames. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors. Deliver such items to Project site in time for installation.

1.7 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace doors that fail in materials or workmanship within specified warranty period.
- B. Warranty includes installation and finishing that may be required due to repair or replacement of defective doors.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide steel doors and frames from a SDI Certified manufacturer:
 - 1. CECO Door Products (C).
 - 2. Curries Company (CU).

2.2 MATERIALS

- A. Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, Commercial Steel (CS), Type B; suitable for exposed applications.

- B. Metallic-Coated Steel Sheet: ASTM A 653/A 653M, Commercial Steel (CS), Type B; with minimum G60 (Z180) or A60 (ZF180) metallic coating.
- C. Frame Anchors: ASTM A 653/A 653M, Commercial Steel (CS), Commercial Steel (CS), Type B; with minimum G60 (Z180) or A60 (ZF180) metallic coating.

2.3 HOLLOW METAL DOORS

- A. General: Provide 1-3/4 inch doors of design indicated, not less than thickness indicated; fabricated with smooth surfaces, without visible joints or seams on exposed faces unless otherwise indicated. Comply with ANSI/SDI A250.8 and ANSI/NAAMM HMMA 867.
- B. Exterior Doors: Face sheets fabricated of commercial quality hot-dipped zinc coated steel that complies with ASTM A 653/A 653M, Coating Designation A60. Provide doors complying with requirements indicated below by referencing ANSI/SDI A250.8 for level and model and ANSI/SDI A250.4 for physical performance level:
 - 1. Design: Flush panel.
 - 2. Core Construction: Manufacturer's thermally enhanced QMax core. Where indicated provide doors fabricated as thermal-rated assemblies with a minimum thermal rating of 0.41 BTU/hr-ft²-F.
 - 3. Level/Model: Level 3 and Physical Performance Level A (Extra Heavy Duty), Minimum 16 gauge (0.053-inch - 1.3-mm) thick steel, Model 2.
 - 4. Top and Bottom Edges: Reinforce tops and bottoms of doors with a continuous steel channel not less than 16 gauge, extending the full width of the door and welded to the face sheet. Doors with an inverted top channel to include a steel closure channel, screw attached, with the web of the channel flush with the face sheets of the door. Plastic or composite channel fillers are not acceptable.
 - 5. Hinge Reinforcement: Minimum 7 gauge (3/16") plate 1-1/4" x 9" or minimum 14 gauge continuous channel with pierced holes, drilled and tapped.
 - 6. Hardware Reinforcements: Fabricate according to ANSI/SDI A250.6 with reinforcing plates from same material as door face sheets.
- C. Manufacturers Basis of Design:
 - 1. Curries Company (CU) - Temperature Rise - 727 Series.

2.4 HOLLOW METAL FRAMES

- A. General: Comply with ANSI/SDI A250.8 and with details indicated for type and profile.
- B. Exterior Frames: Fabricated of hot-dipped zinc coated steel that complies with ASTM A 653/A 653M, Coating Designation A60.
 - 1. Fabricate frames with mitered or coped corners. Profile as indicated on drawings.
 - 2. Manufacturers Basis of Design:
 - a. Curries Company (CU) - Mercury 3 Thermal Break TQ Series.

- C. Interior Frames: Fabricated from cold-rolled steel sheet that complies with ASTM A 1008/A 1008M.
 - 1. Fabricate frames with mitered or coped corners. Profile as indicated on drawings.
 - 2. Manufacturers Basis of Design:
 - a. Curries Company (CU) - C Series.
- D. Fire rated frames: Fabricate frames in accordance with NFPA 80, listed and labeled by a qualified testing agency, for fire-protection ratings indicated.
- E. Hardware Reinforcement: Fabricate according to ANSI/SDI A250.6 Table 4 with reinforcement plates from same material as frames.

2.5 FRAME ANCHORS

- A. Jamb Anchors:
 - 1. Masonry Type: Adjustable strap-and-stirrup or T-shaped anchors to suit frame size, formed from A60 metallic coated material, not less than 0.042 inch thick, with corrugated or perforated straps not less than 2 inches wide by 10 inches long; or wire anchors not less than 0.177 inch thick.
 - 2. Stud Wall Type: Designed to engage stud and not less than 0.042 inch thick.
 - 3. Compression Type for Drywall Slip-on (Knock-Down) Frames: Adjustable compression anchors.
- B. Floor Anchors: Floor anchors to be provided at each jamb, formed from A60 metallic coated material, not less than 0.042 inches thick.
- C. Mortar Guards: Formed from same material as frames, not less than 0.016 inches thick.

2.6 LIGHT OPENINGS AND GLAZING

- A. Stops and Moldings: Provide stops and moldings around glazed lites where indicated. Form corners of stops and moldings with butted or mitered hairline joints at fabricator's shop. Fixed and removable stops to allow multiple glazed lites each to be removed independently. Coordinate frame rabbet widths between fixed and removable stops with the type of glazing and installation indicated.
- B. Moldings for Glazed Lites in Doors and Loose Stops for Glazed Lites in Frames: Minimum 20 gauge thick, fabricated from same material as door face sheet in which they are installed.
- C. Fixed Frame Moldings: Formed integral with hollow metal frames, a minimum of 5/8 inch (16 mm) high unless otherwise indicated. Provide fixed frame moldings and stops on outside of exterior and on secure side of interior doors and frames.
- D. Preformed Metal Frames for Light Openings: Manufacturer's standard frame formed of 0.048-inch-thick, cold rolled steel sheet; with baked enamel or powder coated finish; and approved for use in doors of fire protection rating indicated. Match pre-finished door paint color where applicable.

2.7 ACCESSORIES

- A. Mullions and Transom Bars: Join to adjacent members by welding or rigid mechanical anchors.
- B. Grout Guards: Formed from same material as frames, not less than 0.016 inches thick.

2.8 FABRICATION

- A. Fabricate hollow metal work to be rigid and free of defects, warp, or buckle. Accurately form metal to required sizes and profiles, with minimum radius for thickness of metal. Where practical, fit and assemble units in manufacturer's plant. When shipping limitations so dictate, frames for large openings are to be fabricated in sections for splicing or splining in the field by others.
- B. Tolerances: Fabricate hollow metal work to tolerances indicated in ANSI/SDI A250.8.
- C. Hollow Metal Doors:
 - 1. Exterior Doors: Provide optional weep-hole openings in bottom of exterior doors to permit moisture to escape where specified.
 - 2. Glazed Lites: Factory cut openings in doors with applied trim or kits to fit. Factory install glazing where indicated.
 - 3. Astragals: Provide overlapping astragals as noted in door hardware sets in Division 08 Section "Door Hardware" on one leaf of pairs of doors where required by NFPA 80 for fire-performance rating or where indicated. Extend minimum 3/4 inch beyond edge of door on which astragal is mounted.
 - 4. Continuous Hinge Reinforcement: Provide welded continuous 12 gauge strap for continuous hinges specified in hardware sets in Division 08 Section "Door Hardware".
- D. Hollow Metal Frames:
 - 1. Shipping Limitations: Where frames are fabricated in sections due to shipping or handling limitations, provide alignment plates or angles at each joint, fabricated of same thickness metal as frames.
 - 2. Welded Frames: Weld flush face joints continuously; grind, fill, dress, and make smooth, flush, and invisible.
 - a. Welded frames are to be provided with two steel spreaders temporarily attached to the bottom of both jambs to serve as a brace during shipping and handling. Spreader bars are for bracing only and are not to be used to size the frame opening.
 - 3. High Frequency Hinge Reinforcement: Provide high frequency hinge reinforcements at door openings 48-inches and wider with mortise butt type hinges at top hinge locations.
 - 4. Continuous Hinge Reinforcement: Provide welded continuous 12 gauge straps for continuous hinges specified in hardware sets in Division 08 Section "Door Hardware".
 - 5. Provide countersunk, flat- or oval-head exposed screws and bolts for exposed fasteners unless otherwise indicated for removable stops, provide security screws at exterior locations.
 - 6. Mortar Guards: Provide guard boxes at back of hardware mortises in frames at all hinges and strike preps regardless of grouting requirements.

7. Floor Anchors: Weld anchors to bottom of jambs and mullions with at least four spot welds per anchor.
 8. Jamb Anchors: Provide number and spacing of anchors as follows:
 - a. Masonry Type: Locate anchors not more than 18 inches from top and bottom of frame. Space anchors not more than 32 inches on-center and as follows:
 - 1) Two anchors per jamb up to 60 inches high.
 - 2) Three anchors per jamb from 60 to 90 inches high.
 - 3) Four anchors per jamb from 90 to 120 inches high.
 - 4) Four anchors per jamb plus 1 additional anchor per jamb for each 24 inches or fraction thereof above 120 inches high.
 - b. Stud Wall Type: Locate anchors not more than 18 inches from top and bottom of frame. Space anchors not more than 32 inches o.c. and as follows:
 - 1) Three anchors per jamb up to 60 inches high.
 - 2) Four anchors per jamb from 60 to 90 inches high.
 - 3) Five anchors per jamb from 90 to 96 inches high.
 - 4) Five anchors per jamb plus 1 additional anchor per jamb for each 24 inches or fraction thereof above 96 inches high.
 - 5) Two anchors per head for frames above 42 inches wide and mounted in metal stud partitions.
 9. Door Silencers: Except on weatherstripped or gasketed doors, drill stops to receive door silencers. Silencers to be supplied by frame manufacturer regardless if specified in Division 08 Section "Door Hardware".
 10. Bituminous Coating: Where frames are fully grouted with an approved Portland Cement based grout or mortar, coat inside of frame throat with a water based bituminous or asphaltic emulsion coating to a minimum thickness of 3 mils DFT, tested in accordance with UL 10C and applied to the frame under a 3rd party independent follow-up service procedure.
- E. Hardware Preparation: Factory prepare hollow metal work to receive template mortised hardware; include cutouts, reinforcement, mortising, drilling, and tapping according to the Door Hardware Schedule and templates furnished as specified in Division 08 Section "Door Hardware."
1. Locate hardware as indicated, or if not indicated, according to ANSI/SDI A250.8.
 2. Reinforce doors and frames to receive non-template, mortised and surface mounted door hardware.
 3. Comply with applicable requirements in ANSI/SDI A250.6 and ANSI/DHI A115 Series specifications for preparation of hollow metal work for hardware.
 4. Coordinate locations of conduit and wiring boxes for electrical connections with Division 26 Sections.

2.9 STEEL FINISHES

- A. Prime Finishes: Doors and frames to be cleaned, and chemically treated to insure maximum finish paint adhesion. Surfaces of the door and frame exposed to view to receive a factory applied coat of rust inhibiting shop primer.

1. Shop Primer: Manufacturer's standard, fast-curing, lead and chromate free primer complying with ANSI/SDI A250.10 acceptance criteria; recommended by primer manufacturer for substrate; and compatible with substrate and field-applied coatings.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. General Contractor to verify the accuracy of dimensions given to the steel door and frame manufacturer for existing openings or existing frames (strike height, hinge spacing, hinge back set, etc.).
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Remove welded in shipping spreaders installed at factory. Restore exposed finish by grinding, filling, and dressing, as required to make repaired area smooth, flush, and invisible on exposed faces.
- B. Prior to installation, adjust and securely brace welded hollow metal frames for square, level, twist, and plumb condition.
- C. Tolerances shall comply with SDI-117 "Manufacturing Tolerances Standard Steel Doors and Frames."
- D. Drill and tap doors and frames to receive non-template, mortised, and surface-mounted door hardware.
- E. Verify tolerances against manufacturers installations instructions for tornado and hurricane storm shelter openings.

3.3 INSTALLATION

- A. General: Install hollow metal work plumb, rigid, properly aligned, and securely fastened in place; comply with Drawings and manufacturer's written instructions.
- B. Hollow Metal Frames: Install hollow metal frames of size and profile indicated. Comply with ANSI/SDI A250.11 and NFPA 80 at fire rated openings.
 1. Set frames accurately in position, plumbed, leveled, aligned, and braced securely until permanent anchors are set. After wall construction is complete and frames properly set and secured, remove temporary braces, leaving surfaces smooth and undamaged. Shim as necessary to comply with installation tolerances.
 2. Floor Anchors: Provide floor anchors for each jamb and mullion that extends to floor, and secure with post-installed expansion anchors.

3. Masonry Walls: Coordinate installation of frames to allow for solidly filling space between frames and masonry with mortar.
 4. Grout Requirements: Do not grout head of frames unless reinforcing has been installed in head of frame. Do not grout vertical or horizontal closed mullion members.
- C. Hollow Metal Doors: Fit hollow metal doors accurately in frames, within clearances specified below. Shim as necessary.
1. Non-Fire-Rated Standard Steel Doors:
 - a. Jams and Head: 1/8 inch plus or minus 1/16 inch.
 - b. Between Edges of Pairs of Doors: 1/8 inch plus or minus 1/16 inch.
 - c. Between Bottom of Door and Top of Threshold: Maximum 3/8 inch.
 - d. Between Bottom of Door and Top of Finish Floor (No Threshold): Maximum 3/4 inch.
 2. Fire-Rated Doors: Install doors with clearances according to NFPA 80.
- D. Field Glazing: Comply with installation requirements in Division 08 Section "Glazing" and with hollow metal manufacturer's written instructions.

3.4 ADJUSTING AND CLEANING

- A. Final Adjustments: Check and readjust operating hardware items immediately before final inspection. Leave work in complete and proper operating condition. Remove and replace defective work, including hollow metal work that is warped, bowed, or otherwise unacceptable.
- B. Remove grout and other bonding material from hollow metal work immediately after installation.
- C. Prime-Coat and Painted Finish Touchup: Immediately after erection, sand smooth rusted or damaged areas of prime coat, or painted finishes, and apply touchup of compatible air drying, rust-inhibitive primer, zinc rich primer (exterior and galvanized openings) or finish paint.

3.5 FIELD QUALITY CONTROL

- A. Field Inspection (Punch Report): Reference Division 01 Sections "Closeout Procedures". Produce project punch report for each installed door opening indicating compliance with approved submittals and verification hardware is properly installed, operating and adjusted. Include list of items to be completed and corrected, indicating the reasons or deficiencies causing the Work to be incomplete or rejected.
 1. Organization of List: Include separate Door Opening and Deficiencies and Corrective Action Lists organized by Mark, Opening Remarks and Comments, and related Opening Images and Video Recordings.

END OF SECTION 081113

SECTION 081416 - FLUSH WOOD DOORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. The Drawings and general provisions of the Contract, including the City of Baltimore Department of Public Works Specifications (the "Green Book") and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Five-ply flush wood veneer-faced doors for transparent finish.
 - 2. Factory finishing flush wood doors.
 - 3. Factory fitting flush wood doors to frames and factory machining for hardware.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product, including the following:
 - 1. Door core materials and construction.
 - 2. Door edge construction
 - 3. Door face type and characteristics.
 - 4. Door louvers.
 - 5. Door trim for openings.
 - 6. Door frame construction.
 - 7. Factory-machining criteria.
 - 8. Factory-finishing specifications.
- B. Shop Drawings: Indicate location, size, and hand of each door; elevation of each type of door; construction details not covered in Product Data; and the following:
 - 1. Door schedule indicating door location, type, size, fire protection rating, and swing.
 - 2. Door elevations, dimension and locations of hardware, lite and louver cutouts, and glazing thicknesses.
 - 3. Details of frame for each frame type, including dimensions and profile.
 - 4. Details of electrical raceway and preparation for electrified hardware, access control systems, and security systems.
 - 5. Dimensions and locations of blocking for hardware attachment.
 - 6. Clearances and undercuts.
 - 7. Requirements for veneer matching.
- C. Samples: For factory-finished door frames.

1.4 QUALITY ASSURANCE

- A. Manufacturer's Certification: Licensed participant in AWI's Quality Certification Program.

PART 2 - PRODUCTS

2.1 FLUSH WOOD DOORS AND FRAMES, GENERAL

- A. Quality Standard: In addition to requirements specified, comply with ANSI/WDMA I.S. 1A.

2.2 SOLID-CORE, FIVE-PLY FLUSH WOOD VENEER-FACED DOORS FOR TRANSPARENT FINISH

- A. Interior Doors, Solid-Core Five-Ply Veneer-Faced:

1. Performance Grade: ANSI/WDMA I.S. 1A Heavy Duty.
2. Faces: Single-ply wood veneer not less than 1/50 inch (0.508 mm) thick.
 - a. Species: Select white maple.
 - b. Cut: Plain sliced (flat sliced).
 - c. Match between Veneer Leaves: Book match.
 - d. Assembly of Veneer Leaves on Door Faces: Balance match.
 - e. Pair and Set Match: Provide for doors hung in same opening.
 - f. Room Match:
3. Core for Non-Fire-Rated Doors:
 - 1) Provide doors with glued-wood-stave or WDMA I.S. 10 structural-composite-lumber cores instead of particleboard cores for doors scheduled to receive exit devices in Section 087111 "Door Hardware (Descriptive Specification)."
 - b. Glued wood stave.
 - c. WDMA I.S. 10 structural composite lumber.
 - 1) Screw Withdrawal, Edge: 475 lb (2110 N).
 - d. Either glued wood stave or WDMA I.S. 10 structural composite lumber.
4. Construction: Five plies, hot-pressed bonded (vertical and horizontal edging is bonded to core), with entire unit abrasive planed before veneering.

2.3 LIGHT FRAMES AND LOUVERS

- A. Wood Beads for Light Openings in Wood Doors: Provide manufacturer's standard wood beads unless otherwise indicated.

1. Wood Species: Same species as door faces.
2. Profile: Manufacturer's standard shape.

2.4 FABRICATION

- A. Factory fit doors to suit frame-opening sizes indicated.
 1. Comply with clearance requirements of referenced quality standard for fitting unless otherwise indicated.
 2. Comply with NFPA 80 requirements for fire-rated doors.
- B. Factory machine doors for hardware that is not surface applied.
 1. Locate hardware to comply with DHI-WDHS-3.
 2. Comply with final hardware schedules, door frame Shop Drawings, ANSI/BHMA-156.115-W, and hardware templates.
 3. Coordinate with hardware mortises in metal frames, to verify dimensions and alignment before factory machining.
 4. For doors scheduled to receive electrified locksets, provide factory-installed raceway and wiring to accommodate specified hardware.
- C. Openings: Factory cut and trim openings through doors.
 1. Light Openings: Trim openings with moldings of material and profile indicated.
 2. Glazing: Factory install glazing in doors indicated to be factory finished. Comply with applicable requirements in Section 088000 "Glazing."
 3. Louvers: Factory install louvers in prepared openings.

2.5 FACTORY FINISHING

- A. Comply with referenced quality standard for factory finishing.
 1. Complete fabrication, including fitting doors for openings and machining for hardware that is not surface applied, before finishing.
 2. Finish faces, all four edges, edges of cutouts, and mortises.
 3. Stains and fillers may be omitted on[**top and**] bottom edges, edges of cutouts, and mortises.
- B. Factory finish doors.
- C. Transparent Finish:
 1. Architectural Woodwork Standards Grade: Custom.
 2. ANSI/WDMA I.S. 1A TR-8 UV Cured Acrylated Polyester/Urethane.
 3. Staining: Match Architect's sample.
 4. Sheen: Semigloss.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Hardware: For installation, see Section 087100 "Door Hardware."
- B. Install doors and frames to comply with manufacturer's written instructions and referenced quality standard, and as indicated.
- C. Install frames level, plumb, true, and straight.
 - 1. Shim as required with concealed shims. Install level and plumb to a tolerance of 1/8 inch in 96 inches.
 - 2. Anchor frames to anchors or blocking built in or directly attached to substrates.
 - a. Secure with countersunk, concealed fasteners and blind nailing.
 - b. Use fine finishing nails or finishing screws for exposed fastening, countersunk and filled flush with woodwork.
 - 1) For factory-finished items, use filler matching finish of items being installed.
- D. Job-Fitted Doors:
 - 1. Align and fit doors in frames with uniform clearances and bevels as indicated below.
 - a. Do not trim stiles and rails in excess of limits set by manufacturer or permitted for fire-rated doors.
 - 2. Machine doors for hardware.
 - 3. Seal edges of doors, edges of cutouts, and mortises after fitting and machining.
 - 4. Clearances:
 - a. Provide 1/8 inch at heads, jambs, and between pairs of doors.
 - b. Provide 1/8 inch from bottom of door to top of decorative floor finish or covering unless otherwise indicated on Drawings.
 - c. Where threshold is shown or scheduled, provide 1/4 inch from bottom of door to top of threshold unless otherwise indicated.
 - 5. Bevel non-fire-rated doors 1/8 inch in 2 inches at lock and hinge edges.
- E. Factory-Fitted Doors: Align in frames for uniform clearance at each edge.
- F. Factory-Finished Doors: Restore finish before installation if fitting or machining is required at Project site.

3.2 FIELD QUALITY CONTROL

- A. Inspection Agency: Owner will engage a qualified inspector to perform inspections and to furnish reports to Architect.
- B. Repair or remove and replace installations where inspections indicate that they do not comply with specified requirements.
- C. Reinspect repaired or replaced installations to determine if replaced or repaired door assembly installations comply with specified requirements.

3.3 ADJUSTING

- A. Operation: Rehang or replace doors that do not swing or operate freely.
- B. Finished Doors: Replace doors that are damaged or that do not comply with requirements. Doors may be repaired or refinished if Work complies with requirements and shows no evidence of repair or refinishing.

END OF SECTION 081416

SECTION 083113 - ACCESS DOORS AND FRAMES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. The Drawings and general provisions of the Contract, including the City of Baltimore Department of Public Works Specifications (the “Green Book”) and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Access doors and frames.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Samples: For each type of access door and frame and for each finish specified.
- C. Product Schedule: For access doors and frames. Use same designations indicated on Drawings.

1.4 CLOSEOUT SUBMITTALS

- A. Record Documents: For fire-rated doors, list of applicable room name and number in which access door is located.

PART 2 - PRODUCTS

2.1 ACCESS DOORS AND FRAMES

- A. Flush Access Doors with Exposed Flanges at locations with not in public view.
 - 1. Description: Face of door flush with frame, with exposed flange and concealed hinge.
 - 2. Optional Features: Piano hinges.
 - 3. Locations: Wall and ceiling.
 - 4. Metallic-Coated Steel Sheet for Door: Nominal 0.064 inch, 16 gage, factory finished.
 - 5. Frame Material: Same material, thickness, and finish as door.
 - 6. Latch and Lock: Cam latch, screwdriver operated.
- B. Flush Access Doors with Concealed Flanges for locations in public view:

1. Description: Face of door flush with frame; with concealed flange for gypsum board installation and concealed hinge.
2. Optional Features: Piano hinges.
3. Locations: Wall and ceiling.
4. Metallic-Coated Steel Sheet for Door: Nominal 0.064 inch, 16 gage factory finished.
5. Frame Material: Same material and thickness as door.
6. Latch and Lock: Cam latch, key operated.

2.2 CEILING ACCESS DOOR AND FRAME

- A. Exterior Flush Access Doors with Concealed Flanges for interior sealed ceiling location:
1. Description: Face of door flush with frame; with concealed flange for gypsum board installation and concealed piano hinge.
 2. 1" thick rigid foam insulation and neoprene gasket.
 3. Locations: Ceiling.
 4. Metallic-Coated Steel Sheet for Door and frame: Nominal 0.064 inch, 16 gage factory prime coated for field finish.
 5. Latch and Lock: Cam latch, key operated.

2.3 FIRE-RATED ACCESS DOORS AND FRAMES

- A. Fire-Rated, Flush Access Doors with Exposed Flanges:
1. Description: Door face flush with frame, uninsulated; with exposed flange, self-closing door, and concealed hinge.
 2. Optional Features: Piano hinges.
 3. Locations: Wall and ceiling.
 4. Fire-Resistance Rating: Not less than that of adjacent construction.
 5. Metallic-Coated Steel Sheet for Door: Nominal 0.040 inch, 20 gage, factory finished.
 6. Latch and Lock: Self-latching door hardware, operated by key.
- B. Fire-Rated, Flush Access Doors with Concealed Flanges:
1. Description: Door face flush with frame, uninsulated; with exposed flange, self-closing door, and concealed hinge.
 2. Optional Features: Piano hinges.
 3. Locations: Wall and ceiling.
 4. Fire-Resistance Rating: Not less than that of adjacent construction.
 5. Metallic-Coated Steel Sheet for Door: Nominal 0.040 inch, 20 gage, factory finished.
 6. Latch and Lock: Self-latching door hardware, operated by key.

2.4 FABRICATION

- A. Metal Surfaces: For metal surfaces exposed to view in the completed Work, provide materials with smooth, flat surfaces without blemishes. Do not use materials with exposed pitting, seam marks, roller marks, rolled trade names, or roughness.

- B. Doors and Frames: Grind exposed welds smooth and flush with adjacent surfaces. Furnish mounting holes, attachment devices and fasteners of type required to secure access doors to types of supports indicated.
- C. Latch and Lock Hardware:
 - 1. Quantity: Furnish number of latches and locks required to hold doors tightly closed.
 - 2. Keys: Furnish two keys per lock and key all locks alike.

2.5 FINISHES

- A. Painted Finishes: Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.
 - 1. Factory Primed: Apply manufacturer's standard, lead- and chromate-free, universal primer immediately after surface preparation and pretreatment.
 - 2. Factory Finished: Apply manufacturer's standard baked-enamel or powder-coat finish immediately after cleaning and pretreating, with minimum dry-film thickness of 1 mil for topcoat.
 - a. Color: As selected by Architect from full range of industry colors.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Comply with manufacturer's written instructions for installing access doors and frames.
- B. Adjust doors and hardware, after installation, for proper operation.

3.2 FIELD QUALITY CONTROL

- A. Inspection Agency: Owner will engage a qualified inspector to perform inspections and to furnish reports to Architect.
- B. Inspections:
 - 1. Fire-Rated Door Inspections: Inspect each fire-rated access door in accordance with NFPA 80, Section 5.2.
- C. Repair or remove and replace installations where inspections indicate that they do not comply with specified requirements.
- D. Reinspect repaired or replaced installations to determine if replaced or repaired door assembly installations comply with specified requirements.
- E. Prepare and submit separate inspection report for each fire-rated access door indicating compliance with each item listed in NFPA 80 and NFPA 101.

END OF SECTION 083113

SECTION 083513.13 - MULTIPANEL FOLDING ALUMINUM-FRAMED GLASS DOORS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Multipanel folding aluminum-framed glass doors.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings:

1. Include plans, elevations, sections, and installation details.
2. Indicate dimensions, configuration of panels, and stacking layout.

C. Samples: For each multipanel folding aluminum-framed glass door and for each color specified.

D. Product schedule.

1.3 INFORMATIONAL SUBMITTALS

A. Product test reports.

B. Sample warranty.

1.4 CLOSEOUT SUBMITTALS

A. Maintenance data.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: An installer acceptable to multipanel folding aluminum-framed glass door manufacturer for installation of units required for this Project.

1.6 WARRANTY

A. Manufacturer's Special Warranty: Manufacturer agrees to repair or replace multipanel folding aluminum-framed glass doors that fail(s) in materials or workmanship within specified warranty period.

1. Warranty Period:
 - a. Multipanel Folding Aluminum-Framed Glass Doors: 10 years from date of Substantial Completion.
 - b. Laminated Glass: Five years from date of Substantial Completion.
 - c. Aluminum Finish: 10 years from date of Substantial Completion.
- B. Special Finish Warranty, Factory-Applied Finishes: Standard form in which manufacturer agrees to repair finishes or replace aluminum that shows evidence of deterioration of factory-applied finishes within specified warranty period.
 1. Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MULTIPANEL FOLDING ALUMINUM-FRAMED GLASS DOORS

- A. Basis-of-Design Product by Manufacturer: NanaWall NW ACOUSTICAL 645 by NANA WALL SYSTEMS, INC. (415) 383-3148, www.nanawall.com.
- B. Multipanel Folding Aluminum-Framed Glass Doors: Provide extruded-aluminum-framed multipanel folding glass doors, complete with glazing, threshold, support, and anchorage devices.
 1. Application: Interior.
 2. Stack Storage Configuration: As shown on Drawings.
- C. Frames and Door Panels: Fabricated from aluminum extrusions complying with AAMA/WDMA/CSA 101/I.S.2/A440. Provide factory-assembled door panels that are reglazable without dismantling panel framing, and factory-assembled frames.
 1. Door Panel Design: As indicated design, with 10-inch nominal height bottom rail.
 2. Adjustable sliding and folding hardware with top and bottom tracks.
 3. Mounting Type: Floor track supported with upper guide track.
 4. Panel Configuration: Straight .
 5. Sill Type: Surface Mounted Minimal ADA Sill .
 6. Panels: Single lite; standard.
 7. Panel Size (W x H): As indicated on Drawings.
 - a. Rail Depth: 2-5/8 inch.
 - b. Top Rail and Stile Width: 2-7/8 inch.
 - c. Bottom Rail Width: Manufacturer's standard kickplate on all swing panels. Height of 10 inches.
 - d. Frame Depth: -15/16 inch.
 - e. Head Track Width: 2-13/16 inch standard.
 - f. Side Jamb Width: 2 inches.
 - g. Sill Finish: Black anodized finish.
 8. Aluminum Extrusion: AIMgSi0.5 alloy, 6063-T5.
 - a. Thickness: 0.078 inch nominal.

- b. Acoustic Break: 1-1/4 inch wide specially designed glass fiber reinforced (GFR) polyamide for panels.
9. Aluminum Finish: One color inside and outside. (AAMA 611- Clear or AAMA 2604- Powder Coat)
 - a. Finish Type: Choose from Manufacturer's Standard Colors.

D. Acoustic Performance.

1. System STC (Rw) 44 (44) and 1-9/16 inch (40 mm) double IGU, 10 mm + 8 mm STC 48 enhanced laminated glass or approved equal configuration.

2.2 GLAZING

A. Glass and Glazing: Manufacturer's standard glazing system that produces weathertight seal.

1. Glass: ASTM C1036, Type 1, q3; Category II safety glass complying with testing requirements in 16 CFR 1201.
2. Safety Glazing Labeling: Permanently mark safety glazing with certification label of the SGCC or another certification agency acceptable to authorities having jurisdiction. Label shall indicate manufacturer's name, type of glass, thickness, and safety glazing standard with which glass complies.
3. Manufacturer's glass lites in insulated glazing units, dry glazed with glass stops on the inside.
 - a. 1 7/16", 6 mm + 6 mm STC 42 laminated glass to achieve unit STC of 40
 - b. Glass Spacer: Black; standard

2.3 HARDWARE

A. Provide manufacturer's standard hardware, fabricated from a corrosion-resistant material compatible with door panels and other components, and complying with AAMA 907. Provide hardware designed to smoothly operate, tightly close, and securely lock multipanel folding aluminum-framed glass doors. Size hardware to accommodate panel weights and dimensions. Provide full-perimeter weatherstripping for each door panel.

B. Panel Support System: Provide panel support system designed for size, weight, and performance requirements of multipanel folding aluminum-framed glass doors indicated. Provide carriers with sealed ball bearings.

1. Overhead Supported: Provide multiwheeled overhead carriers suspended from steel or aluminum track, with lower guide system engaged in threshold for smooth operation. Limit track deflection to no more than 0.10 inch between supports when fully loaded.
2. Bottom Supported: Provide carrier system designed to roll on track within threshold, with overhead wheeled guide that engages upper track.
3. Adjustment: Provide panel support system capable of being adjusted for smooth operation and clearances without needing to remove panels from tracks.

4. Threshold Configuration: Extruded-aluminum threshold with low profile, compliant with United States Access Board's "Americans with Disabilities Act (ADA) and Architectural Barriers Act (ABA) Accessibility Guidelines."
 - a. Aluminum Finish: To match panel.
- C. Panel Hinges: Stainless steel, multileaf hinge with painted finish to match exterior. Provide integral hangers and guides for hinges that engage panel support system.
 1. Hinges: Black anodized aluminum with stainless steel security hinge pins and set-screws.
- D. Sound Gasketing: Manufacturer's double layer EPDM between panels and EPDM gasket, Q-Ion gasket, or brush seal between panel and frame, or brush seals with a two-layer fiberglass reinforced polyamide fin attached at both inner and outer edge of bottom of door panels with a recessed sill or on frame for sealing between panels and between panel and frame.
- E. Locking System:
 1. Panel Pairs: Provide manufacturer's standard handles and two-point locking device that operates concealed top and bottom rods at each panel pair.
 2. Trim Design: As selected from manufacturer's full range.
 - a. Finish: As selected from manufacturer's full range of finishes.

2.4 ACCESSORIES

- A. Trim: Provide interior and exterior casings, jamb extensions, and other components in material and finish to match door frames.
- B. Anchors, Clips, and Accessories: Provide anchors, clips, and accessories of aluminum, nonmagnetic stainless steel, or zinc-coated steel or iron for multipanel folding aluminum-framed glass doors, complying with ASTM B456 or ASTM B633 for SC 3 severe service conditions; provide sufficient strength to withstand design pressure indicated.

2.5 FABRICATION

- A. Complete fabrication, assembly, finishing, hardware application, and other work in the factory to greatest extent possible. Disassemble components only as necessary for shipment and installation.
- B. Factory-Glazed Fabrication: Glaze sliding aluminum-framed glass doors in the factory.

2.6 GENERAL FINISH REQUIREMENTS

- A. Appearance of Finished Work: Noticeable variations in same piece are unacceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.7 ALUMINUM FINISHES

- A. Baked-Enamel or Powder-Coat Finish: AAMA 2603, except with a minimum dry film thickness of 1.5 mils. Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.
 - 1. Color and Gloss: As selected by Architect from manufacturer's full range.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Comply with Drawings, Shop Drawings, and manufacturer's written instructions for installing multipanel folding aluminum-framed glass doors, hardware, accessories, and other components.
- B. Install multipanel folding aluminum-framed glass doors level, plumb, square, true to line; without distortion, warp, or rack of frames and panels, and without impeding thermal movement; anchored securely in place to structural support; and in proper relation to wall flashing, vapor retarders, air barriers, water/weather barriers, and other adjacent construction.
- C. Set threshold members in bed of sealant or with gaskets, as indicated, to provide weathertight construction.
- D. Separate aluminum and other corrodible surfaces from sources of corrosion or electrolytic action at points of contact with other materials.

3.2 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- B. Multipanel folding aluminum-framed glass door will be considered defective if it does not pass tests and inspections.

3.3 ADJUSTING

- A. Adjust hardware for proper alignment, smooth operation, and proper latching without unnecessary force or excessive clearance.
- B. Adjust hardware and operable panels to function smoothly and lubricate as recommended by manufacturer.

END OF SECTION 083513.13

SECTION 084313 - ALUMINUM-FRAMED STOREFRONTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. The Drawings and general provisions of the Contract, including the City of Baltimore Department of Public Works Specifications (the “Green Book”) and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Aluminum-framed storefront systems.

1.3 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For aluminum-framed storefronts. Include plans, elevations, sections, full-size details, and attachments to other work.
 - 1. Show connection to and continuity with adjacent thermal, weather, air, and vapor Barriers.
- C. Samples: For each type of exposed finish required.
- D. Delegated-Design Submittal: For aluminum-framed storefronts indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.5 INFORMATIONAL SUBMITTALS

- A. Energy Performance Certificates: NFRC-certified energy performance values from manufacturer.
- B. Product test reports.
- C. Source quality-control reports.

- D. Field quality-control reports.
- E. Sample warranties.

1.6 CLOSEOUT SUBMITTALS

- A. Maintenance data.

1.7 QUALITY ASSURANCE

- A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer and that employs a qualified glazing contractor for this Project who is certified under the North American Contractor Certification Program (NACC) for Architectural Glass & Metal (AGM) contractors and that employs glazing technicians certified under the Architectural Glass and Metal Technician (AGMT) certification program.
- B. Product Options: Information on Drawings and in Specifications establishes requirements for aesthetic effects and performance characteristics of assemblies. Aesthetic effects are indicated by dimensions, arrangements, alignment, and profiles of components and assemblies as they relate to sightlines, to one another, and to adjoining construction.
 - 1. Do not change intended aesthetic effects, as judged solely by Architect, except with Architect's approval. If changes are proposed, submit comprehensive explanatory data to Architect for review.

1.8 WARRANTY

- A. Special Warranty: Manufacturer and Installer agrees to repair or replace components of aluminum-framed storefronts that do not comply with requirements or that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: Two years from date of Substantial Completion.
- B. Special Finish Warranty, Factory-Applied Finishes: Standard form in which manufacturer agrees to repair finishes or replace aluminum that shows evidence of deterioration of baked enamel, powder coat, or organic finishes within specified warranty period.
 - 1. Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design aluminum-framed storefronts.

- B. General Performance: Comply with specified performance requirements, as determined by testing of aluminum-framed storefronts representing those indicated for this Project without failure due to defective manufacture, fabrication, installation, or other defects in construction.
1. Aluminum-framed storefronts shall withstand movements of supporting structure, including, but not limited to, twist, column shortening, long-term creep, and deflection from uniformly distributed and concentrated live loads.
 2. Failure also includes the following:
 - a. Thermal stresses transferring to building structure.
 - b. Glass breakage.
 - c. Noise or vibration created by wind and thermal and structural movements.
 - d. Loosening or weakening of fasteners, attachments, and other components.
 - e. Failure of operating units.
- C. Structural Loads:
1. Wind Loads: As indicated on Drawings.
- D. Deflection of Framing Members Supporting Glass: At design wind load, as follows:
1. Deflection Normal to Wall Plane: Limited to 1/175 of clear span for spans of up to 13 feet 6 inches and to 1/240 of clear span plus 1/4 inch for spans greater than 13 feet 6 inches.
 2. Deflection Parallel to Glazing Plane: Limited to amount not exceeding that which reduces glazing bite to less than 75 percent of design dimension and that which reduces edge clearance between framing members and glazing or other fixed components to less than 1/8 inch.
- E. Structural: Test in accordance with ASTM E330/E330M as follows:
1. When tested at positive and negative wind-load design pressures, storefront assemblies do not evidence deflection exceeding specified limits.
 2. When tested at 150 percent of positive and negative wind-load design pressures, storefront assemblies, including anchorage, do not evidence material failures, structural distress, or permanent deformation of main framing members exceeding 0.2 percent of span.
 3. Test Durations: As required by design wind velocity, but not less than 10 seconds.
- F. Water Penetration under Static Pressure: Test in accordance with ASTM E331 as follows:
1. No evidence of water penetration through fixed glazing and framing areas when tested in accordance with a minimum static-air-pressure differential of 20 percent of positive wind-load design pressure, but not less than 6.24 lbf/sq. ft.
- G. Energy Performance: Certified and labelled by manufacturer for energy performance as follows:
1. Thermal Transmittance (U-factor):
 - a. Fixed Glazing and Framing Areas: U-factor for the system of not more than 0.41 Btu/sq. ft. x h x deg F as determined in accordance with NFRC 100.

2. Solar Heat Gain Coefficient (SHGC):
 - a. Fixed Glazing and Framing Areas: SHGC for the system of not more than 0.23 as determined in accordance with NFRC 200.
 3. Air Leakage:
 - a. Fixed Glazing and Framing Areas: Air leakage for the system of not more than 0.06 cfm/sq. ft. at a static-air-pressure differential of 1.57 lbf/sq. ft. when tested in accordance with ASTM E283.
 4. Condensation Resistance Factor (CRF):
 - a. Fixed Glazing and Framing Areas: CRF for the system of not less than 55 as determined in accordance with AAMA 1503.
- H. Windborne-Debris Impact Resistance: Passes ASTM E1886 missile-impact and cyclic-pressure tests in accordance with ASTM E1996 for Wind Zone enhanced protection.
1. Large-Missile Test: For glazing located within 30 feet of grade.
- I. Thermal Movements: Allow for thermal movements resulting from ambient and surface temperature changes.
1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

2.2 EXTERIOR AND VESTIBULE ALUMINUM-FRAMED STOREFRONT SYSTEMS

- A. Framing Members: Manufacturer's extruded- or formed-aluminum framing members of thickness required and reinforced as required to support imposed loads.
1. Exterior Framing Construction: Thermally broken.
 2. Interior Vestibule Framing Construction: Nonthermal.
 3. Interior Glass Wall Framing Construction: Nonthermal.
 4. Glazing System: Retained mechanically with gaskets on four sides.
 5. Glazing Plane: Front.
 6. Finish: High-performance organic finish.
 7. Fabrication Method: Field-fabricated stick system.
 8. Aluminum: Alloy and temper recommended by manufacturer for type of use and finish indicated.
 9. Steel Reinforcement: As required by manufacturer.
- B. Backer Plates: Manufacturer's standard, continuous backer plates for framing members, if not integral, where framing abuts adjacent construction.
- C. Brackets and Reinforcements: Manufacturer's standard high-strength aluminum with nonstaining, nonferrous shims for aligning system components.

2.3 GLAZING

- A. Glazing: Comply with Section 088000 "Glazing."
- B. Glazing Gaskets: Manufacturer's standard sealed-corner pressure-glazing system of black, resilient elastomeric glazing gaskets, setting blocks, and shims or spacers.
- C. Glazing Sealants: As recommended by manufacturer.

2.4 MATERIALS

- A. Sheet and Plate: ASTM B209.
- B. Extruded Bars, Rods, Profiles, and Tubes: ASTM B221.
- C. Structural Profiles: ASTM B308/B308M.
- D. Steel Reinforcement:
 - 1. Structural Shapes, Plates, and Bars: ASTM A36/A36M.
 - 2. Cold-Rolled Sheet and Strip: ASTM A1008/A1008M.
 - 3. Hot-Rolled Sheet and Strip: ASTM A1011/A1011M.
- E. Steel Reinforcement Primer: Manufacturer's standard zinc-rich, corrosion-resistant primer complying with SSPC-PS Guide No. 12.00; applied immediately after surface preparation and pretreatment. Select surface preparation methods in accordance with recommendations in SSPC-SP COM, and prepare surfaces in accordance with applicable SSPC standard.

2.5 FABRICATION

- A. Form or extrude aluminum shapes before finishing.
- B. Weld in concealed locations to greatest extent possible to minimize distortion or discoloration of finish. Remove weld spatter and welding oxides from exposed surfaces by descaling or grinding.
- C. Fabricate components that, when assembled, have the following characteristics:
 - 1. Profiles that are sharp, straight, and free of defects or deformations.
 - 2. Accurately fitted joints with ends coped or mitered.
 - 3. Physical and thermal isolation of glazing from framing members.
 - 4. Accommodations for thermal and mechanical movements of glazing and framing to maintain required glazing edge clearances.
 - 5. Provisions for field replacement of glazing from exterior.
 - 6. Fasteners, anchors, and connection devices that are concealed from view to greatest extent possible.
- D. Mechanically Glazed Framing Members: Fabricate for flush glazing without projecting stops.

- E. After fabrication, clearly mark components to identify their locations in Project in accordance with Shop Drawings.

2.6 ALUMINUM FINISHES

- A. Superior-Performance Organic Finish, Three-Coat PVDF: Fluoropolymer finish complying with AAMA 2605 and containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat.
 - 1. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
 - 2. Color and Gloss: Match Architect's sample. White to match wood clad windows, medium gloss.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

- A. Comply with manufacturer's written instructions.
- B. Do not install damaged components.
- C. Fit joints to produce hairline joints free of burrs and distortion.
- D. Rigidly secure nonmovement joints.
- E. Install anchors with separators and isolators to prevent metal corrosion and electrolytic deterioration and to prevent impeding movement of moving joints.
- F. Seal perimeter and other joints watertight unless otherwise indicated.
- G. Metal Protection:
 - 1. Where aluminum is in contact with dissimilar metals, protect against galvanic action by painting contact surfaces with materials recommended by manufacturer for this purpose or by installing nonconductive spacers.
 - 2. Where aluminum is in contact with concrete or masonry, protect against corrosion by painting contact surfaces with bituminous paint.
- H. Set continuous sill members and flashing in full sealant bed, as specified in Section 079200 "Joint Sealants," to produce weathertight installation.
- I. Install joint filler behind sealant as recommended by sealant manufacturer.
- J. Install components plumb and true in alignment with established lines and grades.

3.2 INSTALLATION OF GLAZING

- A. Install glazing as specified in Section 088000 "Glazing."

3.3 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Field Quality-Control Testing: Perform the following test on representative areas of aluminum-framed storefronts.
 - 1. Water-Spray Test: Before installation of interior finishes has begun, areas designated by Architect shall be tested in accordance with AAMA 501.2 and shall not evidence water penetration.
 - a. Perform a minimum of one test in area as agreed upon with Owner and Architect.
- C. Aluminum-framed storefronts will be considered defective if they do not pass tests and inspections.
- D. Prepare test and inspection reports.

END OF SECTION 084313

SECTION 085200 - WOOD WINDOWS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. The Drawings and general provisions of the Contract, including the City of Baltimore Department of Public Works Specifications (the “Green Book”) and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:

- 1. Aluminum-clad exterior / wood interior windows. Window types include double hung, fixed, casement and transom.

1.3 REFERENCES

- A. American Society for Testing and Materials (ASTM):

- 1. ASTM C1036 - Standard Specification for Flat Glass.
- 2. ASTM C1048 - Standard Specification for Heat-Treated Flat Glass – Kind HS, Kind FT Coated and Uncoated Glass.
- 3. ASTM E283 - Standard Test Method for Determining Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen.
- 4. ASTM E330 - Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference.
- 5. ASTM E547 - Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors and Curtain Walls by Cyclic Static Air Pressure Difference.
- 6. ASTM E2190 - Standard Specification for Insulating Glass Unit Performance and Evaluation.
- 7. ASTM F588 - Standard Test Methods for Measuring the Forced Entry Resistance of Window Assemblies, Excluding Glazing Impact.

- B. American Architectural Manufacturers Association/Window and Door Manufacturers Association/Canadian Standards Association (AAMA/WDMA/CSA):

- 1. AAMA/WDMA/CSA 101/I.S.2/A440-08/NAFS – North American Fenestration Standard/Specification for Windows, Doors and Skylights.

- C. Window and Door Manufacturers Association (WDMA):

- 1. WDMA I.S.2 – Hallmark Certification Program.

2. WDMA 4-05 - Industry Standard for Water Repellent Preservative Non-Pressure Treatment for Millwork.

D. American Architectural Manufacturers Association (AAMA):

1. AAMA 450 – Voluntary Performance Rating Method for Muller Fenestration Assemblies.
2. AAMA 611 – Voluntary Specification for Anodized Architectural Aluminum.
3. AAMA 2604 - Voluntary Specification, Performance Requirements and Test Procedures for High Performance Organic Coatings on Aluminum Extrusions and Panels.
4. AAMA 2605 – Voluntary Specification, Performance Requirements and Test Procedures for Superior Performing Organic Coatings on Aluminum Extrusions and Panels.

E. National Fenestration Rating Council (NFRC):

1. NFRC 102 - Procedure for Measuring the Steady-State Thermal Transmittance of Fenestration Systems.
2. NFRC 200 - Procedure for Determining Fenestration Product Solar Heat Gain Coefficient and Visible Transmittance at Normal Incidence.
3. NFRC 500 - Procedure for Determining Fenestration Product Condensation Resistance Values.
4. ENERGY STAR[®] Compliant Models available.

F. Insulating Glass Certification Council (IGCC).

G. Safety glass tested in accordance with ANSI Z97.1.

H. Forest Stewardship Council[®] (FSC[®]):

1. FSC-STD-40-003 V1-0 – Standard for Multi-site Certification of Chain of Custody Operations.
2. FSC-STD-40-004 V2-1 – Standard for Chain of Custody Certification.

1.3 PERFORMANCE REQUIREMENTS

A. Design and performance requirements:

1. Double-hung Picture windows shall be Hallmark certified in compliance with ANSI/AAMA/NWDA 101/I.S.2/A440-08:
2. Air infiltration shall not exceed 0.30 cfm/ft² when tested at 1.57 psf according to ASTM E283.
3. No water penetration when tested at the following pressure according to ASTM E547:
4. Double-hung tilt windows must withstand the following positive/negative structural test pressure without damage when tested according to ASTM E330:
5. Double-hung tilt windows must pass a forced entry resistance test of at least Grade 10 to meet requirements set forth in ASTM F588.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
2. Review, discuss, and coordinate the interrelationship of wood windows with other exterior wall components. Include provisions for anchoring, flashing, weeping, sealing perimeters, and protecting finishes.
3. Review and discuss the sequence of work required to construct a watertight and weathertight exterior building envelope.
4. Inspect and discuss the condition of substrate and other preparatory work performed by other trades.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, glazing and fabrication methods, dimensions of individual components and profiles, hardware, and finishes for wood windows.

B. Shop Drawings: For wood windows.

1. Include plans, elevations, sections, hardware, accessories, insect screens, operational clearances, and details of installation, including anchor, flashing, and sealant installation.

C. Samples: For each exposed product and for each color specified, 2 by 4 inches in size.

D. Samples for Initial Selection: For units with factory-applied finishes.

1. Include Samples of hardware and accessories involving color selection.

E. Samples for Verification: For wood windows and components required, prepared on Samples of size indicated below:

1. Exposed Finishes: 2 by 4 inches.
2. Exposed Hardware: Full-size units.

F. Product Schedule: For wood windows. Use same designations indicated on Drawings.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Product Test Reports: For each type of wood window, for tests performed by a qualified testing agency.

C. Field quality-control reports.

D. Sample Warranties: For manufacturer's warranties.

1.7 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Products must be certified by independent third parties and labeled as having been produced in compliance with the accepted principles of sustainable forest management. Current sustainability certification systems that comply include the Sustainable Forestry Initiative (SFI), Forest Stewardship Council (FSC), and Program for the Endorsement of Forest Certification (PEFC).
- B. Certified Wood: Provide an invoice including vendor's chain-of-custody number, product cost, and entity being invoiced.
- C. Vendor Qualifications: A vendor that is certified for chain of custody by a SFI-, FSC-, or PEFC-accredited certification body.
- D. Installer Qualifications: An installer acceptable to wood window manufacturer for installation of units required for this Project.
- E. Mockups: Build single mockup in existing opening to demonstrate aesthetic effects, and to set quality standards for materials and execution.
 - 1. Build mockup of typical window installation as indicated on Drawings including all moldings and finishes.
 - 2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
 - 3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.8 WARRANTY

- A. Manufacturer's Warranty: Manufacturer agrees to repair or replace wood windows that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Failure to meet performance requirements.
 - b. Structural failures including excessive deflection, water leakage, and air infiltration.
 - c. Faulty operation of movable sash and hardware.
 - d. Deterioration of materials and finishes beyond normal weathering.
 - e. Failure of insulating glass.
 - 2. Warranty Period:
 - a. Window: 10 years from date of Substantial Completion.
 - b. Wood rot: 30-year warranty.
 - c. Glazing Units, Non-laminated: 20 years from date of Substantial Completion.
 - d. Glazing Units, Laminated: 10 years from date of Substantial Completion.
 - e. Aluminum-Cladding Finish: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

- A. Obtain wood windows from single source from single manufacturer.

2.2 WINDOW PERFORMANCE REQUIREMENTS

- A. Product Standard: Comply with AAMA/WDMA/CSA 101/I.S.2/A440 for definitions and minimum standards of performance, materials, components, accessories, and fabrication unless more stringent requirements are indicated.
 - 1. Window Certification: WDMA certified with label attached to each window.
- B. Performance Class and Grade: AAMA/WDMA/CSA 101/I.S.2/A440 as follows:
 - 1. Minimum Performance Class: CW.
 - 2. Minimum Performance Grade: 50.
- C. Thermal Transmittance: NFRC 100 maximum whole-window U-factor of 0.28 Btu/sq. ft. x h x deg.
- D. Solar Heat-Gain Coefficient (SHGC): NFRC 200 maximum whole-window SHGC of 0.17.
- E. Windborne-Debris Impact Resistance: Passes ASTM E1886 missile-impact and cyclic-pressure tests in accordance with ASTM E1996 for Wind Zone enhanced protection.
 - 1. Large-Missile Test: For all glazing.

2.3 WOOD WINDOWS

- A. Aluminum-Clad Wood Windows:
 - 1. Basis-of-Design Product: Subject to compliance with requirements, provide Pella Corporation; Architect Series windows or comparable product by one of the following:
 - a. WeatherShield
 - b. Andersen Windows, Inc.; Andersen Corporation.
 - c. Marvin.
 - d. Jenweld.
- B. Operating Types: Provide the following operating types in locations indicated on Drawings:
 - 1. Casement: swing in.
 - 2. Double hung.
 - 3. Fixed.
 - 4. Fixed transom.

- C. Certified Wood: Wood products to be labeled in accordance with the AF&PA's Sustainable Forestry Initiative, be certified as "FSC Pure" in accordance with FSC STD-01-001 and FSC STD-40-004 or be certified and labeled in accordance with the standards of the Programme for Endorsement of Forest Certification.
- D. Certified Wood: Wood products to certified wood tracked through a chain-of-custody process. Certified wood documentation to be provided by sources certified through a forest certification system with principles, criteria, and standards developed using ISO/IEC Guide 59 or the World Trade Organization's "WTO Agreement on Technical Barriers to Trade."
- E. Certified Wood: Wood products to be certified in accordance with the American Tree Farm System's "AFF Standard," the AF&PA's Sustainable Forestry Initiative, FSC STD-01-001 and FSC STD-40-004, or the standards of the Programme for Endorsement of Forest Certification.
- F. Frames and Sashes: Fine-grained wood lumber complying with AAMA/WDMA/CSA 101/I.S.2/A440; kiln dried to a moisture content of not more than 12 percent at time of fabrication; free of visible finger joints on linear members, blue stain, knots, pitch pockets, and surface checks larger than 1/32 inch deep by 2 inches wide; water-repellent preservative treated.
 - 1. Exterior Finish: Aluminum-clad.
 - a. Aluminum Finish: Manufacturer's standard fluoropolymer two-coat system with fluoropolymer color topcoat containing not less than 70 percent PVDF resin by weight and complying with AAMA 2605.
 - b. Color: White.
 - 2. Interior Finish: Manufacturer's standard color-coated finish.
 - a. Painted Color: White.
- G. Windborne-Debris-Impact-Resistant Insulating-Glass Units: ASTM E2190 with two lites and complying with impact-resistance requirements in "Window Performance Requirements" Article.
 - 1. Exterior Lite: ASTM C1036, Type 1, Class 1, q3.
 - a. Tint: Clear.
 - b. Kind: Heat strengthened.
 - 2. Interior Lite: ASTM C1172 clear laminated glass with two plies of float glass.
 - a. Float Glass: As required by performance requirements indicated.
 - b. Interlayer Thickness: As required by performance requirements indicated.
 - 3. Filling: Fill space between glass lites with argon.
 - 4. Low-E Coating: Sputtered on second surface.
- H. Hardware, General: Provide manufacturer's standard hardware fabricated from aluminum, stainless steel, carbon steel complying with AAMA 907, or other corrosion-resistant material compatible with adjacent materials; designed to smoothly operate, tightly close, and securely lock windows, and sized to accommodate sash weight and dimensions.

1. Exposed Hardware Color and Finish: White.

I. Casement Window Hardware:

1. Gear-Type Rotary Operators: Complying with AAMA 901 when tested in accordance with ASTM E405, Method A. Provide operators that function without requiring the removal of interior screens.
 - a. Type and Style: As selected by Architect from manufacturer's full range of types and styles.
2. Hinges: Manufacturer's standard type for sash weight and size indicated.
3. Single-Handle Locking System: Operates positive-acting arms that pull sash into locked position. Provide one lock on sashes up to 29 inches tall and two locks on taller sashes.
4. Limit Devices: Concealed support arms with adjustable, limited, hold-open limit devices designed to restrict sash opening.
 - a. Limit clear opening to 4 inches for ventilation; with custodial key release.
5. Operator Stud Cover: Matching operator handle finish. Provide in locations where operator handle is removed for controlled access.

J. Hung Window Hardware:

1. Counterbalancing Mechanism: Complying with AAMA 902, concealed, of size and capacity to hold sash stationary at any open position.
2. Locks and Latches: Allow unobstructed movement of the sash across adjacent sash in direction indicated and operated from the inside only. Provide custodial locks.
3. Tilt Hardware: Releasing tilt latch allows sash to pivot about horizontal axis to facilitate cleaning exterior surfaces from the interior.

- K. Weather Stripping: Provide full-perimeter weather stripping for each operable sash unless otherwise indicated.

- L. Fasteners: Noncorrosive and compatible with window members, trim, hardware, anchors, and other components.

1. Exposed Fasteners: Do not use exposed fasteners to greatest extent possible. For application of hardware, use fasteners that match finish hardware being fastened.

2.4 ACCESSORIES

- A. Dividers (False Muntins): Provide divider grilles in designs indicated for each sash lite.

1. Quantity and Type: Three per sash, two permanently located at exterior and interior lites and one permanently located between insulating-glass lites.
2. Material: Manufacturer's standard.
3. Pattern: As indicated on Drawings to match existing windows to be demolished.>.
4. Profile: 7/8 inch ogee.
5. Color: To match frame color.

2.5 INSECT SCREENS

- A. General: Fabricate insect screens to integrate with window frame. Provide screen for each operable exterior sash. Screen wickets are not permitted.
 - 1. Type and Location: Full, inside for project-out\Full, outside for double-hung sashes.
- B. Aluminum Frames: Manufacturer's standard aluminum alloy complying with SMA 1004 or SMA 1201. Fabricate frames with mitered or coped joints or corner extrusions, concealed fasteners, and removable PVC spline/anchor concealing edge of frame.
 - 1. Tubular Framing Sections and Cross Braces: Roll formed from aluminum sheet.
 - 2. Finish for Interior Screens: Baked-on organic coating in color selected by Architect from manufacturer's full range.
 - 3. Finish for Exterior Screens: Matching color and finish of cladding.
- C. Glass-Fiber Mesh Fabric: manufacturer's standard mesh of PVC-coated, glass-fiber threads; woven and fused to form a fabric mesh resistant to corrosion, shrinkage, stretch, impact damage, and weather deterioration. Comply with ASTM D3656/D3656M and SMA 1201.
 - 1. Mesh Color: Manufacturer's standard.

2.6 FABRICATION

- A. Fabricate wood windows in sizes indicated. Include a complete system for installing and anchoring windows.
- B. Glaze wood windows in the factory.
- C. Weather strip each operable sash to provide weathertight installation.
- D. Mullions: Provide mullions and cover plates, matching window units, complete with anchors for support to structure and installation of window units. Allow for erection tolerances and provide for movement of window units due to thermal expansion and building deflections. Provide mullions and cover plates capable of withstanding design wind loads of window units.
- E. Complete fabrication, assembly, finishing, hardware application, and other work in the factory to greatest extent possible. Disassemble components only as necessary for shipment and installation. Allow for scribing, trimming, and fitting at Project site.

PART 3 - EXECUTION

3.1 EXAMINATION

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

- B. Verify rough opening dimensions, levelness of sill plate, and operational clearances.
- C. Examine wall flashings, vapor retarders, water and weather barriers, and other built-in components to ensure weathertight window installation.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Comply with manufacturer's written instructions for installing windows, hardware, accessories, and other components. For installation procedures and requirements not addressed in manufacturer's written instructions, comply with installation requirements in ASTM E2112.
- B. Install windows level, plumb, square, true to line, without distortion, anchored securely in place to structural support, and in proper relation to wall flashing and other adjacent construction to produce weathertight construction.
- C. Separate aluminum and other corrodible surfaces from sources of corrosion or electrolytic action (dissimilar materials, treated lumber, etc.) at the points of contact with other materials.
- D. For fin method of attachment, integrate window system installation with exterior water-resistant barrier using flashing/sealant tape. Apply and integrate flashing/sealant tape with water-resistant barrier using watershed principles in accordance with window manufacturer's written instructions.
- E. Place interior seal around window perimeter to maintain continuity of building thermal and air barrier using insulating-foam sealant.
- F. Seal window to exterior wall cladding with sealant and related backing materials at perimeter of assembly.
- G. Leave windows closed and locked.

3.3 ADJUSTING, CLEANING, AND PROTECTION

- A. Adjust operating sashes and hardware for a tight fit at contact points and weather stripping for smooth operation and weathertight closure.
- B. Clean exposed surfaces immediately after installing windows. Remove excess sealants, glazing materials, dirt, and other substances.
 - 1. Keep protective films and coverings in place until final cleaning.
- C. Remove and replace sashes if glass has been broken, chipped, cracked, abraded, or damaged during construction period.
- D. Protect window surfaces from contact with contaminating substances resulting from construction operations. If contaminating substances do contact window surfaces, remove contaminants immediately in accordance with manufacturer's written instructions.

END OF SECTION 085200

SECTION 087100 - DOOR HARDWARE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. The Drawings and general provisions of the Contract, including the City of Baltimore Department of Public Works Specifications (the "Green Book") and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes commercial door hardware for the following:
 - 1. Swinging doors.
 - 2. Other doors to the extent indicated.
- B. Door hardware includes, but is not necessarily limited to, the following:
 - 1. Mechanical door hardware.
 - 2. Electromechanical door hardware.
 - 3. Automatic operators.
 - 4. Cylinders specified for doors in other sections.
- C. Related Sections:
 - 1. Section 011000 "Summary" for restrictions on use of the premises, Owner-occupancy requirements, and phasing requirements.
 - 2. Section 017300 "Execution" for cutting and patching procedures.
 - 3. Section 013516 "Alteration Project Procedures" for general protection and work procedures for alteration projects.
 - 4. Section 0811113 "Hollow Metal Doors and Frames".
 - 5. Section 081416 "Flush Wood Doors".
 - 6. Section 084313 "Aluminum-Framed Storefronts".
 - 7. Section 087113 "Power Door Operators".
- D. Codes and References: Comply with the version year adopted by the Authority Having Jurisdiction.
 - 1. ANSI A117.1 - Accessible and Usable Buildings and Facilities.
 - 2. ICC/IBC - International Building Code.
 - 3. NFPA 70 - National Electrical Code.
 - 4. NFPA 80 - Fire Doors and Windows.
 - 5. NFPA 101 - Life Safety Code.
 - 6. NFPA 105 - Installation of Smoke Door Assemblies.
 - 7. UL/ULC and CSA C22.2 - Standards for Automatic Door Operators Used on Fire and Smoke Barrier Doors and Systems of Doors.
 - 8. State Building Codes, Local Amendments.

- E. Standards: All hardware specified herein shall comply with the following industry standards as applicable. Any undated reference to a standard shall be interpreted as referring to the latest edition of that standard:
1. ANSI/BHMA Certified Product Standards - A156 Series.
 2. UL10C - Positive Pressure Fire Tests of Door Assemblies.
 3. ANSI/UL 294 - Access Control System Units.
 4. UL 305 - Panic Hardware.
 5. ANSI/UL 437- Key Locks.

1.3 SUBMITTALS

- A. Product Data: Manufacturer's product data sheets including installation details, material descriptions, dimensions of individual components and profiles, operational descriptions and finishes.
- B. Door Hardware Schedule: Prepared by or under the supervision of supplier, detailing, fabrication and assembly of door hardware, as well as procedures and diagrams. Coordinate the final Door Hardware Schedule with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of door hardware.
1. Format: Comply with scheduling sequence and vertical format in DHI's "Sequence and Format for the Hardware Schedule."
 2. Organization: Organize the Door Hardware Schedule into door hardware sets indicating complete designations of every item required for each door or opening. Organize door hardware sets in same order as in the Door Hardware Sets at the end of Part 3. Submittals that do not follow the same format and order as the Door Hardware Sets will be rejected and subject to resubmission.
 3. Content: Include the following information:
 - a. Type, style, function, size, label, hand, and finish of each door hardware item.
 - b. Manufacturer of each item.
 - c. Fastenings and other pertinent information.
 - d. Location of door hardware set, cross-referenced to Drawings, both on floor plans and in door and frame schedule.
 - e. Explanation of abbreviations, symbols, and codes contained in schedule.
 - f. Mounting locations for door hardware.
 - g. Door and frame sizes and materials.
 - h. Warranty information for each product.
 4. Submittal Sequence: Submit the final Door Hardware Schedule at earliest possible date, particularly where approval of the Door Hardware Schedule must precede fabrication of other work that is critical in the Project construction schedule. Include Product Data, Samples, Shop Drawings of other work affected by door hardware, and other information essential to the coordinated review of the Door Hardware Schedule.
- C. Shop Drawings: Details of electrified access control hardware indicating the following:
1. Wiring Diagrams: Upon receipt of approved schedules, submit detailed system wiring diagrams for power, signaling, monitoring, communication, and control of the access

control system electrified hardware. Differentiate between manufacturer-installed and field-installed wiring. Include the following:

- a. Elevation diagram of each unique access controlled opening showing location and interconnection of major system components with respect to their placement in the respective door openings.
 - b. Complete (risers, point-to-point) access control system block wiring diagrams.
 - c. Wiring instructions for each electronic component scheduled herein.
2. Electrical Coordination: Coordinate with related sections the voltages and wiring details required at electrically controlled and operated hardware openings.
- D. Keying Schedule: After a keying meeting with the owner has taken place prepare a separate keying schedule detailing final instructions. Submit the keying schedule in electronic format. Include keying system explanation, door numbers, key set symbols, hardware set numbers and special instructions. Owner must approve submitted keying schedule prior to the ordering of permanent cylinders/cores.
- E. Informational Submittals:
1. Product Test Reports: Indicating compliance with cycle testing requirements, based on evaluation of comprehensive tests performed by manufacturer and witnessed by a qualified independent testing agency.

1.4 CLOSEOUT SUBMITTALS

- A. Operating and Maintenance Manuals: Provide manufacturers operating and maintenance manuals for each item comprising the complete door hardware installation in quantity as required in Division 01, Closeout Procedures.
- B. Project Record Documents: Provide record documentation of as-built door hardware sets in digital format (.pdf, .docx, .xlsx, .csv) and as required in Division 01, Project Record Documents.

1.5 QUALITY ASSURANCE

- A. Manufacturers Qualifications: Engage qualified manufacturers with a minimum 5 years of documented experience in producing hardware and equipment similar to that indicated for this Project and that have a proven record of successful in-service performance.
- B. Certified Products: Where specified, products must maintain a current listing in the Builders Hardware Manufacturers Association (BHMA) Certified Products Directory (CPD).
- C. Installer Qualifications: A minimum 3 years documented experience installing both standard and electrified door hardware similar in material, design, and extent to that indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.
- D. Door Hardware Supplier Qualifications: Experienced commercial door hardware distributors with a minimum 5 years documented experience supplying both mechanical and

electromechanical hardware installations comparable in material, design, and extent to that indicated for this Project. Supplier recognized as a factory direct distributor by the manufacturers of the primary materials with a warehousing facility in Project's vicinity. Supplier to have on staff a certified Architectural Hardware Consultant (AHC) available during the course of the Work to consult with Contractor, Architect, and Owner concerning both standard and electromechanical door hardware and keying.

- E. Source Limitations: Obtain each type and variety of door hardware specified in this section from a single source unless otherwise indicated.
 - 1. Electrified modifications or enhancements made to a source manufacturer's product line by a secondary or third party source will not be accepted.
 - 2. Provide electromechanical door hardware from the same manufacturer as mechanical door hardware, unless otherwise indicated.

- F. Each unit to bear third party permanent label indicating compliance with the referenced testing standards.

- G. Keying Conference: Conduct conference to comply with requirements in Division 01 Section "Project Meetings." Keying conference to incorporate the following criteria into the final keying schedule document:
 - 1. Function of building, purpose of each area and degree of security required.
 - 2. Plans for existing and future key system expansion.
 - 3. Requirements for key control storage and software.
 - 4. Installation of permanent keys, cylinder cores and software.
 - 5. Address and requirements for delivery of keys.

- H. Pre-Submittal Conference: Conduct coordination conference in compliance with requirements in Division 01 Section "Project Meetings" with attendance by representatives of Supplier(s), Installer(s), and Contractor(s) to review proper methods and the procedures for receiving, handling, and installing door hardware.
 - 1. Prior to installation of door hardware, conduct a project specific training meeting to instruct the installing contractors' personnel on the proper installation and adjustment of their respective products. Product training to be attended by installers of door hardware (including electromechanical hardware) for aluminum, hollow metal and wood doors. Training will include the use of installation manuals, hardware schedules, templates and physical product samples as required.
 - 2. Inspect and discuss electrical roughing-in, power supply connections, and other preparatory work performed by other trades.
 - 3. Review sequence of operation narratives for each unique access controlled opening.
 - 4. Review and finalize construction schedule and verify availability of materials.
 - 5. Review the required inspecting, testing, commissioning, and demonstration procedures

- I. At completion of installation, provide written documentation that components were applied according to manufacturer's instructions and recommendations and according to approved schedule.

1.6 DELIVERY, STORAGE AND HANDLING

- A. Inventory door hardware on receipt and provide secure lock-up and shelving for door hardware delivered to Project site. Do not store electronic access control hardware, software or accessories at Project site without prior authorization.
- B. Tag each item or package separately with identification related to the final Door Hardware Schedule, and include basic installation instructions with each item or package.
- C. Deliver, as applicable, permanent keys, cylinders, cores, access control credentials, software and related accessories directly to Owner via registered mail or overnight package service. Instructions for delivery to the Owner shall be established at the "Keying Conference".

1.7 COORDINATION

- A. Templates: Obtain and distribute to the parties involved templates for doors, frames, and other work specified to be factory prepared for installing standard and electrified hardware. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing hardware to comply with indicated requirements.
- B. Door and Frame Preparation: Doors and corresponding frames are to be prepared, reinforced and pre-wired (if applicable) to receive the installation of the specified electrified, monitoring, signaling and access control system hardware without additional in-field modifications.

1.8 WARRANTY

- A. General Warranty: Reference Division 01, General Requirements. Special warranties specified in this Article shall not deprive Owner of other rights Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under requirements of the Contract Documents.
- B. Warranty Period: Written warranty, executed by manufacturer(s), agreeing to repair or replace components of standard and electrified door hardware that fails in materials or workmanship within specified warranty period after final acceptance by the Owner. Failures include, but are not limited to, the following:
 - 1. Structural failures including excessive deflection, cracking, or breakage.
 - 2. Faulty operation of the hardware.
 - 3. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
 - 4. Electrical component defects and failures within the systems operation.
- C. Warranty Period: Unless otherwise indicated, warranty shall be one year from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

- A. Manufactures listed herein are for basis of design.

- B. Obtain each type of door hardware from single manufacturer.
 - 1. Provide electrified door hardware from same manufacturer as mechanical door hardware unless otherwise indicated. Manufacturers that perform electrical modifications and that are listed by a testing and inspecting agency acceptable to authorities having jurisdiction are acceptable.

2.2 PERFORMANCE REQUIREMENTS

- A. Electrified Door Hardware: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Means of Egress Doors: Latches do not require more than 15 lbf to release the latch. Locks do not require use of a key, tool, or special knowledge for operation.
- C. Accessibility Requirements: For door hardware on doors in an accessible route, comply with the USDOJ's "2010 ADA Standards for Accessible Design and ICC A117.1.

2.3 BUTT HINGES

- A. Hinges: ANSI/BHMA A156.1 butt hinges with number of hinge knuckles and other options as specified in the Door Hardware Sets.
 - 1. Quantity: Provide the following hinge quantity:
 - a. Two Hinges: For doors with heights up to 60 inches.
 - b. Three Hinges: For doors with heights 61 to 90 inches.
 - c. Four Hinges: For doors with heights 91 to 120 inches.
 - d. For doors with heights more than 120 inches, provide 4 hinges, plus 1 hinge for every 30 inches of door height greater than 120 inches.
 - 2. Hinge Size: Provide the following, unless otherwise indicated, with hinge widths sized for door thickness and clearances required:
 - a. Widths up to 3'0": 4-1/2" standard or heavy weight as specified.
 - b. Sizes from 3'1" to 4'0": 5" standard or heavy weight as specified.
 - 3. Hinge Weight and Base Material: Unless otherwise indicated, provide the following:
 - a. Exterior Doors: Heavy weight, non-ferrous, ball bearing or oil impregnated bearing hinges unless Hardware Sets indicate standard weight.
 - b. Interior Doors: Standard weight, steel, ball bearing or oil impregnated bearing hinges unless Hardware Sets indicate heavy weight.
 - 4. Hinge Options: Comply with the following:
 - a. Non-removable Pins: With the exception of electric through wire hinges, provide set screw in hinge barrel that, when tightened into a groove in hinge pin, prevents removal of pin while door is closed; for the all out-swinging lockable doors.

5. Manufacturers:
 - a. McKinney (MK) - TA/T4A Series, 5-knuckle.

2.4 CONTINUOUS HINGES

- A. Continuous Geared Hinges: ANSI/BHMA A156.26 Grade 1-600 continuous geared hinge. with minimum 0.120-inch thick extruded 6063-T6 aluminum alloy hinge leaves and a minimum overall width of 4 inches. Hinges are non-handed, reversible and fabricated to template screw locations. Factory trim hinges to suit door height and prepare for electrical cut-outs.

1. Manufacturers:
 - a. Pemko (PE).

2.5 POWER TRANSFER DEVICES

- A. Electrified Quick Connect Transfer Hinges: Provide electrified transfer hinges with Molex™ standardized plug connectors and sufficient number of concealed wires (up to 12) to accommodate the electrified functions specified in the Door Hardware Sets with a 1-year warranty. Connectors plug directly to through-door wiring harnesses for connection to electric locking devices and power supplies. Wire nut connections are not acceptable.

1. Manufacturers:
 - a. McKinney (MK) - QC (# wires) Option.

- B. Electric Door Wire Harnesses: Provide electric/data transfer wiring harnesses with standardized plug connectors to accommodate up to twelve (12) wires. Connectors plug directly to through-door wiring harnesses for connection to electric locking devices and power supplies. Provide sufficient number and type of concealed wires to accommodate electric function of specified hardware. Provide a connector for through-door electronic locking devices and from hinge to junction box above the opening. Wire nut connections are not acceptable. Determine the length required for each electrified hardware component for the door type, size and construction, minimum of two per electrified opening.

1. Provide one each of the following tools as part of the base bid contract:
 - a. McKinney (MK) - Electrical Connecting Kit: QC-R001.
 - b. McKinney (MK) - Connector Hand Tool: QC-R003.
2. Manufacturers:
 - a. McKinney (MK) - QC-C Series.

2.6 DOOR OPERATING TRIM

- A. Flush Bolts and Surface Bolts: Provide products conforming to ANSI/BHMA A156.3 and A156.16, Grade 1.

1. Flush bolts to be furnished with top rod of sufficient length to allow bolt retraction device location approximately six feet from the floor.
 2. Furnish dust proof strikes for bottom bolts.
 3. Surface bolts to be minimum 8" in length and U.L. listed for labeled fire doors and U.L. listed for windstorm components where applicable.
 4. Provide related accessories (mounting brackets, strikes, coordinators, etc.) as required for appropriate installation and operation.
 5. Manufacturers:
 - a. Rockwood (RO).
- B. Coordinators: ANSI/BHMA A156.3 door coordinators consisting of active-leaf, hold-open lever and inactive-leaf release trigger. Model as indicated in hardware sets.
1. Manufacturers:
 - a. Rockwood (RO).
- C. Door Push Plates and Pulls: ANSI/BHMA A156.6 door pushes and pull units of type and design specified in the Hardware Sets. Coordinate and provide proper width and height as required where conflicting hardware dictates.
1. Push/Pull Plates: Minimum .050 inch thick, size as indicated in hardware sets, with beveled edges, secured with exposed screws unless otherwise indicated.
 2. Door Pull and Push Bar Design: Size, shape, and material as indicated in the hardware sets. Minimum clearance of 2 1/2-inches from face of door unless otherwise indicated.
 3. Offset Pull Design: Size, shape, and material as indicated in the hardware sets. Minimum clearance of 2 1/2-inches from face of door and offset of 90 degrees unless otherwise indicated.
 4. Pulls, where applicable, shall be provided with a 10" clearance from the finished floor on the push side to accommodate wheelchair accessibility.
 5. Fasteners: Provide manufacturer's designated fastener type as indicated in Hardware Sets. When through-bolt fasteners are in the same location as a push plate, countersink the fasteners flush with the door face allowing the push plate to sit flat against the door.
 6. Manufacturers:
 - a. Rockwood (RO).

2.7 CYLINDERS AND KEYING

- A. General: Cylinder manufacturer to have minimum (10) years experience designing secured master key systems and have on record a published security keying system policy.
1. Manufacturers:
 - a. Match Existing, Field Verify.
- B. Cylinder Types: Original manufacturer cylinders able to supply the following cylinder formats and types:
1. Threaded mortise cylinders with rings and cams to suit hardware application.

2. Rim cylinders with back plate, flat-type vertical or horizontal tailpiece, and raised trim ring.
3. Bored or cylindrical lock cylinders with tailpieces as required to suit locks.
4. Tubular deadlocks and other auxiliary locks.
5. Mortise and rim cylinder collars to be solid and recessed to allow the cylinder face to be flush and be free spinning with matching finishes.
6. Keyway: Match Facility Standard.

C. Keying System: Each type of lock and cylinders to be factory keyed.

1. Supplier shall conduct a "Keying Conference" to define and document keying system instructions and requirements.
2. Furnish factory cut, nickel-silver large bow permanently inscribed with a visual key control number as directed by Owner.
3. Existing System: Field verify and key cylinders to match Owner's existing system.

D. Key Quantity: Provide the following minimum number of keys:

1. Change Keys per Cylinder: Two (2)
2. Master Keys (per Master Key Level/Group): Five (5).
3. Construction Keys (where required): Ten (10).

E. Construction Keying: Provide construction master keyed cylinders.

F. Key Registration List (Bitting List):

1. Provide keying transcript list to Owner's representative in the proper format for importing into key control software.
2. Provide transcript list in writing or electronic file as directed by the Owner.

2.8 MORTISE LOCKS AND LATCHING DEVICES

A. Mortise Locksets, Grade 1 (Heavy Duty): Provide ANSI/BHMA A156.13, Series 1000, Operational Grade 1 Certified Products Directory (CPD) listed mortise locksets. Listed manufacturers shall meet all functions and features as specified herein.

1. Electromechanical locksets shall have the following functions and features:
 - a. Universal Molex plug-in connectors that have standardized color-coded wiring and are available in fail safe or fail secure and operate from 12vdc to 24vdc regulated.
 - b. EcoFlex or equivalent technology that reduces energy consumption up to 92% as certified by GreenCircle.
 - c. Motorized electric latch retraction where the latchbolt retracts in 0.5 seconds of power being applied; removing power allows the latch to project back to the extended position.
 - d. Options to be available for request-to-exit or enter signaling, latchbolt and deadbolt monitoring.
 - e. Two-year limited warranty on electrified functions.
2. Manufacturers:

- a. Sargent Manufacturing (SA) - 8200 Series.

2.9 DEADLOCKS AND LATCHES

- A. Narrow Case Deadlocks and Deadlatches: ANSI/BHMA 156.13 Series 1000 Grade 1 narrow case deadlocks and deadlatches for swinging or sliding door applications. All functions shall be manufactured in a single sized case formed from 12 gauge minimum, corrosion resistant steel (option for fully stainless steel case and components). Provide minimum 2 7/8" throw laminated stainless steel bolt. Bottom rail deadlocks to have 3/8" diameter bolts.

1. Manufacturers:

- a. Adams Rite Manufacturing (AD) - MS1850S / MS1950 Series.

2.10 LOCK AND LATCH STRIKES

- A. Strikes: Provide manufacturer's standard strike with strike box for each latch or lock bolt, with curved lip extended to protect frame, finished to match door hardware set, unless otherwise indicated, and as follows:

1. Flat-Lip Strikes: For locks with three-piece antifriction latchbolts, as recommended by manufacturer.
2. Extra-Long-Lip Strikes: For locks used on frames with applied wood casing trim.
3. Aluminum-Frame Strike Box: Provide manufacturer's special strike box fabricated for aluminum framing.
4. Double-lipped strikes: For locks at double acting doors. Furnish with retractable stop for rescue hardware applications.

- B. Standards: Comply with the following:

1. Strikes for Mortise Locks and Latches: BHMA A156.13.
2. Strikes for Bored Locks and Latches: BHMA A156.2.
3. Strikes for Auxiliary Deadlocks: BHMA A156.36.
4. Dustproof Strikes: BHMA A156.16.

2.11 CONVENTIONAL EXIT DEVICES

- A. General Requirements: All exit devices specified herein shall meet or exceed the following criteria:

1. Exit devices shall have a five-year warranty.
2. At doors not requiring a fire rating, provide devices complying with NFPA 101 and listed and labeled for "Panic Hardware" according to UL305. Provide proper fasteners as required by manufacturer including sex nuts and bolts at openings specified in the Hardware Sets.
3. Where exit devices are required on fire rated doors, provide devices complying with NFPA 80 and with UL labeling indicating "Fire Exit Hardware". Provide devices with the proper fasteners for installation as tested and listed by UL. Consult manufacturer's catalog and template book for specific requirements.

4. Except on fire rated doors, provide exit devices with hex key dogging device to hold the pushbar and latch in a retracted position. Provide optional keyed cylinder dogging on devices where specified in Hardware Sets.
 5. Devices must fit flat against the door face with no gap that permits unauthorized dogging of the push bar. The addition of filler strips is required in any case where the door light extends behind the device as in a full glass configuration.
 6. Lever Operating Trim: Where exit devices require lever trim, furnish manufacturer's heavy duty escutcheon trim with threaded studs for thru-bolts.
 - a. Lock Trim Design: As indicated in Hardware Sets, provide finishes and designs to match that of the specified locksets.
 - b. Where function of exit device requires a cylinder, provide a cylinder (Rim or Mortise) as specified in Hardware Sets.
 7. Vertical Rod Exit Devices: Where surface or concealed vertical rod exit devices are used at interior openings, provide as less bottom rod (LBR) unless otherwise indicated. Provide dust proof strikes where thermal pins are required to project into the floor.
 8. Narrow Stile Applications: At doors constructed with narrow stiles, or as specified in Hardware Sets, provide devices designed for maximum 2" wide stiles.
 9. Dummy Push Bar: Nonfunctioning push bar matching functional push bar.
 10. Rail Sizing: Provide exit device rails factory sized for proper door width application.
 11. Through Bolt Installation: For exit devices and trim as indicated in Door Hardware Sets.
- B. Conventional Push Rail Exit Devices (Heavy Duty): ANSI/BHMA A156.3, Grade 1 Certified Products Directory (CPD) listed exit devices. Listed manufacturers shall meet all functions and features as specified herein.
1. Manufacturers:
 - a. Sargent Manufacturing (SA) - 80 Series.

2.12 DOOR CLOSERS

- A. All door closers specified herein shall meet or exceed the following criteria:
1. General: Door closers to be from one manufacturer, matching in design and style, with the same type door preparations and templates regardless of application or spring size. Closers to be non-handed with full sized covers.
 2. Standards: Closers to comply with UL-10C for Positive Pressure Fire Test and be U.L. listed for use of fire rated doors.
 3. Size of Units: Comply with manufacturer's written recommendations for sizing of door closers depending on size of door, exposure to weather, and anticipated frequency of use. Where closers are indicated for doors required to be accessible to the Americans with Disabilities Act, provide units complying with ANSI ICC/A117.1.
 4. Closer Arms: Provide heavy duty, forged steel closer arms unless otherwise indicated in Hardware Sets.
 5. Closers shall not be installed on exterior or corridor side of doors; where possible install closers on door for optimum aesthetics.

6. Closer Accessories: Provide door closer accessories including custom templates, special mounting brackets, spacers and drop plates as required for proper installation. Provide through-bolt and security type fasteners as specified in the hardware sets.
- B. Door Closers, Surface Mounted (Heavy Duty): ANSI/BHMA A156.4, Grade 1 Certified Products Directory (CPD) listed surface mounted, heavy duty door closers with complete spring power adjustment, sizes 1 thru 6; and fully operational adjustable according to door size, frequency of use, and opening force. Closers to be rack and pinion type, one piece cast iron or aluminum alloy body construction, with adjustable backcheck and separate non-critical valves for closing sweep and latch speed control. Provide non-handed units standard.
1. Heavy duty surface mounted door closers shall have a 30-year warranty.
 2. Manufacturers:
 - a. Sargent Manufacturing (SA) - 351 Series.

2.13 ELECTROHYDRAULIC DOOR OPERATORS

- A. Electrohydraulic Door Operators (High Traffic): Provide ANSI/BHMA A156.19 Certified Products Directory (CPD) listed low energy operators that meet ANSI/BHMA A156.4 requirements and are UL listed for use on fire rated doors and UL10C certified that comply with requirements for the Americans with Disabilities Act (ADA). Operators shall be verified by GreenCircle to offer energy savings of 19% when compared to similar products to accommodate openings up 250 pounds and 48" wide.
1. Provide operators with features as follows:
 - a. Non-handed with push and pull side mounting.
 - b. Operates as mechanical surface closer during close cycles, when door is opened manually or if power is off.
 - c. Activation by push button, hands-free or radio frequency devices.
 - d. On board electronics to collect usage and cycle count data to facilitate preventative maintenance/diagnostics.
 - e. Two-year limited warranty.
 - f. Wi-Fi interface where the operator is a secure, password protected WiFi hot spot with no connection to building's IT required.
 - 1) Simple setup with no app required.
 - 2) View status and make adjustments without removing the cover.
 - 3) Built-in logic to support single use restroom applications with no external relay boards, logic modules, position switches required.
 - g. Mounting backplate to simplify and speed up installation.
 2. Operators shall have the following functionality:
 - a. Adjustable Hold Open: Amount of time a door will stay in the full open position after an activation.
 - b. Blow Open for Smoke Ventilation: Door opens when signal is received from alarm system allowing air or smoke to flow through opening. Door will stay open until signal from alarm system is stopped.

- c. Infinite Hold Open: Door will hold open at set position until power is turned off.
 - d. Obstruction Detection: Door closes if it hits an obstruction while opening; door will reverse to open position if it hits an obstruction while closing. Door will stop once it hits an obstruction and will rest against the obstruction until removed.
 - e. Open Delay: Delays operator opening for locking hardware.
 - f. Overload Safety Shut-Off: After two minutes of receiving a door activation signal, inverter times out and door closes to prevent motor/inverter damage.
 - g. Presence Detector Input: Input for external sensor to detect presence at door open or close position only.
 - h. Push & Go: As the door is manually opened, the operator "senses" movement and opens door to the full-open position.
 - i. Selector Mode Switch: Off disables the signal inputs unless Blow Open is activated, on activates the signal inputs, hold open activates the unit (unless Blow Closed is activated) to the hold open position.
 - j. Vestibule Delay: When the wall switch is pressed, first door in vestibule will open. Second door will open once vestibule door delay has expired. Delay is adjustable.
3. Manufacturers:
- a. Norton Rixson (NO) - 6000 Series.

2.14 ARCHITECTURAL TRIM

A. Door Protective Trim

1. General: Door protective trim units to be of type and design as specified below or in the Hardware Sets.
2. Size: Fabricate protection plates (kick, armor, or mop) not more than 2" less than door width (LDW) on stop side of single doors and 1" LDW on stop side of pairs of doors, and not more than 1" less than door width on pull side. Coordinate and provide proper width and height as required where conflicting hardware dictates. Height to be as specified in the Hardware Sets.
3. Where plates are applied to fire rated doors with the top of the plate more than 16" above the bottom of the door, provide plates complying with NFPA 80. Consult manufacturer's catalog and template book for specific requirements for size and applications.
4. Protection Plates: ANSI/BHMA A156.6 protection plates (kick, armor, or mop), fabricated from the following:
 - a. Stainless Steel: 300 grade, 050-inch thick.
5. Options and fasteners: Provide manufacturer's designated fastener type as specified in the Hardware Sets. Provide countersunk screw holes.
6. Manufacturers:
 - a. Rockwood (RO).

2.15 DOOR STOPS AND HOLDERS

- A. General: Door stops and holders to be of type and design as specified below or in the Hardware Sets.

- B. Door Stops and Bumpers: ANSI/BHMA A156.16, Grade 1 door stops and wall bumpers. Provide wall bumpers, either convex or concave types with anchorage as indicated, unless floor or other types of door stops are specified in Hardware Sets. Do not mount floor stops where they will impede traffic. Where floor or wall bumpers are not appropriate, provide overhead type stops and holders.

- 1. Manufacturers:

- a. Rockwood (RO).

2.16 ARCHITECTURAL SEALS

- A. General: Thresholds, weatherstripping, and gasket seals to be of type and design as specified below or in the Hardware Sets. Provide continuous weatherstrip gasketing on exterior doors and provide smoke, light, or sound gasketing on interior doors where indicated. At exterior applications provide non-corrosive fasteners and elsewhere where indicated.

- B. Smoke Labeled Gasketing: Assemblies complying with NFPA 105 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for smoke control ratings indicated, based on testing according to UL 1784.

- 1. Provide smoke labeled perimeter gasketing at all smoke labeled openings.

- C. Fire Labeled Gasketing: Assemblies complying with NFPA 80 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire ratings indicated, based on testing according to UL-10C.

- 1. Provide intumescent seals as indicated to meet UL10C Standard for Positive Pressure Fire Tests of Door Assemblies, and NFPA 252, Standard Methods of Fire Tests of Door Assemblies.

- D. Sound-Rated Gasketing: Assemblies that are listed and labeled by a testing and inspecting agency, for sound ratings indicated.

- E. Replaceable Seal Strips: Provide only those units where resilient or flexible seal strips are easily replaceable and readily available from stocks maintained by manufacturer.

- F. Manufacturers:

- 1. Pemko (PE).

2.17 ELECTRONIC ACCESSORIES

- A. Touchless Switches: FCC certified microwave sensing switch used for REX or activation of various access control devices in place of a traditional wired switch. Unit to have an adjustable sensing zone from 4" to 24". At exterior locations furnish foam gaskets and weather covers. Provide single gang or double gang unit as specified in the hardware sets.

- 1. Manufacturers:

- a. Norton Rixson (NO) - 700 Series.
- B. Door Position Switches: Door position magnetic reed contact switches specifically designed for use in commercial door applications. On recessed models the contact and magnetic housing snap-lock into a 1" diameter hole. Surface mounted models include wide gap distance design complete with armored flex cabling. Provide SPDT, N/O switches with optional Rare Earth Magnet installation on steel doors with flush top channels.
 1. Manufacturers:
 - a. Securitron (SU) - DPS Series.
- C. Intelligent Switching Power Supplies: Provide power supplies with single, dual or multi-voltage configurations at 12 and/or 24VDC. Power Supply shall have battery backup function with an integrated battery charging circuit. The power supply shall have a standard, integrated Fire Alarm Interface (FAI). The power supply shall provide capability for secondary voltage, power distribution, direct lock control and network monitoring through add on modules. The power supply shall be expandable up to 16 individually protected outputs. Output modules shall provide individually protected, continuous outputs and/or individually protected, relay controlled outputs. Network modules shall provide remote monitoring functions such as status reporting, fault reporting and information logging.
 1. Manufacturers:
 - a. Securitron (SU) - AQL Series.

2.18 FABRICATION

- A. Fasteners: Provide door hardware manufactured to comply with published templates generally prepared for machine, wood, and sheet metal screws. Provide screws according to manufacturers recognized installation standards for application intended.

2.19 FINISHES

- A. Standard: Designations used in the Hardware Sets and elsewhere indicate hardware finishes complying with ANSI/BHMA A156.18, including coordination with traditional U.S. finishes indicated by certain manufacturers for their products.
- B. Provide quality of finish, including thickness of plating or coating (if any), composition, hardness, and other qualities complying with manufacturer's standards, but in no case less than specified by referenced standards for the applicable units of hardware
- C. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine scheduled openings, with Installer present, for compliance with requirements for installation tolerances, labeled fire door assembly construction, wall and floor construction, and other conditions affecting performance.
- B. Notify architect of any discrepancies or conflicts between the door schedule, door types, drawings and scheduled hardware. Proceed only after such discrepancies or conflicts have been resolved in writing.

3.2 PREPARATION

- A. Hollow Metal Doors and Frames: Comply with ANSI/DHI A115 series.
- B. Wood Doors: Comply with ANSI/DHI A115-W series.

3.3 INSTALLATION

- A. Install each item of mechanical and electromechanical hardware and access control equipment to comply with manufacturer's written instructions and according to specifications.
 - 1. Installers are to be trained and certified by the manufacturer on the proper installation and adjustment of fire, life safety, and security products including: hanging devices; locking devices; closing devices; and seals.
- B. Mounting Heights: Mount door hardware units at heights indicated in following applicable publications, unless specifically indicated or required to comply with governing regulations:
 - 1. Standard Steel Doors and Frames: DHI's "Recommended Locations for Architectural Hardware for Standard Steel Doors and Frames."
 - 2. DHI TDH-007-20: Installation Guide for Doors and Hardware.
 - 3. Where indicated to comply with accessibility requirements, comply with ANSI A117.1 "Accessibility Guidelines for Buildings and Facilities."
 - 4. Provide blocking in drywall partitions where wall stops or other wall mounted hardware is located.
- C. Retrofitting: Install door hardware to comply with manufacturer's published templates and written instructions. Where cutting and fitting are required to install door hardware onto or into surfaces that are later to be painted or finished in another way, coordinate removal, storage, and reinstallation of surface protective trim units with finishing work specified in Division 9 Sections. Do not install surface-mounted items until finishes have been completed on substrates involved.
- D. Push Plates and Door Pulls: When through-bolt fasteners are in the same location as a push plate, countersink the fasteners flush with the door face allowing the push plate to sit flat against the door.

- E. Thresholds: Set thresholds for exterior and acoustical doors in full bed of sealant complying with requirements specified in Division 7 Section "Joint Sealants."
- F. Storage: Provide a secure lock up for hardware delivered to the project but not yet installed. Control the handling and installation of hardware items so that the completion of the work will not be delayed by hardware losses before and after installation.

3.4 ADJUSTING

- A. Initial Adjustment: Adjust and check each operating item of door hardware and each door to ensure proper operation or function of every unit. Replace units that cannot be adjusted to operate as intended. Adjust door control devices to compensate for final operation of heating and ventilating equipment and to comply with referenced accessibility requirements.

3.5 CLEANING AND PROTECTION

- A. Protect all hardware stored on construction site in a covered and dry place. Protect exposed hardware installed on doors during the construction phase. Install any and all hardware at the latest possible time frame.
- B. Clean adjacent surfaces soiled by door hardware installation.
- C. Clean operating items as necessary to restore proper finish. Provide final protection and maintain conditions that ensure door hardware is without damage or deterioration at time of owner occupancy.

3.6 DEMONSTRATION

- A. Instruct Owner's maintenance personnel to adjust, operate, and maintain mechanical and electromechanical door hardware.

3.7 DOOR HARDWARE SETS

- A. The hardware sets represent the design intent and direction of the owner and architect. They are a guideline only and should not be considered a detailed hardware schedule. Discrepancies, conflicting hardware and missing items should be brought to the attention of the architect with corrections made prior to the bidding process. Omitted items not included in a hardware set should be scheduled with the appropriate additional hardware required for proper application and functionality.
 - 1. Quantities listed are for each pair of doors, or for each single door.
 - 2. The supplier is responsible for handling and sizing all products.
 - 3. Where multiple options for a piece of hardware are given in a single line item, the supplier shall provide the appropriate application for the opening.
 - 4. At existing openings with new hardware the supplier shall field inspect existing conditions prior to the submittal stage to verify the specified hardware will work as required. Provide alternate solutions and proposals as needed.
- B. Manufacturer's Abbreviations:

1. MK - McKinney
2. PE - Pemko
3. RO - Rockwood
4. SA - SARGENT
5. AD - Adams Rite
6. OT - Other
7. NO - Norton
8. SU - Securitron

Hardware Sets

Set: 1.0

Doors: 110

2 Continuous Hinge	DFM__SLF-HD1 - DOOR HEIGHT		PE
1 Flush Bolt (Manual)	555/557 (TO SUIT)	US32B	RO
1 Mortise Deadlock	MS1850S	628	AD
1 Thumbturn	4066	130	AD
1 Cylinder	Match/Expand Facility Existing		OT
2 Push Pull	RM251 Mtg-Type 1XHD	US32B	RO
1 Surface Closer	351 CPS	626	SA
1 Automatic Opener	6011/6021 (TO SUIT)	689	NO
1 Door Stop	403/441CU (TO SUIT)	US32B	RO
1 Rain Guard	346D		PE
2 Sweep (w/ drip edge)	3452DNB		PE
1 Threshold	252x3DFG MSES25SS		PE
2 Wave Wall Switch	700		NO

Notes:

- Perimeter/meeting stile seals by frame/door supplier.
- Door to remain unlocked during occupancy.
- Electronic operation: Outside, automatic operator by wave to open switch. Inside, Free egress at all times by push plate/door pull or automatic operator by wave to open switch.

Set: 2.0

Doors: 009B

1 Continuous Hinge	DFM__HD1 - DOOR HEIGHT		PE
1 Rim Exit Device, Storeroom	LC 16 8804 862	US10BE	SA
2 Cylinder	Match/Expand Facility Existing		OT

1 Pull	RM201 Mtg-Type 1XHD	10BE	RO
1 Surface Closer	351 CPS	EB	SA
1 Kick Plate	K1050 10" CSK	10BE	RO
1 Rain Guard	346D		PE
1 Gasketing (Head/Jambs)	S773D		PE
1 Sweep (w/ drip edge)	3452DNB		PE
1 Threshold	252x3DFG MSES25SS		PE
1 Position Switch	DPS-M/W-BK (TO SUIT)		SU

Set: 3.0

Doors: 009A

2 Continuous Hinge	DFM__SLF-HD1 - DOOR HEIGHT		PE
1 Removable Mullion	L980A - DOOR HEIGHT	US28	SA
2 Rim Exit Device, Classroom	LC AD8513 ETH016	US10BE	SA
3 Cylinder	Match/Expand Facility Existing		OT
2 Surface Closer	351 CPS	EB	SA

Notes:

- Perimeter/meeting stile seals by frame/door supplier.

Set: 4.0

Doors: 106, 107, 108

1 Continuous Hinge	DFM__SLF-HD1 - DOOR HEIGHT		PE
1 Passage Latch	8215 TRH016	US10BE	SA
1 Door Stop	403/441CU (TO SUIT)	10BE	RO

Notes:

- Perimeter/meeting stile seals by frame/door supplier.

Set: 5.0

Doors: 111

2 Continuous Hinge	DFM__SLF-HD1 - DOOR HEIGHT		PE
2 Push Pull	RM251 Mtg-Type 1XHD	US32B	RO
2 Automatic Opener	6011/6021 (TO SUIT)	689	NO
2 Wave Wall Switch	700		NO
1 Wiring Diagram	Elevation and Point to Point as Specified		OT

Notes:

- Perimeter/meeting stile seals by frame/door supplier.
- Electronic operation: Outside, automatic operator by wall switch. Inside, Free egress at all times by push bar or automatic operator by wall switch.

Set: 6.0

Doors: 011

1 Continuous Hinge	DFM_HD1 - DOOR HEIGHT		PE
1 Rim Exit Device, Storeroom	LC 8804 ETH016	US10BE	SA
1 Cylinder	Match/Expand Facility Existing		OT
1 Surface Closer	351 O/P9 (TO SUIT)	EB	SA
1 Kick Plate	K1050 10" CSK	10BE	RO
1 Door Stop	403/441CU (TO SUIT)	10BE	RO
3 Silencer	608/609 (TO SUIT)		RO

Set: 7.0

Doors: 005

5 Hinge, Full Mortise, Hvy Wt	T4A3786	US10BE	MK
1 Hinge, Full Mortise, Hvy Wt	T4A3786 QC12	US10BE	MK
1 Dust Proof Strike	570	10BE	RO
1 Flush Bolt (Automatic, set)	2842/2962 (TO SUIT)	10BE	RO
1 Fail Secure Lock	LC RX 8271-24V TRH016	US10BE	SA
1 Cylinder	Match/Expand Facility Existing		OT
1 Coordinator	2600 Series x Wear Plates	Black	RO
2 Surface Closer	351 CPS	EB	SA
2 Kick Plate	K1050 10" CSK	10BE	RO
2 Silencer	608/609 (TO SUIT)		RO
1 Frame Harness	QC-C1500P		MK
1 Door Harness	QC-CXXX- LENGTH TO SUIT		MK
1 Card Reader	Provided By Security Supplier		OT
1 Position Switch	DPS-M/W-BK (TO SUIT)		SU
1 Power Supply	AQLxx-R8E1 (TO SUIT)		SU
1 Wiring Diagram	Elevation and Point to Point as Specified		OT

Notes:

- Electronic Operation: Valid card unlocks outside lever or key retracts latchbolt. Request to exit shows authorized egress. Free egress at all times. In case of power loss, door remains locked and latched.

Set: 8.0

Doors: 008, 010

2 Continuous Hinge	DFM__HD1 - DOOR HEIGHT		PE
1 Dust Proof Strike	570	10BE	RO
2 Flush Bolt (Manual)	555/557 (TO SUIT)	10BE	RO
1 Storeroom Lock	LC 8204 TRH016	US10BE	SA
2 Cylinder	Match/Expand Facility Existing		OT
2 Surface Closer	351 O/P9 (TO SUIT)	EB	SA
2 Kick Plate	K1050 10" CSK	10BE	RO
2 Door Stop	403/441CU (TO SUIT)	10BE	RO
2 Silencer	608/609 (TO SUIT)		RO

Set: 9.0

Doors: 003

1 Continuous Hinge	DFM__HD1 - DOOR HEIGHT		PE
1 Storeroom Lock	LC 8204 TRH016	US10BE	SA
1 Cylinder	Match/Expand Facility Existing		OT
1 Surface Closer	351 H	EB	SA
1 Kick Plate	K1050 10" CSK	10BE	RO
1 Door Stop	403/441CU (TO SUIT)	10BE	RO
3 Silencer	608/609 (TO SUIT)		RO

Set: 10.0

Doors: 006

1 Continuous Hinge	DFM__HD1 - DOOR HEIGHT		PE
1 Office Lock	LC 8205 TRH016	US10BE	SA
1 Cylinder	Match/Expand Facility Existing		OT
1 Door Stop	403/441CU (TO SUIT)	10BE	RO
3 Silencer	608/609 (TO SUIT)		RO

Set: 11.0

Doors: 002, 112A, 112B, 112C

1 Continuous Hinge	DFM__HD1 - DOOR HEIGHT		PE
1 Privacy Lock	V21 8265 VN1 H016	US10BE	SA
1 Kick Plate	K1050 10" CSK	10BE	RO
1 Mop Plate	K1050 4" CSK	10BE	RO

1 Door Stop	403/441CU (TO SUIT)	10BE	RO
3 Silencer	608/609 (TO SUIT)		RO
1 Coat Hook	RM802	10BE	RO

Set: 12.0

Doors: 007

1 Continuous Hinge	DFM__HD1 - DOOR HEIGHT		PE
1 Passage Latch	8215 TRH016	US10BE	SA
1 Kick Plate	K1050 10" CSK	10BE	RO
1 Mop Plate	K1050 4" CSK	10BE	RO
1 Door Stop	403/441CU (TO SUIT)	10BE	RO
3 Silencer	608/609 (TO SUIT)		RO

Set: 14.0

Doors: X001

1 Gasketing (Head/Jambs)	S773D		PE
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Set: 15.0

Doors: X004B, X100, X101B, X102, X103, X105, XST01, XST03

1 Surface Closer	351 O/P9 (TO SUIT)	EB	SA
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Set: 16.0

Doors: 101

1 Continuous Hinge	DFM__HD1 - DOOR HEIGHT		PE
1 Storeroom Lock	LC 8204 TRH016	US10BE	SA
1 Cylinder	Match/Expand Facility Existing		OT
1 Surface Closer	351 CPS	EB	SA
1 Kick Plate	K1050 10" CSK	10BE	RO
1 Rain Guard	346D		PE
1 Gasketing (Head/Jambs)	S773D		PE
1 Sweep (w/ drip edge)	3452DNB		PE
1 Threshold	252x3DFG MSES25SS		PE
1 Position Switch	DPS-M/W-BK (TO SUIT)		SU

Set: 17.0

Doors: 007B, 113

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100% CD SUBMISSION
7 FEBRUARY 2025

1 Continuous Hinge	DFM__HD1 - DOOR HEIGHT		PE
1 Storeroom Lock	LC 8204 TRH016	US10BE	SA
1 Cylinder	Match/Expand Facility Existing		OT
1 Kick Plate	K1050 10" CSK	10BE	RO
1 Door Stop	403/441CU (TO SUIT)	10BE	RO
3 Silencer	608/609 (TO SUIT)		RO

END OF SECTION 087100

SECTION 087113 - POWER DOOR OPERATORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. The Drawings and general provisions of the Contract, including the City of Baltimore Department of Public Works Specifications (the “Green Book”) and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Low-energy door operators for swinging doors.

1.3 DEFINITIONS

- A. AAADM: American Association of Automatic Door Manufacturers.
- B. Double-Egress (Doors): A pair of doors that simultaneously swing, with the two doors moving in opposite directions with no mullion between them.

1.4 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For power door operators.
 - 1. Include plans, elevations, sections, hardware mounting heights, and attachment details.
 - 2. Include diagrams for power, signal, and control wiring.
- C. Samples: For each exposed product and for each color and texture specified.

1.6 INFORMATIONAL SUBMITTALS

- A. Product certificates.
- B. Field quality-control reports.

- C. Sample warranties.

1.7 CLOSEOUT SUBMITTALS

- A. Maintenance data.

1.8 QUALITY ASSURANCE

- A. Installer Qualifications: An authorized representative who is trained and approved by manufacturer for installation and maintenance of units required for this Project.

1.9 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of power door operators that fail in materials or workmanship within specified warranty period.

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

PART 2 - PRODUCTS

2.1 POWER DOOR OPERATORS, GENERAL

- A. General: Provide operators of size recommended by manufacturer for door size, weight, and movement; for condition of exposure; and for long-term, maintenance-free operation under normal traffic load for occupancy type indicated; and in accordance with UL 325. Coordinate operator mechanisms with door operation, hinges, and activation and safety devices.
 1. Emergency Breakaway: Where indicated for center-pivoted doors, provide emergency breakaway feature for reverse swing of doors. Equip system to discontinue power to power door operator when door is in emergency breakaway position, to return door to closed position after breakaway, and to automatically reset.
 2. Wind Load: Provide door operators on exterior doors that will open and close doors and maintain them in fully closed position when subjected to wind load as shown on structural drawings.
- B. Electromechanical Operating System: Self-contained unit powered by permanent-magnet dc motor; with closing speed controlled mechanically by gear train and dynamically by braking action of electric motor, connections for power and activation- and safety-device wiring, and manual operation, including spring closing when power is off.
- C. Cover for Surface-Mounted Operators: Fabricated from 0.125-inch- thick, extruded or formed aluminum; manufacturer's standard width; with enclosed end caps, provision for maintenance access, and fasteners concealed when door is in closed position.
- D. Brackets and Reinforcements: Fabricated from aluminum with nonstaining, nonferrous shims for aligning system components.

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

2.2 LOW-ENERGY DOOR OPERATORS FOR SWINGING DOORS

- A. Standard: BHMA A156.19.
- B. Performance Requirements:
 - 1. Opening Force if Power Fails: Not more than 15 lbf required to release latch if provided, not more than 30 lbf required to manually set door in motion, and not more than 15 lbf required to fully open door.
 - 2. Entrapment-Prevention Force: Not more than 15 lbf required to prevent stopped door from closing or opening.
- C. Configuration: Operator to control pair of swinging doors.
 - 1. Traffic Pattern: One way.
 - 2. Operator Mounting: Recessed into wall and/or storefront system.
- D. Operation: Power opening and power-assisted spring closing. When not in automatic mode, door operator shall function as manual door closer, with or without electrical power.
- E. Operating System: Electromechanical.
- F. Microprocessor Control Unit: Solid-state controller.
 - 1. Adjustable opening and closing speed.
 - 2. Adjustable opening and closing force.
 - 3. Adjustable backcheck.
 - 4. Adjustable hold-open time from zero to 30 seconds.
 - 5. Adjustable time delay.
 - 6. Adjustable acceleration.
 - 7. Obstruction recycle.
 - 8. On-off/hold-open switch to control electric power to operator; key operated.
- G. Activation Device: Push-plate switch to activate door operator.
- H. Exposed Finish: Finish matching door and frame.

2.3 MATERIALS

- A. Aluminum: Alloy and temper recommended by manufacturer for type of use and finish indicated.
 - 1. Extrusions: ASTM B221.
 - 2. Sheet: ASTM B209.
- B. Fasteners and Accessories: Corrosion-resistant, nonstaining, nonbleeding fasteners and accessories compatible with adjacent materials.

2.4 CONTROLS

- A. General: Provide controls in accordance with BHMA standards; for condition of exposure; and for long-term, maintenance-free operation under normal traffic load for occupancy type indicated. Coordinate devices with door operation and door operator mechanisms.
- B. Push-Plate Switch: Momentary-contact door control switch with flat push-plate actuator with contrasting-colored, engraved message.
 - 1. Configuration:
 - 2. Square push plate with 4-by-4-inch junction box.
 - a. Mounting: As indicated on Drawings, recess mounted into storefront or other support structure.
 - 3. Rectangular push plate with 2-by-4-inch junction box.
 - a. Mounting: As indicated on Drawings, recess mounted into storefront or other support structure.
 - 4. Storefront recessed push plate
 - a. 1-1/2" W x 4-3/4" H face plate, SPDT UL listed switch-mom, 15 amp @ 125 VAC, fits 2" frame, with blue letters and International symbol of accessibility.
 - 5. Push-Plate Material: Stainless steel as selected by Architect from manufacturer's full range.
 - 6. Message: International symbol of accessibility.
- C. Electrical Interlocks: Unless units are equipped with self-protecting devices or circuits, provide electrical interlocks to prevent activation of operator when door is locked, latched, or bolted.

2.5 ACCESSORIES

- A. Signage: As required by cited BHMA standard for type of door and its operation.
 - 1. Application Process: Etched and painted.
 - 2. Provide sign materials with instructions for field application when operators are installed.

2.6 FABRICATION

- A. Factory fabricate power door operators to comply with indicated standards.
- B. Fabricate exterior components to drain condensation and water-passing joints within operator enclosure to the exterior.
- C. Use concealed fasteners to greatest extent possible. Where exposed fasteners are required, use countersunk Phillips flat-head machine screws, finished to match operator.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

- A. Install power door operators in accordance with manufacturer's written instructions and cited BHMA standard for type of door operation and direction of pedestrian travel, including signage, controls, wiring, remote power units if any, and connection to building's power supply.
- B. Controls: Install devices in accordance with manufacturer's written instructions and cited BHMA standard for operator type and direction of pedestrian travel.
- C. Signage: Apply on both sides of each door as required by cited BHMA standard for type of door operator and direction of pedestrian travel.
- D. Adjusting: Adjust power door operators to function smoothly and lubricate as recommended by manufacturer; comply with requirements of applicable BHMA standards.
 - 1. Adjust operators on exterior doors for tight closure.
 - 2. Readjust power door operators and controls after repeated operation of completed installation equivalent to three days' use by normal traffic (100 to 300 cycles).
- E. Demonstration: Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain power door operators.

3.2 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
 - 1. Test and inspect each power door operator installation, using AAADM inspection forms, to determine compliance of installed systems with applicable BHMA standards.
- B. Power door operators will be considered defective if they do not pass tests and inspections.
- C. Prepare test and inspection reports.

END OF SECTION 087113

SECTION 088000 - GLAZING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. The Drawings and general provisions of the Contract, including the City of Baltimore Department of Public Works Specifications (the "Green Book") and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Glass products.
 - 2. Laminated glass.
 - 3. Insulating glass.
 - 4. Glazing sealants.
 - 5. Glazing tapes.
 - 6. Miscellaneous glazing materials.

1.3 COORDINATION

- A. Coordinate glazing channel dimensions to provide necessary bite on glass, minimum edge and face clearances, and adequate sealant thicknesses, with reasonable tolerances to achieve proper safety margins for glazing retention under each design load case, load case combination, and service condition.

1.4 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at project site.

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Glass Samples: For each type of glass product other than clear monolithic vision glass; 12 inches square.

1.6 INFORMATIONAL SUBMITTALS

- A. Product Certificates: For glass.
- B. Product test reports.

- C. Preconstruction adhesion and compatibility test report.
- D. Sample warranties.

1.7 QUALITY ASSURANCE

- A. Sealant Testing Agency Qualifications: An independent testing agency qualified according to ASTM C1021 to conduct the testing indicated.

1.8 WARRANTY

- A. Manufacturer's Special Warranty for Coated-Glass Products: Manufacturer agrees to replace coated-glass units that deteriorate within specified warranty period. Deterioration of coated glass is defined as defects developed from normal use that are not attributed to glass breakage or to maintaining and cleaning coated glass contrary to manufacturer's written instructions. Defects include peeling, cracking, and other indications of deterioration in coating.
 - 1. Warranty Period: 10 years from date of Substantial Completion.
- B. Manufacturer's Special Warranty for Laminated Glass: Manufacturer agrees to replace laminated-glass units that deteriorate within specified warranty period. Deterioration of laminated glass is defined as defects developed from normal use that are not attributed to glass breakage or to maintaining and cleaning laminated glass contrary to manufacturer's written instructions. Defects include edge separation, delamination materially obstructing vision through glass, and blemishes exceeding those allowed by referenced laminated-glass standard.
 - 1. Warranty Period: 10 years from date of Substantial Completion.
- C. Manufacturer's Special Warranty for Insulating Glass: Manufacturer agrees to replace insulating-glass units that deteriorate within specified warranty period. Deterioration of insulating glass is defined as failure of hermetic seal under normal use that is not attributed to glass breakage or to maintaining and cleaning insulating glass contrary to manufacturer's written instructions. Evidence of failure is obstruction of vision by dust, moisture, or film on interior surfaces of glass.
 - 1. Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Structural Performance: Glazing shall withstand the following design loads within limits and under conditions indicated determined in accordance with the IBC and ASTM E1300:
 - 1. Design Wind Pressures: As indicated on Drawings.
 - 2. Design Snow Loads: As indicated on Drawings.

- B. Safety Glazing: Where safety glazing is indicated, provide glazing that complies with 16 CFR 1201, Category II.
- C. Thermal and Optical Performance Properties: Provide glass with performance properties specified, as indicated in manufacturer's published test data, based on procedures indicated below:
 - 1. U-Factors: Center-of-glazing values, in accordance with NFRC 100 and based on most current non-beta version of LBL's WINDOW computer program, expressed as Btu/sq. ft. x h x deg F.
 - 2. SHGC and Visible Transmittance: Center-of-glazing values, in accordance with NFRC 200 and based on most current non-beta version of LBL's WINDOW computer program.
 - 3. Visible Reflectance: Center-of-glazing values, in accordance with NFRC 300.

2.2 GLASS PRODUCTS, GENERAL

- A. Glazing Publications: Comply with published recommendations of glass product manufacturers and organizations below unless more stringent requirements are indicated. See these publications for glazing terms not otherwise defined in this Section or in referenced standards.
 - 1. NGA Publications: "Laminated Glazing Reference Manual" and "Glazing Manual."
 - 2. AAMA Publications: AAMA GDSG-1, "Glass Design for Sloped Glazing," and AAMA TIR A7, "Sloped Glazing Guidelines."
 - 3. IGMA Publication for Sloped Glazing: IGMA TB-3001, "Guidelines for Sloped Glazing."
 - 4. IGMA Publication for Insulating Glass: SIGMA TM-3000, "North American Glazing Guidelines for Sealed Insulating Glass Units for Commercial and Residential Use."
- B. Safety Glazing Labeling: Where safety glazing is indicated, permanently mark glazing with certification label of the SGCC or another certification agency acceptable to authorities having jurisdiction. Label shall indicate manufacturer's name, type of glass, thickness, and safety glazing standard with which glass complies.
- C. Insulating-Glass Certification Program: Permanently marked either on spacers or on at least one component lite of units with appropriate certification label of the IGCC.
- D. Thickness: Where glass thickness is indicated, it is a minimum. Provide glass that complies with performance requirements and is not less than thickness indicated.
- E. Strength: Where annealed float glass is indicated, provide annealed float glass, heat-strengthened float glass, or fully tempered float glass as needed to comply with "Performance Requirements" Article. Where heat-strengthened float glass is indicated, provide heat-strengthened float glass or fully tempered float glass as needed to comply with "Performance Requirements" Article. Where fully tempered float glass is indicated, provide fully tempered float glass.

2.3 GLASS PRODUCTS

- A. Clear Annealed Float Glass: ASTM C1036, Type I, Class 1 (clear), Quality-Q3.
- B. Tinted Annealed Float Glass: ASTM C1036, Type I, Class 2 (tinted), Quality-Q3.
- C. Fully Tempered Float Glass: ASTM C1048, Kind FT (fully tempered), Condition A (uncoated) unless otherwise indicated, Type I, Class 1 (clear) or Class 2 (tinted) as indicated, Quality-Q3.
- D. Heat-Strengthened Float Glass: ASTM C1048, Kind HS (heat strengthened), Type I, Condition A (uncoated) unless otherwise indicated, Type I, Class 1 (clear) or Class 2 (tinted) as indicated, Quality-Q3.
- E. Reflective- and Low-E-Coated Vision Glass: ASTM C1376.
- F. Ceramic-Coated Spandrel Glass: ASTM C1048, Type I, Condition B, Quality-Q3.

2.4 LAMINATED GLASS

- A. Laminated Glass: ASTM C1172. Use materials that have a proven record of no tendency to bubble, discolor, or lose physical and mechanical properties after fabrication and installation.
 - 1. Construction: Laminate glass with polyvinyl butyral interlayer to comply with interlayer manufacturer's written instructions.
 - 2. Interlayer Thickness: Provide thickness not less than that indicated and as needed to comply with requirements.
 - 3. Interlayer Color: Clear unless otherwise indicated.

2.5 INSULATING GLASS

- A. Insulating-Glass Units: Factory-assembled units consisting of sealed lites of glass separated by a dehydrated interspace, qualified in accordance with ASTM E2190.
 - 1. Sealing System: Dual seal, with manufacturer's standard primary and secondary sealants.
 - 2. Perimeter Spacer: Manufacturer's standard spacer material and construction.
 - 3. Desiccant: Molecular sieve or silica gel, or a blend of both.

2.6 GLAZING SEALANTS

- A. General:
 - 1. Compatibility: Compatible with one another and with other materials they contact, including glass products, seals of insulating-glass units, and glazing channel substrates, under conditions of service and application, as demonstrated by sealant manufacturer based on testing and field experience.
 - 2. Suitability: Comply with sealant and glass manufacturers' written instructions for selecting glazing sealants suitable for applications indicated and for conditions existing at time of installation.

3. Colors of Exposed Glazing Sealants: As selected by Architect from manufacturer's full range of industry colors.
- B. Neutral-Curing Silicone Glazing Sealant, Class as required by manufacturer: Complying with ASTM C920, Type S, Grade NS, Use NT.

2.7 GLAZING TAPES

- A. Back-Bedding Mastic Glazing Tapes: Preformed, butyl-based, 100 percent solids elastomeric tape; nonstaining and nonmigrating in contact with nonporous surfaces; with or without spacer rod as recommended in writing by tape and glass manufacturers for application indicated; and complying with ASTM C1281 and AAMA 800 for products indicated below:
1. AAMA 806.3 tape, for glazing applications in which tape is subject to continuous pressure.
- B. Expanded Cellular Glazing Tapes: Closed-cell, PVC foam tapes; factory coated with adhesive on both surfaces; and complying with AAMA 800 for the following types:
1. AAMA 810.1, Type 1, for glazing applications in which tape acts as primary sealant.
 2. AAMA 810.1, Type 2, for glazing applications in which tape is used in combination with a full bead of liquid sealant.

2.8 MISCELLANEOUS GLAZING MATERIALS

- A. Cleaners, Primers, and Sealers: Types recommended by sealant or gasket manufacturer.
- B. Setting Blocks:
1. Type recommended in writing by sealant or glass manufacturer.
- C. Spacers:
1. Type recommended in writing by sealant or glass manufacturer.
- D. Edge Blocks:
1. Type recommended in writing by sealant or glass manufacturer.

PART 3 - EXECUTION

3.1 GLAZING, GENERAL

- A. Comply with combined written instructions of manufacturers of glass, sealants, gaskets, and other glazing materials, unless more stringent requirements are indicated, including those in referenced glazing publications.

- B. Protect glass edges from damage during handling and installation. Remove damaged glass from Project site and legally dispose of off Project site. Damaged glass includes glass with edge damage or other imperfections that, when installed, could weaken glass, impair performance, or impair appearance.
- C. Apply primers to joint surfaces where required for adhesion of sealants, as determined by preconstruction testing.
- D. Install setting blocks in sill rabbets, sized and located to comply with referenced glazing publications, unless otherwise required by glass manufacturer. Set blocks in thin course of compatible sealant suitable for heel bead.
- E. Do not exceed edge pressures stipulated by glass manufacturers for installing glass lites.
- F. Provide spacers for glass lites where length plus width is larger than 50 inches.
- G. Provide edge blocking where indicated or needed to prevent glass lites from moving sideways in glazing channel, as recommended in writing by glass manufacturer and in accordance with requirements in referenced glazing publications.

3.2 TAPE GLAZING

- A. Position tapes on fixed stops so that, when compressed by glass, their exposed edges are flush with or protrude slightly above sightline of stops.
- B. Install tapes continuously, but not necessarily in one continuous length. Do not stretch tapes to make them fit opening.
- C. Cover vertical framing joints by applying tapes to heads and sills first, then to jambs. Cover horizontal framing joints by applying tapes to jambs, then to heads and sills.
- D. Place joints in tapes at corners of opening with adjoining lengths butted together, not lapped. Seal joints in tapes with compatible sealant approved by tape manufacturer.
- E. Apply heel bead of elastomeric sealant if required by manufacturer.
- F. Center glass lites in openings on setting blocks, and press firmly against tape by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings.

3.3 GASKET GLAZING (DRY)

- A. Cut compression gaskets to lengths recommended by gasket manufacturer to fit openings exactly, with allowance for stretch during installation.
- B. Insert soft compression gasket between glass and frame or fixed stop so it is securely in place with joints miter cut and bonded together at corners.
- C. Installation with Drive-in Wedge Gaskets: Center glass lites in openings on setting blocks, and press firmly against soft compression gasket by inserting dense compression gaskets formed and

installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings. Compress gaskets to produce a weathertight seal without developing bending stresses in glass. Seal gasket joints with sealant recommended in writing by gasket manufacturer.

- D. Installation with Pressure-Glazing Stops: Center glass lites in openings on setting blocks, and press firmly against soft compression gasket. Install dense compression gaskets and pressure-glazing stops, applying pressure uniformly to compression gaskets. Compress gaskets to produce a weathertight seal without developing bending stresses in glass. Seal gasket joints with sealant recommended in writing by gasket manufacturer.
- E. Install gaskets so they protrude past face of glazing stops.

3.4 SEALANT GLAZING (WET)

- A. Install continuous spacers, or spacers combined with cylindrical sealant backing, between glass lites and glazing stops to maintain glass face clearances and to prevent sealant from extruding into glass channel and blocking weep systems until sealants cure. Secure spacers or spacers and backings in place and in position to control depth of installed sealant relative to edge clearance for optimum sealant performance.
- B. Force sealants into glazing channels to eliminate voids and to ensure complete wetting or bond of sealant to glass and channel surfaces.
- C. Tool exposed surfaces of sealants to provide a substantial wash away from glass.

3.5 CLEANING AND PROTECTION

- A. Immediately after installation, remove nonpermanent labels and clean surfaces.
- B. Protect glass from contact with contaminating substances resulting from construction operations. Examine glass surfaces adjacent to or below exterior concrete and other masonry surfaces at frequent intervals during construction, but not less than once a month, for buildup of dirt, scum, alkaline deposits, or stains.
 - 1. If, despite such protection, contaminating substances do contact with glass, remove substances immediately as recommended in writing by glass manufacturer. Remove and replace glass that cannot be cleaned without damage to coatings.
- C. Remove and replace glass that is damaged during construction period.

3.6 LAMINATED GLASS SCHEDULE

- A. Laminated Vision Glass Type GL-3: Two plies of heat-strengthened float glass.
 - 1. Outer Ply: Clear float glass.
 - 2. Inner Ply: Clear float glass.
 - 3. Ceramic Coating Color and Pattern: As selected by Architect from manufacturer's full range.
 - 4. Minimum Thickness of Each Glass Ply: 5 mm.

5. Interlayer Thickness: As required to meet glazing requirements.
 6. Safety glazing required.
- B. Ceramic-Coated, Laminated Vision Glass Type GL-3: Two plies of heat-strengthened float glass.
1. Outer Ply: Clear float glass.
 2. Inner Ply: Clear float glass.
 3. Ceramic Coating Color and Pattern: As selected by Architect from manufacturer's full range.
 4. Minimum Thickness of Each Glass Ply: 5 mm.
 5. Interlayer Thickness: As required to meet glazing requirements.
 6. Coating Location: Second surface.
 7. Safety glazing required.

3.7 INSULATING GLASS SCHEDULE

- A. Low-E-Coated, Clear Insulating Glass Type GL-2:
1. Basis-of-Design Product: "Solarban®" 70 (2) Clear + Clear by Vitro Architectural Glass.
 2. Overall Unit Thickness: 1 inch.
 3. Minimum Thickness of Each Glass Lite: 5 mm.
 4. Outdoor Lite: Heat-strengthened float glass.
 5. Interspace Content: Argon.
 6. Indoor Lite: Heat-strengthened float glass.
 7. Low-E Coating: Sputtered on second surface.
 8. Safety glazing required.

END OF SECTION 088000

SECTION 089119 - FIXED LOUVERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. The Drawings and general provisions of the Contract, including the City of Baltimore Department of Public Works Specifications (the "Green Book") and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes fixed extruded-aluminum louvers.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. For louvers specified to bear AMCA seal, include printed catalog pages showing specified models with appropriate AMCA Certified Ratings Seals.
- B. Shop Drawings: For louvers and accessories. Include plans, elevations, sections, details, and attachments to other work. Show frame profiles and blade profiles, angles, and spacing.
- C. Samples: For each type of metal finish required.

1.4 INFORMATIONAL SUBMITTALS

- A. Product Test Reports: Based on tests performed according to AMCA 500-L.
- B. Sample warranties.

1.5 WARRANTY

- A. Special Finish Warranty, Factory-Applied Finishes: Standard form in which manufacturer agrees to repair finishes or replace aluminum that shows evidence of deterioration of baked enamel, powder coat, or organic finishes within specified warranty period.
 - 1. Warranty Period: 20 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Structural Performance: Louvers withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated without permanent deformation of louver components, noise or metal fatigue caused by louver-blade rattle or flutter, or permanent damage to fasteners and anchors. Wind pressures are considered to act normal to the face of the building.
 - 1. Wind Loads:
 - a. Determine loads based on pressures as indicated on Drawings.
 - b. Determine loads based on a uniform pressure of 20 lbf/sq. ft. or grated if indicated elsewhere in the construction documentation., acting inward or outward.
 - c. Determine loads based on pressures indicated on structural drawings.
- B. Louver Performance Ratings: Provide louvers complying with requirements specified, as demonstrated by testing manufacturer's stock units identical to those provided, except for length and width according to AMCA 500-L.

2.2 FIXED EXTRUDED-ALUMINUM LOUVERS

- A. Horizontal drainable-Blade Louver, Extruded Aluminum:
 - 1. Louver Depth: 2 inch.
 - 2. Blade spacing; 2 inch.
 - 3. Blade Profile: Plain blade with center baffle.
 - 4. Frame and Blade Nominal Thickness: Not less than 0.063 inch for blades and 0.063 inch for frames.
 - 5. Louver Performance Ratings:
 - a. Free Area: Not less than 49 percent.
 - b. Point of Beginning Water Penetration: Not less than 889 fpm.
 - 6. AMCA Seal: Mark units with AMCA Certified Ratings Seal.

2.3 LOUVER SCREENS

- A. General: Provide screen at each exterior louver.
 - 1. Screen Location for Fixed Louvers: Interior face.
 - 2. Screening Type: Insect screening.
- B. Louver Screen Frames: Same type and form of metal as indicated for louver to which screens are attached.
- C. Louver Screening for Aluminum Louvers:

1. Insect Screening, Stainless Steel: 18-by-18 mesh, 0.009-inch wire or manufacturers equivalent.
- D. Aluminum Extrusions: ASTM B221, Alloy 6063-T5, T-52, or T6.
- E. Aluminum Sheet: ASTM B209, Alloy 3003 or 5005, with temper as required for forming, or as otherwise recommended by metal producer for required finish.
- F. Fasteners: Use types and sizes to suit unit installation conditions.
 1. Use tamper-resistant screws for exposed fasteners unless otherwise indicated.
 2. For fastening aluminum, use aluminum or 300 series stainless steel fasteners.
 3. For fastening galvanized steel, use hot-dip-galvanized-steel or 300 series stainless steel fasteners.
 4. For fastening stainless steel, use 300 series stainless steel fasteners.
 5. For color-finished louvers, use fasteners with heads that match color of louvers.
- G. Postinstalled Fasteners for Concrete and Masonry: Torque-controlled expansion anchors, fabricated from stainless steel components, with allowable load or strength design capacities calculated according to ICC-ES AC193 and ACI 318 greater than or equal to the design load, as determined by testing according to ASTM E488/E488M conducted by a qualified testing agency.
- H. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D1187/D1187M.

2.4 FABRICATION

- A. Fabricate frames, including integral sills, to fit in openings of sizes indicated, with allowances made for fabrication and installation tolerances, adjoining material tolerances, and perimeter sealant joints.
- B. Join frame members to each other and to fixed louver blades with fillet welds concealed from view, threaded fasteners, or both, as standard with louver manufacturer unless otherwise indicated or size of louver assembly makes bolted connections between frame members necessary.

2.5 ALUMINUM FINISHES

- A. Superior-Performance Organic Finish, Three-Coat PVDF: Fluoropolymer finish complying with AAMA 2605 and containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat.
 1. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
 2. Color and Gloss: As selected by Architect from manufacturer's full range.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Locate and place louvers level, plumb, and at indicated alignment with adjacent work.
- B. Use concealed anchorages where possible. Provide brass or lead washers fitted to screws where required to protect metal surfaces and to make a weathertight connection.
- C. Provide perimeter reveals and openings of uniform width for sealants and joint fillers, as indicated.
- D. Protect unpainted galvanized- and nonferrous-metal surfaces that are in contact with concrete, masonry, or dissimilar metals from corrosion and galvanic action by applying a heavy coating of bituminous paint or by separating surfaces with waterproof gaskets or nonmetallic flashing.

3.2 ADJUSTING

- A. Restore louvers damaged during installation and construction, so no evidence remains of corrective work. If results of restoration are unsuccessful, as determined by Architect, remove damaged units and replace with new units.

END OF SECTION 089119

SECTION 092900 - GYPSUM BOARD

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. The Drawings and general provisions of the Contract, including the City of Baltimore Department of Public Works Specifications (the "Green Book") and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Interior gypsum board.
 - 2. Exterior gypsum board for ceilings and soffits.
 - 3. Tile backing panels.

1.3 ACTION SUBMITTALS

- A. Product data.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Fire-Resistance-Rated Assemblies: For fire-resistance-rated assemblies, provide materials and construction identical to those tested in assembly indicated in accordance with ASTM E119 by an independent testing agency.
- B. STC-Rated Assemblies: For STC-rated assemblies, provide materials and construction identical to those tested in assembly indicated in accordance with ASTM E90 and classified in accordance with ASTM E413 by an independent testing agency.

2.2 GYPSUM BOARD, GENERAL

- A. Size: Provide maximum lengths and widths available that will minimize joints in each area and that correspond with support system indicated.

2.3 INTERIOR GYPSUM BOARD

- A. Gypsum Wallboard: ASTM C1396/C1396M.

1. Thickness: 5/8 inch.
2. Long Edges: Tapered.

B. Gypsum Board, Type X: ASTM C1396/C1396M.

1. Thickness: 5/8 inch.
2. Long Edges: Tapered.

C. Gypsum Ceiling Board: ASTM C1396/C1396M.

1. Thickness: 1/2 inch.
2. Long Edges: Tapered.

D. Impact-Resistant Gypsum Board: ASTM C1396/C1396M gypsum board, tested in accordance with ASTM C1629/C1629M.

1. Core: 5/8 inch.
2. Surface Abrasion: ASTM C1629/C1629M, meets or exceeds Level 3 requirements.
3. Indentation: ASTM C1629/C1629M, meets or exceeds Level 1 requirements.
4. Soft-Body Impact: ASTM C1629/C1629M, meets or exceeds Level 3 requirements.
5. Hard-Body Impact: ASTM C1629/C1629M, meets or Level 3 requirements in accordance with test in Annex A1.
6. Long Edges: Tapered.
7. Mold Resistance: ASTM D3273, score of 10 as rated in accordance with ASTM D3274.

E. Mold-Resistant Gypsum Board: ASTM C1396/C1396M. With moisture- and mold-resistant core and paper surfaces.

1. Core: 5/8 inch.
2. Long Edges: Tapered.
3. Mold Resistance: ASTM D3273, score of 10 as rated in accordance with ASTM D3274.

2.4 SPECIALTY GYPSUM BOARD

2.5 EXTERIOR GYPSUM BOARD FOR CEILINGS AND SOFFITS

A. Exterior Gypsum Soffit Board: ASTM C1396/C1396M, with manufacturer's standard edges.

1. Core: 5/8 inch.

2.6 TILE BACKING PANELS

A. Glass-Mat, Water-Resistant Backing Board: ASTM C1178/C1178M, with manufacturer's standard edges.

1. Core: 1/2 inch.
2. Mold Resistance: ASTM D3273, score of 10 as rated in accordance with ASTM D3274.

2.7 TRIM ACCESSORIES

A. Interior Trim: ASTM C1047.

1. Material: Galvanized or aluminum-coated steel sheet, rolled zinc, plastic, or paper-faced galvanized-steel sheet.
2. Shapes:
 - a. Cornerbead.
 - b. Bullnose bead.
 - c. LC-Bead: J-shaped; exposed long flange receives joint compound.
 - d. L-Bead: L-shaped; exposed long flange receives joint compound.
 - e. U-Bead: J-shaped; exposed short flange does not receive joint compound.
 - f. Expansion (control) joint.

B. Exterior Trim: ASTM C1047.

1. Material: Hot-dip galvanized-steel sheet, plastic, or rolled zinc.
2. Shapes:
 - a. Cornerbead.
 - b. LC-Bead: J-shaped; exposed long flange receives joint compound.
 - c. Expansion (Control) Joint: One-piece, rolled zinc with V-shaped slot and removable strip covering slot opening.

2.8 JOINT TREATMENT MATERIALS

A. General: Comply with ASTM C475/C475M.

B. Joint Tape:

1. Interior Gypsum Board: Paper.
2. Exterior Gypsum Soffit Board: Paper.
3. Tile Backing Panels: As recommended by panel manufacturer.

C. Joint Compound for Interior Gypsum Board: For each coat, use formulation that is compatible with other compounds applied on previous or for successive coats.

1. Prefilling: At open joints and damaged surface areas, use setting-type taping compound.
2. Embedding and First Coat: For embedding tape and first coat on joints, fasteners, and trim flanges, use setting-type taping or drying-type, all-purpose compound.
 - a. Use setting-type compound for installing paper-faced metal trim accessories.
3. Fill Coat: For second coat, use setting-type, sandable topping or drying-type, all-purpose compound.
4. Finish Coat: For third coat, use setting-type, sandable topping or drying-type, all-purpose compound.

D. Joint Compound for Exterior Applications:

1. Exterior Gypsum Soffit Board: Use setting-type taping compound and setting-type, sandable topping compound.

E. Joint Compound for Tile Backing Panels:

1. Glass-Mat, Water-Resistant Backing Panel: As recommended by backing panel manufacturer.

2.9 AUXILIARY MATERIALS

- A. Provide auxiliary materials that comply with referenced installation standards and manufacturer's written instructions.
- B. Steel Drill Screws: ASTM C1002 unless otherwise indicated.
 1. Use screws complying with ASTM C954 for fastening panels to steel members from 0.033 to 0.112 inch thick.
- C. Sound-Attenuation Blankets: ASTM C665, Type I (blankets without membrane facing) produced by combining thermosetting resins with mineral fibers manufactured from glass, slag wool, or rock wool.
- D. Acoustical Sealant: As specified in Section 079219 "Acoustical Joint Sealants."
- E. Thermal Insulation: As specified in Section 072100 "Thermal Insulation."
- F. Vapor Retarder: As specified in Section 072600 "Vapor Retarders."

PART 3 - EXECUTION

3.1 INSTALLATION OF PANELS

- A. Examine panels before installation. Reject panels that are wet, moisture damaged, and mold damaged.
- B. Comply with ASTM C840.
- C. Isolate perimeter of gypsum board applied to non-load-bearing partitions at structural abutments. Provide 1/4- to 1/2-inch- wide spaces at these locations and trim edges with edge trim where edges of panels are exposed. Seal joints between edges and abutting structural surfaces with acoustical sealant.
- D. For trim with back flanges intended for fasteners, attach to framing with same fasteners used for panels. Otherwise, attach trim according to manufacturer's written instructions.

3.2 FINISHING OF GYPSUM BOARD

- A. Prefill open joints, rounded or beveled edges, and damaged surface areas.

- B. Apply joint tape over gypsum board joints, except for trim products specifically indicated as not intended to receive tape.
- C. Gypsum Board Finish Levels: Finish panels to levels indicated below and in accordance with ASTM C840:
 - 1. Level 1: Ceiling plenum areas, concealed areas, and where indicated.
 - 2. Level 2: Panels that are substrate for tile.
 - 3. Level 4: At panel surfaces that will be exposed to view unless otherwise indicated.
 - a. Primer and its application to surfaces are specified in Section 099123 "Interior Painting."
 - 4. Level 5: Where indicated on Drawings.
 - a. Primer and its application to surfaces are specified in Section 099123 "Interior Painting."

3.3 APPLICATION OF TEXTURE FINISHES

3.4 PROTECTION

- A. Protect installed products from damage from weather, condensation, direct sunlight, construction, and other causes during remainder of the construction period.
- B. Remove and replace panels that are wet, moisture damaged, and mold damaged.

END OF SECTION 092900

SECTION 093013 - CERAMIC TILING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. The Drawings and general provisions of the Contract, including the City of Baltimore Department of Public Works Specifications (the "Green Book") and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 1. Porcelain tile.
 2. Crack isolation membranes.
 3. Setting material.
 4. Grout materials.
 5. Ceramic tile Accessories.

1.3 ACTION SUBMITTALS

- A. Product Data:
 1. Porcelain tile.
 2. Crack isolation membranes.
 3. Setting material.
 4. Grout materials.
 5. Ceramic tile Accessories.
- B. Samples:
 1. Full-size units of each type and composition of tile and for each color and finish required.
 2. Assembled samples mounted on a rigid panel, with grouted joints, for each type and composition of tile and for each color and finish required. Make samples at least 12 inches square, but not fewer than four tiles. Use grout of type and in color or colors approved for completed Work.
 3. Full-size units of each type of trim and accessory for each color and finish required.
 4. Ceramic tile Accessories in 6-inch lengths

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.

1.5 MAINTENANCE MATERIAL SUBMITTALS

- A. Extra Stock Material: Furnish extra materials, from the same production run, to Owner that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Tile and Trim Units: Furnish quantity of full-size units equal to 3 percent of amount installed for each type, composition, color, pattern, and size indicated.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications:
 - 1. Installer is a Five-Star member of the National Tile Contractors Association or a Trowel of Excellence member of the Tile Contractors' Association of America.
 - 2. Installer's supervisor for Project holds the International Masonry Institute's Supervisor Certification.

PART 2 - PRODUCTS

2.1 PRODUCTS, GENERAL

- A. ANSI Standards for Tile Installation Materials: Provide materials complying with ANSI A108.02, ANSI standards referenced in other Part 2 articles, ANSI standards referenced by TCNA installation methods specified in tile installation schedules, and other requirements specified.

2.2 PORCELAIN TILE

- A. Porcelain Tile Type CT-1, CT-2, CT-3
 - 1. Certification: Tile certified by the Porcelain Tile Certification Agency.
 - 2. Face Size: See Finish Schedule.
 - 3. Product Use Classification: Interior, Wet (IW).
 - 4. Physical Properties: Chemical resistant when tested with indicated chemicals in accordance with ASTM C650.
 - a. ANSI / ISO Class A.
 - 5. Tile Color, Glaze, and Pattern: See Finish Schedule.
 - 6. Grout Color: As selected by Architect from manufacturer's full range>.

2.3 CRACK ISOLATION MEMBRANES

- A. General: Manufacturer's standard product,] that complies with ANSI A118.12 for high performance and is recommended by manufacturer for application indicated. Include reinforcement and accessories recommended by manufacturer.

- B. Crack Isolation Membrane, Fluid Applied: Liquid-latex rubber or elastomeric polymer.

2.4 SETTING MATERIALS

- A. Standard Dry-Set Mortar (Thinset): ANSI A118.1.
 - 1. For wall applications, provide mortar that complies with requirements for nonsagging mortar in addition to other requirements in ANSI A118.1.
- B. Modified Dry-Set Mortar (Thinset): ANSI A118.4.
 - 1. Provide prepackaged, dry-mortar mix containing dry, redispersible, vinyl acetate or acrylic additive to which only water must be added at Project site.
 - 2. For wall applications, provide mortar that complies with requirements for nonsagging mortar in addition to other requirements in ANSI A118.4.

2.5 GROUT MATERIALS

- A. Standard Cement Grout: ANSI A118.6.

2.6 MISCELLANEOUS MATERIALS

- A. Top trim, Outside Corners and Cove Base metal trim: Profile designed specifically for wall and flooring applications; height to match tile and setting-bed thickness.
 - 1. Description: See Finish Schedule.
 - 2. Material and Finish: See Finish Schedule.
- B. Temporary Protective Coating: Formulated to protect exposed surfaces of tile against adherence of mortar and grout; compatible with tile, mortar, and grout products and easily removable after grouting is completed without damaging grout or tile.
- C. Tile Cleaner: A neutral cleaner capable of removing soil and residue without harming tile and grout surfaces, specifically approved for materials and installations indicated by tile and grout manufacturers.
- D. Grout Sealer: Grout manufacturer's standard product for sealing grout joints that does not change color or appearance of grout.

2.7 FLOORING TRANSITION TR-4

- 1. Basis of Design; Schluter®-RENO-TK
 - a. Stainless Steel 304

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions where tile will be installed, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
 - 1. Verify that substrates for setting tile are firm; dry; clean; free of coatings that are incompatible with tile-setting materials, including curing compounds and other substances that contain soap, wax, oil, or silicone; and comply with flatness tolerances required by ANSI A108.01 for installations indicated.
 - 2. Verify that concrete substrates for tile floors installed with thinset mortar comply with surface finish requirements in ANSI A108.01 for installations indicated.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Remove coatings, including curing compounds or other coatings, that are incompatible with tile-setting materials.
- B. Fill cracks, holes, and depressions in concrete substrates for tile floors installed with thinset mortar with trowelable leveling and patching compound specifically recommended by tile-setting material manufacturer.
- C. Where indicated, prepare substrates to receive waterproof membrane by applying a reinforced mortar bed that complies with ANSI A108.1 and is sloped 1/4 inch per foot toward drains.
- D. Blending: For tile exhibiting color variations, verify that tile has been factory blended and packaged so tile units taken from one package show same range of colors as those taken from other packages and match approved Samples. If not factory blended, either return to manufacturer or blend tiles at Project site before installing.
- E. Substrate Flatness:
 - 1. For tile shorter than 15 inches, confirm that structure or substrate is limited to variation of 1/4 inch in 10 ft. from the required plane, and no more than 1/16 inch in 12 inches when measured from tile surface high points.
 - 2. For large format tile, tile with at least one edge 15 inches or longer, confirm that structure or substrate is limited to 1/8 inch in 10 ft. from the required plane, and no more than 1/16 inch in 24 inches when measured from tile surface high points.

3.3 INSTALLATION OF CERAMIC TILE SYSTEM

- A. Install tile backing panels and treat joints in accordance with ANSI A108.11 and manufacturer's written instructions for type of application indicated.

- B. Install crack isolation membrane to comply with ANSI A108.17 and manufacturer's written instructions to produce membrane of uniform thickness that is bonded securely to substrate.
 - 1. Allow crack isolation membrane to cure before installing tile or setting materials over it.
- C. Install tile in accordance with TCNA's "Handbook for Ceramic, Glass, and Stone Tile Installation" for TCNA installation methods specified in tile installation schedules. Comply with parts of ANSI A108 series that are referenced in TCNA installation methods and specified in tile installation schedules and apply to types of setting and grouting materials used.
- D. Extend tile work into recesses and under or behind equipment and fixtures to form complete covering without interruptions unless otherwise indicated. Terminate work neatly at obstructions, edges, and corners without disrupting pattern or joint alignments.
- E. Accurately form intersections and returns. Perform cutting and drilling of tile without marring visible surfaces. Carefully grind cut edges of tile abutting trim, finish, or built-in items for straight aligned joints. Fit tile closely to electrical outlets, piping, fixtures, and other penetrations so plates, collars, or covers overlap tile.
- F. Where accent tile differs in thickness from field tile, vary setting-bed thickness so that tiles are flush.
- G. Jointing Pattern: Lay tile in grid pattern unless otherwise indicated. Lay out tile work and center tile fields in both directions in each space or on each wall area. Lay out tile work to minimize use of pieces that are less than half of a tile. Provide uniform joint widths unless otherwise indicated.
- H. Lay out tile wainscots to dimensions indicated or to next full tile beyond dimensions indicated.
- I. Movement Joints: Provide movement joints and other sealant-filled joints, including control, contraction, and isolation joints, where indicated on Drawings. Form joints during installation of setting materials, mortar beds, and tile. Keep joints free of dirt, debris, and setting materials prior to filling with sealants. Do not saw-cut joints after installing tiles.
 - 1. Where joints occur in concrete substrates, locate joints in tile surfaces directly above them.
- J. Metal Flooring Transitions: Install at locations indicated.
- K. Grout Sealer: Apply grout sealer to cementitious grout joints in tile floors in accordance with manufacturer's written instructions. As soon as sealer has penetrated grout joints, remove excess sealer and sealer from tile faces by wiping with soft cloth.

3.4 INTERIOR CERAMIC TILE INSTALLATION SCHEDULE

- 1. TCNA W242: Organic adhesive on gypsum board.
 - a. Ceramic Tile Type: CT-1, CT-2, CT-3.
 - b. Grout: Standard unsanded cement grout.
 - c. Joint Width: 1/8 inch.

- d. Movement Joints: Types located on Drawings.

END OF SECTION 093013

SECTION 095123 - ACOUSTICAL TILE CEILINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. The Drawings and general provisions of the Contract, including the City of Baltimore Department of Public Works Specifications (the "Green Book") and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Acoustical tiles.
 - 2. Metal suspension system.
 - 3. Accessories.

1.3 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

1.4 ACTION SUBMITTAL

- A. Product Data: For each type of product.
- B. Samples: For each exposed product and for each color and texture specified.

1.5 INFORMATIONAL SUBMITTALS

- A. Product test reports.
- B. Research reports.
- C. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

- A. Maintenance data.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Surface-Burning Characteristics: Comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - 1. Flame-Spread Index: Class A in accordance with ASTM E1264.

2.2 ACOUSTICAL TILES ACT-1, ACT-2

- A. Acoustical Tile Standard: Manufacturer's standard tiles of configuration indicated that comply with ASTM E1264.
- B. Classification: See Finish Schedule.
- C. Color: White.
- D. Light Reflectance (LR): 85%
- E. Ceiling Attenuation Class (CAC): 38.
- F. Noise Reduction Coefficient (NRC): .60.
- G. Edge/Joint Detail: Beveled tegular.
- H. Thickness: As indicated in a schedule.
- I. Modular Size: As indicated in a schedule.

2.3 METAL SUSPENSION SYSTEM

- A. Metal Suspension-System Standard: Manufacturer's standard, direct-hung, fully concealed, metal suspension system that complies with applicable requirements in ASTM C635/C635M.
- B. Direct-Hung, Double-Web Suspension System: Main and cross runners roll formed from and capped with cold-rolled steel sheet, prepainted, electrolytically zinc coated, or hot-dip galvanized, G30 coating designation.
 - 1. Structural Classification: Intermediate-duty system.
 - 2. Access: Upward, with initial access openings of size indicated below and located throughout ceiling within each module formed by main and cross runners, with additional access available by progressively removing remaining acoustical tiles.
 - a. Initial Access Opening: In each module, 24 by 24 inches.

2.4 ACCESSORIES

- A. Attachment Devices: Size for five times the design load indicated in ASTM C635/C635M, Table 1, "Direct Hung," unless otherwise indicated. Comply with seismic design requirements.
- B. Seismic Clips: Manufacturer's standard seismic clips designed to secure acoustical tiles in-place during a seismic event.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Measure each ceiling area and establish layout of acoustical tiles to balance border widths at opposite edges of each ceiling. Avoid using less-than-half-width tiles at borders unless otherwise indicated.
- B. Layout openings for penetrations centered on the penetrating items.

3.2 INSTALLATION OF SUSPENDED ACOUSTICAL TILE CEILINGS

- A. Install suspended acoustical tile ceilings in accordance with ASTM C636/C636M and manufacturer's written instructions.
- B. Install edge moldings and trim of type indicated at perimeter of acoustical ceiling area and where necessary to conceal edges of acoustical tiles.
 - 1. Apply acoustical sealant in a continuous ribbon concealed on back of vertical legs of moldings before they are installed.
 - 2. Do not use exposed fasteners, including pop rivets, on moldings and trim.
- C. Arrange directionally patterned acoustical tiles as indicated on reflected ceiling plans.

END OF SECTION 095123

SECTION 096513 - RESILIENT BASE AND ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. The Drawings and general provisions of the Contract, including the City of Baltimore Department of Public Works Specifications (the "Green Book") and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Thermoplastic-rubber base.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Samples: For each exposed product and for each color and texture specified.

PART 2 - PRODUCTS

2.1 THERMOPLASTIC-RUBBER BASE RB-1, RB-2

- A. Product Standard: ASTM F1861, Type TP (rubber, thermoplastic).
 - 1. Group: I (solid, homogeneous).
 - 2. Style and Location:
 - a. Style A, Straight: Provide in areas with carpet.
 - b. Style B, Cove: Provide in areas with resilient floor coverings.
- B. Thickness: 0.125 inch.
- C. Height: 4 inches.
- D. Lengths: Coils in manufacturer's standard length.
- E. Outside Corners: Preformed.
- F. Inside Corners: Preformed.
- G. Colors: As selected from manufacturer's standard colors.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Prepare substrates according to manufacturer's written instructions to ensure adhesion of resilient products.
- B. Fill cracks, holes, and depressions in substrates with trowelable leveling and patching compound; remove bumps and ridges to produce a uniform and smooth substrate.
- C. Do not install resilient products until materials are the same temperature as space where they are to be installed.
- D. Immediately before installation, sweep and vacuum clean substrates to be covered by resilient products.

3.2 RESILIENT BASE INSTALLATION

- A. Comply with manufacturer's written instructions for installing resilient base.
- B. Apply resilient base to walls, columns, pilasters, casework and cabinets in toe spaces, and other permanent fixtures in rooms and areas where base is required.
- C. Install resilient base in lengths as long as practical without gaps at seams and with tops of adjacent pieces aligned.
- D. Tightly adhere resilient base to substrate throughout length of each piece, with base in continuous contact with horizontal and vertical substrates.
- E. Do not stretch resilient base during installation.
- F. On masonry surfaces or other similar irregular substrates, fill voids along top edge of resilient base with manufacturer's recommended adhesive filler material.
- G. Preformed Corners: Install preformed corners before installing straight pieces.

3.3 CLEANING AND PROTECTION

- A. Comply with manufacturer's written instructions for cleaning and protecting resilient products.

END OF SECTION 096513

SECTION 096519 - RESILIENT TILE FLOORING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. The Drawings and general provisions of the Contract, including the City of Baltimore Department of Public Works Specifications (the "Green Book") and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. High performance luxury vinyl floor tile.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Samples: For each exposed product and for each color and pattern specified.

1.4 CLOSEOUT SUBMITTALS

- A. Maintenance data.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: An entity that employs installers and supervisors who are competent in techniques required by manufacturer for floor tile installation.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Fire-Test-Response Characteristics: For resilient floor tile, as determined by testing identical products according to ASTM F1700 by a qualified testing agency.
 - 1. Class III printed vinyl plank

2.2 HIGH PERFORMANCE VINYL FLOOR TILE RES-1

- A. Tile Standard: ASTM F1700.
 - 1. Class: Class III, Printed Film Vinyl Tile.
 - 2. Type: A, Smooth Surface.
- B. Thickness: 4.5 mm.
- C. Size: 25 by 1000 mm.
- D. Colors and Patterns: As indicated on finish schedule.

2.3 FLOORING TRANSITIONS

- A. Wheel Traffic Transitional Mouldings
 - 1. Manufactured from a homogeneous composition of polyvinyl chloride (PVC), high quality additives, and colorants. All Wheel Traffic Transitional Mouldings to comply with A.D.A. requirements of Section 4.5.2 Changes of Level. Thickness: 4.5 mm.
 - 2. Size: 12 foot lengths minimum.
 - 3. Colors and Patterns: As indicated on finish schedule.
 - 4. Hardness: ASTM D 2240 - Not less than 85 Shore A
 - 5. Abrasion Resistance: ASTM D 3389 - 0.22 mg/cycle.
 - 6. Slip Resistance: ASTM D 2047 - Exceed Federal Standards and ADA recommendations of .5 for flat surfaces.
 - 7. Fire Resistance: ASTM E 648/NFPA 253 (Critical Radiant Flux) - Class 1.

2.4 INSTALLATION MATERIALS

- A. Trowelable Leveling and Patching Compounds: Latex-modified, portland-cement-based or blended hydraulic-cement-based formulation provided or approved by floor tile manufacturer for applications indicated.
- B. Adhesives: Water-resistant type recommended by floor tile and adhesive manufacturers to suit floor tile and substrate conditions indicated.
- C. Floor Polish: Provide protective, liquid floor-polish products recommended by floor tile manufacturer.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Prepare substrates according to floor tile manufacturer's written instructions to ensure adhesion of resilient products.
- B. Concrete Substrates: Prepare according to ASTM F710.

1. Verify that substrates are dry and free of curing compounds, sealers, and hardeners.
 2. Remove substrate coatings and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, using mechanical methods recommended by floor tile manufacturer. Do not use solvents.
 3. Alkalinity and Adhesion Testing: Perform tests recommended by floor tile manufacturer. Proceed with installation only after substrate alkalinity falls within range on pH scale recommended by manufacturer in writing, but not less than 5 or more than 9 pH.
 4. Moisture Testing: Perform tests so that each test area does not exceed 200 sq. ft. and perform no fewer than three tests in each installation area and with test areas evenly spaced in installation areas.
 - a. Relative Humidity Test: Using in-situ probes, ASTM F2170. Proceed with installation only after substrates have a maximum 85 percent relative humidity level measurement.
- C. Immediately before installation, sweep and vacuum clean substrates to be covered by resilient floor tile.

3.2 FLOOR TILE INSTALLATION

- A. Comply with manufacturer's written instructions for installing floor tile.
- B. Lay out floor tiles from center marks established with principal walls, discounting minor offsets, so tiles at opposite edges of room are of equal width. Adjust as necessary to avoid using cut widths that equal less than one-half tile at perimeter.
 1. Lay tiles in pattern indicated.
- C. Match floor tiles for color and pattern by selecting tiles from cartons in the same sequence as manufactured and packaged, if so numbered. Discard broken, cracked, chipped, or deformed tiles.
 1. Lay tiles in pattern of colors and sizes indicated.
- D. Scribe, cut, and fit floor tiles to butt neatly and tightly to vertical surfaces and permanent fixtures including built-in furniture, cabinets, pipes, outlets, and door frames.
- E. Extend floor tiles into toe spaces, door reveals, closets, and similar openings. Extend floor tiles to center of door openings.
- F. Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating on floor tiles as marked on substrates. Use chalk or other nonpermanent marking device.
- G. Adhere floor tiles to substrates using a full spread of adhesive applied to substrate to produce a completed installation without open cracks, voids, raising and puckering at joints, telegraphing of adhesive spreader marks, and other surface imperfections.

END OF SECTION 096519

SECTION 096813 - TILE CARPETING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. The Drawings and general provisions of the Contract, including the City of Baltimore Department of Public Works Specifications (the "Green Book") and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Carpet tile.
 - 2. Walk off mat.

1.3 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

1.4 ACTION SUBMITTALS

- A. Product data.
- B. Shop Drawings: For carpet tile installation.
- C. Samples: Manufacturer's standard color sheets, showing full range of available colors for each type of carpet tile.

1.5 INFORMATIONAL SUBMITTALS

- A. Product test reports.
- B. Sample warranties.

1.6 CLOSEOUT SUBMITTALS

- A. Maintenance data.

1.7 QUALITY ASSURANCE

- A. Installer Qualifications: An authorized representative who is certified by the International Certified Floorcovering Installers Association at the Commercial II certification level.

1.8 WARRANTY

- A. Special Warranty for Carpet Tiles: Manufacturer agrees to repair or replace components of carpet tile installation that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: 15 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 CARPET TILE CPT-1

- A. Color: As indicated on Finish Schedule.
- B. Pattern: As indicated on Finish Schedule.
- C. Fiber Content: 100% Recycled Content Nylon.
- D. Pile Characteristic: Engaged Tufted Pattern Loop.
- E. Density: 8,780 oz/yd³.
- F. Pile Thickness: .12 inches for finished carpet tile].
- G. Stitches: 7.5 inch.
- H. Gage: 1/10 inch.
- I. Backing System: Manufacturers standard vinyl backing system, GlasBac.
- J. Size: As indicated on Finish Schedule.
- K. Applied Treatments:
 - 1. Soil-Resistance Treatment: Protekt²®.
 - 2. Antimicrobial Treatment: Manufacturer's standard treatment that protects carpet tiles as follows:
 - a. Antimicrobial Activity: Not less than 2 mm halo of inhibition for gram-positive bacteria, not less than 1 mm halo of inhibition for gram-negative bacteria, and no fungal growth, in accordance with AATCC 174.
- L. Performance Characteristics:

1. Texture Appearance Retention Rating (TARR): Heavy traffic, 3.0 minimum in accordance with ASTM D7330.
2. Critical Radiant Flux Classification: Not less than 0.45 W/sq. cm in accordance with NFPA 253.
3. Dimensional Tolerance: Within .10% of specified size dimensions, as determined by physical measurement.
4. Colorfastness to Crocking: Not less than 4, wet and dry, in accordance with AATCC 165.
5. Colorfastness to Light: Not less than 4 after 60 AFU (AATCC fading units) in accordance with AATCC 16.3 Option 3.
6. Electrostatic Propensity: Less than 3 kV in accordance with AATCC 134.

2.2 CARPET TILE CPT-2

- A. Color: As indicated on Finish Schedule.
- B. Pattern: As indicated on Finish Schedule.
- C. Fiber Content: 100% Recycled Content Nylon.
- D. Pile Characteristic: Tufted Textured Loop.
- E. Density: 7,962 oz/yd³.
- F. Pile Thickness: .10 inches for finished carpet tile].
- G. Stitches: 9.8 inch.
- H. Gage: 1/12 inch.
- I. Backing System: Manufacturers standard vinyl backing system, GlasBac.
- J. Size: As indicated on Finish Schedule.
- K. Applied Treatments:
 1. Soil-Resistance Treatment: Protekt²®.
 2. Antimicrobial Treatment: Manufacturer's standard treatment that protects carpet tiles as follows:
 - a. Antimicrobial Activity: Not less than 2 mm halo of inhibition for gram-positive bacteria, not less than 1 mm halo of inhibition for gram-negative bacteria, and no fungal growth, in accordance with AATCC 174.
- L. Performance Characteristics:
 1. Texture Appearance Retention Rating (TARR): Heavy traffic, 3.0 minimum in accordance with ASTM D7330.
 2. Critical Radiant Flux Classification: Not less than 0.45 W/sq. cm in accordance with NFPA 253.

3. Dimensional Tolerance: Within .10% of specified size dimensions, as determined by physical measurement.
4. Colorfastness to Crocking: Not less than 4, wet and dry, in accordance with AATCC 165.
5. Colorfastness to Light: Not less than 4 after 60 AFU (AATCC fading units) in accordance with AATCC 16.3 Option 3.
6. Electrostatic Propensity: Less than 3 kV in accordance with AATCC 134.

2.3 CARPET TILE CPT-3

- A. Color: As indicated on Finish Schedule.
- B. Pattern: As indicated on Finish Schedule.
- C. Fiber Content: 100% Recycled Content Nylon.
- D. Pile Characteristic: Tufted Textured Loop.
- E. Density: 6,968 oz/yd³.
- F. Pile Thickness: .09 inches for finished carpet tile].
- G. Stitches: 8.3 inch.
- H. Gage: 1/12 inch.
- I. Backing System: Manufacturers standard vinyl backing system, GlasBac.
- J. Size: As indicated on Finish Schedule.
- K. Applied Treatments:
 1. Soil-Resistance Treatment: Protekt²®.
 2. Antimicrobial Treatment: Manufacturer's standard treatment that protects carpet tiles as follows:
 - a. Antimicrobial Activity: Not less than 2 mm halo of inhibition for gram-positive bacteria, not less than 1 mm halo of inhibition for gram-negative bacteria, and no fungal growth, in accordance with AATCC 174.
- L. Performance Characteristics:
 1. Texture Appearance Retention Rating (TARR): Heavy traffic, 3.0 minimum in accordance with ASTM D7330.
 2. Critical Radiant Flux Classification: Not less than 0.45 W/sq. cm in accordance with NFPA 253.
 3. Dimensional Tolerance: Within .10% of specified size dimensions, as determined by physical measurement.
 4. Colorfastness to Crocking: Not less than 4, wet and dry, in accordance with AATCC 165.
 5. Colorfastness to Light: Not less than 4 after 60 AFU (AATCC fading units) in accordance with AATCC 16.3 Option 3.

6. Electrostatic Propensity: Less than 3 kV in accordance with AATCC 134.

2.4 CARPET TILE WOM-1

- A. Color: As indicated on Finish Schedule.
- B. Pattern: As indicated on Finish Schedule.
- C. Fiber Content: Ecosolution Q100™ Nylon.
- D. Pile Characteristic: Multi-Level Pattern Loop.
- E. Density: 7,814 oz/yd³.
- F. Pile Thickness: .25 inches for finished carpet tile].
- G. Stitches: 8.5 inch.
- H. Gage: 1/12 inch.
- I. Primary Backing/Backcoating: Manufacturer's standard composite materials.
- J. Secondary Backing System: Ecoworx® Tile
- K. Size: As indicated on Finish Schedule.
- L. Applied Treatments:
 1. Soil-Resistance Treatment: SSP® Shaw Soil Protection
 2. Antimicrobial Treatment: Manufacturer's standard treatment that protects carpet tiles as follows:
 - a. Antimicrobial Activity: Not less than 2 mm halo of inhibition for gram-positive bacteria, not less than 1 mm halo of inhibition for gram-negative bacteria, and no fungal growth, in accordance with AATCC 174.
- M. Performance Characteristics:
 1. Texture Appearance Retention Rating (TARR): Heavy traffic, 3.0 minimum in accordance with ASTM D7330.
 2. Critical Radiant Flux Classification: Not less than 0.45 W/sq. cm in accordance with NFPA 253.
 3. Dimensional Tolerance: Within .10% of specified size dimensions, as determined by physical measurement.
 4. Colorfastness to Crocking: Not less than 4, wet and dry, in accordance with AATCC 165.
 5. Colorfastness to Light: Not less than 4 after 60 AFU (AATCC fading units) in accordance with AATCC 16.3 Option 3.
 6. Electrostatic Propensity: Less than 3 kV in accordance with AATCC 134.

2.5 INSTALLATION ACCESSORIES

- A. Trowelable Leveling and Patching Compounds: Latex-modified, hydraulic-cement-based formulation provided or recommended in writing by carpet tile manufacturer.
- B. Adhesives: Water-resistant, mildew-resistant, nonstaining, pressure-sensitive types to suit products and subfloor conditions indicated, that comply with flammability requirements for installed carpet tile, and that are recommended in writing by carpet tile manufacturer for releasable installation.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for maximum moisture content, alkalinity range, installation tolerances, and other conditions affecting carpet tile performance.
- B. Examine carpet tile for type, color, pattern, and potential defects.
- C. Concrete Slabs: Verify that finishes comply with requirements specified in Section 033000 "Cast-in-Place Concrete" and that surfaces are free of cracks, ridges, depressions, scale, and foreign deposits.
 - 1. Moisture Testing: Perform tests so that each test area does not exceed 200 sq. ft. (and perform no fewer than three tests in each installation area and with test areas evenly spaced in installation areas.
 - a. Relative Humidity Test: Using in situ probes, ASTM F2170. Proceed with installation only after substrates have a maximum 75 percent relative humidity level measurement.
 - b. Perform additional moisture tests recommended in writing by adhesive and carpet tile manufacturers. Proceed with installation only after substrates pass testing.
- D. Wood Subfloors: Verify the following:
 - 1. Underlayment over subfloor complies with requirements specified in Section 061600 "Sheathing."
 - 2. Underlayment surface is free of irregularities and substances that may interfere with adhesive bond or show through surface.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. General: Comply with CRI 104 and with carpet tile manufacturer's written installation instructions for preparing substrates.

- B. Use trowelable leveling and patching compounds, in accordance with manufacturer's written instructions, to fill cracks, holes, depressions, and protrusions in substrates. Fill or level cracks, holes and depressions 1/8 inch wide or wider, and protrusions more than 1/32 inch unless more stringent requirements are required by manufacturer's written instructions.
- C. Concrete Substrates: Remove coatings, including curing compounds, and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, without using solvents. Use mechanical methods recommended in writing by adhesive and carpet tile manufacturers.
- D. Metal Substrates: Clean grease, oil, soil and rust, and prime if recommended in writing by adhesive manufacturer. Rough sand painted metal surfaces and remove loose paint. Sand aluminum surfaces, to remove metal oxides, immediately before applying adhesive.
- E. Broom and vacuum clean substrates to be covered immediately before installing carpet tile.

3.3 INSTALLATION

- A. General: Comply with CRI 104, Section 10, "Carpet Tile," and with carpet tile manufacturer's written installation instructions.
- B. Installation Method: Glue down; install every tile with full-spread, releasable, pressure-sensitive adhesive.
- C. Maintain dye-lot integrity. Do not mix dye lots in same area.
- D. Maintain pile-direction patterns indicated on Drawings.
- E. Cut and fit carpet tile to butt tightly to vertical surfaces, permanent fixtures, and built-in furniture including cabinets, pipes, outlets, edgings, thresholds, and nosings. Bind or seal cut edges as recommended in writing by carpet tile manufacturer.
- F. Extend carpet tile into toe spaces, door reveals, closets, open-bottomed obstructions, removable flanges, alcoves, and similar openings.
- G. Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating on carpet tile as marked on subfloor. Use nonpermanent, nonstaining marking device.
- H. Install pattern parallel to walls and borders.

3.4 CLEANING AND PROTECTION

- A. Perform the following operations immediately after installing carpet tile:
 - 1. Remove excess adhesive and other surface blemishes using cleaner recommended by carpet tile manufacturer.
 - 2. Remove yarns that protrude from carpet tile surface.
 - 3. Vacuum carpet tile using commercial machine with face-beater element.

- B. Protect carpet tile against damage from construction operations and placement of equipment and fixtures during the remainder of construction period. Use protection methods indicated or recommended in writing by carpet tile manufacturer.

END OF SECTION 096813

SECTION 099114 - EXTERIOR PAINTING (MPI STANDARDS)

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. The Drawings and general provisions of the Contract, including the City of Baltimore Department of Public Works Specifications (the "Green Book") and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:

- 1. Surface preparation and application of paint systems on the following exterior substrates:
 - a. Steel and iron.
 - b. Galvanized metal.
 - c. Wood.
 - d. Fiberglass.
 - e. Gypsum soffit board.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include printout of current "MPI Approved Products List" for each product category specified, with the proposed product highlighted.
- B. Samples: For each type of topcoat product.
- C. Product List: Cross-reference to paint system and locations of application areas. Use same designations indicated on Drawings and in the Exterior Painting Schedule to cross-reference paint systems specified in this Section. Include color designations.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, products listed in the Exterior Painting Schedule for the paint category indicated.

2.2 PAINT PRODUCTS

- A. MPI Standards: Provide products complying with MPI standards indicated and listed in its "MPI Approved Products List."
- B. Material Compatibility:
 - 1. Provide materials for use within each paint system that are compatible with one another, and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
 - 2. For each coat in a paint system, provide products recommended in writing by topcoat manufacturers for use in paint system and on substrate indicated.
- C. Colors: As indicated in a color schedule or match existing color.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify suitability of substrates, including surface conditions and compatibility, with existing finishes and primers.
- B. Proceed with coating application only after unsatisfactory conditions have been corrected.
 - 1. Application of coating indicates acceptance of surfaces and conditions.

3.2 PREPARATION

- A. Comply with manufacturer's written instructions and recommendations in "MPI Manual" applicable to substrates and paint systems indicated.
- B. Remove hardware, covers, plates, and similar items already in place that are removable and are not to be painted. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and painting.
 - 1. After completing painting operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection.

3.3 INSTALLATION

- A. Apply paints in accordance with manufacturer's written instructions and recommendations in "MPI Manual."
- B. Apply paints to produce surface films without cloudiness, spotting, holidays, laps, brush marks, roller tracking, runs, sags, ropiness, or other surface imperfections. Cut in sharp lines and color breaks.

3.4 CLEANING AND PROTECTION

- A. After completing paint application, clean spattered surfaces. Remove spattered paints by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.
- B. Protect work of other trades against damage from paint application. Correct damage to work of other trades by cleaning, repairing, replacing, and refinishing, as approved by Architect, and leave in an undamaged condition.
- C. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

3.5 EXTERIOR PAINTING SCHEDULE

- A. Steel and Iron Substrates:
 - 1. Water-Based Light Industrial Coating System MPI EXT 5.1B:
 - a. Zinc-Rich Prime Coat: Primer, zinc rich, inorganic, MPI #19.
 - b. Intermediate Coat: Light industrial coating, exterior, water based, matching topcoat.
 - c. Semigloss Topcoat: Light industrial coating, exterior, water based, semigloss (MPI Gloss Level 5), MPI #163.
- B. Galvanized-Metal Substrates:
 - 1. Latex System MPI EXT 5.3H:
 - a. Water-Based Prime Coat: Primer, galvanized, water based, MPI #134.
 - b. Intermediate Coat: Latex, exterior, matching topcoat.
 - c. Semigloss Topcoat: Latex, exterior, semigloss (MPI Gloss Level 5), MPI #11.
- C. Wood Substrates: Wood trim, Architectural woodwork, and Doors.
 - 1. Latex System MPI EXT 6.3A:
 - a. Prime Coat: Primer, alkyd for exterior wood, MPI #5.
 - b. Intermediate Coat: Latex, exterior, matching topcoat.
 - c. Semigloss Topcoat: Latex, exterior, semigloss (MPI Gloss Level 5), MPI #11.
- D. Fiberglass Substrates:
 - 1. Latex System MPI EXT 6.7A:
 - a. Prime Coat: Primer, bonding, solvent based, MPI #69.

- b. Intermediate Coat: Latex, exterior, matching topcoat.
 - c. Semigloss Topcoat: Latex, exterior, semigloss (MPI Gloss Level 5), MPI #11.
- E. Exterior Gypsum Board Substrates:
- 1. Latex System MPI EXT 9.2A:
 - a. Prime Coat: Primer, latex for exterior wood (reduced), MPI #6.
 - b. Intermediate Coat: Latex, exterior, matching topcoat.
 - c. Semigloss Topcoat: Latex, exterior, semigloss (MPI Gloss Level 5), MPI #11.

END OF SECTION 099114

SECTION 099124 - INTERIOR PAINTING (MPI STANDARDS)

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. The Drawings and general provisions of the Contract, including the City of Baltimore Department of Public Works Specifications (the "Green Book") and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes surface preparation and the application of paint systems on interior substrates.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product. Include preparation requirements and application instructions.
 - 1. Include printout of current "MPI Approved Products List" for each product category specified, with the proposed product highlighted.
- B. Samples: For each type of topcoat product.
- C. Product List: Use same designations indicated on Drawings and in the Interior Painting Schedule to cross-reference paint systems specified in this Section. Include color designations.

1.4 QUALITY ASSURANCE

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to products listed in the Interior Painting Schedule for the paint category indicated.

2.2 PAINT, GENERAL

- A. MPI Standards: Products shall comply with MPI standards indicated and shall be listed in its "MPI Approved Products List."
- B. Material Compatibility:

1. Materials for use within each paint system shall be compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
 2. For each coat in a paint system, products shall be recommended in writing by topcoat manufacturers for use in paint system and on substrate indicated.
- C. Colors: As indicated in a color schedule.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify suitability of substrates, including surface conditions and compatibility, with existing finishes and primers.
- B. Proceed with coating application only after unsatisfactory conditions have been corrected.
 1. Application of coating indicates acceptance of surfaces and conditions.

3.2 PREPARATION

- A. Comply with manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual" applicable to substrates and paint systems indicated.
- B. Remove hardware, covers, plates, and similar items already in place that are removable and are not to be painted. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and painting.
- C. After completing painting operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection if any.

3.3 INSTALLATION

- A. Apply paints according to manufacturer's written instructions and to recommendations in "MPI Manual."
- B. Apply paints to produce surface films without cloudiness, spotting, holidays, laps, brush marks, roller tracking, runs, sags, ropiness, or other surface imperfections. Cut in sharp lines and color breaks.
- C. Painting Fire-Suppression, Plumbing, HVAC, Electrical, Communication, and Electronic Safety and Security Work:
 1. Paint the following work where exposed in equipment rooms:
 - a. Uninsulated metal piping.
 - b. Uninsulated plastic piping.
 - c. Pipe hangers and supports.

2. Paint portions of internal surfaces of metal ducts, without liner, behind air inlets and outlets that are visible from occupied spaces.

3.4 FIELD QUALITY CONTROL

- A. Dry-Film Thickness Testing: Owner may engage the services of a qualified testing and inspecting agency to inspect and test paint for dry-film thickness.
 1. Contractor shall touch up and restore painted surfaces damaged by testing.
 2. If test results show that dry-film thickness of applied paint does not comply with paint manufacturer's written recommendations, Contractor shall pay for testing and apply additional coats as needed to provide dry-film thickness that complies with paint manufacturer's written recommendations.

3.5 CLEANING AND PROTECTION

- A. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.
- B. After completing paint application, clean spattered surfaces. Remove spattered paints by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.
- C. Protect work of other trades against damage from paint application. Correct damage to work of other trades by cleaning, repairing, replacing, and refinishing, as approved by Architect, and leave in an undamaged condition.
- D. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

3.6 INTERIOR PAINTING SCHEDULE

- A. Concrete Substrates, Traffic Surfaces:
 1. Solvent-Based Concrete Floor Sealer System, MPI INT 3.2F:
 - a. First Coat: Sealer, solvent based, for concrete floors, matching topcoat.
 - b. Topcoat: Sealer, solvent based, for concrete floors, MPI #104.
- B. CMU Substrates:
 1. Institutional Low-Odor/VOC Latex System, MPI INT 4.2E:
 - a. Block Filler: Block filler, latex, interior/exterior, MPI #4.
 - b. Intermediate Coat: Latex, interior, institutional low odor/VOC, matching topcoat.
 - c. Topcoat: Latex, interior, institutional low odor/VOC (MPI Gloss Level 3), MPI #145.

C. Steel Substrates:

1. Institutional Low-Odor/VOC Latex System, MPI INT 5.1S:
 - a. Prime Coat: Primer, rust inhibitive, water based MPI #107.
 - b. Intermediate Coat: Latex, interior, institutional low odor/VOC, matching topcoat.
 - c. Topcoat: Latex, interior, institutional low odor/VOC, semigloss (MPI Gloss Level 5), MPI #147.

D. Galvanized-Metal Substrates:

1. Institutional Low-Odor/VOC Latex System, MPI INT 5.3N:
 - a. Prime Coat: Primer, galvanized, water based, MPI #134.
 - b. Intermediate Coat: Latex, interior, institutional low odor/VOC, matching topcoat.
 - c. Topcoat: Latex, interior, institutional low odor/VOC (MPI Gloss Level 2), MPI #144.

E. Aluminum (Not Anodized or Otherwise Coated) Substrates:

1. Institutional Low-Odor/VOC Latex System, MPI INT 5.4G:
 - a. Prime Coat: Primer, quick dry, for aluminum, MPI #95.
 - b. Intermediate Coat: Latex, interior, institutional low odor/VOC, matching topcoat.
 - c. Topcoat: Latex, interior, institutional low odor/VOC, gloss (MPI Gloss Level 6), MPI #148.

F. Wood Substrates: Wood trim, Architectural woodwork, Doors.

1. Institutional Low-Odor/VOC Latex System, MPI INT 6.3V:
 - a. Prime Coat: Primer, latex, for interior wood, MPI #39.
 - b. Intermediate Coat: Latex, interior, institutional low odor/VOC, matching topcoat.
 - c. Topcoat: Latex, interior, institutional low odor/VOC, semigloss (MPI Gloss Level 5), MPI #147.

G. Wood Substrates: Wood paneling and casework.

1. Institutional Low-Odor/VOC Latex System, MPI INT 6.4T:
 - a. Prime Coat: Primer, latex, for interior wood, MPI #39.
 - b. Intermediate Coat: Latex, interior, institutional low odor/VOC, matching topcoat.

- c. Topcoat: Latex, interior, institutional low odor/VOC, semigloss (MPI Gloss Level 5), MPI #147.

H. Gypsum Board and Plaster Substrates:

- 1. Institutional Low-Odor/VOC Latex System, MPI INT 9.2M:
 - a. Prime Coat: Primer sealer, interior, institutional low odor/VOC, MPI #149.
 - b. Intermediate Coat: Latex, interior, institutional low odor/VOC, matching topcoat.
 - c. Topcoat: Latex, interior, institutional low odor/VOC (MPI Gloss Level 3), MPI #145.

END OF SECTION 099124

SECTION 099600 - HIGH-PERFORMANCE COATINGS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes surface preparation and the application of high-performance coating systems on the following substrates:
 - 1. Exterior Substrates:
 - a. Concrete, vertical surfaces.
 - b. Clay masonry.
 - c. Concrete masonry units (CMUs).
 - d. Steel.
 - e. Galvanized metal.
 - f. Aluminum (not anodized or otherwise coated).
 - g. Wood.

1.2 DEFINITIONS

- A. MPI Gloss Level 5: 35 to 70 units at 60 degrees, according to ASTM D523.
- B. MPI Gloss Level 6: 70 to 85 units at 60 degrees, according to ASTM D523.
- C. MPI Gloss Level 7: More than 85 units at 60 degrees, according to ASTM D523.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product. Include preparation requirements and application instructions.
 - 1. Include printout of current "MPI Approved Products List" for each product category specified, with the proposed product highlighted.
- B. Samples: For each type of coating system and in each color and gloss of topcoat indicated.

1.4 QUALITY ASSURANCE

- A. Mockups: Apply mockups of each coating system indicated to verify preliminary selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
 - 1. Architect will select one surface to represent surfaces and conditions for application of each coating system.

- a. Other Items: Architect will designate items or areas required.
2. Final approval of color selections will be based on mockups.
 - a. If preliminary color selections are not approved, apply additional mockups of additional colors selected by Architect at no added cost to Owner.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to products listed in the Exterior High-Performance Coating Schedule or Interior High-Performance Coating Schedule for the coating category indicated.

2.2 HIGH-PERFORMANCE COATINGS, GENERAL

- A. MPI Standards: Products shall comply with MPI standards indicated and shall be listed in its "MPI Approved Products Lists."
- B. Material Compatibility:
 1. Materials for use within each paint system shall be compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
 2. For each coat in a paint system, products shall be recommended in writing by topcoat manufacturers for use in paint system and on substrate indicated.
- C. Colors: As selected by Architect from manufacturer's full range.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.
- B. Maximum Moisture Content of Substrates: When measured with an electronic moisture meter as follows:
 1. Concrete: 12 percent.
 2. Fiber-Cement Board: 12 percent.
 3. Masonry (Clay and CMUs): 12 percent.
 4. Wood: 15 percent.
 5. Gypsum Board: 12 percent.
 6. Plaster: 12 percent.

- C. Verify suitability of substrates, including surface conditions and compatibility with existing finishes and primers.
- D. Proceed with coating application only after unsatisfactory conditions have been corrected.
 - 1. Application of coating indicates acceptance of surfaces and conditions.

3.2 PREPARATION

- A. Comply with manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual" applicable to substrates and coating systems indicated.
- B. Remove hardware, covers, plates, and similar items already in place that are removable and are not to be painted. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and painting.
 - 1. After completing painting operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection if any.
- C. Clean substrates of substances that could impair bond of coatings, including dust, dirt, oil, grease, and incompatible paints and encapsulants.
 - 1. Remove incompatible primers and reprime substrate with compatible primers or apply tie coat as required to produce coating systems indicated.

3.3 APPLICATION

- A. Apply high-performance coatings according to manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual."
- B. Apply coatings to produce surface films without cloudiness, spotting, holidays, laps, brush marks, runs, sags, ropiness, or other surface imperfections. Produce sharp glass lines and color breaks.

3.4 EXTERIOR HIGH-PERFORMANCE COATING SCHEDULE

- A. Concrete Substrates, Vertical Surfaces:
 - 1. Epoxy-Modified Latex System MPI EXT 3.1E:
 - a. Prime Coat: Epoxy-modified latex, matching topcoat.
 - b. Intermediate Coat: Epoxy-modified latex, matching topcoat.
 - c. Topcoat: Epoxy-modified latex, semi-gloss (MPI Gloss Level 5).
- B. Concrete Substrates, Horizontal Surfaces:
 - 1. Epoxy Non-Slip Deck Coating System MPI EXT 3.2C:
 - a. Prime Coat: As recommended in writing by topcoat manufacturer.

- b. Intermediate Coat: As recommended in writing by topcoat manufacturer.
- c. Topcoat: Epoxy deck coating (slip resistant), MPI #82.

C. CMU Substrates:

- 1. Epoxy System MPI EXT 4.2E:
 - a. Block Filler: Block filler, epoxy, MPI #116.
 - b. Intermediate Coat: Epoxy, matching topcoat.
 - c. Topcoat: Epoxy, gloss, MPI #77.

D. Steel Substrates:

- 1. Epoxy System MPI EXT 5.1F:
 - a. Prime Coat: Primer, epoxy, anti-corrosive, for metal, MPI #101.
 - b. Intermediate Coat: Epoxy, high build, low gloss, MPI #108.
 - c. Topcoat: Epoxy, gloss, MPI #77.

E. Galvanized-Metal Substrates:

- 1. Epoxy System MPI EXT 5.3C:
 - a. Prime Coat: Primer, epoxy, anti-corrosive, for metal, MPI #101.
 - b. Intermediate Coat: Epoxy, matching topcoat.
 - c. Topcoat: Epoxy, gloss, MPI #77.

F. Aluminum (Not Anodized or Otherwise Coated) Substrates:

- 1. Epoxy System MPI EXT 5.4E:
 - a. Prime Coat: Primer, vinyl wash, MPI #80.
 - b. Intermediate Coat: Epoxy, matching topcoat.
 - c. Topcoat: Epoxy, gloss, MPI #77.

END OF SECTION 099600

SECTION 101419 - DIMENSIONAL LETTER SIGNAGE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. The Drawings and general provisions of the Contract, including the City of Baltimore Department of Public Works Specifications (the "Green Book") and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Dimensional characters.
 - a. Illuminated, fabricated channel dimensional characters.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For signs.
 - 1. Include fabrication and installation details and attachments to other work.
 - 2. Show sign mounting heights, locations of supplementary supports to be provided by other installers, and accessories.
 - 3. Show message list, typestyles, graphic elements, and layout for each sign at 1/2" per foot scale.
 - 4. Show locations of electrical service connections.
 - 5. Include diagrams for power, signal, and control wiring.
- C. Delegated Design Submittal: For signs indicated in "Performance Requirements" Article.
 - 1. Include structural analysis calculations for signs indicated to comply with design loads; signed and sealed by the qualified professional engineer responsible for their preparation.

1.4 INFORMATIONAL SUBMITTALS

- A. Sample warranty.

1.5 CLOSEOUT SUBMITTALS

- A. Maintenance data.

1.6 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of signs that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design sign structure and anchorage of dimensional character sign according to structural performance requirements.
- B. Structural Performance: Signs and supporting elements shall withstand the effects of gravity and other loads within limits and under conditions indicated.
- C. Thermal Movements: For exterior fabricated channel dimensional characters, allow for thermal movements from ambient and surface temperature changes.
 - 1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.
- D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.2 DIMENSIONAL CHARACTERS

- A. Fabricated Channel Characters: Metal face and side returns, formed free from warp and distortion; with uniform faces, sharp corners, and precisely formed lines and profiles; internally braced for stability, to meet structural performance loading without oil-canning or other surface deformation, and for securing fasteners; and as follows.
 - 1. Illuminated Characters: Backlighting character construction with LED lighting, including transformers, insulators, and other accessories for operability, with provision for servicing and concealing connections to building electrical system. Use tight or sealed joint construction to prevent unintentional light leakage. Space lamps apart from each other and away from character surfaces as needed to illuminate evenly.
 - a. Removable, light diffused, Lexan back.
 - b. Material thickness as required by signage manufacturer.
 - c. Internal face of letter to be painted high gloss white.
 - d. Power: As indicated on electrical Drawings.
 - 2. Character Material: Sheet or plate aluminum
 - 3. Character Height: As indicated on Drawings.
 - 4. Character Depth: As indicated on Drawings.
 - 5. Finishes:

- a. Baked-Enamel or Powder-Coat Finish: Manufacturer's standard, in color as selected by Architect from manufacturer's full range.
- 6. Mounting: Projecting studs.
 - a. Hold characters at 1 1/2-inch distance or manufacturer's recommended distance, as confirmed by architect, from wall surface.
 - 1) Threaded studs with sleeve spacer.
 - 2) Stainless steel mounting studs.
 - 3) Screw set aluminum detachable stud.
 - 4) Stainless steel "L" brackets.

2.3 DIMENSIONAL CHARACTER MATERIALS

2.4 ACCESSORIES

- A. Fasteners and Anchors: Manufacturer's standard as required for secure anchorage of signs, noncorrosive and compatible with each material joined, and complying with the following:
 - 1. Use concealed fasteners and anchors unless indicated to be exposed designed for masonry installation.
 - 2. For exterior exposure, furnish nonferrous-metal devices unless otherwise indicated.
- B. Adhesive: As recommended by sign manufacturer.
- C. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D1187/D1187M.

2.5 FABRICATION

- A. General: Provide manufacturer's standard sign assemblies according to requirements indicated.
 - 1. Mill joints to a tight, hairline fit. Form assemblies and joints exposed to weather to resist water penetration and retention.
 - 2. Provide welds and brazes behind finished surfaces without distorting or discoloring exposed side. Clean exposed welded and brazed connections of flux, and dress exposed and contact surfaces.
 - 3. Conceal connections if possible; otherwise, locate connections where they are inconspicuous.
 - 4. Internally brace dimensional characters for stability, to meet structural performance loading without oil-canning or other surface deformation, and for securing fasteners.
 - 5. Provide rabbets, lugs, and tabs necessary to assemble components and to attach to existing work. Drill and tap for required fasteners. Use concealed fasteners where possible; use exposed fasteners that match sign finish.
 - 6. Castings: Fabricate castings free of warp, cracks, blowholes, pits, scale, sand holes, and other defects that impair appearance or strength. Grind, wire brush, sandblast, and buff castings to remove seams, gate marks, casting flash, and other casting marks before finishing.

- B. Brackets: Fabricate brackets, fittings, and hardware for bracket-mounted signs to suit sign construction and mounting conditions indicated. Modify manufacturer's standard brackets as required.
 - 1. Stainless Steel Brackets: Factory finish brackets to match sign background finish unless otherwise indicated.

PART 3 - EXECUTION

3.1 INSTALLATION OF DIMENSIONAL CHARACTERS

- A. General: Install signs using mounting methods indicated and according to manufacturer's written instructions.
 - 1. Install signs level, plumb, true to line, and at locations and heights indicated, with sign surfaces free of distortion and other defects in appearance.
 - 2. Before installation, verify that sign surfaces are clean and free of materials or debris that would impair installation.
 - 3. Corrosion Protection: Coat concealed surfaces of exterior aluminum in contact with grout, concrete, masonry, wood, or dissimilar metals, with a heavy coat of bituminous paint.
- B. Mounting Methods:
 - 1. Projecting Studs: Using a template, drill holes in substrate aligning with studs on back of sign. Remove loose debris from hole and substrate surface.
 - a. Masonry Substrates: Fill holes with adhesive. Leave recess space in hole for displaced adhesive. Place spacers on studs, place sign in position, and push until spacers are pinched between sign and substrate, embedding the stud ends in holes. Temporarily support sign in position until adhesive fully sets.
- C. Remove temporary protective coverings and strippable films as signs are installed.

END OF SECTION 101419

SECTION 102600 - WALL AND DOOR PROTECTION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Wall covering
2. Corner guards.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For each type of wall and door protection showing locations and extent.
 1. Include plans, elevations, sections, and attachment details.
- C. Samples: For each exposed product and for each color and texture specified, 12 inches long.

1.3 INFORMATIONAL SUBMITTALS

- A. Product certificates.
- B. Material certificates.
- C. Sample warranty.

1.4 CLOSEOUT SUBMITTALS

- A. Maintenance data.

1.5 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of wall- and door-protection units that fail in materials or workmanship within specified warranty period.
 1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Surface Burning Characteristics: Comply with ASTM E84 or UL 723; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
1. Flame-Spread Index: 25 or less.
 2. Smoke-Developed Index: 450 or less.

2.2 WALL GUARDS

1. Engineered PVC FREE rigid sheet:
 - a. Rigid sheet should be high-impact. Chemical and stain resistance should be per ASTM D543 standards as established by the manufacturer.
 - 1) Nominal Thickness: .040".
 - 2) Sheet Size: 4' x10'.
 - 3) Suede Texture.
 - b. Finishes:
 - 1) Select from one of manufacturer's solid colors.
 - 2) Color-matched caulk, manufacturer's trims as needed for joints/transitions.

2.3 CORNER GUARDS

1. Stainless steel corner guards: Surface mounted guards to be 16 gauge stainless steel.
 - a. 90° stainless steel corner guard with 3/16" radius and 3 1/2" legs. Mounted with construction adhesive and stainless-steel screws.
 - 1) Finish
 - a) #4 Satin
 - b) #304 stainless steel

2.4 MATERIALS

- A. Fasteners: Stainless-steel metal screws, bolts, and other fasteners compatible with items being fastened. Use security-type fasteners where exposed to view.
- B. Adhesive: As recommended by protection product manufacturer.

2.5 INSTALLATION

- A. Installation Quality: Install wall and door protection according to manufacturer's written instructions, level, plumb, and true to line without distortions. Do not use materials with chips, cracks, voids, stains, or other defects that might be visible in the finished Work.

- B. Mounting Heights: Install wall and door protection in locations and at mounting heights indicated on Drawings.
- C. Accessories: Provide splices, mounting hardware, anchors, trim, joint moldings, and other accessories required for a complete installation.
 - 1. Provide anchoring devices and suitable locations to withstand imposed loads.
 - 2. Where splices occur in horizontal runs, splice aluminum retainers and plastic covers at different locations along the run, but no closer than 12 inches (305 mm) apart.
 - 3. Adjust end and top caps as required to ensure tight seams.

END OF SECTION 102600

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SECTION 102800 - TOILET, BATH, AND LAUNDRY ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. The Drawings and general provisions of the Contract, including the City of Baltimore Department of Public Works Specifications (the “Green Book”) and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Public-use washroom accessories.
 - 2. Custodial accessories.

1.3 ACTION SUBMITTALS

- A. Product data.
- B. Samples: For each exposed product and for each finish specified, full size.
 - 1. Approved full-size Samples will be returned and may be used in the Work.
- C. Delegated Design Submittals: For grab bars.
 - 1. Include structural design calculations indicating compliance with specified structural-performance requirements.

1.4 INFORMATIONAL SUBMITTALS

- A. Sample warranties.

1.5 CLOSEOUT SUBMITTALS

- A. Maintenance data.

1.6 WARRANTY

- A. Manufacturer's Special Warranty for Mirrors: Manufacturer agrees to repair or replace mirrors that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Structural Performance: Design accessories and fasteners to comply with the following requirements:
 - 1. Grab Bars: Installed units are able to resist 250 lbs concentrated load applied in any direction and at any point.

2.2 PUBLIC-USE WASHROOM ACCESSORIES

- A. Basis of design: Bobrick Classic Series
- B. Toilet Tissue (Roll) Dispenser:
 - 1. Description: Roll-in-reserve dispenser with hinged front secured with tumbler lockset.
 - 2. Mounting: Surface Mounted.
 - 3. Operation: Non-control delivery with theft-resistant spindle.
 - 4. Capacity: Designed for 5-inch-diameter tissue rolls.
 - 5. Material and Finish: Stainless steel, ASTM A480/A480M No. 4 finish (satin.)
- C. Combination Towel (Folded) Dispenser/Waste Receptacle:
 - 1. Description: Combination unit for dispensing C-fold or multifold towels, with removable waste receptacle.
 - 2. Mounting: Recessed.
 - a. Designed for nominal 4-inch wall depth.
 - 3. Minimum Towel-Dispenser Capacity: 800 multifold paper towels.
 - 4. Minimum Waste-Receptacle Capacity: 4 gal.
 - 5. Material and Finish: Stainless steel, ASTM A480/A480M No. 4 finish (satin.)
 - 6. Liner: Reusable, vinyl waste-receptacle liner.
 - 7. Lockset: Tumbler type for towel-dispenser compartment and waste receptacle.
- D. Soap Dispenser:
 - 1. Description: Designed for manual operation and dispensing soap in liquid or lotion form.
 - 2. Mounting: Vertically oriented, surface mounted.
 - 3. Capacity: 40 Oz.
 - 4. Materials: Stainless steel, ASTM A480/A480M No. 4 finish (satin.)
 - 5. Lockset: Tumbler type.
 - 6. Refill Indicator: Window type.
- E. Grab Bar:
 - 1. Mounting: Flanges with concealed fasteners.
 - 2. Material: Stainless steel, 0.05 inch thick.

- a. Finish: Smooth, ASTM A480/A480M No. 4 finish (satin) on ends and slip-resistant texture in grip area.
 3. OD: 1-1/4 inches.
 4. Configuration and Length: As indicated on Drawings.
- F. Sanitary-Napkin Disposal Unit:
1. Mounting: Recessed.
 2. Door or Cover: Self-closing, disposal-opening cover.
 3. Receptacle: Removable.
 4. Material and Finish: Stainless steel, ASTM A480/A480M No. 4 finish (satin).
- G. Sanitary Napkin/Tampon Vendor
1. Mounting: Recessed.
 2. Material and Finish: Stainless steel, ASTM A480/A480M No. 4 finish (satin).
 3. Coordinate price with Owner.
 4. Two tumbler door locks.
 5. Separately-keyed coin box lock.
- H. Seat-Cover Dispenser:
1. Mounting: Surface mounted.
 2. Minimum Capacity: 250 seat covers.
 3. Exposed Material and Finish: Stainless steel, ASTM A480/A480M No. 4 finish (satin).
 4. Lockset: Tumbler type.
- I. Mirror Unit:
1. Frame: Stainless steel angle.
 - a. Corners: Manufacturer's standard.
 2. Size: As indicated on Drawings.
 3. Hangers: Manufacturer's standard rigid, tamper and theft resistant.
- J. Hook:
1. Description: Double-prong.
 2. Mounting: Concealed.
 3. Material and Finish: Stainless steel, ASTM A480/A480M No. 4 finish (satin).

2.3 UNDERLAVATORY GUARDS

A. Underlavatory Guard:

1. Description: Insulating pipe covering for supply and drain piping assemblies that prevents direct contact with and burns from piping; allow service access without removing coverings.

2. Material and Finish: Antimicrobial, molded plastic, white.

2.4 CUSTODIAL ACCESSORIES

A. Custodial Mop and Broom Holder:

1. Description: Unit with shelf, hooks, holders, and rod suspended beneath shelf.
2. Length: 36 inches.
3. Hooks: Four.
4. Mop/Broom Holders: Three, spring-loaded, rubber hat, cam type.
5. Material and Finish: Stainless steel, ASTM A480/A480M No. 4 finish (satin).
 - a. Shelf: Not less than nominal 0.05-inch- thick stainless steel.
 - b. Rod: Approximately 1/4-inch- diameter stainless steel.

2.5 FABRICATION

- ### A. Keys: Provide universal keys for internal access to accessories for servicing and resupplying. Provide minimum of six keys to Owner's representative.

PART 3 - EXECUTION

3.1 INSTALLATION

- #### A. Install accessories in accordance with manufacturers' written instructions, using fasteners appropriate to substrate indicated and recommended by unit manufacturer. Install units level, plumb, and firmly anchored in locations and at heights indicated.
1. Remove temporary labels and protective coatings.
- #### B. Grab Bars: Install to comply with specified structural-performance requirements.

END OF SECTION 102800

SECTION 104413 - FIRE PROTECTION CABINETS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. The Drawings and general provisions of the Contract, including the City of Baltimore Department of Public Works Specifications (the “Green Book”) and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Fire-protection cabinets for portable fire extinguishers.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For fire-protection cabinets.
- C. Samples: For each type of exposed finish required.

1.4 CLOSEOUT SUBMITTALS

- A. Maintenance data.

1.5 COORDINATION

- A. Coordinate size of fire-protection cabinets to ensure that type and capacity of fire extinguishers indicated are accommodated.
- B. Coordinate sizes and locations of fire-protection cabinets with wall depths.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

2.2 FIRE-PROTECTION CABINET

- A. Fire-Protection Cabinet Type: Suitable for fire extinguisher.

- B. Cabinet Construction: Nonrated.
- C. Cabinet Material: Stainless steel sheet.
- D. Recessed Cabinet:
 - 1. Exposed Flat Trim: One-piece combination trim and perimeter door frame overlapping surrounding wall surface, with exposed trim face and wall return at outer edge (backbend).
- E. Cabinet Trim Material: Same material and finish as door.
- F. Door Material: Stainless steel sheet.
- G. Door Style: Vertical duo panel with.
- H. Door Glazing: Acrylic sheet.
 - 1. Acrylic Sheet Color: Clear
- I. Door Hardware: Manufacturer's standard door-operating hardware of proper type for cabinet type, trim style, and door material and style indicated.
- J. Accessories:
 - 1. Identification: Lettering complying with authorities having jurisdiction for letter style, size, spacing, and location. Locate as directed by Architect.
 - a. Identify fire extinguisher in fire-protection cabinet with the words "FIRE EXTINGUISHER".
 - 1) Location: Applied to cabinet door.
 - 2) Application Process: Engraved.
 - 3) Lettering Color: Red.
 - 4) Orientation: Vertical.
 - 2. Alarm: Manufacturer's standard alarm that actuates when fire-protection cabinet door is opened and that is powered by batteries.
- K. Materials:
 - 1. Cold-Rolled Steel: ASTM A1008/A1008M, Commercial Steel (CS), Type B.
 - a. Finish: Baked enamel, TGIC polyester powder coat, HAA polyester powder coat, epoxy powder coat, or polyester/epoxy hybrid powder coat, complying with AAMA 2603.
 - b. Color: matte white.
 - 2. Stainless Steel: ASTM A240/A240M or ASTM A666, Type 304.
 - a. Finish: ASTM A480/A480M No. 4 directional satin finish.
 - 3. Transparent Acrylic Sheet: ASTM D4802, Category A-1 (cell-cast sheet), with Finish 1 (smooth or polished).

2.3 FABRICATION

- A. Fire-Protection Cabinets: Provide manufacturer's standard box (tub) with trim, frame, door, and hardware to suit cabinet type, trim style, and door style indicated.

PART 3 - EXECUTION

3.1 INSTALLATION OF FIRE-PROTECTION CABINETS

- A. Prepare recesses for recessed fire-protection cabinets as required by type and size of cabinet and trim style.
- B. Install fire-protection cabinets in locations and at mounting heights indicated or, if not indicated, at heights acceptable to authorities having jurisdiction.
- C. Fire-Protection Cabinets: Fasten cabinets to structure, square and plumb.
- D. Adjust fire-protection cabinet doors to operate easily without binding. Verify that integral locking devices operate properly.

END OF SECTION 104413

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SECTION 104416 - FIRE EXTINGUISHERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. The Drawings and general provisions of the Contract, including the City of Baltimore Department of Public Works Specifications (the “Green Book”) and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes portable, hand-carried fire extinguishers.

1.3 ACTION SUBMITTALS

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

1.4 INFORMATIONAL SUBMITTALS

- A. Warranty: Sample of special warranty.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

1.6 COORDINATION

- A. Coordinate type and capacity of fire extinguishers with fire-protection cabinets to ensure fit and function.

1.7 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace fire extinguishers that fail in materials or workmanship within specified warranty period.

- 1. Warranty Period: Six years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. NFPA Compliance: Fabricate and label fire extinguishers to comply with NFPA 10, "Portable Fire Extinguishers."
- B. Fire Extinguishers: Listed and labeled for type, rating, and classification by an independent testing agency acceptable to authorities having jurisdiction.

2.2 PORTABLE, HAND-CARRIED FIRE EXTINGUISHERS

- A. Fire Extinguishers: Type, size, and capacity for each fire-protection cabinet indicated.
 - 1. Instruction Labels: Include pictorial marking system complying with NFPA 10, Appendix B.
- B. Multipurpose Dry-Chemical Type: UL-rated 5 lbs nominal capacity, with monoammonium phosphate-based dry chemical in manufacturer's standard enameled container.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Examine fire extinguishers for proper charging and tagging.
 - 1. Remove and replace damaged, defective, or undercharged fire extinguishers.
- B. Install fire extinguishers in locations indicated and in compliance with requirements of authorities having jurisdiction.

END OF SECTION 104416

SECTION 105113 - METAL LOCKERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. The Drawings and general provisions of the Contract, including the City of Baltimore Department of Public Works Specifications (the “Green Book”) and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Knocked-down athletic lockers.

1.3 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For metal lockers.
 - 1. Include plans, elevations, sections, and attachment details.
 - 2. Include locker identification system and numbering sequence.
- C. Samples: For each color specified.

1.5 INFORMATIONAL SUBMITTALS

- A. Sample warranty.

1.6 CLOSEOUT SUBMITTALS

- A. Maintenance data.

1.7 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of metal lockers that fail in materials or workmanship, excluding finish, within specified warranty period.

1. Warranty Period for Welded Metal Lockers: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Accessibility Standard: For lockers indicated to be accessible, comply with applicable provisions in the DOJ's "2010 ADA Standards for Accessible Design and ICC A117.1.

2.2 WELDED CORRIDOR LOCKERS

- A. Doors: One piece; fabricated from 14 GA nominal-thickness steel sheet; formed into channel shape with double bend at vertical edges and with right-angle single bend at horizontal edges.
 1. Reinforcement: Manufacturer's standard reinforcing angles, channels, or stiffeners.
 2. Door Style: Vented panel as follows:
 - a. Louvered Vents: No fewer than two louver openings at top and bottom, or three louver openings at top or bottom, for triple-tier lockers.
- B. Body: Assembled by riveting or bolting body components together. Fabricate from unperforated steel sheet with thicknesses as follows:
 1. Tops, Bottoms, and Intermediate Dividers: 16 GA. nominal thickness, with single bend at sides.
 2. Backs and Sides: 16 GA. nominal thickness, with full-height, double-flanged connections.
 3. Shelves: No shelves required.
- C. Hinges:
 1. Hinges: Manufacturer's standard, steel, continuous or knuckle type.
- D. Recessed Door Handle and Latch: Stainless steel cup with integral door pull, recessed so locking device does not protrude beyond door face; pry and vandal resistant.
 1. Single-Point Latching:
 - a. Integral Pocket and Pull: 22 gauge brushed stainless steel securely fastened to door with two lugs and a positive tamper-resistant decorative fastener.
 - b. Pocket Depth: Sufficient to prevent a combination padlock, built- in combination lock, or key lock from protruding beyond door face.
 - c. Pull: Formed in pocket.
 - d. Padlock Staple: Protruding through pocket.
- E. Identification Plates: Manufacturer's standard, etched, embossed, or stamped aluminum plates, with numbers and letters at least 3/8 inch high.

- F. Continuous Zee Base: Fabricated from manufacturer's standard thickness, but not less than 0.060-inch nominal-thickness steel sheet.
 - 1. Height: 4 inches.
- G. Continuous Sloping Tops: Fabricated from manufacturer's standard thickness, but not less than 0.036-inch nominal-thickness steel sheet.
 - 1. Closures: Vertical-end type.
- H. Recess Trim: Fabricated from 18 GA nominal-thickness steel sheet.
- I. Filler Panels: Fabricated from manufacturer's standard thickness, but not less than 0.036-inch nominal-thickness steel sheet.
- J. Finished End Panels: Fabricated from 16 GA nominal-thickness steel sheet.
- K. Materials:
 - 1. Cold-Rolled Steel Sheet: ASTM A1008/A1008M, Commercial Steel (CS), Type B, suitable for exposed applications.
- L. Finish: Baked enamel or powder coat.
 - 1. Color: As selected by Architect from manufacturer's full range.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install lockers level, plumb, and true; shim as required, using concealed shims.
 - 1. Anchor locker runs at ends and at intervals recommended by manufacturer, but not more than 36 inches o.c. Using concealed fasteners, install anchors through backup reinforcing plates, channels, or blocking as required to prevent metal distortion.
 - 2. Anchor single rows of metal lockers to walls near top and bottom of lockers.
 - 3. Anchor back-to-back metal lockers to floor.
- B. Welded Lockers: Connect groups together with manufacturer's standard fasteners, with no exposed fasteners on face frames.
- C. Trim: Fit exposed connections of trim, fillers, and closures accurately together to form tight, hairline joints, with concealed fasteners and splice plates.
 - 1. Attach filler panels with concealed fasteners.
 - 2. Attach sloping-top units to metal lockers, with closures at exposed ends.
 - 3. Attach finished end panels using fasteners only at perimeter to conceal exposed ends of nonrecessed metal lockers.

END OF SECTION 105113

SECTION 122413 - ROLLER WINDOW SHADES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. The Drawings and general provisions of the Contract, including the City of Baltimore Department of Public Works Specifications (the "Green Book") and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Manually operated roller shades with single rollers.
 - 2. Motor-operated roller shades with single rollers.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: Show fabrication and installation details for roller shades, including shadeband materials, their orientation to rollers, and their seam and batten locations.
 - 1. Motor-Operated Shades: Include details of installation and diagrams for power, signal, and control wiring.
- C. Samples: For each exposed product and for each color and texture specified.

1.4 INFORMATIONAL SUBMITTALS

- A. Product certificates.
- B. Product test reports.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: Fabricator of products.

1.7 WARRANTY

A. Motorized Shade.

Basis of Design WhisperShade IQ2 by Mecho, 42-03 35TH Steet, Long Island City, NY 11101, [202-322-9221, Dana.Archer@mechoshade.com](mailto:Dana.Archer@mechoshade.com)

1. Shade Hardware - 25 years unless otherwise indicated:
2. Shadecloth: Manufacturer's standard 25-year warranty.
3. Roller Shade Motors, Motor Control Systems, and Accessories: Manufacturer's standard non-depreciating 10-year warranty for AC motors and controls and 10-year warranty for DC motors, power panels and controls.
4. Roller Shade Installation: One year from date of Substantial Completion.

B. Mechanical Shade.

1. Manufacturer's standard non-depreciating, transferrable warranty for interior shading.
2. Shade Hardware – 25 years.
3. Roller Shade Installation: One year from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MOTOR-OPERATED, SINGLE-ROLLER SHADES WT-1

A. Motorized Shades: Comply with NFPA 70.

1. Components capable of being removed or adjusted without removing mounted shade brackets or cassette support channel.
2. Operates smoothly when raising or lowering shades.
3. Cradle-to-Cradle certified and listed in C2C (DIR).
4. Electrical Components: Listed, classified, and labeled as suitable for intended purpose. Test as total system. Individual component testing is acceptable.
 - a. Components: FCC compliant where applicable.
5. Voltage: 120 VAC.
6. Description: Single roller.
7. Drop Position: Regular roll.
8. Mounting: Wall mounted or recessed ceiling as indicated on drawings.
9. Size: As indicated on drawings.
10. Fabric: As indicated under Shade Fabric article.
11. Brackets and Mounting Hardware: As recommended by manufacturer for mounting indicated and to accommodate shade fabric roll-up size and weight.
12. Material: Provide shade hardware constructed of minimum 1/8-inch (3.18 mm) thick plated steel, or heavier, thicker, as required to support 150 percent of the full weight of each shade. Plastic components without use of steel angle construction do not meet the intent of this specification and shall not be accepted. Styrene based plastics, and /or polyester, or reinforced polyester shall not be accepted.
13. Provide shade hardware system that allows for field adjustment of motor or replacement of any operable hardware component without requiring removal of brackets, regardless of mounting position (inside, or outside mount).

14. Provide shade hardware system that allows for operation of multiple shade bands offset by a maximum of 8-45 degrees from motor axis between shade bands (4-22.5 degrees) on each side of the radial line, by a single shade motor (multi-banded shade, subject to manufacturer's design criteria).
15. All bands within a single motor group shall be aligned within ¼ inch.
16. Multiple Shade Operation: Provide hardware as necessary to operate more than one shade using a single motor.

B. Roller Tubes:

Rollers: Corrosion-resistant steel or extruded-aluminum tubes of diameters and wall thicknesses required for accommodating operating mechanisms and weights and widths of shadebands indicated without deflection. Provide with permanently lubricated drive-end assemblies and idle-end assemblies designed to facilitate removal of shadebands for service.

1. Roller Drive-End Location: Closest proximity to J Box
2. Direction of Shadeband Roll: Regular, from back of roller.
3. Shadeband-to-Roller Attachment: Removable spline fitting integral channel in tube.
4. Material: Corrosion-resistant steel or Extruded aluminum.
5. Size: As recommended by manufacturer; selected for suitability for installation conditions, span, and weight of shades.
6. Fabric Attachment: Utilize extruded channel in tube to accept vinyl spline welded to fabric edge. Shade band to be removable and replaceable without removing roller tube from brackets or inserting spline from the side of the roller tube.

C. Hembars: Designed to maintain bottom of shade straight and flat.

1. Style: Full wrap fabric covered bottom bar, flat profile with heat sealed closed ends.
 - a. Profile: Rectangular.

D. Accessories:

1. Fascia: Removable extruded aluminum fascia, size as required to conceal shade mounting, attachable to brackets without exposed fasteners.
 - a. Finish: Baked enamel.
 - b. Capable of installation across two or more shade bands in one piece.
 - c. Color: As selected by Architect from Manufacturer's standard colors.
 - d. Profile: Square.
 - e. Configuration: Continuous, fascia extends past continuous bracket.
 - f. Designed to accommodate installation of motor control and wiring accessories within pocket including, but not limited to, line voltage disconnect modular connector, Wireless Controller, IQ2 Dual Splitter, and non-plenum rated daisy chain wiring.
2. Closure and Closure Mount: provided by shade contractor
 - a. Provide exposed extruded aluminum closure mount and removable closure panel to provide access to shades

E. Intelligent Encoded Electronic Drive System:

1. Electronic Drive Unit (EDU) System General Requirements:

- a. A UL 325 listed solution.
 - 1) Component certification in lieu of system testing is not acceptable.
 2. Listing Label and Motor Rating: To be visible for inspection without dismounting of shade assembly to remove motor or EDU from shade roller tube.
 3. Size and Configuration: As recommended by manufacturer for type, size, and arrangement of shades.
 4. Conceal EDU inside shade roller tube.
 5. EDU Rated Speed: The same nominal speed for shades in the same room.
 6. Hanging Weight of Shade Band: 80 percent of rated lifting capacity of shade EDU and tube assembly.
 7. Capable of upgrading firmware from anywhere on network without touching the motor.
- F. Line Voltage EDU (120 VAC):
1. Tubular, asynchronous, integral AC motor and reversible capacitor. 120 VAC, single phase, 60 Hz; temperature Class B, thermally-protected, totally enclosed, maintenance-free. Powered by line voltage power supply connection equipped with locking disconnect plug assembly furnished with EDU.
 2. Audible Noise: 46 dBA measured 3 ft (914 mm) from motor unit, depending on motor torque.
 3. Nominal Speed: 34 RPM. Not to vary due to load/lift capacity.
 4. Isolated, low voltage power supply for powering external accessories connected to either the dry contact or network port.
 5. Products requiring accessories to be powered by a plug-in or externally-supplied power supply are not acceptable.
- G. Modes of Operation:
1. Normal Mode: Shades move to defined intermediate stop positions and any position between defined upper and lower limits.
 2. Maintenance Mode: Prevents shade from moving via dry contact or network control commands mode has been cleared/disabled.
- H. Control Methods: Local isolated dry contact input and network control.
1. Local Isolated Dry Contact Inputs:
 - a. Local switch control, third party system integration without separate interface.
 - b. Moving EDU/shade to upper and lower limits and local switch preset positions.
 - c. Configuration of upper and lower limits, custom presets, and key modes of operation without a PC or microprocessor-based tools.
 - d. Configuration under protected sequences to prevent changes by casual user.
 - e. Switch Personalities: Configuration of dry contact control port over network such that any type of dry contact keypad/third-party interface and actuation methodology (maintained and/or momentary actuation) can be used to operate shade.
 - f. Dry Contact Control Connection Options to Include:
 2. Five-button. Able to support configuring limits, presets, and key operating modes.
- I. Alignment Positions:
1. Repeatable and precisely aligned shade positions and limits.

- a. Support positioning commands from 0 to 100 percent in 1 percent increments.
 - b. Customizable Presets: 32.
 - c. Include three intermediate dry contact presets
 - d. Shades on same switch circuit or same network group address with same opening height, to align at each intermediate stopping position when traveling from any position, up or down.
 - e. Alignment of shade bands mechanically aligned on same EDU: Plus or minus 0.125 inch (3 mm).
 - f. Alignment of standard shades on adjacent EDUs: Plus or minus 0.25 inch (6 mm) when commanded to same alignment position.
2. Local Switch Presets:
- a. Minimum of three customizable preset positions accessible over the local dry contact control inputs and over the network connection.
 - b. Preset positions: Customizable to any position between and including defined upper and lower limits (initially defaults to 25, 50, and 75 percent of shade travel).
 - c. Configuration of Custom Preset Positions: A handheld removable program module/configurator or a local switch.

J. MOTOR CONTROLS, INTERFACES, AND ACCESSORIES

1. Unless indicated to be excluded, provide required equipment as necessary for a complete operating system providing the control intent specified. Provide components and connections necessary to interface with other systems as indicated.
2. Digital Network Controls:
3. Reprogram control without requiring wiring modifications.
4. Ten-year non-volatile power failure memory for system configuration settings.
5. Low-Voltage Wall Controls; IQ Switch:
 - a. Momentary dry contact switch enables manual local control or network control of any individual shade motor or shade group/sub-group on MechoNet network.
6. Control Functions:
 - a. Open: Automatically open controlled shades to fully open position when button is pressed.
 - b. Close: Automatically close controlled shades to fully closed position when button is pressed.
 - c. Presets: For selection of predetermined shade positions.
 - d. Dual Stations: For individual control of two shades/groups.
7. Finish: White.
8. Single Station: 5-button (open, close, and three intermediate stop positions).
9. Wireless Daylight Sensor
 - a. Sensor shall be solar powered photovoltaic requiring no wires or batteries
 - b. Sensor shall operate using EnOcean wireless technology, 902 MHz
 - c. Sensor shall have a temperature range between 32-140 degrees Fahrenheit, a sensitivity of 0-65 klux
 - d. Photosensor shall be daylight spectrum photopic with a field of view as follows: horizontal- 60 degree cone angle, up- 30 degrees and down- 30 degrees
 - e. Provide intermediate stopping positions that allow for 2, 3, 4 or 5 customizable stop positions
 - f. Wireless range shall be 80ft unobstructed
10. Occupancy/vacancy, based on input from wireless occupancy/vacancy sensors (where specified); shades to go to configurable unoccupied/vacant mode shade position (default of full-down) optimize energy conservation; provide configurable timers for detection of both unoccupied and occupied states.

- K. Manual temporary override of shade positions:
 - 1. IQ Switch low-voltage wall controls or touchscreen manual override panels.
 - 2. Browser Interface: Enables control of individual shade motors, shade groups, or zones. Administrative settings allow for assignment of shade control restrictions for specific users.
- L. Configurable resumption of automatic control following manual temporary override event based on wake, sunrise, sunset, sleep, time duration, and specific times.

2.2 MANUALLY OPERATED SHADES WITH SINGLE ROLLERS WT-2

- 1. Shade Type: Single Roller.
 - 2. Universal drive capability to offset drive chain for reverse or regular roll shades.
 - 3. Drop Position: Regular roll.
- A. Chain-and-Clutch Operating Mechanisms: With continuous-loop bead chain and clutch that stops shade movement when bead chain is released; permanently adjusted and lubricated
 - B. Mounting: Recessed ceiling mount.
 - C. Size: As indicated on drawings.
 - D. Fabric: As indicated under Shade Fabric article.
 - E. Brackets and Mounting Hardware: As recommended by manufacturer for mounting indicated and to accommodate shade fabric roll-up size and weight.
 - 1. Material: Steel, 1/8 inch (3 mm) thick.
 - F. Roller Tubes:
 - 1. Material: Extruded aluminum.
 - 2. Size: As recommended by manufacturer; selected for suitability for installation conditions, span, and weight of shades.
 - 3. Fabric Attachment: Utilize extruded channel in tube to accept vinyl spline welded to fabric edge. Shade band to be removable and replaceable without removing roller tube from brackets or inserting spline from the side of the roller tube.
 - 4. Roller tubes to be capable of being removed and reinstalled without affecting roller shade limit adjustments.
 - G. Hembars: Designed to maintain bottom of shade straight and flat.
 - 1. Style: Full wrap fabric covered bottom bar, flat profile with heat sealed closed ends.
 - H. Clutch Operator: Manufacturer's standard material and design integrated with bracket/brake assembly.
 - 1. Heavy-duty, 1/8" steel mounting bracket and integrated steel brake, clutch and sprocket assembly rigidly affix the shade support and user control to the building structure fully independent of the roller tube components.

2. Permanently lubricated maintenance-free brake assembly employs an oil-impregnated steel hub with wrapped spring clutch.
 3. Brake must withstand minimum pull force of 50 pounds (22.7 kg) in the stopped position.
 4. Direct drive clutch requires no interstitial gear stages or plastic parts between the building structure and clutch ensuring reliable operation across the full range of shade sizes.
 5. Maximum shade hanging weight of 18 pounds (8.2 kg).
- I. Drive Chain: Continuous loop stainless steel beaded ball chain, 100 pound (45 kg) minimum breaking strength. Provide upper and lower limit stops.
1. Chain Retainer: Chain tensioning device complying with ANSI/WCMA A100.1-202.
 2. Limit stops: Bead stops affixed to the chain maintain consistent shadeband alignment at the top and bottom of shade travel across multiple shades and help prevent shade damage resulting from unmanaged user control.
- J. Accessories:
1. Fascia: Removable extruded aluminum fascia, size as required to conceal shade mounting, attachable to brackets without exposed fasteners.
 - a. Finish: Baked enamel.
 - 1) Color: As selected by Architect from Manufacturer's standard colors.
 2. Can be installed across two or more shade bands in one piece.
 3. Single Fascia: Accommodate regular roll shades.
 4. Profile: Square.
 5. Configuration: Continuous, fascia extends past continuous bracket.

2.3 SHADEBAND MATERIALS

- A. Shadeband Material Flame-Resistance Rating: Comply with NFPA 701. Testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
- a. Light-Filtering Fabric: ThermoVeil: 1000 series. 3 percent open, dense linear-weave pattern.
 - 1) Low-Emitting Material Certification: Greenguard Gold certified and listed in UL (GGG).
 - 2) Health Product Declaration (HPD): Published declaration with full disclosure of known hazards.
- B. ROLLER SHADE FABRICATION
- C. Product Safety Standard: Fabricate roller shades to comply with ANSI/WCMA A100.1-202
- D. Unit Sizes: Fabricate units in sizes to fill window and other openings as follows, measured at 74 deg F.
1. Between (Inside) Jamb Installation: Width equal to jamb-to-jamb dimension of opening in which shade is installed less 1/4 inch per side or 1/2-inch total, plus or minus 1/8 inch. Length equal to head-to-sill or -floor dimension of opening in which shade is installed less 1/4 inch, plus or minus 1/8 inch.

- E. Shadeband Fabrication: Fabricate shadebands without battens or seams to extent possible, except as follows:
 - 1. Vertical Shades: Where width-to-length ratio of shadeband is equal to or greater than 1:4, provide battens and seams at uniform spacings along shadeband length to ensure shadeband tracking and alignment through its full range of movement without distortion of the material.

PART 3 - EXECUTION

3.1 ROLLER SHADE INSTALLATION

- A. Install roller shades level, plumb, and aligned with adjacent units according to manufacturer's written instructions.
- B. Electrical Connections: Connect motor-operated roller shades to building electrical system.
- C. Adjust and balance roller shades to operate smoothly, easily, safely, and free from binding or malfunction throughout entire operational range.
- D. Clean roller shade surfaces, after installation, according to manufacturer's written instructions.
- E. Replace damaged roller shades that cannot be repaired, in a manner approved by Architect, before time of Substantial Completion.

END OF SECTION 122413

SECTION 123661.16 - SOLID SURFACING COUNTERTOPS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. The Drawings and general provisions of the Contract, including the City of Baltimore Department of Public Works Specifications (the "Green Book") and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Solid surface material countertops.
 - 2. Solid surface material backsplashes.

1.3 ACTION SUBMITTALS

- A. Product Data: For countertop materials.
- B. Shop Drawings: For countertops. Show materials, finishes, edge and backsplash profiles, methods of joining, and cutouts for plumbing fixtures.
- C. Samples: For each type of material exposed to view.

PART 2 - PRODUCTS

2.1 SOLID SURFACE COUNTERTOP MATERIALS

- A. Solid Surface Material: Homogeneous-filled plastic resin complying with ISFA 2-01.
 - 1. Basis of Design: LG-Hi-Macs by LX Hausys America, Inc. 900 Circle 75 Parkway, Suite 1500, Atlanta, GA 30339, www.lxhausys.com
 - 2. Type: Provide Standard type or Veneer type made from material complying with requirements for Standard type, as indicated unless Special Purpose type is indicated.
 - 3. Colors and Patterns: As shown on Woodwork Finish legend.
- B. Plywood: Exterior softwood plywood complying with DOC PS 1, Grade C-C Plugged, touch sanded.

2.2 FABRICATION

- A. Fabricate countertops according to solid surface material manufacturer's written instructions and to the AWI/AWMAC/WI's "Architectural Woodwork Standards."
 - 1. Grade: Custom.
- B. Countertops:
 - 1. 1/4-inch-thick, solid surface material laminated to 3/4-inch- thick plywood with exposed edges built up with 3/4-inch- thick, solid surface material or exposed edges faced with 1/4-inch- thick, solid surface material.
- C. Backsplashes: 1/2-inch- thick, solid surface material.
- D. Joints:
 - 1. Fabricate countertops without joints.
- E. Cutouts and Holes:
 - 1. Undercounter Plumbing Fixtures: Make cutouts for fixtures in shop using template or pattern furnished by fixture manufacturer. Form cutouts to smooth, even curves. Ensure no plywood is exposed. Build up cut edge as required for fixture installation.

2.3 INSTALLATION MATERIALS

- A. Adhesive: Product recommended by solid surface material manufacturer.
- B. Sealant for Countertops: Comply with applicable requirements in Section 079200 "Joint Sealants."

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Fasten countertops by screwing through corner blocks of base units into underside of countertop. Pre-drill holes for screws as recommended by manufacturer.
- B. Fasten subtops to cabinets by screwing through subtops into cornerblocks of base cabinets. Shim as needed to align subtops in a level plane.
- C. Secure countertops to subtops with adhesive according to solid surface material manufacturer's written instructions.
- D. Install backsplashes by adhering to wall and countertops with adhesive.
- E. Complete cutouts not finished in shop. Mask areas of countertops adjacent to cutouts to prevent damage while cutting. Make cutouts to accurately fit items to be installed, and at right angles to

finished surfaces unless beveling is required for clearance. Ease edges slightly to prevent snipping.

- F. Apply sealant to gaps at walls; comply with Section 079200 "Joint Sealants."

END OF SECTION 123661.16

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SECTION 129300 - SITE FURNISHINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Tables and Chairs
 - 2. Benches and Backrests
 - 3. Litter Receptacles
 - 4. Lighting and Bollards
 - 5. Planters
- B. Related Requirements:
 - 1. Section 03 30 00 "Cast-in-Place Concrete" for installing anchorage items cast in concrete footings.

1.3 ACTION SUBMITTALS

- A. Product Data: Cut Sheet for each product listed above.
- B. Samples: For colors and textures specified.
- C. Product Schedule: For site furnishings. Use same designations indicated on Drawings.

1.4 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For site furnishings to include in maintenance manuals.

1.5 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Trash Receptacle Inner Containers: Two full-size units for each size indicated

2. Anchors

PART 2 - PRODUCTS

2.1 TABLES AND CHAIRS

- A. Table: Carousel Table. Landscapeforms, 7800 East Michigan Avenue Kalamazoo, MI 49048. Tracey Friedley tracey@nolanbrands.com 703-648-0848. www.landscapeforms.com
 1. Locate as shown on plans
 2. Installation Method: Surface mount per Manufacturer's Recommendations
 3. Size: 90" x 33"
 4. Model: Dining hoop table (3 seats) with Solstice Umbrella
 5. Include umbrella hole
 6. Color: Stormcloud (table and umbrella)
 7. Frame Material: Aluminum with powdercoating.
- B. Chair A: Adirondack Chair (Flat). Loll Designs, 5912 Waseca Street Duluth, MN 55807. 877-740-3387. www.lolldesigns.com
 1. Locate as shown on plans
 2. Model: SKU: AD-4SFC-NB
 3. Color: Navy Blue
 4. Installation Method: Freestanding in lawn panel

2.2 TRASH AND RECYCLING RECEPTACLES

- A. Basis of Design Trash/Litter: SD-42. Victor Stanley Inc. (301) 855-8300; www.victorstanley.com
 1. Structural Features: A receptacle with side-door to provide easy access and utility (no lifting of side door or heavy liners). Side door must have door hinges composed of stainless-steel pivot pins and oil-impregnated bronze bushings. The receptacle must have one anchor bolt hole for quick and cost-effective installation, as well as adjustable leveling feet to keep receptacle off the surface and to prevent the bottom of the steel frame from scuffing and allow easier cleaning underneath the receptacle. To prevent dirt from reaching the body of the receptacle the receptacle must also have a pedestal-style base.
 2. Other features: The receptacle must have a high-density plastic liner; reinforce, ribbed and molded for durability. The steel is to have a thickness of 8-10 MILS; powder coat process must include steel shot blasting for adequate adhesion to enhance product life and appearance. The process cannot include toxic solvents.
 3. Locate (1) per grouping, as shown on plans
 4. Surface mount per manufacturer instructions.
 5. Powdercoat finish; Color: Black
 6. Material: 3/8" x 1" solid vertical steel bars with a 5/8" top ring. Steel bar material must be domestic and at least 98% of the mills' steel composition must be obtained from recycled scrap metal. The manufacturing facility cannot be of further distance than 500 miles from final destination coating.
 7. Capacity: 36-gallon.
 8. Standard product specifications to be provided by the manufacturer, at Owner's request.

- B. Recycling: Basis of Design: SD-42 Special with side door opening, rain bonnet/restrictive lid, and recycling decals; Victor Stanley Inc. (301) 855-8300 www.victorstanley.com
1. Locate (1) per grouping, as shown on plans.
 2. Surface mount per manufacturer's instructions
 3. Powdercoat finish; Color: Blue
 1. Material: 3/8" x 1" solid vertical steel bars with a 5/8" top ring. Steel bar material must be domestic and at least 98% of the mills' steel composition must be obtained from recycled scrap metal. The manufacturing facility cannot be of further distance than 500 miles from final destination.
 2. Lids: Recycle decals; rain bonnet, restrictive lid.
 3. Capacity: 36-gallon
 4. Standard product specifications to be provided by the manufacturer, at Owner's request.

2.3 MISCELLANEOUS

- A. Metal Screen Line System. Landscapeforms, 7800 East Michigan Avenue Kalamazoo, MI 49048. Tracey Friedley tracey@nolanbrands.com 703-648-0848. www.landscapeforms.com
1. Panel Type: Perforated Panel
 2. Size: 6'-0" Ht. See plans for layouts
 3. Color: Black
 4. Material: Powdercoated Steel
- B. Metal Screen Gate Line System. Landscapeforms, 7800 East Michigan Avenue Kalamazoo, MI 49048. Tracey Friedley tracey@nolanbrands.com 703-648-0848. www.landscapeforms.com
1. Gate Type: Perforated Panel
 2. Size: 6'-0" Ht. 4'-0" Wdth. See plans for layouts
 3. Color: Black
 4. Material: Powdercoated Steel
- C. Bike Rack BRWS-101 Bike Rack. Victor Stanley
Victor Stanley Inc. (301) 855-8300; www.victorstanley.com
1. Installation: Embedded per Manufacturer's Recommendations
 2. Size: 22" x 2 3/8 OD x 36" H
 3. Color: Powdercoat Black

2.4 MATERIALS

- A. Steel and Iron: Free of surface blemishes and complying with the following:
1. Plates, Shapes, and Bars: ASTM A 36/A 36M.
 2. Steel Pipe: Standard-weight steel pipe complying with ASTM A 53/A 53M, or electric-resistance-welded pipe complying with ASTM A 135/A 135M.
 3. Tubing: Cold-formed steel tubing complying with ASTM A 500/A 500M.
 4. Mechanical Tubing: Cold-rolled, electric-resistance-welded carbon or alloy steel tubing complying with ASTM A 513, or steel tubing fabricated from steel complying with ASTM A 1011/A 1011M and complying with dimensional tolerances in ASTM A 500/A 500M; zinc coated internally and externally.
 5. Sheet: Commercial steel sheet complying with ASTM A 1011/A 1011M.

- B. Anchors, Fasteners, Fittings, and Hardware: Manufacturer's standard, corrosion-resistant-coated or noncorrodible materials; commercial quality, tamperproof, vandal and theft resistant , concealed, recessed, and capped or plugged.
 - 1. Angle Anchors: For inconspicuously bolting legs of site furnishings to on or below]-grade substrate; extent as indicated.
- C. Nonshrink, Nonmetallic Grout: Premixed, factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107/C 1107M; recommended in writing by manufacturer, for exterior applications.
- D. Erosion-Resistant Anchoring Cement: Factory-packaged, nonshrink, nonstaining, hydraulic-controlled expansion cement formulation for mixing with potable water at Project site to create pourable anchoring, patching, and grouting compound; resistant to erosion from water exposure without needing protection by a sealer or waterproof coating; recommended in writing by manufacturer, for exterior applications.

2.5 FABRICATION

- A. Metal Components: Form to required shapes and sizes with true, consistent curves, lines, and angles. Separate metals from dissimilar materials to prevent electrolytic action.
- B. Welded Connections: Weld connections continuously. Weld solid members with full-length, full-penetration welds and hollow members with full-circumference welds. At exposed connections, finish surfaces smooth and blended so no roughness or unevenness shows after finishing and welded surface matches contours of adjoining surfaces.
- C. Pipes and Tubes: Form simple and compound curves by bending members in jigs to produce uniform curvature for each repetitive configuration required; maintain cylindrical cross section of member throughout entire bend without buckling, twisting, cracking, or otherwise deforming exposed surfaces of handrail and railing components.
- D. Exposed Surfaces: Polished, sanded, or otherwise finished; all surfaces smooth, free of burrs, barbs, splinters, and sharpness; all edges and ends rolled, rounded, or capped.
- E. Factory Assembly: Assemble components in the factory to greatest extent possible to minimize field assembly. Clearly mark units for assembly in the field.

2.6 GENERAL FINISH REQUIREMENTS

- A. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.7 STEEL AND GALVANIZED-STEEL FINISHES

- A. Baked-Enamel, Powder-Coat Finish: Manufacturer's standard, baked, polyester, powder-coat finish complying with finish manufacturer's written instructions for surface preparation, including pretreatment, application, baking, and minimum dry film thickness.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and conditions, with Installer present, for compliance with requirements for correct and level finished grade, mounting surfaces, installation tolerances, and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

- A. Comply with manufacturer's written installation instructions unless more stringent requirements are indicated. Complete field assembly of site furnishings where required.
- B. Unless otherwise indicated, install site furnishings after landscaping and paving have been completed.
- C. Install site furnishings level, plumb, true, and securely anchored or positioned, if indicated not to be anchored, at locations indicated on Drawings.

END OF SECTION

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SECTION 142123.16 - MACHINE ROOM-LESS HOLELESS HYDROLIOC PASSENGER ELEVATORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. The Drawings and general provisions of the Contract, including the City of Baltimore Department of Public Works Specifications (the "Green Book") and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes: Machine-room-less hole-less hydraulic passenger elevators as shown and specified. Elevator work includes:
 - 1. Standard pre-engineered hydraulic passenger elevators.
 - 2. Elevator car enclosures, hoistway entrances and signal equipment.
 - 3. Operation and control systems.
 - 4. Jack(s).
 - 5. Accessibility provisions for physically disabled persons.
 - 6. Equipment, machines, controls, systems and devices as required for safely operating the specified elevators at their rated speed and capacity.
 - 7. Materials and accessories as required to complete the elevator installation.
- B. Work Not Included: General contractor shall provide the following in accordance with the requirements of the Model Building Code and ANSI A17.1 Code. For specific rules, refer to ANSI A17.1, Part 3 for hydraulic elevators. State or local requirements must be used if more stringent. The cost of this work is not included in the TK Elevator's proposal, since it is a part of the building construction.
 - 1. Elevator hoist beam to be provided at top of elevator shaft. Beam must be able to accommodate proper loads and clearances for elevator installation and operation.
 - 2. Supply in ample time for installation by other trades, inserts, anchors, bearing plates, brackets, supports and bracing including all setting templates and diagrams for placement.
 - 3. Hatch walls require a minimum fire rating as required. Hoistway should be clear and plumb with variations not to exceed 1/2" at any point.
 - 4. Elevator hoistways shall have barricades, as required.
 - 5. Install bevel guards at 75° on all recesses, projections or setbacks over 2" (4" for A17.1 2000 areas) except for loading or unloading.
 - 6. Provide rail bracket supports at pit, each floor and roof. For guide rail bracket supports, provide divider beams between hoistway at each floor and roof.

7. Pit floor shall be level and free of debris. Reinforce dry pit to sustain normal vertical forces from rails and buffers.
8. Where pit access is by means of the lowest hoistway entrance, a vertical ladder of non-combustible material extending 42" minimum, (48" minimum for A17.1-2000 areas) shall be provided at the same height, above sill of access door or handgrips.
9. All wire and conduit should run remote from the hoistways.
10. When heat, smoke or combustion sensing devices are required, connect to elevator control cabinet terminals. Contacts on the sensors should be sided for 12 volt D.C.
11. Install and furnish finished flooring in elevator cab.
12. Finished floors and entrance walls are not to be constructed until after sills and door frames are in place. Consult elevator contractor for rough opening size. The general contractor shall supply the drywall framing so that the wall fire resistance rating is maintained, when drywall construction is used.
13. Where sheet rock or drywall construction is used for front walls, it shall be of sufficient strength to maintain the doors in true lateral alignment. Drywall contractor to coordinate with elevator contractor.
14. Before erection of rough walls and doors; erect hoistway sills, headers, and frames. After rough walls are finished; erect fascias and toe guards. Set sill level and slightly above finished floor at landings.
15. To maintain legal fire rating (masonry construction), door frames are to be anchored to walls and properly grouted in place.
16. The elevator wall shall interface with the hoistway entrance assembly and be in strict compliance with the elevator contractor's requirements.
17. General Contractor shall fill and grout around entrances, as required.
18. All walls and sill supports must be plumb where openings occur.
19. Locate a light fixture (200 lx / 19 fc) and convenience outlet in pit with switch located adjacent to the access door.
20. Provide telephone line, light fixture (200 lx / 19 fc), and convenience outlet in the hoistway at the landing where the elevator controller is located. Typically this will be at the landing above the 1st floor. Final location must be coordinated with elevator contractor.
21. As indicated by elevator contractor, provide a light outlet for each elevator, in center of hoistway.
22. For signal systems and power operated door: provide ground and branch wiring circuits.
23. For car light and fan: provide a feeder and branch wiring circuits to elevator control cabinet.
24. Controller landing wall thickness must be a minimum of 8 1/2 inches thick. This is due to the controller being mounted on the second floor landing in the door frame on the return side of the door. For center opening doors, the controller is located on the right hand frame (from inside the elevator cab looking out). These requirements must be coordinated between the general contractor and the elevator contractor.
25. Cutting, patching and recesses to accommodate hall button boxes, signal fixtures, etc.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include Product Data for car enclosures, hoistway entrances, and operation, control, and signal systems.
- B. Shop Drawings:
 - 1. Include plans, elevations, sections, and large-scale details indicating service at each landing, coordination with building structure, relationships with other construction, and locations of equipment.
 - 2. Indicate maximum dynamic and static loads imposed on building structure at points of support, and maximum and average power demands.
- C. Samples: For each type of exposed finish involving color selection.

1.4 INFORMATIONAL SUBMITTALS

- A. Seismic Qualification Certificates: For elevator equipment, accessories, and components, from manufacturer.
- B. Manufacturer Certificates: Signed by elevator manufacturer certifying that hoistway and pit layout and dimensions, as indicated on Drawings, and electrical service including standby power generator, as shown and specified, are adequate for elevator system being provided.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.
- B. Inspection and Acceptance Certificates and Operating Permits: As required by authorities having jurisdiction for normal, unrestricted elevator use.
- C. Continuing Maintenance Proposal: Submit a continuing maintenance proposal from Installer to Owner, in the form of a standard five-year maintenance agreement, starting on date initial maintenance service is concluded.

1.6 WARRANTY

- A. Manufacturer's Special Warranty: Manufacturer agrees to repair, restore, or replace elevator work that fails in materials or workmanship within specified warranty period.
 - 1. Warranty Period: one year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Basis of Design; Endura MRL, Passenger, twinpost above-ground by TK Elevator Corporation, Atlanta, GA. +1-844-427-5461

2.2 PERFORMANCE REQUIREMENTS

- A. Regulatory Requirements: Comply with ASME A17.1/CSA B44.
- B. Accessibility Requirements: Comply with requirements for accessible elevators in the United States Access Board's ADA-ABA Accessibility Guidelines and with ICC A117.1.
- C. Seismic Performance: Elevator system to withstand the effects of earthquake motions determined in accordance with ASCE/SEI 7 and comply with elevator seismic requirements in ASME A17.1/CSA B44.
 - 1. Project Seismic Design Category: A.
 - 2. Elevator Component Importance Factor: 1.0.
 - 3. Design earthquake spectral response acceleration short period (Sds) for Project is 0.150.
 - 4. Provide earthquake equipment required by ASME A17.1/CSA B44.

2.3 ELEVATORS

- A. Elevator System, General: Manufacturer's standard elevator systems. Unless otherwise indicated, manufacturer's standard components are to be used, as included in standard elevator systems and as required for complete system.
- B. Elevator Description:
 - 1. Elevator Number(s): One.
 - 2. Rated Load: 3500 lb.
 - 3. Rated Speed: 100 fpm .
 - 4. Operation System: Selective-collective automatic operation.
 - 5. Auxiliary Operations:
 - a. Standby power operation.
 - b. Earthquake Emergency Operation: Comply with requirements in ASME A17.1/CSA B44.
 - c. Automatic dispatching of loaded car.
 - d. Nuisance-call cancel.
 - e. Loaded-car bypass.
 - f. Off-peak operation.
 - g. Automatic operation of lights and ventilation fans.
 - 6. Car Enclosures:
 - a. Inside Width: Not less than 80 from side wall to side wall.

- b. Inside Depth: Not less than 66 inches from back wall to front wall (return panels).
 - c. Inside Height: Not less than 88 inches to underside of ceiling.
 - d. Front Walls (Return Panels): Satin stainless steel, ASTM A480/A480M, No. 4 finish.
 - e. Car Fixtures: Satin stainless steel, ASTM A480/A480M, No. 4 finish.
 - f. Side and Rear Wall Panels Plastic laminate, or Textured stainless steel as selected by architect.
 - g. Reveals: Black.
 - h. Door Faces (Interior): Satin stainless steel, ASTM A480/A480M, No. 4 finish.
 - i. Ceiling: Satin stainless steel, ASTM A480/A480M, No. 4 finish.
 - j. Handrails: 1-1/2 inches round satin stainless steel, at sides and rear of car.
 - k. Floor: Standard carpet. To match finish floor.
 - l. Floor prepared to receive carpet (specified in Section 096813 "Tile Carpeting").
7. Hoistway Entrances:
- a. Width: 42 inches.
 - b. Height: 84 inches.
 - c. Type: Single-speed side sliding
 - d. Frames: Satin stainless steel, ASTM A480/A480M, No. 4 finish.
 - e. Doors: Satin stainless steel, ASTM A480/A480M, No. 4 finish.
8. Hall Fixtures: Satin stainless steel, ASTM A480/A480M, No. 4 finish.
9. Additional Requirements:
- a. Provide inspection certificate in each car, mounted under acrylic cover with frame made from stainless steel, ASTM A480/A480M, No. 4 finish.
 - b. Provide hooks for protective pads in all cars and one complete set(s) of full-height protective pads.

2.4 HOISTWAY EQUIPMENT

- A. Platform: Fabricated frame of formed or structural steel shapes, gusseted and rigidly welded with a wood sub-floor. Underside of the platform shall be fireproofed. The car platform shall be designed and fabricated to support one-piece loads weighing up to 25% of the rated capacity.
- B. Sling: Steel stiles bolted or welded to a steel crosshead and bolstered with bracing members to remove strain from the car enclosure.
- C. Guide Rails: Steel, omega shaped, fastened to the building structure with steel brackets.
- D. Guides: Slide guides shall be mounted on top and bottom of the car.
- E. Buffers: Provide substantial buffers in the elevator pit. Mount buffers on continuous channels fastened to the elevator guide rail or securely anchored to the pit floor. Provide extensions if required by project conditions.
- F. Jack: A jack unit shall be of sufficient size to lift the gross load the height specified. Factory test jack to ensure adequate strength and freedom from leakage. Brittle material, such as gray cast iron, is prohibited in the jack construction. Provide the following jack type: Twin post holeless.

Two jacks piped together, mounted one on each side of the car with a polished steel hydraulic plunger housed in a sealed steel casing having sufficient clearance space to allow for alignment during installation. Each plunger shall have a high pressure sealing system which will not allow for seal movement or displacement during the course of operation. Each Jack Assembly shall have a check valve built into the assembly to allow for automatically re-syncing the two plunger sections by moving the jack to its fully contracted position. The jack shall be designed to be mounted on the pit floor or in a recess in the pit floor. Each jack section shall have a bleeder valve to discharge any air trapped in the section..

- G. Automatic Self-Leveling: Provide each elevator car with a self-leveling feature to automatically bring the car to the floor landings and correct for over travel or under travel. Self-leveling shall, within its zone, be automatic and independent of the operating device. The car shall be maintained approximately level with the landing irrespective of its load.
- H. Wiring, Piping, and Oil: Provide all necessary hoistway wiring in accordance with the National Electrical Code. All necessary code compliant pipe and fittings shall be provided to connect the power unit to the jack unit. Provide proper grade inherently biodegradable oil as specified by the manufacturer of the power unit (see Power Unit section 2.04.G for further details)
- I. Pit moisture/water sensor located approximately 1 foot above the pit floor to be provided. Once activated, elevator will perform “flooded pit operation”, which will run the car up to the designated floor, cycle the doors and shut down and trip the circuit breaker shunt to remove 3 phase power from all equipment, including pit equipment.
- J. Motorized oil line shut-off valve shall be provided that can be remotely operated from the controller landing service panel. Also a means for manual operation at the valve in the pit is required.

2.04 POWER UNIT

- A. Power Unit (Oil Pumping and Control Mechanism): A self-contained unit located in the elevator pit consisting of the following items:
 - 1. NEMA 4/Sealed Oil reservoir with tank cover including vapor removing tank breather
 - 2. An oil hydraulic pump.
 - 3. An electric motor.
 - 4. Electronic oil control valve with the following components built into single housing; high pressure relief valve, check valve, automatic unloading up start valve, lowering and leveling valve, and electro-magnetic controlling solenoids.
- B. Pump: Positive displacement type pump specifically manufactured for oil-hydraulic elevator service. Pump shall be designed for steady discharge with minimum pulsation to give smooth and quiet operation. Output of pump shall not vary more than 10 percent between no load and full load on the elevator car.

- C. Motor: Standard manufacture motor specifically designed for oil-hydraulic elevator service. Duty rating – motors shall be capable of 80 starts per hour with a 30% motor run time during each start.
- D. Oil Control Unit: The following components shall be built into a single housing. Welded manifolds with separate valves to accomplish each function are not acceptable. Adjustments shall be accessible and be made without removing the assembly from the oil line.
 - 1. Relief valve shall be adjustable and be capable of bypassing the total oil flow without increasing back pressure more than 10 percent above that required to barely open the valve.
 - 2. Up start and stop valve shall be adjustable and designed to bypass oil flow during start and stop of motor pump assembly. Valve shall close slowly, gradually diverting oil to or from the jack unit, ensuring smooth up starts and up stops.
 - 3. Check valve shall be designed to close quietly without permitting any perceptible reverse flow.
 - 4. Lowering valve and leveling valve shall be adjustable for down start speed, lowering speed, leveling speed and stopping speed to ensure smooth "down" starts and stops. The leveling valve shall be designed to level the car to the floor in the direction the car is traveling after slowdown is initiated.
 - 5. Provided with constant speed regulation in both up and down direction. Feature to compensate for load changes, oil temperature, and viscosity changes.
 - 6. Solid State Starting: Provide an electronic starter featuring adjustable starting currents.
 - 7. A secondary hydraulic power source (powered by 110VAC single phase) must be provided. This is required to be able to raise (reposition) the elevator in the event of a system component failure (i.e. pump motor, starter, etc.)
 - 8. Oil Type: Provide a zinc free, inherently biodegradable lubricant formulated with premium base stocks to provide outstanding protection for demanding hydraulic systems, especially those operating in environmentally sensitive areas.

2.05 HOISTWAY ENTRANCES

- A. Doors and Frames: Provide complete hollow metal type hoistway entrances at each hoistway opening bolted\knock down construction.
 - 1. Manufacturer's standard entrance design consisting of hangers, doors, hanger supports, hanger covers, fascia plates (where required), sight guards, and necessary hardware.
 - 2. Main landing door & frame finish: ASTM A1008 steel panels, factory applied powder coat finish with factory-applied powder coat finish entrance frame.
 - 3. Typical door & frame finish: ASTM A366 steel panels, factory applied powder coat enamel finish with factory-applied powder coat finish entrance frame.
- B. Integrated Control System: the elevator controller to be mounted to hoistway entrance above 1st landing. The entrance at this level, shall be designed to accommodate the control system and provide a means of access to critical electrical components and troubleshooting features. See section 2.09 Control System for additional requirements.

- C. At the controller landing, the hoistway entrance frame shall have space to accommodate and provide a lockable means of access (group 2 security) to a 3 phase circuit breaker. See section 2.11 Miscellaneous Elevator Components for further details
- D. Interlocks: Equip each hoistway entrance with an approved type interlock tested as required by code. Provide door restriction devices as required by code.
- E. Door Hanger and Tracks: Provide sheave type two point suspension hangers and tracks for each hoistway horizontal sliding door.
 - 1. Sheaves: Polyurethane tires with ball bearings properly sealed to retain grease.
 - 2. Hangers: Provide an adjustable device beneath the track to limit the up-thrust of the doors during operation.
 - 3. Tracks: Drawn steel shapes, smooth surface and shaped to conform to the hanger sheaves.
- F. Hoistway Sills: Extruded metal, with groove(s) in top surface. Provide mill finish on aluminum.

2.06 PASSENGER ELEVATOR CAR ENCLOSURE

A. Car Enclosure:

- 1. Walls: Cab type TKAP, reinforced cold-rolled steel with two coats factory applied baked enamel finish, with applied vertical wood core panels covered on both sides with high pressure plastic laminate.
 - 2. Reveals and frieze: a. Reveals and frieze: Stainless steel, no. 4 brushed finish
 - 3. Canopy: Cold-rolled steel with hinged exit.
 - 4. Ceiling: Suspended type, LED lighting with translucent diffuser mounted in stainless steel. Exposed framework shall be stainless steel to match ceiling.
 - 5. Cab Fronts, Return, Transom, Soffit and Strike: Provide panels faced with brushed stainless steel.
 - 6. Doors: Horizontal sliding car doors reinforced with steel for panel rigidity. Hang doors on sheave type hangers with polyurethane tires that roll on a polished steel track and are guided at the bottom by non-metallic sliding guides.
 - a. Door Finish: Stainless steel panels: No. 4 brushed finish.
 - b. Cab Sills: Extruded aluminum, mill finish.
 - 7. Handrail: Provide 1 1/2' round metal on sides and rear walls on front opening cars and side walls only on front and rear opening cars. Handrails shall have a stainless steel, no. 4 brushed finish.
 - 8. Ventilation: Manufacturer's standard exhaust fan, mounted on the car top.
 - 9. Protection pads and buttons: One set.
- B. Car Top Inspection: Provide a car top inspection station with an "Auto-Inspection" switch, an "emergency stop" switch, and constant pressure "up and down" direction and safety buttons to make the normal operating devices inoperative. The station shall give the inspector complete

control of the elevator. The car top inspection station shall be mounted in the door operator assembly.

2.07 DOOR OPERATION

- A. Door Operation: Provide a direct or alternating current motor driven heavy duty operator designed to operate the car and hoistway doors simultaneously. The door control system shall be digital closed loop and the closed loop circuit shall give constant feedback on the position and velocity of the elevator door. The motor torque shall be constantly adjusted to maintain the correct door speed based on its position and load. All adjustments and setup shall be through the computer based service tool. Door movements shall follow a field programmable speed pattern with smooth acceleration and deceleration at the ends of travel. The mechanical door operating mechanism shall be arranged for manual operation in event of power failure. Doors shall automatically open when the car arrives at the landing and automatically close after an adjustable time interval or when the car is dispatched to another landing. AC controlled units with oil checks, or other deviations are not acceptable.
1. No Un-Necessary Door Operation: The car door shall open only if the car is stopping for a car or hall call, answering a car or hall call at the present position or selected as a dispatch car.
 2. Door Open Time Saver: If a car is stopping in response to a car call assignment only (no coincident hall call), the current door hold open time is changed to a shorter field programmable time when the electronic door protection device is activated.
 3. Double Door Operation: When a car stops at a landing with concurrent up and down hall calls, no car calls, and no other hall call assignments, the car door opens to answer the hall call in the direction of the car's current travel. If an onward car call is not registered before the door closes to within 6 inches of fully closed, the travel shall reverse and the door shall reopen to answer the other call.
 4. Nudging Operation: The doors shall remain open as long as the electronic detector senses the presence of a passenger or object in the door opening. If door closing is prevented for a field programmable time, a buzzer shall sound. When the obstruction is removed, the door shall begin to close at reduced speed. If the infra-red door protection system detects a person or object while closing on nudging, the doors shall stop and resume closing only after the obstruction has been removed.
 5. Door Reversal: If the doors are closing and the infra-red beam(s) is interrupted, the doors shall reverse and reopen. After the obstruction is cleared, the doors shall begin to closed.
 6. Door Open Watchdog: If the doors are opening, but do not fully open after a field adjustable time, the doors shall recycle closed then attempt to open six times to try and correct the fault.
 7. Door Close Watchdog: If the doors are closing, but do not fully close after a field adjustable time, the doors shall recycle open then attempt to close six times to try and correct the fault.

8. Door Close Assist: When the doors have failed to fully close and are in the recycle mode, the door drive motor shall have increased torque applied to possibly overcome mechanical resistance or differential air pressure and allow the door to close.
- B. Door Protection Device: Provide a door protection system using microprocessor controlled infra-red light beams. The beams shall project across the car opening detecting the presence of a passenger or object. If door movement is obstructed, the doors shall immediately reopen.

2.08 CAR OPERATING STATION

- A. Car Operating Station, General: The main car control shall contain the devices required for specific operation mounted in an integral swing return panel requiring no applied faceplate. Wrap return shall have a brushed stainless steel finish. The main car operating panel shall be mounted in the return and comply with handicap requirements. Pushbuttons that illuminate using long lasting LED's shall be included for each floor served, and emergency buttons and switches shall be provided per code. Switches for car light and accessories shall be provided.
- B. Emergency Communications System: Integral phone system provided.
- C. Auxiliary Operating Panel:
- D. Column Mounted Car Riding Lantern: A car riding lantern shall be installed in the elevator cab and located in the entrance. The lantern, when illuminated, will indicate the intended direction of travel. The lantern will illuminate and a signal will sound when the car arrives at a floor where it will stop. The lantern shall remain illuminated until the door(s) begin to close.
- E. Special Equipment: Not Applicable
- F. Digital Services: Cloud-based IoT monitoring system comes standard with these options:

Remote Monitoring with Application Programming Interface (API) Integration

ADA Phone - Code Compliant Cellular Connectivity

A17.1 2019 Code - Enhanced Communications

Smart Device Elevator Calling with occupant app API integration

2.09 CONTROL SYSTEMS

- A. Controller: Shall be integrated in a hoistway entrance jamb. Should be microprocessor based, software oriented and protected from environmental extremes and excessive vibrations in a NEMA 1 enclosure. Control of the elevator shall be automatic in operation by means of push buttons in the car numbered to correspond to floors served, for registering car stops, and by

"up-down" push buttons at each intermediate landing and "call" push buttons at terminal landings.

B. Service Panel – to be located outside the hoistway in the controller entrance jamb and shall provide the following functionality/features:

1. Access to main control board and CP
2. Main controller diagnostics
3. Main controller fuses
4. Universal Interface Tool (UIT)
5. Remote valve adjustment
6. Electronic motor starter adjustment and diagnostics
7. Operation of pit motorized shut-off valve with LED feedback to the state of the valve in the pit
8. Operation of auxiliary pump/motor (secondary hydraulic power source)
9. Operation of electrical assisted manual lowering
10. Provide male plug to supply 110VAC into the controller
11. Run/Stop button

C. Automatic Light and Fan shut down: The control system shall evaluate the system activity and automatically turn off the cab lighting and ventilation fan during periods of inactivity. The settings shall be field programmable.

D. Emergency Power Operation: (10-DOA) Upon loss of the normal power supply, building-supplied standby power is available on the same wires as the normal power supply. Once the loss of normal power is detected and standby power is available, the elevator is lowered to a pre-designated landing and the doors are opened. After passengers have exited the elevator, the doors are closed, and the car is shut down. When normal power is restored, the elevator automatically resumes operation.

E. Digital Services:

Cloud-based IoT Monitoring System (standard): Contractor shall provide a cloud-based IoT (internet of things) monitoring system capable of tracking door movements and timing, trips, power cycles, car calls, out-of-service events and modes. This observation will continue 24/7 and it shall be capable of providing service technicians a minimum of three recommended solutions for defined failure events and automatically dispatch service technicians in the event of failure(s) while sending notifications to end users of changes in their equipment's state via both email and mobile device. Access to IoT and related equipment data and status will be made available in both a web portal and mobile application secured by password and username with at least two-factor authentication. Finally, this system must be self-contained and not require internet provision by others.

Along with the monitoring system, options are available.

Remote Monitoring with Application Programming Interface (API) Integration: Contractor shall provide a portal and mobile device application (app) that communicates relevant service and operational information such as elevator operational status, open service call tickets, call ticket history and performance and service history. This system shall provide a REST application pro-

programming interface (API) capable of transmitting relevant information from the cloud-based IoT monitoring system. This data includes equipment operational status, door movements, service and maintenance history, traffic statistics and failure alerts.

ADA Phone – Code Compliant Cellular Connectivity: Contractor shall provide a phone service through a self-contained cellular based VoIP system. This system shall meet code, include a backup battery capable of powering the emergency communication equipment for 4+ hours in the event of a power outage. The solution shall have remote monitoring capability to ensure continuous connectivity with a means of remote troubleshooting. Remote monitoring capability shall include, at a minimum, the ability to monitor connectivity and power supply. Remote monitoring shall be capable of providing local alerts to response personnel when on-site intervention is required.

A17.1 2019 Code – Enhanced Communications: For jobs installed under enforcement of 2018 International Building Code or ASME A17.1-2019/CSA B44:19 Safety Code, contractor will provide a video camera necessary for viewing the elevator cab interior floor as well as a position indicator display in the cab operating panel capable of providing means of two-way, text-based communication when the emergency call button is engaged in the elevator car. These components, and associated cloud-based monitoring platform, will be non-proprietary in nature, allowing customization on where to direct emergency calls, while offering capability for any party to provide the emergency monitoring services.

Smart Device Elevator Calling with Occupant app API Integration: Contractor will provide an elevator calling application for smart devices (app) that can be accessed through Android and IOS smart device operating systems. This calling service shall be accomplished on both, Destination Dispatch and Traditional ETA elevator control system applications. Furthermore, a single, common and consistent app shall have the same user experience and user interface on both Destination Dispatch and Traditional ETA dispatching control systems. To enable mobile calling functionality without creating unnecessary wear on elevator components resulting from false calls, proximity detection beacons shall be installed in the elevator lobby at each floor. These beacons shall detect user smart devices and restrict calling of elevators when the user is not within a pre-configured range of elevator entrance. Beacon-based proximity detection distance must be configurable to accommodate various building and floor layouts. Once Bluetooth signal is detected, the user can place a floor call directly from their handheld or wearable device. The elevator calling app shall remove the need for interaction with hall fixtures, buttons or kiosks. This system shall be capable of placing an automatic call to a user-configured destination floor automatically based on both location in building (floor) and time of day. App users shall be able to configure their own source or starting floor, destination floor and schedule of automatic calling service, and be able to configure multiple automatic calling services and routines. System shall have reasonable ability to auto-provision users from access control system and not require duplicate entry of users for access control purposes. Finally, all services above shall be made available via an application programming interface (API) so that a 3rd party or tenant occupant app could be integrated with elevator smart device calling service so that users could receive multiple occupant experience-based services in a single, common, 3rd party mobile device application

3.2 FIELD QUALITY CONTROL

- A. Acceptance Testing: On completion of elevator installation and before permitting elevator use (either temporary or permanent), perform acceptance tests as required and recommended by ASME A17.1/CSA B44 and by governing regulations and agencies.

3.3 PROTECTION

- A. Temporary Use: Not permitted.

3.4 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to operate, adjust, and maintain elevator.

3.5 MAINTENANCE SERVICE

- A. Initial Maintenance Service: Beginning at Substantial Completion, maintenance service to include 60 months' full maintenance by skilled employees of elevator Installer. Include monthly preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper elevator operation at rated speed and capacity.

END OF SECTION 142123.16

Specifications for:

City of Baltimore
Department of General Services
Design and Construction Division



Contract No. PROJ 1801

Forest Park Library
Addition and Renovation

3023 Garrison Blvd.
Baltimore, Maryland 21216



100% CD Submission
February 7, 2025

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Section 260519 - Conductors and Cables
Section 260526 – Grounding and Bonding
Section 260529 - Hangers and Supports for Electrical Systems
Section 260533 - Raceways and Boxes
Section 260540 - Underground Ducts and Utility Structures
Section 260553 - Electrical Identification
Section 260573 - Power Systems Analysis
Section 260800 – Commissioning of Electrical Systems
Section 260943 - Lighting Control System
Section 262416 – Panelboards
Section 262714 – Electric Submetering
Section 262726 - Wiring Devices
Section 262813 – Fuses
Section 262816 - Enclosed Switches and Circuit Breakers
Section 263213 - Packaged Engine Generator
Section 263600 - Transfer Switches
Section 264113 - Lightning Protection System
Section 264313 - Surge Protective Devices
Section 265119 – Lighting

DIVISION 27 – COMMUNICATIONS

Section 271513 – Telecommunications Systems
Section 275123 – Intercom Systems

DIVISION 28 – ELECTRONIC SAFETY AND SECURITY

Section 283000 – Fire Alarm, Systems
Section 283111 - Fire-Alarm System

DIVISION 31 – EARTHWORK

Section 301000 – Site Clearing
Section 312300 – Excavating, filling & Grading
Section 312319 – Dewatering
Section 312500 – Soil Erosion and Sediment Control
Section 313116 – Termite Control
Section 315000 – Excavation Support
Section 321200 – Flexible Paving
Section 321300 – Rigid Paving
Section 321723 – Pavement Markings
Section 329113 – Soil Preparation
Section 331000 – Water Utilities
Section 333000 – Sanitary Sewage Utilities
Section 333400 – Storm Drainage Utilities

DIVISION 32 – EXTERIOR IMPROVEMENTS

Section 321400 – Unit Paving
Section 329113 – Soil Preparation
Section 329200 – Turf and Grasses
Section 329300 - Planting

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SECTION 210110 - FIRE PROTECTION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings, general provisions of Contract, as well as Division-22 and Division-26 sections shall apply to this Section.

1.2 SUMMARY

- A. This Section specifies automatic sprinkler and standpipe systems for buildings and structures. Materials and equipment specified in this Section include:
 - 1. Pipe, fittings, valves, and specialties;
 - 2. Sprinklers, fire department valve cabinets, and accessories.
- B. Products furnished but not installed include sprinkler head cabinet with spare sprinkler heads. Furnish to the Owner's maintenance personnel.

1.3 DEFINITIONS

- A. Pipe sizes used in this Specification are Nominal Pipe Size (NPS).
- B. Other definitions for fire protection systems are listed in the most current edition of NFPA Standards 13, 14 and 20.
- C. Working Plans as used in this Section means those documents (including drawings and calculations) prepared pursuant to the requirements contained in the most current edition of NFPA 13 for obtaining approval of the authority having jurisdiction.

1.4 SYSTEM DESCRIPTION

- A. Fire Flow Test Data:
 - 1. Flow Hydrant:
 - a. Location: F3015 – Hydrant on Garrison Boulevard Baltimore, MD
21217
 - b. Pitot Pressure: _____ PSI
 - c. Outlet Diameter: 2.5 Inches
 - d. Flow: 1097 GPM

- e. Nozzle Coefficient: _____
 - f. Corrected Flow: _____ GPM
 - g. Main Size: _____ 16 Inches
2. Residual Hydrant:
- a. Location: F3015 - Hydrant on Garrison Boulevard, Baltimore, MD 21217
 - b. Static Pressure: _____ 60 PSI
 - c. Residual Pressure: _____ 56 PSI
 - d. Pitot Flow: _____ 1097_GPM
 - e. Adjusted Residual Pressure w/ Pitot Flow: 56 PSI
 - f. Loss: _____ PSI
 - g. Flow at 20 PSI (140 kPa): 3803 GPM
 - h. Main Size: _____ 16 Inches
3. Date of Flow Test: July 12, 2022
4. The above information is for informational purposes only. The Contractor shall provide an independent flow test to confirm flow and pressure availability.

1.5 SUBMITTALS

- A. Product Data: Include each type sprinkler head, valve, piping specialty, fire protection specialty, fire department connection, fire and jockey pumps and fire department valve cabinet specified.
- B. Shop Drawings: Submit drawings which have been prepared in accordance with the most current editions of NFPA, UL, FM, as well as the owner's insurance carrier requirements. Shop drawings shall include hydraulic calculations where applicable, and which have been approved by the authority having jurisdiction.
 - 1. Sprinkler shop drawings shall be integrated into the Contractor's installation/coordination drawings.
 - 2. Shop drawings shall include a written statement indicating compliance with all applicable requirements of NFPA, UL, FM, and the Owner's insurance carrier.
- C. Coordination Drawings: Detail fire protection piping systems in accordance with Division-22 Section "Basic Plumbing Requirements." Fire protection piping shall be coordinated with work of all other trades.

- D. Maintenance Data: For each type sprinkler head, valve, piping specialty, fire protection specialty, fire department connection, and fire and jockey pump, specified, include in operating and maintenance manual.
- E. Quality Control Submittals:
 - 1. Welders' qualification certificates. Submit for each qualified welder the following documentation according to AWS B2.1. Welding Procedure Specification (WPS), Procedure Qualification Record (PQR), Welder Qualification Record (WQR), verifying the AWS qualification within the previous six (6) months, or certified work history showing no break in work.
 - 2. Test Reports and Certificates: Include "Contractor's Material & Test Certificate for Aboveground Piping" and "Contractor's Material & Test Certificate for Underground Piping" as described in the most current edition of NFPA 13.
 - 3. Internal Inspection of Piping; where sprinkler piping is welded, an obstruction investigation will be conducted and report submitted.
- F. Computer (CADD) files of drawings will not be made available to the Contractor for any purposes.

1.6 MATERIAL, EQUIPMENT AND SUBSTITUTION REQUIREMENTS

- A. Use products of one manufacturer where two or more items of same kind of equipment are required.
- B. Materials and equipment shall have a record of two (2) years successful field use.
- C. Where a specific manufacturer is listed on the drawings, that manufacturer shall be considered the basis of design for that particular item of equipment. Only the basis of design manufacturer has been verified to meet the project requirements (i.e. dimensions, weights, service clearances, electrical requirements, etc.).
- D. Where the drawings and/or specifications indicate more than one manufacturer for a particular item of equipment, only those listed may submit products and services to be included in the work; manufacturers other than those listed will not be acceptable. Should the contractor choose to use one of the specified manufacturers other than the basis of design, it shall be the responsibility of the contractor to verify that the equipment meets all project requirements including, but not limited to, verification of all dimensions, weights, service clearances, electrical requirements, etc. All changes incurred shall be the responsibility of the contractor and shall be provided at no additional cost to the owner.
- E. Substitutions must be submitted for consideration seven (7) days prior to the original bid date. Consideration of substitutions shall be at the sole discretion of the Engineer. Substitution submittals shall include all information required in the "Submittals" paragraph of this specification section, as well as all other requirements indicated through the Division-23 specifications. Substitutions will not mitigate, in any way, the Contractor's responsibility in complying with the coordination, contract requirements or design intent. Any additional electrical, structural or special requirements, etc. shall be the responsibility

of the Contractor. Also, any additional cost incurred as a result of substitution shall be the responsibility of the Contractor.

- F. Nameplate: For each piece of power operated mechanical equipment provide a permanent operational data nameplate 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.
- G. Where items of equipment are indicated as Base Bid on the bid form include in the Bid price the cost of providing the equipment upon which the specification is based. In addition, submit with bid for Owner's consideration the amount to be added or deducted from the base bid for other listed manufacturers' equipment. Owner will advise Contractor within forty-five (45) days after award of contract of his selection.

1.7 QUALITY ASSURANCE

- A. Installer Qualifications: Installation and alterations of fire protection piping, equipment, specialties, and accessories, and repair and servicing of equipment shall be performed only by a qualified installer having a minimum of five (5) years' experience with work similar in size and scope to this project.
- B. Qualifications for Welding Processes and Operators: Comply with the requirements of AWS B2.1", Specifications for Qualifications of Welding Procedures and Welders for Piping and Tubing, Level AR-3."
- C. Regulatory Requirements: Comply with the requirements of the most current edition of the following codes:
 - 1. NFPA 13 - Standard for the Installation of Sprinkler Systems.
 - 2. NFPA 14 - Standard for the Installation of Standpipe and Hose Systems.
 - 3. NFPA 20 - Standard for the Installation of Centrifugal Fire Pumps.
 - 4. UL and FM Compliance: Fire protection system materials and components shall be Underwriter's Laboratories listed and labeled, and Factory Mutual approved for the application anticipated.
 - 5. In addition to all regulatory requirements, the complete fire protection system shall meet the requirements of the Owner's insurance carrier.
- D. Miscellaneous Materials:
 - 1. Sprinkler Wrenches: Furnish to Owner, two (2) wrenches for each type of sprinkler head installed as provided by the sprinkler manufacturer.
 - 2. Sprinkler Heads and Cabinets: Furnish six extra sprinkler heads of each style included in the project. Furnish each style with its own sprinkler head cabinet and special wrenches as specified in this Section.
- E. Structural Certification:

1. The Sprinkler Contractor shall provide certification from a Maryland Registered Engineer that the existing building structure is capable of supporting all proposed sprinkler system piping. The certification letter must be signed and sealed prior to the submission of shop drawings.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering fire protection system products which may be incorporated in the work include the following:
 1. Gate Valves:
 - a. Fairbanks
 - b. Jenkins
 - c. Kennedy Valve, Div of ITT Grinnell Valve Co., Inc.
 - d. Stockham
 2. Swing Check Valves:
 - a. Fairbanks
 - b. Jenkins
 - c. Kennedy Valve, Div of ITT Grinnell Valve Co., Inc.
 - d. Stockham
 - e. Victaulic
 - f. Reliable Automatic Sprinkler Co., Inc.
 3. Grooved Mechanical Couplings:
 - a. Stockham
 - b. Victaulic
 4. Water Flow Indicators:
 - a. Reliable Automatic Sprinkler Co., Inc.
 - b. Viking Corp.
 5. Electric Alarm Gong:

- a. Reliable Automatic Sprinkler Co., Inc.
 - b. Victaulic
6. Air-Pressure Maintenance Device, Dry-Pipe System:
- a. Reliable Automatic Sprinkler Co., Inc.
 - b. Viking Corp.
 - c. Victaulic
7. Dry-Pipe Valves:
- a. Reliable Automatic Sprinkler Co., Inc.
 - b. Viking Corp.
 - c. Victaulic
8. Detector Check Valves:
- a. Ames Company, Inc.
 - b. Kennedy Valve, Div of ITT Grinnell Valve Co., Inc.
9. Alarm Check Valve:
- a. Reliable Automatic Sprinkler Co., Inc.
 - b. Viking Corp.
10. Siamese Connection:
- a. Guardian Fire Equipment, Inc.
 - b. Elkhart Brass
11. Fire Department Valve:
- a. Guardian Fire Equipment, Inc.
 - b. Elkhart Brass
12. Sprinkler Heads:
- a. Central Sprinkler Corp.
 - b. Johnsons Controls International
 - c. Reliable Automatic Sprinkler Co., Inc.

- d. Viking Corp.
 - e. Victaulic
13. Fire and Jockey Pumps:
- a. Peerless
 - b. ITT A-C
 - c. Aurora
 - d. MTH Pumps

2.2 PIPING MATERIALS AND PRODUCTS

- A. General: Provide piping materials and factory-fabricated piping products of sizes, types, pressure ratings, temperature ratings, and capacities as indicated. Where more than one type of materials or products are indicated, selection is Installer's option. All products in a grooved system shall be of the same manufacturer.

2.3 BASIC IDENTIFICATION

- A. General: Provide identification complying with Division-22 section "Identification for Plumbing Piping and Equipment".

2.4 BASIC PIPES AND PIPE FITTINGS

- A. General: Provide pipes and pipe fittings complying with Division-22 section "Pipe, Tube and Fittings for Plumbing Systems", in accordance with the following listing:
 - 1. Pipe Size 2" (50 mm) and Smaller: Black steel pipe; Schedule 40; cast-iron threaded.
 - 2. Pipe Size 2" (50 mm) and Smaller: Black steel pipe; Schedule 10; roll-grooved fittings.
 - 3. Pipe Size 3" (50 mm) and Smaller: Pipe shall meet or exceed the requirements of ASTM F442 material designation CPVC 4120-06 in standard dimension ratio (SDR) 13.5. Additionally, the pipe must be marked with the following pressure ratings: "320 PSI @ 73° F", "175 PSI @ 150° F" and "100 PSI @ 180° F". Fittings: ASTM F438 (Sch. 40) and ASTM F439 (Sch. 80), ASTM F1970; Pipe Color – orange. FM/UL listed. All socket type joints shall be assembled with solvent cements that meet or exceed the requirements of ASTM F493. Safe handling of solvent cements shall be in accordance with ASTM F402. Solvent cement shall be certified by NSF International for use with potable water and approved by the manufacturers. The solvent cements shall be approved for use with BlazeMaster® CPVC pipe and fittings. Use of CPVC shall be approved by local authority having jurisdiction.

4. Pipe Size 2-1/2" (65 mm) and Larger: Black steel pipe; Schedule 10; welded or grooved-end fittings, ductile iron.
5. "Weld-o-let" or "Thread-o-let" fittings shall be used for branch/runouts to sprinkler heads.
6. "U-bolt" clamps, Gruvlok clamps or socket type tees shall not be used and will not be acceptable.

2.5 BASIC VALVES

- A. Gate Valves - 2 Inch (50 mm) and Smaller: Body and bonnet of cast bronze, 175 pound (1200 kPa) cold water working pressure - non-shock, threaded ends, solid wedge. outside screw and Yoke, rising stem, screw-in bonnet, and malleable iron handwheel. Valves shall be capable of being repacked under pressure, with valve wide open.
- B. Gate Valves - 2-1/2 Inch (65 mm) and Larger: Iron body; bronze mounted, 175 pound (1200 kPa) cold water working pressure - non-shock. Valves shall have solid taper wedge; outside screw and Yoke, rising stem; flanged bonnet with body and bonnet conforming to ASTM A 126 Class B; replaceable bronze wedge facing rings; flanged ends; and a packing assembly consisting of a cast iron gland flange, brass gland, packing, bonnet, and bronze bonnet bushing. Valves shall be capable of being repacked under pressure, with valve wide open.
- C. Swing Check Valves: MSS SP-71; Class 175, cast iron body and bolted cap conforming to ASTM A 126, Class B; horizontal swing, with a bronze disc or cast iron disc with bronze disc ring, and flanged ends. Valve shall be capable of being refitted while the valve remains in the line.

2.6 SPECIALTY VALVES

- A. Alarm Check Valve: 300 psig (2050 kPa) working pressure, designed for horizontal or vertical installations, and have cast iron, flanged inlet and outlet, bronze grooved seat with "O" ring seals, single hinge pin and latch design. Provide trim sets for bypass, drain, electric sprinkler alarm switch, pressure gages, drip cup assembly piped without valves separate from main drain line, and fill line attachment with strainer.
- B. Alarm Check Valve: 300 psig (2050 kPa) working pressure, designed for horizontal or vertical installations, and have ductile iron, grooved ends, bronze grooved seat with "O" ring seals, single hinge pin and latch design. Provide trim sets for bypass, drain, electric sprinkler alarm switch, pressure gages, precision retarding chamber, drip cup assembly piped without valves separate from main drain line, and fill line attachment with strainer.
- C. Alarm Check Valve: 300 psig (2050 kPa) working pressure, designed for horizontal or vertical installations, and have ductile iron, grooved ends, bronze grooved seat with "O" ring seals, single hinge pin and latch design. Provide trim sets for bypass, drain, electric sprinkler alarm switch, pressure gages, precision retarding chamber, drip cup assembly piped with check valve to main drain line, and fill line attachment with strainer.
- D. Dry-Pipe Valves

1. Differential type: valve with single hinge pin and latch design with galvanized trim. Water to air seat area differential to be at least 6 to 1, capable of controlling air pressure ranging from 20 to 50 psi (1.4 to 3.4 bar). Dry pipe valve construction shall be cast iron. Dry pipe valve seat shall be of bronze construction with O-ring seals to prevent corrosion and leakage. Threaded-in, one piece air and water seat shall be removable for ease of maintenance. Clapper shall consist of ductile iron with sintered brass clapper bushings, and contain a one-piece clapper rubber facing. End connection styles to be ANSI flanged inlet and outlet in accordance with ANSI B16.1 (125 lb.), ANSI flanged inlet and grooved outlet, with grooved outlet dimensions per ANSI/AWWA C606, or grooved inlet and outlet, with grooved outlet dimensions per ANSI/AWWA C606. Dry pipe valve shall have a minimum rated working pressure of 175 psi (12.1 bar) and shall be factory hydrostatic tested at 350 psi (24.1 bar).
 2. Low-pressure type: valve shall be capable of providing a 17:1 water-to-air force differential, requiring an air pressure between 10 and 26 psi (0,7 to 1,8 bar). Dry pipe valve system shall consist of a hydraulically operated differential latching clapper-type valve of lightweight, ductile-iron construction with "drop in" navy bronze seat and clapper assembly. Bronze seat shall have O-ring seals to resist corrosion and leakage. Clapper facing shall be pressure actuated, providing a limited compression seat for the sealing force between the clapper rubber facing and the valve seat. Deluge valve shall have an external reset knob for resetting the clapper without having to remove the valve face plate. Push-rod chamber design shall consist of a stainless steel piston/push-rod and spring assembly with diaphragm seal secured to the casting through a push-rod guide constructed of a synthetic engineering plastic to resist corrosion. Inlet restriction shall be built into the push-rod chamber. Casting shall have a bleeder hole located on the push-rod chamber for air/water leakage indication. End connection style to be grooved inlet and grooved outlet, per ANSI/AWWA C606. Valve and trim components shall have a rated working pressure of 250 psi (17,2 bar).
- E. Air-Pressure Maintenance Device, Dry-Pipe System: An automatic device to maintain the correct air pressure in a dry-pipe system. System shall have shut-off valves to permit servicing without shutting down the sprinkler system, bypass valve for quick system filling, pressure regulator or switch to maintain system pressure, strainer; pressure ratings 14 to 60 psig (95 to 410 kPa) adjustable range, and 175 psig (1200 kPa) maximum inlet pressure. Electrical ratings shall match compressor ratings. Provide a tank mounted air compressor of size and capacity as required.
- F. Automatic Air Release Valves for Fire Protection System: FM approved for 175 psig (1210 kPa) working pressure, brass construction automatic float type air vent used to reduce the amount of air trapped in a pressurized wet pipe fire system. Air vent shall be 1/2" NPT inlet with 40 mesh type strainer and 1/2" male NPT outlet to drain. Provide 1/2" ball valve and nipple. Air vent shall be Potter Model PAV. Drain shall be extended to nearest storm water piping with backwater valve.
- G. Detector Check Valves: Galvanized cast iron body, with a bolted cover with air bleed device for access to internal parts; 175 psig (1200 kPa) working pressure. One piece bronze disc with bronze bushings, pivot and replaceable seat. Provide threaded bypass taps in the inlet and outlet for bypass meter connection. Valve shall be set to allow minimal water flow through the bypass meter; when major water flow is required, the water pressure will fully open the clapper.

H. Air Supply for Dry-Pipe Systems:

1. Air Compressor: A tank-mounted air compressor with associated pressure switch and check valve. Compressor shall be selected from those available from manufacturer and listed with unit based upon system size. Motor size, voltage, and other electrical characteristics shall be coordinated with electrical subcontractor. Air supply shall be regulated by an approved regulating type air maintenance device containing a field adjustable regulator having a range of 5 to 100 psi (.34 to 6,9 bar), a check valve, strainer, and a rapid fill valve.

2.7 AUTOMATIC SPRINKLERS

A. Sprinkler Heads: Fusible link or glass bulb type, and style as indicated or required by the application. All heads shall be UL Listed/FM Approved. For each application, all heads shall be of the same manufacturer. Unless otherwise indicated, provide heads with nominal 1/2 inch (13 mm) discharge orifice, for "Ordinary" temperature range.

B. Sprinkler Head Finishes: Provide heads with the following finishes:

1. Upright or Pendent Styles: Standard bronze finish for heads in unfinished spaces and not exposed to view. Heads shall be wax-coated where installed exposed to acids, chemicals, or other corrosive fumes.
2. Recessed Ceiling and Sidewall Styles: Bright chrome, with [bright chrome] [painted white] escutcheon plate.
3. Concealed Style: Rough brass and painted white cover, screwed-on adjustment plate.
4. Residential Style: White with matching escutcheon plate.
5. Intermediate Level Style: Bright chrome.
6. Extended Coverage: bright chrome.
7. For dry pipe systems in garage area, provide dry upright sprinkler heads.

C. Provide quick response sprinkler heads throughout the building.

D. Provide high temperature sprinkler heads in equipment spaces where pressure and temperature relief valve(s) are to be installed.

E. For fire pump applications, all sprinkler heads shall be 250 psi (1710 kPa).

F. Sprinkler Head Cabinet and Wrench: Finished steel cabinet, suitable for wall mounting, with hinged cover and space for six (6) spare sprinkler heads plus sprinkler head wrench. Provide a separate cabinet for each style sprinkler head on the project.

2.8 FIRE DEPARTMENT VALVE

- A. Fire Department valve shall be a 2-1/2" (65 mm) polished brass pressure reducing device capable of handling inlet pressures up to 300 psi (2040 kPa).
- B. Valve shall be complete with removable 2-1/2" x 1-1/2" (65 mm x 40 mm) reducer, cap and chain.

2.9 SIAMESE CONNECTIONS

- A. Wall Type Siamese Connections: Polished cast brass, flush wall type, with wall escutcheon and two-way connections. Connection sizes shall be 4 inch (100 mm) outlet and two 2-1/2 inch (65 mm) female inlets, having NH standard threads, for the connection size indicated, as specified in NFPA. Each inlet shall have a clapper valve, and plug and chain. Unit shall have wall escutcheon of cast brass, finish to match connections, with words "AUTO SPKR & STANDPIPE" in raised letters.

2.10 ALARM DEVICES

- A. General: Types and sizes shall mate and match piping and equipment connections.
- B. Water Flow Indicators: Vane type waterflow detector, rated to 250 psig (1724 kPa); designed for horizontal or vertical installation; have 2-SPDT circuit switches to provide isolated alarm and auxiliary contacts, 7 ampere 125 volts AC and 2.5 ampere 24 Volts DC; complete with factory-set, field-adjustable retard element to prevent false signals, and tamper-proof cover which sends a signal when cover is removed.
- C. Electric Alarm Gongs: 10 inch (250 mm) diameter cast aluminum gong, with factory-finish in red enamel; bell shall be weatherproof and listed for outdoor use by Underwriters Laboratories and Factory Mutual. Power supply shall be compatible with fire alarm control panel. Alarm bell shall be motor driven with under dome striker.
- D. Supervisory Switches: SPST, normally closed contacts, designed to signal valve in other than full open position.

2.11 FIRE PUMP

- A. Fire Pump - Electric Motor Driven:
 - 1. Furnish and install where shown on the drawings, Fire Pump System complete with pump, electric driver, controller and all related accessories. The pump unit shall be UL listed -- FM approved. The pumping unit shall meet all requirements of NFPA Standard 20. The fire pump shall be of capacity as indicated on the drawings. The pump shall also deliver not less than 150% of rated capacity at a pressure not less than 65% rated pressure. The shut off pressure shall not exceed 120% of rated pressure. The pump shall operate at a maximum speed of not less 3560 RPM.

2. The fire pump shall be a horizontal base mounted, split case, bronze fitted, single stage, double suction centrifugal unit, or vertical in-line type, as indicated on the drawings.
3. The electric driver shall be a horizontal mounted, open drip proof ball bearing type, AC induction squirrel cage motor, wound for 460 volts-3 phase-60 cycles. Locked rotor current shall not exceed the values specified in NFPA Standard 20.
4. Casing shall be of cast iron having a minimum tensile strength of 35,000 pounds. Bearing housing supports, suction and discharge flanges shall be integrally cast with the lower half of the casing. Removal of the upper half of the casing must allow the rotating element to be removed without disconnecting the suction and discharge flanges.
5. Impellers shall be of the enclosed type of vacuum cast bronze. Impellers shall be dynamically balanced, keyed to the drive shaft and held in place with threaded shaft sleeves.
6. The fire pump shaft shall be made of SAE 1045 steel or equal, accurately machined to give a true running rotating element. The shaft shall be protected by bronze sleeves which shall be key locked and threaded so that the sleeves tighten with the rotation of the shaft. A gasket shall seal between the impeller hub and the shaft to protect the pump shaft.
7. The fire pump shall be equipped with renewable casing rings so designed that hydraulic pressure will seat the rings against a shoulder in the pump case around the full periphery of the wearing ring. The wearing ring will be locked by dowling to prevent rotating. The rotating element shall use heavy duty grease lubricated ball bearings and shall be equipped with water slingers. Bearing housings shall be so designed to flush the lubricant through the bearing.
8. All packed pumps shall be provided with a lantern ring connected to the pressure side of the fire pump by cored passage in the parting flange of the pump. Stuffing boxes shall be equipped with split packing glands designed for the easy removal for packing inspection and maintenance.
9. The fire pumping unit shall include the following accessories:
 - a. Eccentric tapered suction reducer
 - b. Concentric tapered discharge increaser
 - c. Coupling guard
 - d. Hose valves
 - e. Caps and chains
 - f. Hose valve header
 - g. Pressure gauges
 - h. Circulation relief valve

- i. Automatic air release valve
 - j. Ball drip valve
10. The fire pump motor shall be completely assembled, wired and tested by the manufacturer before shipment from the factory. The fire pump, controller(s) and all accessories shall be purchased under a unit contract. The pump shall be given a complete performance test with Positive Suction Pressure. Certified performance curves for both conditions shall be prepared and submitted for approval prior to shipment. The pump shall also be hydrostatically tested to twice the shutoff pressure, but in no case less than 250 psi.
11. The fire pump manufacturer shall assume unit responsibility and shall provide the services of a factory trained engineer to supervise the fire pump installation and also be available to conduct final field testing and acceptance.

2.12 FIRE PUMP CONTROLLER

- A. The fire pump controller shall be of the combined manual/automatic type equipped with a solid state soft start starter. The controller shall be a completely factory assembled, wired unit, specifically meeting the requirements of NFPA Standard 20 and the National Electrical Code. The controller shall be UL listed and FM approved and supplied in a NEMA Type 3R enclosure. The fire pump controller shall be tested by the manufacturer before shipment from the factory and shall be identified as A Fire Pump Controller.
- B. Limited-service controllers are not permitted.
- C. Provide minimum run timer to prevent short cycling.
- D. The fire pump controller shall be provided with digital readouts of the voltage of each phase, amperage of each phase, and frequency.
- E. The fire pump controller shall monitor [isolation switch open on secondary source, secondary source operation,] fire pump running, loss of phase or line power, and phase reversal. Alarms shall be individually displayed on the front of the fire pump controller by lighting of visual lamps. The fire pump controller shall be equipped with terminals for remote monitoring of secondary power operation, pump running, loss of power and phase reversal.
- F. The fire pump controller shall be provided with voltage surge arrestors installed in accordance with NFPA 20.
- G. The fire pump controller shall be equipped with an USB port for information download. The controller shall be provided with a minimum 3,000 events recorder.
- H. The fire pump controller shall be equipped with an integral automatic transfer switch. The automatic transfer switch shall be factory assembled and packaged as a unit with the fire pump controller. See specification section 263600 for additional automatic transfer switch requirements.
- I. The controller shall have both an isolating switch and a circuit breaker that are motor rated and capable of interrupting the motor locked rotor current. The isolation switch and

circuit breaker assembly shall be mechanically interlocked to operate with a single externally operated handle, with the enclosure door open or closed. The operating assembly shall also be mechanically interlocked to the enclosure door.

- J. The circuit shall be of a type to accommodate a short circuit potential of not less than 100,000 amperes RMS at [208 volts]. The circuit breaker trip functions shall be self-contained within the circuit breaker case and not require additional current transformers or voltage sources to accomplish the trip function. The breaker trip curve adjustments shall be capable of being field tested to verify actual pick-up, locked rotor, and instantaneous trip points, after field installation, without disturbing line or load wiring.
 - K. The complete assembly shall be listed for fire pump service.
 - L. An emergency power disconnect/isolating switch shall be furnished, motor horsepower rated and capable of interrupting the motor locked rotor current. The switch shall be mechanically interlocked with the enclosure door, and operated by a single externally operated handle with the enclosure door open or closed. An auxiliary contact from the switch shall be provided to prevent starting of the emergency generator when the main fire pump controller is being serviced.
 - M. The controller shall have a front mounted "Power On" pilot light, a "Start" and "Stop" push-button, and an "Emergency Run" mechanism. The "Power On" pilot light shall indicate loss of control transformer power as well as line power. An FTA200C factory built-in alarm system shall be provided, giving an audible alarm for "Pump Running" or "Power Failure", and a visual alarm for "Supervisory Power Failure". Additional power failure and pump running alarm contacts shall also be wired to terminals for remote alarm in central fire alarm panel provided by Division-26.
 - N. A pressure switch shall be provided and shall be adjustable. The combined pressure settings, and a minimum differential of 6 psi. A minimum running period timer shall be provided.
 - O. Where required by the Owner's insurance carrier, the controller shall be configured for manual shut-down only. The contractor shall verify the requirement and configure the controller accordingly.
 - P. The fire pump controller shall be manufactured by Master, Firetrol or Sylvania.
- 2.13 JOCKEY (MAKE-UP) PUMP
- A. Pump shall have minimum capacity and electrical characteristics as follows: 5 to 8 GPM, 178 psi and 208 volt, 3 phase.
 - B. Pump shall be equipped with mechanical seals and open drip proof motor.
 - C. Control panel in a NEMA 3R enclosure, shall include fusible disconnect switch, magnetic A-T-L starter, control transformer, H-O-A selector switch, pilot light and necessary circuitry to provide automatic start and stop from pressure switch; pressure relief valve and pressure gauges shall be provided in system.

2.14 PRESSURE SENSING LINE

- A. The fire pump controller and jockey pump controller shall be provided with completely separate pressure sensing lines in accordance with NFPA 20.

2.15 BACKFLOW PREVENTER (FIRE PROTECTION)

- A. Provide double check detector assembly consisting of two independently operated check valves, two resilient wedge gate valves and bypass assembly. Working pressure shall be a minimum of 175 psi (1200 kPa). Flange dimension shall be in accordance with AWWA Class D. The entire assembly, including shutoff valves, shall be UL, FM, and ASSE approved.
- B. Where hydraulic calculations require a reduction in system pressure loss to meet desired conditions, size of backflow preventer shall be increased as required to reduce system losses. Backflow preventer size shall not be less than the connected line size indicated.
- C. Backflow preventer assembly shall be an AMES 3000 SS (Silver Bullet) or equivalent. Pressure losses shall not exceed the documented flow characteristics of the AMES 3000 SS.
- D. Contractor shall verify code compliance of a double check assembly versus a reduced pressure principle backflow preventer. Should the local authority require a reduced pressure type, the reduced pressure assembly shall be **AMES 3000 SS** or equivalent.
- E. Backflow preventer shall be installed by a certified plumbing contractor in accordance with the local plumbing authority.
- F. Backflow preventer shall be supplied and installed with a Howard County owned and supplied bypass meter. Refer to Howard County, Maryland Department of Public Works, Inside Combined Fire/Domestic Water Meter Detail for more information.

PART 3 - EXECUTION

3.1 PIPING INSTALLATIONS

- A. Locations and Arrangements: Drawings (plans, schematics, and diagrams) indicate the general location and arrangement of piping systems. So far as practical, installation of piping shall leave adequate space for work of all other trades.
 - 1. Deviations from approved "Working Plans" for sprinkler piping require written approval of the authority having jurisdiction. Written approval shall be on file with the Architect prior to deviating from the approved "Working Plans."
- B. Install sprinkler piping to provide for system drainage in accordance with the most current edition of NFPA 13.
- C. Use approved fittings to make all changes in direction, branch takeoffs from mains, and reductions in pipe sizes. Branch takeoffs to sprinkler heads shall occur from the top of sprinkler branch piping.

- D. Install unions in pipes 2 inch (50 mm) and smaller, adjacent to each valve. Unions are not required on flanged devices or in piping installations using roll-grooved mechanical couplings.
- E. Install flanges on valves, apparatus, and equipment having 2-1/2 inch (65 mm) and larger connections, unless ductile iron with grooved ends.
- F. Hangers and Supports: In addition to the requirements specified in the Division-22 Section "Hangers and Supports for Plumbing Piping and Equipment," comply with the requirements of the most current editions of NFPA 13 and NFPA 14. Hanger and support spacing and locations for piping joined with roll-grooved mechanical couplings shall be in accordance with the roll-grooved mechanical coupling manufacturer's written instructions, for rigid systems. Provide protection from damage where subject to earthquake in accordance with the most current edition of NFPA 13.
- G. Make connections between underground and above-ground piping using an approved transition piece strapped or fastened to prevent separation.
- H. Provide mechanical sleeve seals at pipe penetrations in basement and foundation walls and penetration seals at openings in fire rated walls, floors and ceilings. Refer to Division-22 Section "Piping Specialties for Plumbing Systems" for description and installation requirements.
- I. Install test connections sized and located in accordance with the most current edition of NFPA 13 complete with shutoff valve. Test connections may also serve as drain pipes.
- J. Install pressure gage on the riser or feed main at or near each test connection. Provide gage with a connection not less than 1/4 inch (6 mm) and having a soft metal seated globe valve, arranged for draining pipe between gage and valve. Install gages to permit removal, and where they will not be subject to freezing.
- K. Piping passing through areas exposed to freezing conditions shall be protected against freezing by insulated coverings, frostproof casings or other reliable means capable of maintaining a minimum temperature of 40°F (4°C). All sprinkler piping, heads, fittings, etc. shall be installed on "warm" side of insulation. Insulation shall be tight with no open joints. Piping shall not touch or be run immediately adjacent to building structural steel. Prior to installing piping in areas exposed to freezing, the contractor shall notify the architect or owner's representative.

3.2 PIPE JOINTS

- A. Welded Joints: AWS B2.1, Level AR-3.
- B. Threaded Joints: Conform to ANSI B1.20.1, tapered pipe threads for field cut threads. Join pipe, fittings, and valves as follows:
 - 1. Note the internal length of threads in fittings or valve ends, and proximity of internal seat or wall, to determine how far pipe should be threaded into joint.
 - 2. Align threads at point of assembly.
 - 3. Apply appropriate tape or thread compound to the external pipe threads.

4. Assemble joint to appropriate thread depth. When using a wrench on valves place the wrench on the valve end into which the pipe is being threaded.
 5. Damaged Threads: Do not use pipe with threads which are stripped, chipped, corroded, or otherwise damaged. If a weld opens during cutting or threading operations, that portion of pipe shall not be used.
- C. Flanged Joints: Align flanges surfaces parallel. Assemble joints by sequencing bolt tightening to make initial contact of flanges and gaskets as flat and parallel as possible. Use suitable lubricants on bolt threads. Tighten bolts gradually and uniformly to appropriate torque specified by the bolt manufacturer.
 - D. Mechanical Roll-Grooved Joints: Roll grooves on pipe ends dimensionally compatible with the couplings.
 - E. End Treatment: After cutting pipe lengths, remove burrs and fins from pipe ends.

3.3 VALVE INSTALLATIONS

- A. General: Install fire protection specialty valves, fittings, and specialties in accordance with the manufacturer's written instructions, the most current editions of NFPA 13 and 14, and the authority having jurisdiction.
- B. Gate Valves: Install supervised-open gate valves so located to control all sources of water supply except fire department connections. Where there is more than one control valve, provide permanently marked identification signs indicating the portion of the system controlled by each valve. Refer to Division-22 Section "Identification for Plumbing Piping and Equipment" for valve tags and signs.
- C. Install check valves in each water supply connection.
- D. Alarm Check Valves: Install valves in the vertical position, or horizontal if allowed by manufacturer in proper direction of flow including the bypass check valve and retard chamber drain line connection. Install valve trim in accordance with the valve manufacturer's appropriate trim diagram. Test valve for proper operation.
- E. Dry-Pipe Valves: Install in the vertical position, or horizontal if allowed by manufacturer in proper direction of flow, in the main supply to the dry-pipe system. Install the basic trim set, priming chamber attachment and fill line attachment in accordance with the manufacturer's written instructions. During hydrostatic test of system piping at pressures in excess of 50 psi, position the clapper in latched wide open position or removed from valve, to prevent injury to the valve. Test valve for proper operation.
- F. Detector Check Valves: Install in proper direction of flow in a location to detect system leakage and unauthorized use of water, and to prevent backflow into public water mains. Install bypass meter, with gate valves on each side of the meter to permit meter removal, and check valve downstream from the meter.
- G. Fire Department Valves: Install 2-1/2 inch (65 mm) fire department valves with quick-disconnect 2-1/2 to 1-1/2 inch (65 mm to 40 mm) reducing coupling and flow restriction device at each standpipe outlet for hose connections.

H. Siamese Installations:

1. Install automatic drip valves at the check valve on the fire department connection to the mains.
2. Install mechanical sleeve seal at pipe penetration in outside walls.

3.4 SPRINKLER HEAD INSTALLATIONS

- A. In areas with acoustical tile ceilings, sprinkler heads shall be installed in the center of the ceiling grid.
- B. Use manufacturer supplied tools to prevent damage during installations and as required to maintain UL Listing/FM Approval.
- C. Sprinkler Heads: Fusible link type, and style as indicated or required by the application. Unless otherwise indicated, provide heads with nominal 1/2 inch (13 mm) discharge orifice, for "Ordinary" temperature range.
- D. Provide high temperature sprinkler heads in equipment spaces where pressure and temperature relief valve(s) are to be installed.
- E. Provide quick response sprinkler heads throughout the building.
- F. For fire pump applications, all sprinkler heads shall be 250 psi (1710 kPa).
- G. Provide NFPA approved sprinkler head guards in all areas subject to potential damage. Sprinkler head guards shall be provided in the following areas and other similar type spaces subject to potential damage: multi-purpose rooms, fitness areas, activity rooms, mechanical rooms, electrical rooms, etc.

3.5 BACKFLOW PREVENTER

- A. Install backflow preventer assemblies in accordance with UL, FM, and ASSE standards, as well as the local plumbing code and the local fire protection authority having jurisdiction.

3.6 FIRE PUMP AND JOCKEY PUMP CONTROLLER

- A. Install fire pump controller and jockey pump controller as required by NFPA 20 and NFPA 70.
- B. For emergency generator applications, control conductors installed between the transfer switch and the generator shall be as follows:
 1. Control wire installation shall comply with NEC Article 695.14 (F).
 2. The control conductors shall be kept entirely independent of all other wiring and shall meet the conditions of NEC Article 695.14 (F).

3. The integrity of the generator remote start circuit shall be monitored for broken, disconnected, or shorted wires. Loss of integrity shall start the generator(s).

3.7 FIELD QUALITY CONTROL

- A. Flush, test, and inspect sprinkler piping systems in accordance with the most current edition of NFPA 13.
- B. Flush, test, and inspect standpipe systems in accordance with the most current edition of NFPA 14.
- C. Replace piping system components which do not pass the test procedures specified, and retest repaired portion of the system.

END OF SECTION 210110

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SECTION 22 01 00 - BASIC PLUMBING REQUIREMENTS

PART 1 - GENERAL

1.1 CONTRACT DOCUMENTS

- A. Unless otherwise modified, provisions of General Conditions, Supplementary Conditions and Division-01 govern work under the Plumbing Divisions.
- B. Contract drawings for plumbing work are diagrammatic, intended to convey scope and general arrangement. Contractor shall review and coordinate routing of new work to clear existing piping, electrical, structure, etc. at no cost to the Owner. All dimensions of existing conditions shall be considered approximate (for information only). All dimensions shall be verified prior to construction.
- C. Contract Document Interpretation/Discrepancies:
 - 1. Should the Contractor discover any discrepancies or omissions on the drawings or in the specifications, he shall notify the Architect/Engineer (A/E) of such conditions prior to the bid date. Otherwise, it will be understood that the drawings and specifications are clear as to what is intended and shall be as interpreted by the A/E.
 - 2. In addition, should any contradiction, ambiguity, inconsistency, discrepancy or conflict appear in or between any of the Contract Documents, the Contractor, shall, before proceeding with the work in question, notify the A/E and request an interpretation. In no case shall he proceed with the affected work until advised by the A/E.
 - 3. If the Contractor fails to make a request for interpretation of discrepancies or conflicts in the drawings or specifications, no excuse will be accepted for failure to carry out the work in a satisfactory manner, as interpreted by the A/E. In all cases, the Contractor will be deemed to have estimated the most stringent materials and methods (i.e. the highest quality materials and most expensive manner of completing the work) unless he has requested and obtained written authorization as to which methods or materials will be required.
 - 4. Each and every trade or subcontractor will be deemed to have familiarized himself with all drawings of this project, including Site/Civil, Architectural, Structural, Mechanical, Electrical, Information Technology, etc. so as to avoid coordination errors, omissions, and misinterpretations. No additional compensation will be authorized for alleged errors, omissions, and misinterpretation, whether they are a result of failure to observe these requirements or not.
- D. The complete set of Architectural, Structural, Civil, Mechanical, and Electrical drawings and specifications apply to this work.

1.2 SCOPE

- A. The work in Division-22 includes furnishing and installing the plumbing systems complete and ready for satisfactory service.
- B. Requirements specified govern work in all sections of Division-22.

1.3 REFERENCES

- A. References to standards, codes, catalogs and recommendations are latest edition in effect on date of invitation to bid.
- B. Refer to applicable contract drawings, specifications and addenda pertaining to other divisions for conditions affecting work.
- C. Refer to Division-01 for description of alternates.
- D. Refer to Division-01 for description of allowance items.
- E. Refer to Division-01 for description of base bid items.

1.4 DEFINITIONS

- A. Following are definitions of terms and expressions used in this Division:
 - 1. "Approve" - to permit use of material, equipment or methods conditional upon compliance with contract document requirements.
 - 2. "Concealed" - hidden from normal sight; includes work in crawl spaces, above ceilings, and in building shafts.
 - 3. "Directed" - directed by Engineer.
 - 4. "Equal, equivalent" - possessing the same performance qualities and characteristics and fulfilling the same utilitarian function.
 - 5. "Exposed" - not concealed.
 - 6. "Indicated" - indicated in Contract Documents.
 - 7. "Piping" - includes pipe, fittings, valves, supports and accessories comprising a system.
 - 8. "Provide" - furnish and install.
 - 9. "Removable" - detachable from the structure or system without physical alteration of materials or equipment or disturbance to other construction.
 - 10. "Review" - limited observation or checking to ascertain general conformance with design concepts and general compliance with contract document requirements.

Such action does not constitute a waiver or alteration of the contract requirements. Verification of quantities and dimensions shall be the responsibility of the Contractor.

11. "Appurtenances" - a device or assembly installed in the referenced system which performs some useful referenced function in the operation, maintenance, servicing, economy or safety of the system. Some examples include, but are not limited to aerators, anchors, supports, gauges, backflow preventers, expansion tanks, filters, flow controls, heat exchangers, interceptors, meters, pressure reducing valves, relief valves, dampers, separators and similar devices.
12. "Record Documents" - drawings, plans and specifications that indicate the nature and location of work reported by Contractors, but not verified by Consultant. Record documents cannot be considered reliable; as they are based on information reported by the Contractor only and is not verified by the Architect or Engineer (A/E).

1.5 RIGGING REQUIREMENTS

- A. Prior to bidding, the Contractor shall verify that all equipment can be physically rigged to the proposed location without disturbance or dismantling of any existing or new physical obstacles. Should the rigging of any new equipment appear to be an issue, the Contractor shall inform the Architect or Engineer (A/E) seven (7) days prior to the bid date that the rigging of the new equipment may present a problem. Otherwise, the Contractor shall, in accordance with the manufacturer's approval and without voiding warranties and/or certifications, have the equipment "broken down" into sections as required to install the equipment in its proposed location without disturbance or dismantling of any existing or new physical obstacles.
- B. Failure to inform the Architect or Engineer (A/E) seven (7) days prior to the bid of any rigging problems will result in the Contractor accepting full responsibility for all modifications to the equipment or the physical obstacles required to install the equipment in its proposed location without additional cost to the Owner.

1.6 CONTRACTOR'S INSTALLATION DRAWINGS

- A. Prior to fabrication and installation, submit shop drawings (min. scale - 1/4" = 1' - 0") illustrating all plumbing piping, lighting fixtures, cable tray, conduit, expansion loops, supports, alignment guides and fire protection coordinated with each other and with the structure. Installation drawings shall be reviewed by Owner's representative prior to fabrication and installation of any new work and prior to the ordering of any plumbing equipment.
- B. Should the Contractor not provide the coordinated installation drawings required above, the following shall apply:
 1. The Contractor shall accept full and absolute responsibility for the coordination of all project materials and equipment to be installed as indicated on the contract documents.

2. Proposed change orders and/or time extensions will not be accepted for any additional work that results from coordination related changes.
 3. A credit shall be issued to the Owner for the value of the coordinated installation drawings; the value of the credit to the Owner shall be as determined by the A/E.
- C. Computer (CADD) files of mechanical drawings (HVAC, plumbing, etc.) will not be made available to the Contractor for use in the preparation of coordinated drawings, shop drawings or any other use.

1.7 MATERIAL, EQUIPMENT AND SUBSTITUTION REQUIREMENTS

- A. Use products of one manufacturer where two or more items of same kind of equipment are required.
- B. Materials and equipment shall have a record of two (2) years successful field use.
- C. Where a specific manufacturer is listed on the drawings, that manufacturer shall be considered the basis of design for that particular item of equipment. Only the basis of design manufacturer has been verified to meet the project requirements (i.e. dimensions, weights, service clearances, electrical requirements, etc.).
- D. Where the drawings and/or specifications indicate more than one manufacturer for a particular item of equipment, only those listed may submit products and services to be included in the work; manufacturers other than those listed will not be acceptable. Should the contractor choose to use one of the specified manufacturers other than the basis of design, it shall be the responsibility of the contractor to verify that the equipment meets all project requirements including, but not limited to, verification of all dimensions, weights, service clearances, electrical requirements, etc. All changes incurred shall be the responsibility of the contractor and shall be provided at no additional cost to the owner.
- E. Substitutions must be submitted for consideration seven (7) days prior to the original bid date. Consideration of substitutions shall be at the sole discretion of the Engineer. Substitution submittals shall include all information required in the "Submittals" paragraph of this specification section, as well as all other requirements indicated through the Division-22 specifications. Substitutions will not mitigate, in any way, the Contractor's responsibility in complying with the coordination, contract requirements or design intent. Any additional electrical, structural or special requirements, etc. shall be the responsibility of the Contractor. Also, any additional cost incurred as a result of substitution shall be the responsibility of the Contractor.
- F. Nameplate: For each piece of power operated plumbing equipment provide a permanent operational data nameplate 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.
- G. Where items of equipment are indicated as Base Bid on the bid form include in the Bid price the cost of providing the equipment upon which the specification is based. In addition, submit with bid for Owner's consideration the amount to be added or deducted from the base bid for other listed manufacturers' equipment. Owner will advise Contractor within forty-five (45) days after award of contract of his selection.

1.8 MATERIAL AND EQUIPMENT LIST

- A. Within thirty (30) days after award of the contract, submit for Engineer's review a list of subcontractors' and manufacturers' names for items proposed for this project.

1.9 SUBMITTALS

- A. Where the drawings and/or specifications indicate more than one allowable manufacturer for a particular piece of equipment and/or product, only those manufacturers indicated may submit products and services to be included in the work. Unless otherwise indicated, manufacturers other than those listed will not be acceptable.
- B. Submit shop drawings, manufacturer's data and certificates for equipment, materials and finish, and pertinent details for each system where specified in each individual section, and obtain approval before procurement, fabrication, or delivery of the items to the job site. Partial submittals are not acceptable and will be returned without review.
- C. Shop Drawings: Drawings shall include floor plans, sectional views, wiring diagrams, and installation details of equipment. Include equipment spaces identifying and indicating proposed location, layout and arrangement of items of equipment, control panels, accessories, piping, ductwork, and other items that must be shown to assure a coordinated installation. Wiring diagrams shall identify circuit terminals, and indicate the internal wiring for each item of equipment and the interconnection between each item of equipment. Drawings shall indicate adequate clearance for operation, maintenance, and replacement of operating equipment devices. If equipment is disapproved, drawings shall be revised to show acceptable equipment and be resubmitted. All equipment and/or products shall be submitted by an authorized factory representative of that particular product.
- D. Manufacturer's Data: Submittals for each manufactured item shall be manufacturer's descriptive literature of cataloged products, equipment drawings, diagrams, performance and characteristic curves, and catalog cuts.
- E. Standards Compliance: When materials or equipment must conform to the standards of organizations such as the American National Standards Institute (ANSI), American Society for Testing and Materials (ASTM), National Electrical Manufacturers Association (NEMA), American Society of Mechanical Engineers (ASME), American Gas Association (AGA), American Refrigeration Institute (ARI), and Underwriters' Laboratories (UL), proof of such conformance shall be submitted to the Engineer for review. If an organization uses a label or listing to indicate compliance with a particular standard, the label or listing will be acceptable evidence, unless otherwise specified in the individual sections. In lieu of the label or listing, the Contractor shall submit a certificate from an independent testing organization, which is competent to perform acceptable testing. The certificate shall state that the item has been tested in accordance with the specified organization's test methods and that the item conforms to the specified organization's standard. For materials and equipment whose compliance with organizational standards or specifications is not regulated by an organization using its own listing or label as proof of compliance, a certificate of compliance from the manufacturer shall be submitted for review. The certificate shall identify the manufacturer, the product, and the referenced standard and shall simply state that the manufacturer certifies that the product conforms to all requirements of the project specification and of the referenced standards listed.

- F. Contractor shall thoroughly review and stamp all submittals to indicate compliance with contract requirements prior to submission and coordinate installation requirements for equipment submitted, including a) the verification of equipment weights relative to the existing and/or new structural support system and b) the verification of equipment dimensions relative to existing and/or new architectural conditions. Contractor shall be responsible for correctness of all submittals.
- G. Submittals will be checked only for general conformance with the design concept and are subject to the original contract documents, as well as any corrections and comments noted. Comments noted, if any, will not be considered a complete list of all omissions, deviations and corrections necessary to meet the requirements of the contract documents. The contractor will be responsible to confirm that the final product and installation will be in conformance with the contract documents in their entirety, including the responsibility to fully coordinate all work with other trades and to confirm the correctness of dimensions, quantities, and capacities. Submittal review does not authorize or constitute a change to the contract requirements and does not release the contractor of responsibility to conform to the contract requirements. Requirements of the contract are not waived by review of any and all substitutions. The contractor must fulfill the terms of the contract.
- H. Compliance Review Form: Each equipment submittal must include a Compliance Review Form formatted as follows:
1. Section 1: Certify that the submittal is in complete compliance with the plans and specifications, except for the numbered and footnoted deviations and exceptions as defined herein. Deviations or exceptions taken in a cover letter or by contradiction or omission shall not constitute a release from the requirement that the equipment be in complete compliance with the plans and specifications.
 2. Section 2: Provide a detailed paragraph by paragraph annotation of the specification with an individual "C", "D", or "E" noted in the margin, as follows:
 - a. "C" shall mean compliance with no exceptions. Provide a numbered footnote (i.e. C1, C2, C3, etc.) for each comment or clarification.
 - b. "D" shall mean compliance with deviations. For each deviation, provide a numbered footnote (i.e. D1, D2, D3, etc.) with a detailed explanation of how the intent of this specification is to be satisfied.
 - c. "E" shall mean exception. The equipment offered is not in compliance with the specifications. For each exception, provide a numbered footnote (i.e. E1, E2, E3, etc.) with a detailed description of the exception.
- I. Electronic Submittals: Should the contractor elect to submit electronic shop drawings/submittals, the procedure shall be as follows:
1. Provide a transmittal with the electronic shop drawing/submittal indicating that the document was transmitted electronically. Transmittal shall also include verification of the contractor's review indicating compliance with the contract documents in accordance with paragraph 1.09.F of this section.
 2. Sequentially number all pages on the electronic shop drawing/submittal. The total number of pages shall be reflected in the transmittal.

3. Submittal review comments shall be transmitted electronically. Large documents will be scanned with comments as necessary and returned electronically.
 4. All shop drawings such as, but not limited to: coordination drawings, ductwork shop drawings, fire alarm drawings, ductbank layouts, etc. shall be submitted in hard copy, full size format.
 5. Provide hard copy of the shop drawing/submittal for each of the Operations and Maintenance Manuals.
 6. Failure to comply with the above will result in the submittal being returned and marked "Not Reviewed".
- J. Submittals will be reviewed for general compliance with design concept in accordance with contract documents. Dimensions, quantities, weights, or other details will not be verified by the A/E; this is the responsibility of the Contractor.
- K. Acceptance will not constitute waiver of contract requirements unless deviations are specifically indicated and clearly noted.
- L. Review Period: BKM shall be allotted two (2) weeks for the processing, review and return of all submittals. It shall be incumbent upon the Contractor to include this time period in their schedule.
1. Resubmittals: BKM shall be allotted an additional two weeks (14 days) for the review of each resubmittal. Again, it shall be the Contractor's responsibility to submit the appropriate materials in a timely fashion.
 2. Contract Extension: No extension in contract time will be authorized as a result of the timeline addressed above.
- M. Submittal Identifications:
1. Place a permanent label or title block on each submittal for identification.
 2. Indicate name of firm or entity that prepared each submittal on label or title block.
 3. Provide a space approximately 4 by 5 inches on label or beside title block to record contractor's review and approval markings and action taken by A/E.
 4. Include the following information on label for processing and recording action taken:
 - a. Project name
 - b. Date
 - c. Name and address of A/E
 - d. Name and address of contractor
 - e. Name and address of subcontractor

- f. Name and address of supplier
 - g. Name of manufacturer
 - h. Unique identifier, including revision number
 - i. Number and title of appropriate specification section
 - j. Drawing number and detail references, as appropriate
 - k. Other necessary identification
 - l. Example: 220700-01-0
 - 1) 220700 references the spec section
 - 2) 01 indicates this is the first submittal from this spec section
 - 3) 0 indicates this is the original submittal (where 1 would indicate this is the first re-submittal)
- N. The engineer will provide a maximum of two (2) submittal reviews per equipment submittal; the initial review plus one (1) re-submittal. Should the re-submittal be returned "Not Acceptable" or "Revise and Resubmit", the contractor shall choose one of the following courses of action:
- 1. Provide the exact manufacturer and model indicated in the contract documents as the basis of design, or
 - 2. Reimburse the engineer for all additional review time required to achieve a submittal review from the engineer of "No Exceptions Taken."
 - 3. Should the contractor choose option 2 above, the engineer shall be reimbursed at an hourly rate of \$175 per hour with payment due prior to the return of the final submittal. In addition, the contractor shall accept complete responsibility for all delays resulting from the submittal review process extending beyond two (2) reviews per equipment submittal.
- O. Resubmittals: Resubmittals shall comply with paragraph 1.09 of this section and the following additional requirements.
- 1. Resubmittals shall include a written response to each submittal comment. Provide a detailed comment by comment annotation of the submittal review comments with an individual "C", "D", or "E" as follows:
 - a. "C" shall mean compliance with no exceptions. Provide a numbered footnote (i.e. C1, C2, C3, etc.) for each comment or clarification.
 - b. "D" shall mean compliance with deviations. For each deviation, provide a numbered footnote (i.e. D1, D2, D3, etc.) with a detailed explanation of how the intent of this specification is to be satisfied.

- c. "E" shall mean exception. The equipment offered is not in compliance with the specifications. For each exception, provide a numbered footnote (i.e. E1, E2, E3, etc.) with a detailed description of the exception.

1.10 MANUFACTURER'S RECOMMENDATIONS

- A. Installation procedures are required to be in accordance with the recommendations of the manufacturer of the material being installed.

1.11 ACCESSIBILITY

- A. Install equipment and materials to provide required access for servicing and maintenance. Coordinate the final location of concealed equipment and devices requiring access with final location of required access panels and doors. Allow ample space for removal of all parts that require replacement or servicing.

1.12 SAFETY REQUIREMENTS

- A. Belts, pulleys, chains, gears, couplings, projecting setscrews, keys, and other rotating parts located so that any person can come in close proximity thereto shall be fully enclosed or properly guarded in accordance with OSHA. High-temperature equipment and piping so located as to endanger personnel or create a fire hazard shall be properly guarded or covered with insulation of a type as specified herein. Items such as catwalks, ladders, and guardrails shall be provided where required for safe operation and maintenance of equipment.

1.13 WORKMANSHIP

- A. Remove and replace, at no extra cost, all work not orderly, reasonably neat, or workmanlike.
- B. Coordinate all work and cooperate with other trades to facilitate execution of work.

1.14 SITE EXAMINATION/EXISTING CONDITIONS VERIFICATION

- A. Failure to visit site and become familiar with existing conditions prior to bidding will not relieve the Contractor of responsibility for complying with the Contract documents.
- B. Contractor shall field verify existing services and direction of flow of piping prior to connection. Existing plumbing identification shall not constitute proper verification of service or direction of flow.

1.15 REGULATIONS AND PERMITS

- A. Comply with all applicable codes and regulations.

- B. All equipment provided shall be in accordance with all applicable local, state, and federal codes, guidelines and standards, as well as the authority having jurisdiction. Equipment and installation shall be in compliance with all applicable energy codes including the most current version of ASHRAE Standard 90.1.
- C. Obtain and pay for all required permits.

1.16 UTILITY CONNECTIONS

- A. Area connection charges for water and sewers will be paid by the Owner.
- B. Application for water meter will be made by the Owner.
- C. Contractor shall include an allowance as identified in Division-01 for providing water meter, vault, and connection to main by Bureau of Water Supply.
- D. Gas Service: Arrange for installation of gas meter and connection to main by gas utility. Pay charges, if required. Gas main extension charges, if any, will be paid by the Owner.
 - 1. All gas installations on and at the Owner's property/building must conform to BGE's construction and installation requirements. Gas meter installation requirements shall include, but not be limited to, the following:
 - a. Meters shall not be installed within three feet (900 mm) of any equipment with an open flame or subject to electric arcing.
 - b. Meters shall not be installed in areas where the clearance from the front of the meter to an opposite wall is less than two feet (600 mm).
 - c. Gas meters shall be installed such that there are four feet (1200 mm) of clearance from the front of the meter to a wall directly opposite where an electric meter is located.
 - d. Outside meters shall not be installed within three feet (900 mm) of an opening used for ventilation.
 - e. Meters shall not be installed in unventilated spaces.
 - f. Meters shall not be installed in places where they may be subject to damage (driveways, sidewalks, etc.) unless suitable traffic protection is provided.
 - g. Contractor shall provide a concrete pad for installation of the gas meter. Pad requirements shall be as required by the gas utility company.
 - 2. Gas conduit installation requirements shall be as follows:
 - a. The following gas conduit specification is acceptable for use on BGE system: UL Schedule 40 DB 60.
 - b. Conduit for gas services (not mains) is required whenever installed in common with electric ducts.

- c. Gas conduit shall not exceed one 45-degree (.785 Radians) bend, and must be terminated a minimum of five feet (1500 mm) from all buildings/structures. No 90-degree (1.57 Radians) bends are permitted.
- d. Only one gas service per conduit is permitted.
- e. Gas conduits will be concrete-encased.
- f. Installation of gas piping into electrical conduit bank is prohibited.
- g. PVC conduit (minimum 4") (minimum 100 mm), solid wall, not split) may be used as a sleeve installed in advance of paving to facilitate future installation of small size (2" and smaller) (50 mm and smaller) gas services where casing is not required. The ends of the sleeve should not be sealed after insertion of the carrier pipe to avoid containment of gas in case of a gas leak. However, the end of the sleeve on a service line nearest the building should be sealed after installation of the carrier pipe and the opposite end of the sleeve left open.
- h. Lengths of continuous runs for gas ducts shall not exceed 450 feet (135 m).
- i. Mechanical joints on gas services are not allowed inside of conduit. Open trench space provision must be made to allow BGE room to make these connections.
- j. Marker tape is required, and must be 12" (300 mm) minimum above all gas conduits.
- k. Required minimum depth of conduits from final grade to top of conduit is 24" (600 mm).
- l. Required vertical separation for gas conduit crossing foreign structures is 12" (300 mm).
- m. Horizontal separation between gas conduit and electric conduit, in common trench, should be 12" (300 mm) minimum.

1.17 CUTTING AND PATCHING

- A. Unless otherwise directed, do all cutting and patching. Damaged work, including fireproofing and waterproofing shall be repaired by skilled mechanics of the trade involved.
- B. Do not cut walls, floors, roofs, reinforced concrete or structural steel without structural Engineer's permission. Install services without affecting reinforcing steel.
- C. In precast concrete plank drill all holes with a Carboly tipped drill. Follow instructions of structural Engineer. Cut no reinforcing bars.

1.18 LINTELS

- A. Under this Section provide all lintels not provided elsewhere which are required for openings for the installations of mechanical and plumbing work. Lintels shall meet the requirements of the structural sections.

1.19 CLEANING UP

- A. Keep premises free from accumulation of debris.
- B. Remove tools, scaffolding, surplus material, debris, and leave premises broom clean.
- C. On discontinuance of part of the work, place all debris in containers and promptly remove them from the Owner's property.
- D. Leave all areas broom clean.
- E. Final clean-up shall be performed.

1.20 AREAS REQUIRING SPECIAL FINISHES/PAINTING

- A. In kitchens, cafeterias, dining rooms, serving pantries and utility rooms [polish chromium or nickel plate] [paint as specified under Painting] all exposed and uninsulated piping including valves, traps, strainers and appurtenant items; and exposed electrical work including conduit, boxes, switches starters and disconnects. Finish shall not be applied to nameplates, pushbuttons. Stainless steel housing and plates require no plating or paints.
- B. Provide surface preparation, priming and painting of all mechanical room floors to provide a smooth, cleanable surface. Primer and paint shall be appropriate for concrete slab surfaces. Where painting over existing surfaces or coatings, follow manufacturer's recommendations for surface preparation, priming and painting. Architectural section "Painting" shall govern the painting installation. Color shall be selected by Architect.

1.21 PROTECTION

- A. Protect mechanical and electrical material and equipment from the elements or other injury as soon as delivered on premises. Protect fixtures as soon as they are set. Board over water closets and post notices prohibiting their use.
- B. Cap or plug openings in equipment, piping and conduit systems to exclude dirt and other foreign material. Rags, wool, cotton, paper, waste or similar materials shall not be used for plugging.
- C. Contractor shall protect all existing mechanical, electrical and architectural equipment, materials, finishes, etc. located within or adjacent to the work environment. Contractor shall be responsible for restoration of all existing mechanical, electrical and architectural items to remain. All equipment to remain must be restored to its pre-existing condition prior to the start of work. Restoration and/or replacement shall be at no cost to the Owner.

- D. Contractor shall provide temporary cooling and heating as required to protect all construction materials from the potential adverse effects of high or low temperature and humidity. Upon delivery of ceiling and other finish materials to a location within the building, environmental conditions in all spaces where the materials will be either stored or installed shall be permanently maintained at 75°F (+2°F) and 50% RH (+5%). Should the HVAC include a reheat system, the reheat system shall be energized to provide temperature and humidity control whenever the HVAC system is energized. Contractor shall pay for all utility, fuel, operational, maintenance and repair costs associated with providing the environmental conditions indicated above until the owner accepts occupancy of the building.

1.22 PIPE TESTING

- A. Prior to the balancing of systems, the mechanical contractor shall air and/or hydrostatically test the following systems in accordance with the latest ASME B31 (ASME Code for Pressure Piping) and NFPA requirements.
 - 1. Air Test:
 - a. Air, Gas
 - 2. Hydrostatic Test:
 - a. Domestic Water
- B. Pressure tests shall also be performed prior to the installation of all insulation materials.
- C. Hydrostatic Test: Provide temporary equipment for testing, including pump and gages. Test piping system before insulation is installed, wherever feasible and remove control devices before testing. Test each natural section of each piping system independently, but do not use piping system valves to isolate sections where test pressure exceeds valve pressure rating. Fill each section with water and pressurize for indicated pressure and time.
 - 1. Required test period is four (4) hours.
 - 2. Hydrostatically test each piping system at 150% of operating pressure indicated, but not less than 100 psi (690 kPa) test pressure.
 - 3. Observe each test section for leakage at end of test period. Test fails if leakage is observed or if pressure drop exceeds less than one percent (1.0%) of test pressure.
 - 4. Upon completion of roughing-in and before setting fixtures, the entire new domestic water system shall be tested. Where a portion of the water piping system is to be concealed before completion, this portion shall be tested separately in a manner described for the entire system.
 - 5. Prior to testing, verify the pressures listed above are in accordance with the latest ASME B31 code and NFPA. Should a discrepancy exist between the ASME B31 code, NFPA, and/or the pressures indicated above, contact the Engineer prior to testing.

D. Air Test:

1. Air, gas piping shall be air tested at 200 psi (1380 kPa).
2. Prior to testing, verify the pressures listed above are in accordance with the latest ASME B31 code and NFPA. Should a discrepancy exist between the ASME B31 code, NFPA, and/or the pressures indicated above, contact the Engineer prior to testing.

E. Sanitary and Storm Water Piping Systems:

1. All soil, waste, vent and storm water piping shall be tested by the Contractor and reviewed by the Architect before acceptance. All piping located underground shall be tested before backfilling. The costs of all equipment required for tests are to be included under the contract price.
2. The entire new drainage system and venting system shall have all necessary openings plugged and filled with water to the level of the highest vent stack above the roof. The system shall hold this water for four (4) hours without showing a drop in water level. Where a portion of the system is to be tested, the test shall be conducted in the same manner as described for the entire system, except a vertical stack 10 feet (3000 mm) above the highest horizontal line to be tested may be installed and filled with water to maintain sufficient pressure, or a pump may be used to supply the required pressure.

F. Drain test water from piping systems after testing and repair work has been completed.

G. Repair piping systems sections which fail required piping test, by disassembly and re-installation, using new materials to extent required to overcome leakage. Do not use chemicals, stop-leak compounds, mastics, or other temporary repair methods.

1.23 CLEANING OF SYSTEMS

A. After satisfactory completion of pressure tests and before permanently connecting fixtures, equipment, traps, strainers and other accessory items, thoroughly clean all systems. Blow out and flush piping until interiors are free of foreign matter.

B. Flush piping in recirculating water systems to remove all cutting oil, excess pipe joint compound and other foreign materials. Furnish necessary temporary pumping equipment to thoroughly clean the water piping. Do not use any system pump until after cleaning and flushing has been accomplished to the satisfaction of the Engineer. Employ chemical cleaners, including a non-foaming detergent, not harmful to system components. After cleaning operation, final flushing and refilling the residual alkalinity shall not exceed 300 parts per million. Work shall be performed or supervised by a qualified water treatment service company with personnel skilled in the safe and proper use of chemicals and in testing procedures. After completion, submit a certificate of completion to Engineer stating name of the service company used.

C. Leave strainers and dirt pockets in clean condition.

- D. Should any system become clogged with construction refuse after acceptance, the contractor shall pay for all labor and materials required to locate and remove the obstruction and replace and repair work disturbed.
- E. Thoroughly clean plumbing fixture using non-scratching cleaners. Polish chromium plated work.
- F. Leave all systems clean, and in complete running order.
- G. Disinfect potable water systems as prescribed by local code. Take precautions to avoid use of fixtures during disinfection period.
- H. Equipment that has been subjected to the elements shall be cleaned of all rust, dirt and debris and repainted to match original finish.

1.24 FUNCTIONAL PERFORMANCE TESTING AND VERIFICATION

- A. General: In addition to the tests required during and after installation of all mechanical systems, as well as any other formal commissioning requirements, the Contractor shall perform functional performance tests to verify that all systems are designed, installed, calibrated and adjusted to perform as required in the Contract.
- B. Comply with all applicable specification sections including, but not be limited to, "Basic Plumbing Requirements", "Testing, Adjusting and Balancing", "Automatic Temperature Controls" and "Commissioning", where applicable.
- C. Prior to functional performance testing, all indicating, recording and control devices shall be calibrated. A verification calibration report shall be provided with the final test report.
- D. Provide functional performance testing to verify proper operation of each and every control sequence indicated throughout the contract documents.
- E. Failure of Tests: Should any test, verification, or demonstration fail to meet the specification requirements, the component of the system causing the failure shall be repaired, replaced or readjusted. The failed test, verification, or demonstration shall then be repeated.
- F. A "Functional Performance Test Verification Form" is included at the end of Section 230900. This form (electronic version is available upon request) shall be completed for all mechanical equipment provided under this contract.
- G. Test Report: Upon satisfactory verification of calibration and functional performance tests, a copy of the final test results shall be bound in the operations and maintenance manual. The final report shall also include a full compliance statement, on company letterhead, indicating that all systems are installed and functioning per the contract requirements including drawings, specifications, control sequences and accepted submittals.
- H. The mechanical systems shall not be considered complete until all functional performance verification forms, calibration reports and compliance statement have been submitted and reviewed. Submit in accordance with the submittal requirements indicated elsewhere in these specifications.

1.25 OPERATING AND MAINTENANCE MANUAL

- A. Submit Operation and Maintenance Manuals in three-ring binders with each section separated by tab dividers. Include protective plastic sleeves for any software or folded large documents submitted.
- B. At a minimum, the manual shall contain the following:
 - 1. Title page
 - 2. Table of contents
 - 3. Contractor and sub-contractor contact information
 - 4. Supplier contact information for all plumbing equipment
 - 5. Copies of manufacturer's and contractor's warranty information (project and equipment) for all plumbing equipment.
 - 6. Submittal log for all plumbing equipment
 - 7. One (1) reviewed copy of each shop drawing or submittal incorporating all A/E and owner submittal review comments.
 - 8. Copy of inspector acceptance certificates / documents.
 - 9. Provide an 11 x 17 fold-out drawing of each floor plan and indicate locations of system shutoff valves.
 - 10. All pipe and equipment pressure test reports complete with 11 x 17 fold-out drawing, indicating all systems tested.
 - 11. Maintenance procedures for each item of plumbing equipment to include frequency and type of maintenance, spare parts and attic/stock list. This shall include the manufacturer's literature indicating operating and maintenance instructions, parts list, illustrations and diagrams.
 - 12. Valve tag chart
 - 13. Mechanical systems functional performance verification forms, calibration reports and compliance statement indicating that all systems are installed and functioning per the contract requirements.
- C. The O & M Manuals shall be submitted to the A/E for review of general conformance.

1.26 TOOLS AND LUBRICANTS

- A. Furnish and turn over to the Owner, special tools not readily available commercially, that are required for disassembly or adjustment of equipment and machinery furnished.

- B. Grease Guns with Attachments for Applicable Fittings: One for each type of grease required for each motor or other equipment.
- C. Tool Containers: Hardwood or metal, permanently identified for intended service and mounted, or located, where directed by the Owner.
- D. Lubricants: A minimum of one quart (.9 L) of oil, and one pound (450 g) of grease, of equipment manufacturer's recommended grade and type, in unopened containers and properly identified as to use for each different application.

1.27 FIELD INSTRUCTION

- A. Upon completion of work, instruct Owner's representative in the proper operation and maintenance of the plumbing and electrical systems.
- B. Instruction periods specified below shall be in addition to instruction specified for certain items elsewhere in the specifications.
- C. Instructions shall be given by persons expert in the operation and maintenance and shall be for a period of not less than . one . eight hour days.
- D. Prepare statement(s) for signing by Owner's representative indicating date of completion of instructions and hours expended. Furnish copy of signed statement to Engineer.
- E. Final demonstration of all plumbing equipment shall be recorded in DVD compatible format. Provide DVD's to the Owner.

1.28 RECORD DOCUMENTS

- A. The Contractor shall maintain a record set of plumbing prints at the project site and shall indicate thereon any changes made to the contract drawings, including, but not limited to addenda, field sketches, RFI responses, supplemental drawings, sketches, etc. Where changes are made that are reflective of supplemental instructions, revisions, RFI responses, etc., the Contractor shall make clear references to those changes.
- B. A separate set of neat, legible mechanical contract prints shall be kept at the project site at all times during the construction of the work for the express purpose of showing any and all changes indicated in paragraph A. above. The prints shall be marked up daily showing all changes to the original documents. The prints shall be marked up in a neat, legible manner using a red pen. Periodic review of the Record Documents will be conducted by the Owner's Representative or A/E. Should this review indicate that the Record Documents are deficient or not up to date, the Contractor shall immediately bring the documents into compliance and make the corrections
- C. Upon completion of the project and before final close-out, the Contractor shall be responsible for producing a final set of record documents in electronic CADD format. One (1) set of full size prints, one (1) CD of the electronic CADD drawings (in AutoCad and pdf format), along with the red-lined marked up field set shall be delivered to the owner upon completion. If requested, the electronic CADD documents shall be up-loaded to the owner's FTP site. The final CADD documents shall indicate in the title or revision block "RECORD DOCUMENTS" along with the date completed. The electronic format

shall be compatible with the owner's preferred version of AutoCad. Coordinate with the owner before producing the CD or up-loading to the FTP site. Not acceptable are contractor installation drawings, shop drawings or multi-layers of work on a single drawing. The final as-built product shall mirror the contract bid documents using the project page layout, format and project title block.

- D. Computer (CADD) files of plumbing drawings will be made available to the Contractor upon receipt of a signed waiver (available upon request). One CD will be made available to the general contractor or construction manager for distribution to the trades.
- E. Should the Contractor's electronic Record Documents not be considered complete, they will be returned for completion and/or correction.

1.29 LEAD FREE COMPLIANCE

- A. Lead Free Compliance: All components associated with potable water systems (including, but not limited to, valves, end use devices/fixtures, pipe, pipe fittings, solder/flux, etc.) shall be "lead-free" in accordance with all local, state and federal codes, as well as NSF/ANSI 372 (NSF 61-G).

1.30 GUARANTEE/WARRANTY

- A. Each Contractor shall furnish a guarantee covering all labor and materials furnished by him for a period of two (2) years from the date of final acceptance of his work, and he shall agree to repair and make good at his own expense any and all defects which may appear in his work during that time if, in the judgment of the Engineer, such defects arise from defective workmanship and/or imperfect or inferior material.
- B. The above shall not in any way void or abrogate equipment manufacturer's guarantee or warranty. Certificates of guarantee shall be delivered to the Owner.
- C. Within the two (2) year warranty/guarantee period, manufacturer's recommended maintenance shall be provided by the Contractor.

1.31 PIPING LEAKAGE TEST FORMS

- A. Contractor shall submit piping leakage test results to the A/E within 72 hours of completed tests. Only test results that meet the specified leakage requirements shall be submitted. Piping test results shall be recorded on the "Piping Leakage Test Summary Form (Plumbing)" located at the end of this section; no other forms will be accepted. In addition, the pipe leakage submittals shall include 11x17 drawing(s) as required to clearly indicate the full extent of the piping test section (each piping test section shall be numbered and color coded).

PART 2 - PRODUCTS

Not Applicable

PART 3 - EXECUTION

Not Applicable

END OF SECTION 22 01 00

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PIPING LEAKAGE TEST SUMMARY FORM
(PLUMBING)

Project Name: _____ Project Number: _____ Page _____ of _____

System Tested	Sections Tested (1)	System Operating Pressure	Test Pressure (PSI/FT-HD) (2)	Duration (3)	Pressure Drop (4)	Pass/Fail

Name of Testing Agency/Company: _____
 Date of Test(s): _____
 Test Conducted By (Print/Sign): _____

- (1) Identified by an 11 x 17 numbered and color coded test section plan. Plan shall accompany this test report.
- (2) 150% of operating pressure but not less than 100 psi , 200 psi for air-gas-vacuum, 10 ft. static head pressure or to the maximum rating of the joint. Include joint cut sheets showing their ratings.
- (3) Four (4) hours minimum.
- (4) Shall not exceed 0.0%.

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SECTION 22 02 00 - PROJECT CLOSEOUT PLUMBING

PART 1 - GENERAL

1.1 SUMMARY

- A. This section provides a summary of the primary mechanical project closeout activities, however, this section does not attempt to address all project closeout requirements. Closeout activities referenced in this section include the following:

1. Pressure Testing
2. Start-up
3. Punch-out Procedures
4. Testing, Adjusting and Balancing
5. Functional Performance Testing and Verification
6. Operation and Maintenance Manuals (O & M Manuals)
7. Demonstration and Training
8. Record Documents
9. Close-out Documents

- B. This Section shall not supersede any other close-out section or requirements of the Contract. Refer to other Divisions of the specifications and the General Requirements of the Contract for further instructions.

PART 2 - PRODUCTS

Not Applicable

PART 3 - EXECUTION

3.1 PRESSURE TESTING

- A. Piping: The Contractor shall perform pressure testing on all piping systems.
- B. Final pressure test results shall be submitted as a separate project submittal for review and included with the Test and Balance Report. Upon review for general conformance, include all pressure tests in the O & M Manual.

- C. All factory performed equipment test results shall be included in the final O & M Manuals.
- D. Where re-tests were required, indicate remedial action taken and submit in test report.

3.2 START-UP

- A. The Contractor shall perform start-up on each piece of mechanical equipment as specified in each section of Division-22.
- B. Where indicated in each section of Division-22, the services of a factory authorized and certified technician shall be required to perform the equipment start-up. Start-up by any other organization other than as required by the manufacturer is unacceptable.
- C. Start-up reports shall be provided for all equipment and be included in the final O & M Manuals.

3.3 PUNCH-OUT PROCEDURES

- A. Preliminary Punch-out:
 - 1. Prior to requesting an inspection from the Owner, Engineer, or Permit Official, the General Contractor or Construction Manager (GC or CM) shall provide a preliminary punch-out of the area in question.
 - 2. Once completed, their punch list shall be supplied to each trade for corrections and completion. The punch list shall also be provided to the Engineer for their use.
 - 3. Upon being informed that the trade contractors have addressed all of the outstanding items, the GC / CM shall backcheck the work and update the punch list.
- B. Final Punch-out:
 - 1. Final punch-out by the engineer shall not commence until the GC or CM has exhausted their review and has signed off on all items.
 - 2. A copy of the sign-off shall be provided to the Engineer for their record.
 - 3. Once the above has been completed, the Engineer shall be notified that the work is substantially complete and ready for a final punch-out.
 - 4. Depending on the size, schedule, and project complexity, punch-outs may be requested for specific areas or systems, rather than the facility as a whole. Examples of specific requests include the following:
 - a. Above ceiling
 - b. Mock-ups for any repetitive installation to confirm acceptance prior to continuing (apartment, etc.)
 - c. Equipment rooms

- C. Upon completion of any and all punch lists (i.e. above ceiling, final, partial, phased, factory review, or specific item) the contractor shall provide an item by item sign-off indicating the date and who completed the item. The sign-off shall be submitted to the A/E and owner before final payment is processed. Should the contractor disagree with any item, they shall provide a written exception giving reason for review.

3.4 TESTING, ADJUSTING AND BALANCING

- A. Comply with all provisions of Division-23 Section, "Testing, Adjusting and Balancing" (TAB) for the systems listed, but not limited to, the following:
 - 1. Domestic hot water recirc pump and associated balance valves
- B. TAB reports shall be submitted as a separate project submittal for review. Upon review for general conformance, include the final TAB report in the O & M Manual.

3.5 FUNCTIONAL PERFORMANCE TESTING AND VERIFICATION

- A. General: In addition to the tests required during and after installation of all mechanical systems, as well as any other formal commissioning requirements, the Contractor shall perform functional performance tests to verify that all systems are designed, installed, calibrated and adjusted to perform as required in the Contract.
- B. Comply with all applicable specification sections including, but not be limited to, "Basic Plumbing Requirements", "Testing, Adjusting and Balancing", "Automatic Temperature Controls" and "Commissioning", where applicable.
- C. Prior to functional performance testing, all indicating, recording and control devices shall be calibrated. A verification calibration report shall be provided with the final test report.
- D. Provide functional performance testing to verify proper operation of each and every control sequence indicated throughout the contract documents.
- E. Failure of Tests: Should any test, verification, or demonstration fail to meet the specification requirements, the component of the system causing the failure shall be repaired, replaced or readjusted. The failed test, verification, or demonstration shall then be repeated.
- F. A "Functional Performance Test Verification Form" is included at the end of Section 230900. This form (electronic version is available upon request) shall be completed for all mechanical equipment provided under this contract.
- G. Test Report: Upon satisfactory verification of calibration and functional performance tests, a copy of the final test results shall be bound in the operations and maintenance manual. The final report shall also include a full compliance statement, on company letterhead, indicating that all systems are installed and functioning per the contract requirements including drawings, specifications, control sequences and accepted submittals.
- H. The mechanical systems shall not be considered complete until all functional performance verification forms, calibration reports and compliance statement have been

submitted and reviewed. Submit in accordance with the submittal requirements indicated elsewhere in these specifications.

3.6 OPERATION AND MAINTENANCE MANUALS

A. Submit Operation and Maintenance Manuals in three-ring binders with each section separated by tab dividers. Include protective plastic sleeves for any software or folded large documents submitted.

B. At a minimum, the manual shall contain the following:

1. Title page
2. Table of contents
3. Contractor and sub-contractor contact information
4. Supplier contact information for all mechanical equipment
5. Copies of manufacturer's and contractor's warranty information (project and equipment) for all mechanical equipment.
6. Submittal log for all mechanical equipment
7. One (1) reviewed copy of each shop drawing or submittal incorporating all A/E and owner submittal review comments.
8. Copy of inspector acceptance certificates / documents.
9. Provide an 11 x 17 fold-out drawing of each floor plan and indicate locations of system shutoff valves.
10. All pipe and equipment pressure test reports complete with 11 x 17 fold-out drawing, indicating all systems tested.
11. Final Test and Balance (TAB) Reports. Do not include reports that have not been accepted by the A/E. Pencil or partial copies will not be acceptable.
12. Maintenance procedures for each item of mechanical equipment to include frequency and type of maintenance, spare parts and attic/stock list. This shall include the manufacturer's literature indicating operating and maintenance instructions, parts list, illustrations and diagrams.
13. Valve tag chart
14. Mechanical systems functional performance verification forms, calibration reports and compliance statement indicating that all systems are installed and functioning per the contract requirements.

C. The O & M Manuals shall be submitted to the A/E for review of general conformance.

3.7 DEMONSTRATION AND TRAINING

- A. Upon completion of work, instruct the owner's representative in the proper operation and maintenance of each mechanical system in accordance with applicable specification sections.
- B. Instructions shall be given by persons expert in the operation and maintenance of each system / equipment.
- C. Prepare statement(s) for signing by Owner's representative indicating the date of completion of instructions and hours expended. Furnish copies of signed statements to the A/E.
- D. Final demonstration of all mechanical equipment shall be recorded in DVD compatible format. Provide DVDs to the Owner.

3.8 RECORD DOCUMENTS

- A. The Contractor shall maintain a record set of plumbing prints at the project site and shall indicate thereon any changes made to the contract drawings, including, but not limited to addenda, field sketches, RFI responses, supplemental drawings, sketches, etc. Where changes are made that are reflective of supplemental instructions, revisions, RFI responses, etc., the Contractor shall make clear references to those changes.
- B. A separate set of neat, legible mechanical contract prints shall be kept at the project site at all times during the construction of the work for the express purpose of showing any and all changes indicated in paragraph A. above. The prints shall be marked up daily showing all changes to the original documents. The prints shall be marked up in a neat, legible manner using a red pen. Periodic review of the Record Documents will be conducted by the Owner's Representative or A/E. Should this review indicate that the Record Documents are deficient or not up to date, the Contractor shall immediately bring the documents into compliance and make the corrections
- C. Upon completion of the project and before final close-out, the Contractor shall be responsible for producing a final set of record documents in electronic CADD format. One (1) set of full size prints, one (1) CD of the electronic CADD drawings (in AutoCad and pdf format), along with the red-lined marked up field set shall be delivered to the owner upon completion. If requested, the electronic CADD documents shall be up-loaded to the owner's FTP site. The final CADD documents shall indicate in the title or revision block "RECORD DOCUMENTS" along with the date completed. The electronic format shall be compatible with the owner's preferred version of AutoCad. Coordinate with the owner before producing the CD or up-loading to the FTP site. Not acceptable are contractor installation drawings, shop drawings or multi-layers of work on a single drawing. The final as-built product shall mirror the contract bid documents using the project page layout, format and project title block.
- D. Computer (CADD) files of plumbing drawings will be made available to the Contractor upon receipt of a signed waiver (available upon request). One CD will be made available to the general contractor or construction manager for distribution to the trades.
- E. Should the Contractor's electronic Record Documents not be considered complete, they will be returned for completion and/or correction.

3.9 CLOSEOUT DOCUMENTS

- A. Prior to Substantial Completion and /or Final Payment, the Contractor shall prepare and submit the following:
1. Final punch lists indicating completion of all items
 2. All record drawings
 3. All record specifications
 4. Operation and Maintenance Manuals
 5. Complete final cleaning
 6. Remove temporary facilities and complete site restoration

END OF SECTION 22 02 00

SECTION 22 05 00 - BASIC PLUMBING MATERIALS AND METHODS

PART 1 - GENERAL

1.1 CONTRACT DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-01 Specification Sections, apply to this Section.
- B. Requirements specified in all Division-22 sections apply to this Section.

1.2 SUMMARY

- A. This Section includes limited scope general construction materials and methods for application with mechanical installations as follows:
 - 1. Mechanical equipment nameplate data.
 - 2. Firestopping: Provide seals for all openings through fire-rated walls, floors, or ceilings used as passage for mechanical and electrical components such as piping, conduit, etc.
 - 3. Excavation for underground utilities and services, including underground piping (under the building and from building to utility connection), tanks, basins, and equipment up to five (5) feet (1500 mm) outside the building.
 - 4. Miscellaneous metals for support of mechanical materials and equipment.
 - 5. Wood grounds, nailers, blocking, fasteners, and anchorage for support of mechanical materials and equipment.
 - 6. Joint sealers for sealing around mechanical materials and equipment; and for sealing penetrations in fire and smoke barriers, floors, and foundation walls.
 - 7. Access panels and doors in walls, ceilings, and floors for access to mechanical materials and equipment.

1.3 DEFINITIONS

- A. The following definitions apply to excavation operations:
 - 1. Additional Excavation: Where excavation has reached required subgrade elevations, if unsuitable bearing materials are encountered, continue excavation until suitable bearing materials are reached. The Contract Sum may be adjusted by an appropriate Contract Modification.

2. Subbase: As used in this Section refers to the compacted soil layer used in pavement systems between the subgrade and the pavement base course material.
3. Subgrade: As used in this Section refers to the compacted soil immediately below the slab or pavement system.
4. Unauthorized excavation consists of removal of materials beyond indicated subgrade elevations or dimensions without specific direction from the Architect.

B. The following definitions apply to firestopping:

1. Assembly: Particular arrangement of materials specific to given type of construction described or detailed in referenced documents.
2. Barriers: Time rated fire walls, smoke barrier walls, time rated ceiling/floor assemblies and structural floors.
3. Firestopping: Methods and materials applied in penetrations and unprotected openings to limit spread of heat, fire, gases and smoke.
4. Penetration: Opening or foreign material passing through or into barrier or structural floor such that full thickness of rated materials is not obtained.
5. Construction Gaps: Gaps between adjacent sections of walls, exterior walls, at wall tops between top of wall and ceiling, and structural floors or roof decks; and gaps between adjacent sections of structural floors.
6. System: Specific products and applications classified and numbered by Underwriters Laboratories, Inc. to close specific barrier penetrations.
7. Sleeve: Metal fabrication or pipe section extending through thickness of barrier and used to permanently guard penetration. Sleeves are described as part of penetrating system in other sections and may or may not be required.

1.4 SUBMITTALS

- A. General:** Submit the following in accordance with Conditions of Contract and Division-01 Specification Sections.
- B. Product data for the following products:**
 1. Access panels and doors
 2. Joint sealers
- C. Firestopping:** Indicate dimensions, description of materials and finishes, general construction, specific modifications, component connections, anchorage methods, hardware, and installation procedures.
 1. Provide details of each proposed assembly identifying intended products and applicable UL system number, or UL classified devices.

2. Provide drawings relating to non-standard applications as needed.
- D. Shop drawings detailing fabrication and installation for metal fabrications, and wood supports and anchorage for mechanical materials and equipment.
 - E. Coordination drawings for access panel and door locations in accordance with Division-22 sections.
 - F. Samples of joint sealer, consisting of strips of actual products showing full range of colors available for each product.
 - G. Welder certificates, signed by Contractor, certifying that welders comply with requirements specified under "Quality Assurance" article of this Section.
 - H. Schedules indicating proposed methods and sequence of operations for selective demolition prior to commencement of Work. Include coordination for shut-off of utility services and details for dust and noise control.
1. Coordinate sequencing with construction phasing and Owner occupancy specified in Division-01 Section "Summary of Work."

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Engage an Installer for the installation and application of joint sealers, access panels and doors, and firestopping materials with at least two years' experience with installations.
- B. Qualify welding processes and welding operators in accordance with AWS D1.1 "Structural Welding Code - Steel."
- C. Certify that each welder has satisfactorily passed AWS qualification tests for welding processes involved and, if pertinent, has undergone recertification.
- D. Fire-Resistance Ratings: Where a fire-resistance classification is indicated, provide access door assembly with panel door, frame, hinge, and latch from manufacturer listed in the UL "Building Materials Directory" for rating shown.
 1. Provide UL Label on each fire-rated access door.
- E. Local and State Regulatory Requirements: Submit forms or acceptance for proposed assemblies not conforming to specific UL firestop system numbers, or UL classified devices.
- F. Lead Free Compliance: All components associated with potable water systems (including, but not limited to, valves, end use devices/fixtures, pipe, pipe fittings, solder/flux, etc.) shall be "lead-free" in accordance with all local, state and federal codes, as well as NSF/ANSI 372 (NSF 61- G).

1.6 DELIVERY, STORAGE AND HANDLING

- A. Deliver joint sealer materials in original unopened containers or bundles with labels informing about manufacturer, product name and designation, color, expiration period for use, pot life, curing time, and mixing instructions for multi-component materials.
- B. Store and handle joint sealer materials in compliance with the manufacturers' recommendations to prevent their deterioration and damage.

1.7 PROJECT CONDITIONS

- A. Conditions Affecting Excavations: The following project conditions apply:
 - 1. Maintain and protect existing building services which transit the area affected by selective demolition.
 - 2. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by excavation operations.
 - 3. Site Information: Subsurface conditions were investigated during the design of the Project. Reports of these investigations are available for information only; data in the reports are not intended as representations or warranties of accuracy or continuity of conditions. The Owner will not be responsible for interpretations or conclusions drawn from this information.
 - 4. Existing Utilities: Locate existing underground utilities in excavation areas prior to excavation. If utilities are indicated to remain, support and protect services during excavation operations.
 - 5. Uncharted or Incorrectly Charted Utilities: Contact utility owner immediately for instructions.
 - 6. Provide temporary utility services to affected areas. Provide minimum of 48-hour notice to Architect prior to utility interruption.
 - 7. Use of explosives is not permitted.
- B. Environmental Conditions: Apply joint sealers under temperature and humidity conditions within the limits permitted by the joint sealer manufacturer. Do not apply joint sealers to wet substrates.

1.8 SEQUENCE AND SCHEDULING

- A. Coordinate the shut-off and disconnection of utility services with the Owner and the utility company.
- B. Notify the Architect at least five (5) days prior to commencing demolition operations.
- C. Perform demolition in phases as indicated.

PART 2 - PRODUCTS

2.1 MECHANICAL EQUIPMENT NAMEPLATE DATA

- A. Nameplate: For each piece of power operated mechanical equipment provide a permanent operational data nameplate 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.

2.2 FIRESTOPPING

- A. All penetrations through fire barriers shall be firestopped with an approved material that is capable of maintaining the fire resistance rating of the barrier. All firestop sealants shall conform to ASTM E 814, ASTM E 119, UL 1479, UL 2079 CAN/ULC S115, and CAN/ULC S101.
- B. Firestop material shall be latex based, intumescent caulk intended for use for all thru-penetrations with piping, cable trays, conduit, and cables.
- C. When exposed to high temperatures or fires, the caulk shall expand in volume to quickly close off voids left by melting or burning construction materials. Caulk shall be applied by a standard caulk gun and remain flexible after curing.
- D. Acceptable products shall be limited to Johns Manville "Firetemp-C1," Hilti "FS-One," or 3M "CP25WB+." Coordinate with General Contractor such that a single manufacturer/product is utilized throughout the project for all fire and smoke stopping materials.

2.3 SMOKE STOPPING

- A. All penetrations through smoke barriers, smoke partitions, or any other surface required to resist the passage of smoke shall be provided with a smoke stop sealant and/or system that has been independently tested to provide an acceptable smoke seal that will resist the passage of smoke. Smoke stop systems (including product and installation) shall conform to all applicable standards (including but not limited to ASTM, UL and NFPA), as well as all other local, state or federal requirements.
- B. Acceptable manufacturers shall be limited to the manufacturers that may provide firestopping materials/systems (see paragraph 2.02 of this section). Coordinate with the General Contractor such that a single manufacturer/product is utilized throughout the project for all fire and smoke stopping materials.

2.4 SOIL MATERIALS

- A. Subbase Material: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, crushed slag, or natural or crushed sand.

- B. Drainage Fill: Washed, evenly graded mixture of crushed stone, or crushed or uncrushed gravel, with 100 percent passing a 1-1/2-inch (40 mm) sieve, and not more than 5 percent passing a No. 4 sieve.
- C. Backfill and Fill Materials: Materials complying with ASTM D2487 soil classification groups GW, GP, GM, SM, SW, and SP; free of clay, rock, or gravel larger than 2 inches (150 mm) in any dimension; debris; waste; frozen materials; and vegetable and other deleterious matter.

2.5 MISCELLANEOUS METALS

- A. Steel plates, shapes, bars, and bar grating: ASTM A 36.
- B. Cold-Formed Steel Tubing: ASTM A 500.
- C. Hot-Rolled Steel Tubing: ASTM A 501.
- D. Steel Pipe: ASTM A 53, Schedule 40, welded.
- E. Non-shrink, Non-metallic Grout: Premixed, factory-packaged, non-staining, non-corrosive, non-gaseous grout, recommended for interior and exterior applications.
- F. Fasteners: Zinc-coated, type, grade, and class as required.

2.6 MISCELLANEOUS LUMBER

- A. Framing Materials: Standard Grade, light-framing-size lumber of any species. Number 3 Common or Standard Grade boards complying with WCLIB or AWPA rules, or Number 3 boards complying with SPIB rules. Lumber shall be preservative treated in accordance with AWPB LP-2, and kiln dried to a moisture content of not more than 19 percent.
- B. Construction Panels: Plywood panels; APA C-D PLUGGED INT, with exterior glue; thickness as indicated, or if not indicated, not less than 15/32 inches (12 mm).

2.7 JOINT SEALERS

- A. General: Joint sealers, joint fillers, and other related materials compatible with each other and with joint substrates under conditions of service and application.
- B. Colors: As selected by the Architect from manufacturer's standard colors.
- C. Elastomeric Joint Sealers: Provide the following types:
 - 1. One-part, nonacid-curing, silicone sealant complying with ASTM C 920, Type S, Grade NS, Class 25, for uses in non-traffic areas for masonry, glass, aluminum, and other substrates recommended by the sealant manufacturer.
 - 2. One-part, mildew-resistant, silicone sealant complying with ASTM C 920, Type S, Grade NS, Class 25, for uses in non-traffic areas for glass, aluminum, and

nonporous joint substrates; formulated with fungicide; intended for sealing interior joints with non-porous substrates; and subject to in-service exposure to conditions of high humidity and temperature extremes.

- D. Acrylic-Emulsion Sealants: One-part, non-sag, mildew-resistant, paintable complying with ASTM C 834 recommended for exposed applications on interior and protected exterior locations involving joint movement of not more than plus or minus 5 percent.
- E. Fire-Resistant Joint Sealers: Two-part, foamed-in-place, silicone sealant formulated for use in through-penetration fire-stopping around cables, conduit, pipes through fire rated walls and floors. Sealants and accessories shall have fire resistance ratings indicated, as established by testing identical assemblies in accordance with ASTM E 814, by Underwriters' Laboratories, Inc., or other testing and inspection agency acceptable to authorities having jurisdiction.

2.8 ACCESS DOORS

- A. Steel Access Doors and Frames: Factory-fabricated and assembled units, complete with attachment devices and fasteners ready for installation. Joints and seams shall be continuously welded steel, with welds ground smooth and flush with adjacent surfaces.
- B. Frames: 16-gage (1.6 mm) steel, with a 1-inch (25 mm) wide exposed perimeter flange for units installed in unit masonry, pre-cast, or cast-in-place concrete, ceramic tile, or wood paneling.
 - 1. For Installation in Masonry, Concrete, Ceramic Tile, or Wood Paneling: 1-inch (25 mm) wide exposed perimeter flange and adjustable metal masonry anchors.
 - 2. For Gypsum Wallboard or Plaster: Perforated flanges with wallboard bead.
 - 3. For Full-Bed Plaster Applications: Galvanized expanded metal lath and exposed casing bead, welded to perimeter of frame.
- C. Flush Panel Doors: 14-gage (2 mm) sheet steel, with concealed spring hinges or concealed continuous piano hinge set to open 175 degrees (3.05 Radians); factory-applied prime paint.
 - 1. Fire-Rated Units: Insulated flush panel doors, with continuous piano hinge and self-closing mechanism.
- D. Locking Devices: Flush, screwdriver-operated cam locks. [Common use]
- E. Locking Devices: Where indicated, provide 5-pin or 5-disc type cylinder locks, individually keyed; provide two (2) keys. [Secured areas only: note as such].

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting installation and application of joint sealers and access panels. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 FIRESTOP INSTALLATION

- A. Install penetration seal materials in accordance with printed instructions of the UL Fire Resistance Directory and in accordance with manufacturer's instruction.
- B. Seal holes or voids made by penetrations to ensure an effective smoke barrier.
- C. Where floor openings without penetrating items are more than four inches (100 mm) in width and subject to traffic or loading, install firestopping materials capable of supporting same loading as floor.
- D. Protect materials from damage on surface subject to traffic.
- E. Place firestopping in annular space around fire dampers before installation of damper's anchoring flanges which are installed in accordance with fire damper manufacturer's recommendations.
- F. Where large openings are created in walls or floors to permit installation of pipes, cable tray, bus duct or other items, close unused portions of opening with firestopping material tested for the application.
- G. Install smoke stopping as specified for firestopping.
- H. Where rated walls are constructed with horizontally continuous air space, double width masonry, or double stud frame construction, provide vertical, 12 inch (300 mm) wide fiber dams for full thickness and height of air cavity at maximum 15 foot (4500 mm) intervals.

3.3 PREPARATION FOR JOINT SEALERS

- A. Surface Cleaning for Joint Sealers: Clean surfaces of joints immediately before applying joint sealers to comply with recommendations of joint sealer manufacturer.
- B. Apply joint sealer primer to substrates as recommended by joint sealer manufacturer. Protect adjacent areas from spillage and migration of primers, using masking tape. Remove tape immediately after tooling without disturbing joint seal.

3.4 EXCAVATION

- A. Slope sides of excavations to comply with local codes and ordinances. Shore and brace as required for stability of excavation.
- B. Shoring and Bracing: Establish requirements for trench shoring and bracing to comply with local codes and authorities. Maintain shoring and bracing in excavations regardless of time period excavations will be open.
 - 1. Remove shoring and bracing when no longer required. Where sheeting is allowed to remain, cut top of sheeting at an elevation of 30 inches (750 mm) below finished grade elevation.
- C. Install sediment and erosion control measures in accordance with local codes and ordinances.
- D. Dewatering: Prevent surface water and subsurface or ground water 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 bearing materials. Provide and maintain 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 surface water to collecting or run-off areas. Do not use trench excavations as temporary drainage ditches.
- E. Material Storage: Stockpile satisfactory excavated materials where directed, until required for backfill or fill. Place, grade and shape stockpiles for proper drainage.
 - 1. Locate and retain soil materials away from edge of excavations. Do not store within drip-line of trees indicated to remain.
 - 2. Remove and legally dispose of excess excavated materials and materials not acceptable for use as backfill or fill.
- F. Excavation for Underground Tanks, Basins, and Mechanical Structures: Conform to elevations and dimensions shown within a tolerance of plus or minus 0.10 foot (30 mm); plus a sufficient distance to permit placing and removal of concrete formwork, installation of services, other construction, and for inspection.
 - 1. Excavate by hand, areas within drip-line of large trees. Protect the root system from damage and dry-out. Maintain moist conditions for root system and cover exposed roots with burlap. Paint root cuts of 1 inch (25 mm) in diameter and larger with emulsified asphalt tree paint.
 - 2. Take care not to disturb bottom of excavation. Excavate by hand to final grade just before concrete reinforcement is placed.
- G. Trenching: Excavate trenches for mechanical installations as follows:

1. Excavate trenches to the uniform width, sufficiently wide to provide ample working room and a minimum of 6 to 9 inches (150 to 225 mm) clearance on both sides of pipe and equipment.
 2. Excavate trenches to depth indicated or required for piping to establish indicated slope and invert elevations. Beyond building perimeter, excavate trenches to an elevation below frost line.
 3. Limit the length of open trench to that in which pipe can be installed, tested, and the trench backfilled within the same day.
 4. Where rock is encountered, carry excavation below required elevation and backfill with a layer of crushed stone or gravel prior to installation of pipe. Provide a minimum of 6 inches (150 mm) of stone or gravel cushion between rock bearing surface and pipe.
 5. Excavate trenches for piping and equipment with bottoms of trench to accurate elevations for support of pipe and equipment on undisturbed soil.
 6. For pipes or equipment 6 inches (150 mm) or larger in nominal size, shape bottom of trench to fit bottom 1/4 of the circumference. Fill unevenness with tamped sand backfill. At each pipe joint over-excavate to relieve the bell or pipe joint of the pipe of loads, and to ensure continuous bearing of the pipe barrel on the bearing surface.
- H. Cold Weather Protection: Protect excavation bottoms against freezing when atmospheric temperature is less than 35 degrees F (2 degrees C).
- I. Backfilling and Filling: Place soil materials in layers to required subgrade elevations for each area classification listed below, using materials specified in Part 2 of this Section.
1. Under walks and pavements, use a combination of subbase materials and excavated or borrowed materials.
 2. Under building slabs, use drainage fill materials.
 3. Under piping and equipment, use subbase materials where required over rock bearing surface and for correction of unauthorized excavation.
 4. For piping less than 30 inches (750 mm) below surface of roadways, provide 4-inch (100 mm) thick concrete base slab support. After installation and testing of piping, provide a 4-inch (100 mm) thick concrete encasement (sides and top) prior to backfilling and placement of roadway subbase.
 5. In other areas, use excavated or borrowed materials.
- J. Backfill excavations as promptly as work permits, but not until completion of the following:
1. Inspection, testing, approval, and locations of underground utilities have been recorded.
 2. Removal of concrete formwork.

3. Removal of shoring and bracing, and backfilling of voids.
 4. Removal of trash and debris.
- K. Placement and Compaction: Place backfill and fill materials in layers of not more than 8 inches (200 mm) in loose depth for material compacted by heavy equipment, and not more than 4 inches (100 mm) in loose depth for material compacted by hand-operated tampers.
- L. 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 specified below. Do not place backfill or fill material on surfaces that are muddy, frozen, or contain frost or ice.
- M. Place backfill and fill materials evenly adjacent to structures, piping, and equipment to required elevations. Prevent displacement of piping and equipment by carrying material uniformly around them approximately to same elevation in each lift.
- N. Compaction: Control soil compaction during construction, providing minimum percentage of density specified for each area classification indicated below.
1. Percentage of Maximum Density Requirements: Compact soil to not less than the following percentages of maximum density for soils which exhibit a well-defined moisture-density relationship (cohesive soils), determined in accordance with ASTM D 1557 and not less than the following percentages of relative density, determined in accordance with ASTM D 2049, for soils which will not exhibit a well-defined moisture-density relationship (cohesionless soils).
 2. Areas Under Structures, Building Slabs and Steps, Pavements: Compact top 12 inches (300 mm) of subgrade and each layer of backfill or fill material to 90 percent maximum density for cohesive material, or 95 percent relative density for cohesionless material.
 3. Areas Under Walkways: Compact top 6 inches (150 mm) of subgrade and each layer of backfill or fill material to 90 percent maximum density for cohesive material, or 95 percent relative density for cohesionless material.
 4. Other Areas: Compact top 6 inches (150 mm) of subgrade and each layer of backfill or fill material to 85 percent maximum density for cohesive soils, and 90 percent relative density for cohesionless soils.
 5. Moisture Control: Where subgrade or layer of soil material must be moisture conditioned before compaction, uniformly apply water. Apply water in minimum quantity necessary to achieve required moisture content and to prevent water appearing on surface during, or subsequent to, compaction operations.
- O. Subsidence: Where subsidence occurs at mechanical installation excavations during the period twelve (12) months after Substantial Completion, remove surface treatment (i.e., pavement, lawn, or other finish), add backfill material, compact to specified conditions, and replace surface treatment. Restore appearance, quality, and condition of surface or finish to match adjacent areas.

3.5 ERECTION OF METAL SUPPORTS AND ANCHORAGE

- A. Cut, fit, and place miscellaneous metal fabrications accurately in location, alignment, and elevation to support and anchor mechanical materials and equipment.
- B. Field Welding: Comply with AWS "Structural Welding Code."

3.6 ERECTION OF WOOD SUPPORTS AND ANCHORAGE

- A. Cut, fit, and place wood grounds, nailers, blocking, and anchorage accurately in location, alignment, and elevation to support and anchor mechanical materials and equipment.
- B. Select fastener sizes that will not penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections between members. Install fasteners without splitting wood members.
- C. Attach to substrates as required to support applied loads.

3.7 APPLICATION OF JOINT SEALERS

- A. General: Comply with joint sealer manufacturers' printed application instructions applicable to products and applications indicated, except where more stringent requirements apply.
 - 1. Comply with recommendations of ASTM C 962 for use of elastomeric joint sealants.
 - 2. Comply with recommendations of ASTM C 790 for use of acrylic emulsion joint sealants.
- B. Tooling: Immediately after sealant application and prior to time shinning or curing begins, tool sealants to form smooth, uniform beads; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint. Remove excess sealants from surfaces adjacent to joint. Do not use tooling agents that discolor sealants or adjacent surfaces or are not approved by sealant manufacturer.

3.8 INSTALLATION OF ACCESS DOORS

- A. Provide access doors (minimum 18" x 18") as required to provide maintainable access to all mechanical equipment including, but not limited to, valves, etc.
- B. Set frames accurately in position and securely attached to supports, with face panels plumb and level in relation to adjacent finish surfaces.
- C. Adjust hardware and panels after installation for proper operation.

END OF SECTION 22 05 00

SECTION 22 05 13 - ELECTRICAL PROVISIONS FOR PLUMBING EQUIPMENT

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

- A. Types of work normally recognized as electrical, but provided as mechanical, specified or partially specified in this section, include but are not necessarily limited to the following:
 - 1. Motors for mechanical equipment.
 - 2. Motor starters and Variable Frequency Drives (VFDs) for mechanical equipment.
 - 3. Wiring from motors to disconnect switches or junction boxes for motors of mechanical equipment, but only where specifically indicated to be furnished integrally with equipment.
 - 4. Wiring of field-mounted float control switches, flow control switches, and similar mechanical-electrical devices provided for mechanical systems, to equipment control panels.
- B. Refer to requirements of Division-26 sections.

1.2 QUALITY ASSURANCE

- A. Coordination with electrical work: wherever possible, match elements of electrical provisions of mechanical work with similar elements of electrical work specified in division-26 sections for electrical work of this section which is not otherwise specified.
- B. Standards: For electrical equipment and products, comply with applicable NEMA standards, and refer to NEMA standards for definitions of terminology herein. Comply with National Electrical Code (NFPA 70) for workmanship and installation requirements.

1.3 SUBMITTALS

- A. Listing, Motors of Mechanical Work: Concurrently, with submittal of mechanical products listing (Basic Mechanical and Division-01 requirements), submit separate listing showing rating, power characteristics, application (connected equipment), and general location of every motor to be provided with mechanical work. Submit updated information promptly when and if initial data is revised.
 - 1. Include in listing of motors, notations of whether motor starter is furnished or installed integrally with motor or equipment containing motor.

PART 2 - PRODUCTS

2.1 MOTORS

- A. Motor Characteristics: Except where more stringent requirements are indicated, and except where required item of mechanical equipment cannot be obtained with fully complying motor, comply with the following requirements for motors of mechanical work:
- B. Temperature Rating: Rated for 113 degrees F (40 degrees C) environment with maximum 122 degrees F (50 degrees C) temperature rise for continuous duty at full-load (Class B Insulation).
- C. Starting Capability: Provide each motor capable of making starts as frequently as indicated by automatic control system, and not less than five (5) starts per hour for manually controlled motors.
- D. Phases and Current Characteristics: Provide squirrel cage induction polyphase motors for 1/2 hp (.4 kW) and larger, and provide capacitor-start single-phase motors for 1/3 hp (.25 kW) and smaller, except 1/6 hp (.1 kW) and smaller may, at equipment manufacturer's option, be split-phase type. Coordinate current characteristics with power specified in Division-26 sections, and with individual equipment requirements specified in other Division-22 requirements. For 2-speed motors provide two (2) separate windings on polyphase motors. Do not purchase motors until power characteristics available at locations of motors have been confirmed, and until rotation directions have been confirmed.
- E. Service Factor: 1.15 for polyphase motors and 1.35 for single-phase motors.
- F. Motor Construction: Provide general purpose, continuous duty motors, Class F insulation, Design "B" except "C" where required for high starting torque.
 - 1. Bearings: Ball or roller bearings with inner and outer shaft seals, regreasable except permanently sealed where motor is normally inaccessible for regular maintenance. Where belt drives and other drives produce lateral or axial thrust in motor, provide bearings designed to resist thrust loading. Refer to individual sections of Division-22 for fractional-hp light-duty motors where sleeve-type bearings are permitted.
 - 2. Enclosure Type: Except as otherwise indicated, provide open drip-proof motors for indoor use where satisfactorily housed or remotely located during operation, and provide guarded drip-proof motors where exposed to contact by employees or building occupants. Provide weather-protected Type I for outdoor use, Type II where not housed. Refer to individual sections of Division-22 for other enclosure requirements.
 - 3. Overload Protection: Provide built-in thermal overload protection and, where indicated, provide internal sensing device suitable for signaling and stopping motor at starter.
 - 4. Noise Rating: Provide industry standard "Quiet" rating on motors.

5. Efficiency: For motors 1 horsepower (.7 kW) or higher, provide motors with minimum efficiencies as follows in accordance with IEEE Standard 112, Test Method B:

a. Open Motors (ODP)

<u>MOTOR HP (KW)</u>	<u>MINIMUM EFFICIENCY *</u>		
	<u>1200 RPM</u>	<u>1800 RPM</u>	<u>3600 RPM</u>
1 (.7)	82.5%	85.5%	77.0%
1.5 (1.1)	86.5%	86.5%	84.0%
2 (1.5)	87.5%	86.5%	85.5%
3 (2.2)	88.5%	89.5%	85.5%
5 (4)	89.5%	89.5%	86.5%
7.5 (5.6)	90.2%	91.0%	88.5%
10 (8)	91.7%	91.7%	89.5%
15 (11)	91.7%	93.0%	90.2%
20 (15)	92.4%	93.0%	91.0%
25 (19)	93.0%	93.6%	91.7%
30 (22)	93.6%	94.1%	91.7%
40 (30)	94.1%	94.1%	92.4%
50 (38)	94.1%	94.5%	93.0%
60 (45)	94.5%	95.0%	93.6%
75 (56)	94.5%	95.0%	93.6%
100 (75)	95.0%	95.4%	93.6%

* Required Full Load Nominal Efficiency shall be in accordance with EISA 2007. Where efficiency listed above is higher than the EISA 2007 requirement, provide the higher efficiency indicated.

b. Enclosed Motors (TEFC)

<u>MOTOR HP (KW)</u>	<u>MINIMUM EFFICIENCY *</u>		
	<u>1200 RPM</u>	<u>1800 RPM</u>	<u>3600 RPM</u>

1 (.7)	82.5%	85.5%	77.0%
1.5 (1.1)	87.5%	86.5%	84.0%
2 (1.5)	88.5%	86.5%	85.5%
3 (2.2)	89.5%	89.5%	86.5%
5 (4)	89.5%	89.5%	88.5%
7.5 (5.6)	91.0%	91.7%	89.5%
10 (8)	91.0%	91.7%	90.2%
15 (11)	91.7%	92.4%	91.0%
20 (15)	91.7%	93.0%	91.0%
25 (19)	93.0%	93.6%	91.7%
30 (22)	93.0%	93.6%	91.7%
40 (30)	94.1%	94.1%	92.4%
50 (38)	94.1%	94.5%	93.0%
60 (45)	94.5%	95.0%	93.6%
75 (56)	94.5%	95.4%	93.6%
100 (75)	95.0%	95.4%	94.1%

* Required Full Load Nominal Efficiency shall be in accordance with EISA 2007. Where efficiency listed above is higher than the EISA 2007 requirement, provide the higher efficiency indicated.

- c. Where fan or pump motors are used in conjunction with, or controlled by, a variable frequency drive (VFD), motors shall be suitable for VFD operation (inverter duty motors).
 - d. For motors less than 1 horsepower (.7 kW), provide motors with higher efficiency than "average standard industry motors," in accordance with IEEE Standard 112, test method B.
- G. Nameplate: Provide metal nameplate on each motor, indicating full identification of manufacturer, ratings, characteristics, construction, special feature and similar information.
- H. Motor Modifications: In cases where the equipment submitted requires additional motors and/or controls, circuiting and related equipment shall be provided as approved and in accordance with the National Electrical Code. All costs relative to these electrical

changes shall be included under the Section in which the equipment is furnished and installed and shall be coordinated with the electrical work at no expense to the Owner.

- I. Power Factor: All motors one (1) horsepower and above shall have a minimum power factor of 0.90.
- J. All motors operated on variable frequency drives shall be equipped with a maintenance free, conductive microfiber, shaft grounding ring with a minimum of two (2) rows of circumferential microfibers to discharge electrical shaft currents within the motor and/or its bearings. Motors up to 100 HP shall be provided with a minimum of one (1) shaft grounding ring installed either on the drive end or non-drive end. Motors over 100 HP shall be provided with an insulated bearing on the non-drive end and a shaft grounding ring on the drive end of the motor. Grounding rings shall be provided and installed by the motor pump manufacturer or contractor and shall be installed in accordance with the manufacturer's recommendations.

2.2 MOTOR STARTERS AND VARIABLE FREQUENCY DRIVES (VFDS)

- A. Where motor starters and/or variable frequency drives (VFDS) are indicated for mechanical equipment, they shall comply with all requirements outlined with the electrical specifications for motor starters and VFDS. Where motor starters and/or VFDS are provided by the mechanical contractor, or as a portion of a packaged mechanical unit, the electrical specifications shall also apply. All VFDS for the project, whether provided by the mechanical or electrical contractor, shall be provided by a single manufacturer, and shall include the same features and options.

2.3 MECHANICAL EQUIPMENT

- A. All mechanical equipment shall be approved and listed by Underwriters' Laboratories (UL) and shall bear nameplate indicating same.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install motors on motor mounting systems in accordance with motor manufacturer's instructions, securely anchored to resist torque, drive thrusts, and other external forces inherent in mechanical work. Secure sheaves and other drive units to motor shafts with keys and Allen set screws, except motors of 1/3 hp (.25 kW) and less may be secured with Allen set screws on flat surface of shaft. Unless otherwise indicated, set motor shafts parallel with machine shafts.
- B. Deliver starters and wiring devices which have not been factory installed on equipment unit to electrical Installer for installation.
- C. Install furnished under Division-26 starter panels and wiring devices at locations indicated, securely supported and anchored, and in accordance with manufacturer's installation instructions. Locate in accordance with National Electric Code for installation requirements.

END OF SECTION 22 05 13

SECTION 22 05 14 - PIPE, TUBE AND FITTINGS FOR PLUMBING SYSTEMS

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

- A. Extent of pipes and pipe fittings required by this section is indicated on drawings and/or specified in other Division-22 sections.
- B. Types of pipes and pipe fittings specified in this section include the following:
 - 1. Steel Pipes
 - 2. Copper Tube
 - 3. Cast-Iron Pressure Pipes
 - 4. Cast-Iron Soil Pipes
 - 5. Plastic Pipes
 - 6. Foundation Drainage Tile and Pipes
 - 7. Grooved Piping Products
 - 8. Miscellaneous Piping Materials/Products
- C. Pipes and pipe fittings furnished as part of factory-fabricated equipment are specified as part of the equipment assembly in other Division-22 sections.
- D. Refer to all Division-21 and -22 sections.

1.2 QUALITY ASSURANCE

- A. Codes and Standards:
 - 1. Welding: Qualify welding procedures, welders and operators in accordance with ASME B 3 1.1, or ASME B 31.9, as applicable, for shop and project site welding of piping work.
 - a. Certify welding of piping work using the Standard Procedure Specifications by, and welders tested under supervision of, National Certified Pipe Welding Bureau (NCPWB).
 - 2. Brazing: Certify brazing procedures, brazers and operators in accordance with ASME Boiler and Pressure Vessel Code, Section IX, for shop and job-site brazing of piping work.

3. NSF Labels: Where plastic piping is indicated to transport potable water, provide pipes and pipe fittings bearing approval label by National Sanitation Foundation (NSF).
 4. Lead Free Compliance: All components associated with potable water systems (including, but not limited to, valves, end use devices/fixtures, pipe, pipe fittings, solder/flux, etc.) shall be "lead-free" in accordance with all local, state and federal codes, as well as NSF/ANSI 372 (NSF 61-G).
- B. Pipe Testing Procedures: Contractor shall pressure test all piping systems in accordance with the following:
1. ASME Code for Pressure Piping B31, most current edition.
 2. National Fire Protection Association (NFPA), all applicable sections, most current edition.

1.3 SUBMITTALS

- A. Product Data: Submit manufacturer's technical product data and installation instructions for each type of pipe and pipe fitting. In addition, submit a matrix indicating each service and the proposed pipe material and fitting.
- B. Welding Certifications: Submit reports as required for piping work.
- C. Brazing Certifications: Submit reports as required for piping work.
- D. Maintenance Data: Submit maintenance data and parts lists for each type of mechanical fitting. Include this data, product data, and certifications in maintenance manual; in accordance with requirements of Division-01.

1.4 DELIVERY, STORAGE AND HANDLING

- A. Except for hub-and-spigot and similar units of pipe, provide factory-applied plastic end-caps on each length of pipe and tube. Maintain end-caps through shipping, storage and handling as required to prevent pipe-end damage, and eliminate dirt and moisture from inside of pipe and tube.
- B. Where possible, store pipe and tube inside and protected from weather. Where necessary to store outside, elevate above grade and enclose with durable, waterproof wrapping.
- C. Protect flanges and fittings from moisture and dirt by inside storage and enclosure, or by packaging with durable, waterproof wrapping.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Piping Materials: Provide pipe and tube of type, joint type, grade, size and weight (wall thickness or Class) indicated for each service; where type, grade or class is not indicated. Provide proper selection as determined by Installer for installation requirements, and comply with governing regulations and industry standards.
- B. Pipe/Tube Fittings: Provide factory-fabricated fittings of type, materials, grade, class and pressure rating indicated for each service and pipe size. Provide sizes and types matching pipe, tube, valve or equipment connection in each case. Where not otherwise indicated, comply with governing regulations and industry standards for selections, and with pipe manufacturer's recommendations where applicable.

2.2 STEEL PIPES AND PIPE FITTINGS

- A. Black Steel Pipe: ASTM A 53, A 106 or A 120; except comply with ASTM A 53 or A 106 where close coiling or bending is required.
- B. Seamless Steel Pipe: ASTM A 53, A 106, or A 120; except comply with ASTM A 53 or A 106 where close coiling or bending is required.
- C. Galvanized Seamless Steel Pipe: ASTM A 53 or A 120; except comply with ASTM A 53 where close coiling or bending is required.
- D. Electric-Resistance-Welded Steel Pipe: ASTM A 135.
- E. Electric-Fusion-Welded Steel Pipe: ASTM A 671, A 672, or A 691.
- F. Steel Water Pipe: AWWA C200 for pipe 6" (150 mm) and larger.
- G. Coal Tar Protective Coatings and Linings for Steel Water Pipe: AWWA C203 for enamel and tape, hot applied.
- H. Cast-Iron Flanged Fittings: ANSI B16.1, including bolting.
- I. Cast-Iron Threaded Fittings: ANSI B16.4.
- J. Malleable-Iron Threaded Fittings: ANSI B16.3; plain or galvanized as indicated.
- K. Malleable-Iron Threaded Unions: ANSI B16.39; selected by Installer for proper piping fabrication and service requirements, including style, end connections, and metal-to-metal seats (iron, bronze or brass); plain or galvanized as indicated.
- L. Threaded Pipe Plugs: ANSI B16.14.
- M. Steel Flanges/Fittings: ANSI B16.5, including bolting and gasketing of the following material group, end connection and facing, except as otherwise indicated.

1. Material Group: Group 1.1.
 2. End Connections: Buttwelding.
 3. Facings: Raised-face.
- N. Steel Pipe Flanges for Waterworks Service: AWWA C207.
- O. Corrosion-Resistant Cast Flanges/Fittings: MSS SP-51, including bolting and gasketing.
- P. Forged-Steel Socket-Welding and Threaded Fittings: ANSI B16.11 except MSS SP-79 for threaded reducer inserts; rated to match schedule of connected pipe.
- Q. Wrought-Steel Buttwelding Fittings: ANSI B16.9, except ANSI B16.28 for short-radius elbows and returns; rated to match connected pipe.
- R. Cast-Iron Threaded Drainage Fittings: ANSI B16.12.
- S. Forged Branch-Connection Fittings: Except as otherwise indicated, provide type as determined by Installer to comply with installation requirements.
- T. Pipe Nipples: Fabricated from same pipe as used for connected pipe; except do not use less than Schedule 80 pipe where length remaining unthreaded is less than 1-1/2" (40 mm), and where pipe size is less than 1-1/2" (40 mm), and do not thread nipples full length (no close-nipples).

2.3 COPPER TUBE AND FITTINGS

- A. Copper Type: ASTM B 88; Type (wall thickness) as indicated for each service; hard-drawn temper, except as otherwise indicated.
- B. DWV Copper Tube: ASTM B 306.
- C. ACR Copper Tube: ASTM B 280.
- D. Cast-Copper Solder-Joint Fittings: ANSI B16.18.
- E. Wrought-Copper Solder-Joint Fittings: ANSI B16.22.
- F. Cast-Copper Solder-Joint Drainage Fittings: ANSI B16.23.
- G. Wrought-Copper Solder-Joint Drainage Fittings: ANSI B16.29.
- H. Cast-Copper Flared Tube Fittings: ANSI B16.26.
- I. Bronze Pipe Flanges/Fittings: ANSI B16.24.
- J. Copper-Tube Unions: Provide standard products recommended by manufacturer for use in service indicated.

2.4 CAST-IRON PRESSURE PIPES AND PIPE FITTINGS

- A. Ductile-Iron Pipe: ANSI A21.51; AWWA C151.
- B. Polyethylene Encasement for Gray and Ductile Cast-Iron Piping: ANSI A21.5; AWWA C105.
- C. Cast-Iron Fittings: AWWA C110.
- D. Gray-Iron Fittings: AWWA C110.
- E. Ductile-Iron Fittings: AWWA C110.
- F. Rubber-Gasket Joints: AWWA C111.

2.5 CAST-IRON SOIL PIPES AND PIPE FITTINGS

- A. Hubless Cast-Iron Soil Pipe: FS WW-P-401.
- B. Cast-Iron Hub-and-Spigot Soil Pipe: ASTM A 74.
- C. Hubless Cast-Iron Soil Pipe Fittings: Neoprene gasket complying with ASTM C 564 and stainless steel clamp holding band.
- D. Cast-Iron Hub-and-Spigot Soil Pipe: Match soil pipe units; complying with same standards (ASTM A 74).
- E. Compression Gaskets: ASTM C 564.

2.6 PLASTIC PIPE AND FITTINGS

- A. Virgin Rigid Polyvinyl Chloride (PVC) Schedule 40 Pipe: Solid wall pipe with a cell class of 12454. Materials shall comply with ASTM D 1784, ASTM D 1785, ASTM D 2665 and NSF Standards 14 and 61.
- B. Virgin Rigid Polyvinyl Chloride (PVC) Schedule 80 Pipe: Solid wall pipe with a cell class of 12454. Materials shall comply with ASTM D 1784, ASTM D 1785, and NSF Standards 14 and 61.
- C. Virgin Rigid Chlorinated Polyvinyl Chloride (CPVC) Pipe: Copper Tube Size (CTS), Standard Dimensional Ratio (SDR) 11 with a cell class of 24448. Materials shall comply with ASTM D 1784, ASTM D 2846, and NSF Standards 14 and 61.
- D. Fittings for PVC Schedule 40 Pipe:
 - 1. Injection molded PVC DWV fittings: ASTM D 2665.
 - 2. Fabricated PVC DWV fittings: ASTM F 1866.
 - 3. All fittings shall conform to NSF Standard 14.

- E. Fittings for PVC Schedule 80 Pipe:
 - 1. Injection molded PVC DWV fittings: ASTM D 2467.
 - 2. Threaded PVC Schedule 80 fittings: ASTM D 2464.
 - 3. All fittings shall conform to NSF Standards 14 and 61.
- F. Fittings for CPVC Pipe: ASTM D 2846, NSF Standards 14 and 61.

2.7 FOUNDATION DRAINAGE TILE AND PIPE FITTINGS, AND ACCESSORIES

- A. Corrugated High Density Polyethylene Drainage (Perforated) Pipe: Piping shall be single wall and perforated with holes, applicable for storm drainage.
- B. Rigid Perforated Polyvinyl Chloride Pipe (PVC): ASTM D 2729; perforated except where standard sections of pipe are indicated.
- C. Fittings for Accessories for Foundation Drainage Tile and Pipe: Unless otherwise indicated, match and of same material as pipe units; comply with same standards, where applicable, except fittings need not be perforated where pipe is required to be perforated.

2.8 GROOVED PIPING PRODUCTS

- A. General: As Installer's option, mechanical grooved pipe couplings and fittings may be used only in mechanical rooms and areas where piping is installed above acoustic tile ceilings for the following systems in lieu of welded, flanged or threaded methods:
 - 1. Fire protection
 - 2. Domestic water
- B. Coupling Housings:
 - 1. Coupling Housings: Malleable iron conforming to ASTM A 47.
 - 2. Coupling Housings: Ductile iron conforming to ASTM A 536.
- C. Coupling Housings Description: Grooved mechanical type, which engages roll grooved pipe ends, encasing an elastomeric gasket which bridges pipe ends to create seal. Cast in two or more parts, secure together during assembly with nuts and bolts. Permit degree of contraction and expansion as specified in manufacturer's latest published literature.
- D. Gaskets: Mechanical roll grooved coupling design, pressure responsive so that internal pressure serves to increase seal's tightness, constructed of elastomers having properties as designated by ASTM D 2000.
 - 1. Water Services: EDPM Grade E, with green color code identification.
 - 2. Other Services: As recommended by manufacturer.

- E. Bolts and Nuts: Heat-treated carbon steel, ASTM A 183, minimum tensile 110,000 psi (758420 kPa).
 - 1. Exposed Locations: Tamper resistant nuts.
- F. Branch Stub-Ins: Upper housing with full locating collar for rigid positioning engaging machine-cut hole in pipe, encasing elastomeric gasket conforming to pipe outside diameter around hole, and lower housing with positioning lugs, secured together during assembly with nuts and bolts.
- G. Fittings: Roll grooved end design to accept grooved mechanical couplings.
 - 1. Malleable Iron: ASTM A 47.
 - 2. Ductile Iron: ASTM A 536.
 - 3. Fabricated Steel: ASTM A 53, Type F for 3/4" (20 mm) to 1-1/2" (40 mm): Type E or S, Grade B for 2" (50 mm) to 20" (500 mm).
 - 4. Steel: ASTM A 234.
- H. Flanges: Conform to Class 125 cast iron and Class 150 steel bolt hole alignment.
 - 1. Malleable Iron: ASTM A 47.
 - 2. Ductile Iron: ASTM A 536.
- I. Roll Grooves: Conform to the following:
 - 1. Lightweight Steel: Roll grooved.

2.9 MISCELLANEOUS PIPING MATERIALS/PRODUCTS

- A. Welding Materials: Except as otherwise indicated, provide welding materials as determined by Installer to comply with installation requirements.
 - 1. Comply with Section II, Part C, ASME Boiler and Pressure Vessel Code for welding materials.
- B. Soldering Materials: Except as otherwise indicated, provide soldering materials as determined by Installer to comply with installation requirements.
 - 1. Tin-Antimony Solder: ASTM B 32, Grade 95TA.
 - 2. Silver Solder: ASTM B 32, Grade 96TS.
- C. Brazing Materials: Except as otherwise indicated, provide brazing materials as determined by Installer to comply with installation requirements.
 - 1. Comply with SFA-5.8, Section II, ASME Boiler and Pressure Vessel Code for brazing filler metal materials.

- D. Gaskets for Flanged Joints: ANSI B16.21; full-faced or cast-iron raised face for steel flanges, unless otherwise indicated.
- E. Piping Connectors for Dissimilar Non-Pressure Pipe: Elastomeric annular ring insert, or elastomeric flexible coupling secured at each end with stainless steel clamps, sized for exact fit to pipe ends and subject to approval by plumbing code.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. General: Install pipes and pipe fittings in accordance with recognized industry practices which will achieve permanently-leakproof piping systems, capable of performing each indicated service without piping failure. Install each run with minimum joints and couplings, but with adequate and accessible unions for disassembly and maintenance/replacement of valves and equipment. Reduce sizes (where indicated) by use of reducing fittings. Align piping accurately at connections, within 1/16" (1.6 mm) misalignment tolerance.
 - 1. Comply with ANSI B31 Code for Pressure Piping.
- B. Locate piping runs, except as otherwise indicated, vertically and horizontally (pitched to drain) and avoid diagonal runs wherever possible. Where trapping is unavoidable, install drain valve with 3/4" (20 mm) hose end connection, cap and chain. Provide access panels as required. Orient horizontal runs parallel with walls and column lines. Locate runs as shown or described by diagrams, details and notations or, if not otherwise indicated, run piping in shortest route which does not obstruct usable space or block access for servicing building and its equipment. Hold piping close to walls, overhead construction, columns and other structural and permanent enclosure elements of building; limit clearance to 1/2" (13 mm) where furring is shown for enclosure or concealment of piping, but allow for insulation thickness, if any. Where possible, locate insulated piping for 1" (25 mm) clearance outside insulation. Wherever possible in finished and occupied spaces, conceal piping from view, by locating in column enclosures, in hollow wall construction or above suspended ceilings; do not encase horizontal runs in solid partitions, except as indicated.
- C. Exposed piping in finished areas shall be covered with a 16 gauge steel cover primed and painted, secured to an adjacent structure and painted to match adjacent surfaces.
- D. Electrical Equipment Spaces: Do not run piping through transformer vaults and other electrical or electronic equipment spaces and enclosures unless unavoidable. Install drip pan under piping that must be run through electrical spaces.

3.2 PIPING SYSTEM JOINTS

- A. General: Provide joints of type indicated in each piping system.
 - 1. Thread pipe in accordance with ANSI B2.1; cut threads full and clean using sharp dies. Ream threaded ends to remove burrs and restore full inside diameter. Apply pipe joint compound, or pipe joint tape (Teflon) where recommended by pipe/fitting

- manufacturer, on male threads at each joint and tighten joint to leave not more than 3 threads exposed.
2. Braze copper tube-and-fitting joints where indicated, in accordance with ASME B31.
 3. Solder copper tube-and-fitting joints where indicated, in accordance with recognized industry practice. Cut tube ends squarely, ream to full inside diameter, and clean outside of tube ends and inside of fittings. Apply solder flux to joint areas of both tubes and fittings. Insert tube full depth into fitting, and solder in manner which will draw solder full depth and circumference of joint. Wipe excess solder from joint before it hardens.
- B. Weld pipe joints in accordance with ASME Code for Pressure Piping, B31.
- C. Weld pipe joints in accordance with recognized industry practice and as follows:
1. Weld pipe joints only when ambient temperature is above 0°F (-18°C) where possible.
 2. Bevel pipe ends at a 37.5° angle where possible, smooth rough cuts, and clean to remove slag, metal particles and dirt.
 3. Use pipe clamps or tack-weld joints with 1" (25 mm) long welds; 4 welds for pipe sizes to 10" (250 mm), 8 welds for pipe sizes 12" (300 mm) to 20" (500 mm).
 4. Build up welds with stringer-bead pass, followed by hot pass, followed by cover or filler pass. Eliminate valleys at center and edges of each weld. Weld by procedures which will ensure elimination of unsound or unfused metal, cracks, oxidation, blow-holes and non-metallic inclusions.
 5. Do not weld-out piping system imperfections by tack-welding procedures; refabricate to comply with requirements.
 6. At Installer's option, install forged branch-connection fittings wherever branch pipe is indicated; or install regular "T" fitting.
 7. At Installer's option, install forged branch-connection fittings wherever branch pipe of size smaller than main pipe is indicated; or install regular "T" fitting.
- D. Weld pipe joints of steel water pipe in accordance with AWWA C206.
- E. Flanged Joints: Match flanges within piping system, and at connections with valves and equipment. Clean flange faces and install gaskets. Tighten bolts to provide uniform compression of gaskets.
- F. Lead Joint Installation: Tightly pack joint with joint packing material. Do not permit packing to enter bore of finished joint. Clean joint after packing. Fill remaining joint space with one pouring of lead to indicated minimum depth measured from face of bell. After lead has cooled, caulk joint tightly by use of hammer and calking iron.
- G. Hubless Cast-Iron Joints: Comply with coupling manufacturer's installation instructions.

- H. Plastic Pipe/Tube Joints: Comply with manufacturer's instructions and recommendations, and with applicable industry standards:
 - 1. Heat Joining of Thermoplastic Pipe: ASTM D 2657.
 - 2. Making Solvent-Cemented Joints: ASTM D 2235, and ASTM F 402.
- I. Open Drain-Tile Joints: Except as otherwise indicated, provide 1/4" (6 mm) open joint with top 2/3 of annular space covered by joint accessory material.
- J. Grooved Pipe Joints: Comply with fitting manufacturer's instructions for making grooves in pipe ends. Remove burrs and ream pipe ends. Assemble joints in accordance with manufacturer's instructions.

3.3 PIPING INSTALLATION

- A. Install drain tile piping from lowest end of slope to highest, solidly bedded in filtering or drainage fill. Shape bed for bells of piping (if any). Place bells/hubs and grooved ends of units up-stream. Lay perforated pipe with perforations down. Refer to Division-2 specifications for filter cloth, bedding material and backfill installation requirements.
- B. Install ductile cast-iron water mains and appurtenances in accordance with-AWWA C600.

3.4 RADIOGRAPHIC (X-RAY) TESTING

- A. Field weld joints for all black steel pipe shall be radiographically (x-ray) tested to the extent identified below.
- B. Testing shall be conducted by an independent testing company. The testing company shall provide arrest report identifying the results of each weld tested (pass/fail).
- C. The Contractor shall engage the Owner and Engineer of Record to identify welds to be tested.
- D. Testing:
 - 1. If the total quantity of field welds is greater than 50, test 10% of field welds.
 - 2. If the total quantity of field welds is less than 50, test 25% of field welds.
 - 3. Should any of the initial welds tested fail, Contractor will be required to test an additional 20% of all remaining welds, at no additional cost to the Owner.
 - 4. Should any of the additional 20% of welds tested fail, Contractor will be requested to test 100% of all remaining welds, at no additional cost to the Owner.

3.5 PIPE TESTING

- A. The mechanical contractor shall air and/or hydrostatically test the following systems in accordance with the latest ASME B31 (ASME Code for Pressure Piping) and NFPA requirements.
 - 1. Air Test:
 - a. Air, Gas
 - 2. Hydrostatic Test:
 - a. Domestic Water
- B. Pressure tests shall also be performed prior to the installation of all insulation materials.
- C. Hydrostatic Test: Provide temporary equipment for testing, including pump and gages. Test piping system before insulation is installed, wherever feasible and remove control devices before testing. Test each natural section of each piping system independently, but do not use piping system valves to isolate sections where test pressure exceeds valve pressure rating. Fill each section with water and pressurize for indicated pressure and time.
 - 1. Required test period is four (4) hours.
 - 2. Hydrostatically test each piping system at 150% of operating pressure indicated, but not less than 100 psi (690 kPa) test pressure.
 - 3. Observe each test section for leakage at end of test period. Test fails if leakage is observed or if pressure drop exceeds less than zero percent (0.0%) of test pressure.
 - 4. Upon completion of roughing-in and before setting fixtures, the entire new domestic water system shall be tested. Where a portion of the water piping system is to be concealed before completion, this portion shall be tested separately in a manner described for the entire system.
 - 5. Prior to testing, verify the pressures listed above are in accordance with the latest ASME B31 code and NFPA. Should a discrepancy exist between the ASME B31 code, NFPA, and/or the pressures indicated above, contact the Engineer prior to testing.
- D. Air Test:
 - 1. Air, gas and vacuum piping shall be air tested at 200 psi (1380 kPa).
 - 2. Prior to testing, verify the pressures listed above are in accordance with the latest ASME B31 code and NFPA. Should a discrepancy exist between the ASME B31 code, NFPA, and/or the pressures indicated above, contact the Engineer prior to testing.
 - 3. Required test period is four (4) hours.

4. Observe each test section for leakage at end of test period. Test fails if leakage is observed or if pressure drop exceeds less than zero percent (0.0%) of test pressure.

E. Sanitary and Storm Water Piping Systems:

1. All soil, waste, vent and storm water piping shall be tested by the Contractor and reviewed by the Architect before acceptance. All piping located underground shall be tested before backfilling. The costs of all equipment required for tests are to be included under the contract price.
2. The entire new drainage system and venting system shall have all necessary openings plugged and filled with water to the level of the highest vent stack above the roof or to the maximum pressure rating of the joint used. The system shall hold this water for four (4) hours without showing a drop in water level. Where a portion of the system is to be tested, the test shall be conducted in the same manner as described for the entire system, except a vertical stack 10 feet (3000 mm) above the highest horizontal line to be tested may be installed and filled with water to maintain sufficient pressure, or a pump may be used to supply the required pressure.
3. Where sections are tested, overlap the sections so that all joints are subjected to the test procedures.

F. Drain test water from piping systems after testing and repair work has been completed.

G. Repair piping systems sections which fail required piping test, by disassembly and re-installation, using new materials to extent required to overcome leakage. Do not use chemicals, stop-leak compounds, mastics, or other temporary repair methods.

H. Contractor shall submit pipe leakage test results to the A/E within 72 hours of completed tests. Only test results that meet the specified leakage requirements shall be submitted. Pipe test results shall be recorded on the attached "Piping Leakage Test Summary Form - Plumbing" at the end of this section; no other forms will be accepted. In addition, the pipe leakage submittals shall include 11x17 drawing(s) as required to clearly indicate the full extent of the pipe test section (each pipe test section shall be numbered and color coded).

I. All pipe leakage test results shall be included with the final TAB report and the O&M Manual.

3.6 CLEANING, FLUSHING, INSPECTING

A. General: Clean exterior surfaces of installed piping systems of superfluous materials, and prepare for application of specified coatings (if any). Flush out piping systems with clean water before proceeding with required tests. Inspect each run of each system for completion of joints, supports and accessory items.

1. Inspect pressure piping in accordance with procedures of ASME B31.

B. Disinfect water mains and water service piping in accordance with AWWA C601.

- C. After final testing for leaks, all new potable water lines shall be thoroughly flushed by plumbing contractor to remove foreign material. Before placing the systems in service, Contractor shall engage a qualified service organization, to sterilize the systems in accordance with the following procedure:
1. Through a 3/4" (20 mm) hose connection in the main entering the building, pump in sufficient sodium hypochlorite to produce a free available chlorine residual of not less than 200 PPM. Plumbing contractor shall provide plumbing connections and power for pumping chlorine into the system.
 2. Proceed upstream from the point of chlorine application opening all faucets and taps until chlorine is detected. Close faucets and taps when chlorine is evident.
 3. When chlorinated water has been brought to every faucet and tap with a minimum concentration of 200 PPM chlorine, retain this water in the system for three hours. CAUTION: Over-concentration of chlorine and more than three (3) hours of retention may result in damage to piping system.
 4. At the end of the retention period, no less than 100 PPM of chlorine shall be present at the extreme end of the system.
 5. Proceed to open all faucets and taps and thoroughly flush all new lines until the chlorine residual in the water is less than 1.0 PPM.
 6. Obtain representative water samples from the system for analysis by a recognized bacteriological laboratory.
 7. If the sample tested for coliform organisms is negative, a letter and laboratory reports shall be submitted by the service organization to the Contractor, certifying successful completion of the sterilization.
 8. If any samples tested indicate the presence of coliform organisms, the entire sterilization procedure shall be repeated.

END OF SECTION 22 05 14

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**PIPING LEAKAGE TEST SUMMARY FORM
(PLUMBING)**

Project Name: _____ Project Number: _____ Page _____ of _____

System Tested	Sections Tested (1)	System Operating Pressure	Test Pressure (PSI/FT-HD) (2)	Duration (3)	Pressure Drop (4)	Pass/Fail

Name of Testing Agency/Company: _____
 Date of Test(s): _____
 Test Conducted By (Print/Sign): _____

- (1) Identified by an 11 x 17 numbered and color coded test section plan. Plan shall accompany this test report.
- (2) 150% of operating pressure but not less than 100 psi , 200 psi for air-gas, 10 ft. static head pressure or to the maximum rating of the joint. Include joint cut sheets showing their ratings.
- (3) Four (4) hours minimum.
- (4) Shall not exceed 0.0%.

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SECTION 22 05 15 - PIPING SPECIALTIES FOR PLUMBING SYSTEMS

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

- A. Extent of piping specialties work required by this section is indicated on drawings and schedules and by requirements of this section.
- B. Types of piping specialties specified in this section include the following:
 - 1. Pipe Escutcheons
 - 2. Pipeline Strainers
 - 3. Vandal-Proof Vent Caps
 - 4. Dielectric Fittings
 - 5. Mechanical Sleeve Seals
 - 6. Penetration Seals
 - 7. Water Hammer Arresters
 - 8. Drip Pans
 - 9. Pipe Sleeves
 - 10. Sleeve Seals
 - 11. Flexible Connector
 - 12. Domestic Water Mixing Valve
 - 13. Electric Pipe Trace
- C. Piping specialties furnished as part of factory-fabricated equipment, are specified as part of equipment assembly in other Division-22 sections.

1.2 QUALITY ASSURANCE

- A. Codes and Standards:
 - 1. FCI Compliance: Test and rate "Y" type strainers in accordance with FCI 73-1 "Pressure Rating Standard for "Y" Type Strainers". Test and rate other type strainers in accordance with FCI 78-1 "Pressure Rating Standard for Pipeline Strainers Other than "Y" Type".

2. Lead Free Compliance: All components associated with potable water systems (including, but not limited to, valves, end use devices/fixtures, pipe, pipe fittings, solder/flux, etc.) shall be "lead-free" in accordance with all local, state and federal codes, as well as NSF/ANSI 372 (NSF 61-G).

1.3 SUBMITTALS

- A. Product Data: Submit manufacturer's technical product data, including installation instructions, and dimensioned drawings for each type of manufactured piping specialty. Include pressure drop curve or chart for each type and size of pipeline strainer. Submit schedule showing manufacturer's figure number, size, location, and features for each required piping specialty.
- B. Shop Drawings: Submit for fabricated specialties, indicating fabrication, materials, and method of support.
- C. Maintenance Data: Submit maintenance data and spare parts lists for each type of manufactured piping specialty. Include this data, product data, and shop drawings in maintenance manual.

PART 2 - PRODUCTS

2.1 PIPING SPECIALTIES

- A. General: Provide factory-fabricated piping specialties recommended by manufacturer for use in service indicated. Provide piping specialties of types and pressure ratings indicated for each service, or if not indicated, provide proper selection to comply with installation requirements. Provide sizes as indicated, and connections, which properly mate with pipe, tube, and equipment connections.

2.2 PIPE ESCUTCHEONS

- A. General: Provide pipe escutcheons as specified herein with inside diameter closely fitting pipe outside diameter, or outside of pipe insulation where pipe is insulated. Select outside diameter of escutcheon to completely cover pipe penetration hole in floors, walls, or ceilings; and pipe sleeve extension, if any. Furnish pipe escutcheons with nickel or chrome finish for occupied areas, prime paint finish for unoccupied areas.
- B. Pipe Escutcheons for Moist Areas: For waterproof floors, and areas where water and condensation can be expected to accumulate, provide cast brass or sheet brass escutcheons, solid or split hinged.
- C. Pipe Escutcheons for Dry Areas: Provide sheet steel escutcheons, solid or split hinged.

2.3 LOW PRESSURE Y-TYPE PIPELINE STRAINERS

- A. General: Provide strainers full line size of connecting piping, with ends matching piping system materials. Select strainers for 125 psi (850 kPa) working pressure, with Type 304 stainless steel screens, with perforations as follows:
 - 1. Piping 2" (50 mm) and Smaller: 1/32" (.8 mm) diameter perforations.
 - 2. Piping 2-1/2" (65 mm) and Larger: 3/64" (1.2 mm) diameter perforations for water systems and 1/16" diameter perforations for steam systems.
- B. Threaded Ends, 2" (50 mm) and Smaller: Brass, screwed screen retainer with centered blowdown fitted with valve and pipe plug.
- C. Threaded Ends, 2-1/2" (65 mm) and Larger: Cast-iron body, bolted screen retainer with off-center blowdown fitted with valve and pipe plug.
- D. Flanged Ends, 2-1/2" (65 mm) and Larger: Cast-iron body, bolted screen retainer with off-center blowdown fitted with valve and pipe plug.
- E. Butt Welded Ends, 2-1/2" (65 mm) and Larger: Schedule 40 cast carbon steel body, bolted screen retainer with off-center blowdown fitted with valve and pipe plug.
- F. Grooved Ends, 2-1/2" (65 mm) and Larger: Tee pattern, ductile-iron or malleable-iron body and access end cap, access coupling with EDPM gasket.

2.4 VANDAL-PROOF VENT CAPS

- A. General: Provide cast-iron vandal-proof vent caps, full size of vent pipe, caulked base connection for cast-iron pipes, threaded base for steel pipes.

2.5 DIELECTRIC FITTINGS

- A. General: Provide assembly or fitting having insulating material to isolate dissimilar metals to prevent galvanic action and stop corrosion.
 - 1. Dielectric-Flange Insulation Kits: Field-assembled, companion-flange assembly, full-face or ring type. Components include neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.
 - a. Provide separate companion flanges and steel bolts and nuts for 150- or 300-psig (1035 kPa or 2070 kPa) minimum working pressure to suit system pressures.
 - 2. Dielectric Nipples: Electroplated steel nipple, having inert and non-corrosive thermoplastic lining, with combination of plain, threaded, or grooved end types and 300-psig (2070 kPa) working pressure at 225°F (107°C) temperature.
 - 3. Dielectric unions shall NOT be acceptable.

2.6 MECHANICAL SLEEVE SEALS

- A. General: Modular mechanical type, consisting of interlocking synthetic rubber links shaped to continuously fill annular space between pipe and sleeve, connected with bolts and pressure plates which cause rubber sealing elements to expand when tightened, providing watertight seal and electrical insulation.

2.7 PENETRATION SEALS

- A. Provide seals for all openings through fire-rated walls, floors, or ceilings used as passage for mechanical piping. See Division-22 Section "Basic Plumbing Materials and Methods" for penetration seals and firestopping requirements.
- B. Provide seals for all openings through walls, floors or ceilings used as passage for mechanical components such as piping.

2.8 WATER HAMMER ARRESTERS

- A. General: Provide bellows type water hammer arresters, stainless steel casing and bellows, pressure rated for 250 psi (1724 kPa), tested and certified in accordance with PDI Standard WH-201.

2.9 FABRICATED PIPING SPECIALTIES

- A. Drip Pans: Provide drip pans fabricated from corrosion-resistant sheet metal with watertight joints, and with edges turned up 2-1/2" (65 mm). Reinforce top, either by structural angles or by rolling top over 1/4" (6 mm) steel rod. Provide hole, gasket, and flange at low point for watertight joint and 1" (25 mm) drain line connection.
- B. Pipe Sleeves: Provide pipe sleeves of one of the following:
 - 1. Sheet-Metal: Fabricate from galvanized sheet metal; round tube closed with snaplock joint, welded spiral seams, or welded longitudinal joint. Fabricate from the following gages: 3" (75 mm) and smaller, 20 gage (1.0 mm); 4" to 6" (100 mm to 150 mm), 16 gage (1.6 mm); over 6" (150 mm), 14 gage (2 mm).
 - 2. Steel-Pipe: Fabricate from Schedule 40 galvanized steel pipe; remove burrs.
 - 3. Iron-Pipe: Fabricate from cast-iron or ductile-iron pipe; remove burrs.

2.10 FLEXIBLE CONNECTORS

- A. Furnish and install braided stainless steel flexible connectors on the inlet and outlet of each pump, chiller, cooling tower, and all other piping connected to a vibrating piece of equipment. Construction shall be of annular corrugated stainless steel close-pitch hose with stainless steel overbraid.

1. The corrugated metal hose, braids, and a stainless steel ring-ferrule/band (material gauge not less than .048") (material gauge not less than 1.2 mm) shall be integrally welded using a 100% circumferential, full-penetration TIG weld.
2. End fittings shall be flat-face plate steel flanges with 150#ANSI drilling and outside diameter. Fittings shall be attached using a 100% circumferential TIG/MIG weld.
3. Braided stainless steel connectors shall be suitable for operating temperatures up to 850°F (454°C).
4. The rated working pressure of braided metal hose shall have a minimum 4:1 safety factor based on an operating temperature of 70°F (20°C). Each braided stainless steel connector shall be individually leak tested by the manufacturer using air-under-water or hydrostatic pressure.
5. Flanged connectors shall be prepared for shipment using cut-to-length spacers, securely positioned between the flanges to prevent axial compression damage and maintain the manufactured length. Spacers must be removed prior to system start-up.
6. All braided stainless steel connectors shall be covered by a three (3) year warranty.
7. Minimum overall lengths shall be as follows:

Through 4" (100 mm) diameter:	9" (225 mm)
5" (125 mm), 6" 150 mm) diameter:	11" (275 mm)
Over 6" (150 mm) diameter:	1.5 times nominal diameter

2.11 DOMESTIC HOT WATER MIXING VALVES

A. Thermostatic Mixing Valve:

1. Furnish and install where indicated on the floor plans. Refer to floor plans/details for manufacturer, size, model and setting. Mixing valve for tempered water controls shall be of the thermostatic type with liquid sensor and shall be in accordance with ASSE 1017. Valve shall be constructed of a bronze body with internal non-corrosive parts. Valve construction shall employ poppets which are independently seated, balanced, and self-aligning. Union inlets with strainers and check stops shall be provided. Temperature adjustment control shall be tamper-resistant. Provide thermometer on outlet and valved inlets.

2.12 ELECTRIC PIPE TRACING

- A. Furnish and install self-regulating pipe trace heater consisting of two (2) 16 AWG nickel plated copper bus parallel wires embedded in a self-regulating polymer core that varies its power output to respond to temperature along its length, allowing the heater to cross over itself without overheating, and to be cut to length in the field. The heater shall be covered by a radiation cross linked polyethylene dielectric jacket rated at 300 VAC at 222°F (105°C) with VW-1 flame resistance.

- B. The heater shall operate on line voltage 120V, without the use of transformers.
- C. The heater shall be sized according to the following table. The output rating is in watts per linear foot at 50°F (10°C).

<u>Pipe Size</u>	<u>Heater Capacity</u>
1/2 - 1 inch (13 mm - 25 mm)	3 W/LF (1 W/m)
1-1/4 - 2 inch (32 mm - 50 mm)	5 W/LF (1.6 W/m)
3 inch (75 mm)	5 W/LF (1.6 W/m)
4 inch (100 mm)	8 W/LF (2 W/m)
6 inch (150 mm)	8 W/LF (2 W/m)

- D. All heating cable cores shall be permanently marked with manufacturer's batch or serial number for traceability. All cable jackets shall be continuously marked with manufacturer's name, catalog number, nominal supply voltage and nominal power output in watts per foot. Use of temporary printing or tags not permitted.
- E. All cables shall be capable of withstanding 1,600 VAC RMS (50 to 60 HZ) applied for one minute between the parallel conductors and the metallic braid.
- F. Power retention of the heating element shall be a minimum of 90% after a minimum of 30 thermal cycles between 50°F and 150°F (10°C and 66°C).
- G. Power connection, end seal, splice and tee kit components shall be applied in the field.
- H. The system shall be controlled by an ambient sensing thermostat set at 40°F.

PART 3 - EXECUTION

3.1 INSTALLATION OF PIPING SPECIALTIES

- A. Pipe Escutcheons: Install pipe escutcheons on each pipe penetration thru floors, walls, partitions, and ceilings where penetration is exposed to view; and on exterior of building. Secure escutcheon to pipe or insulation so escutcheon covers penetration hole, and is flush with adjoining surface.
- B. Y-Type Strainers: Install Y-type strainers full size of pipeline, in accordance with manufacturer's installation instructions. Install pipe nipple and shutoff valve in strainer blow down connection, full size of connection, except for strainers 2" (50 mm) and smaller installed ahead of control valves feeding individual terminals. Where indicated, provide drain line from shutoff valve to drain, full size of blow down connection.
 - 1. Locate Y-type strainers ahead of the following equipment, and elsewhere as indicated, if integral strainer is not included in equipment:

- a. Pumps
 - b. Pressure reducing valves
 - c. Temperature or pressure regulating valves
- C. Vandal-Proof Vent Caps: Install vandal-proof vent caps on each vent pipe passing through roof, and elsewhere as indicated. Locate base of vent cap 6" (150 mm) above roof surface, or higher where required by Code.
- D. Dielectric Fittings: Install at each piping joint between ferrous and non-ferrous piping. Comply with manufacturer's installation instructions.
- E. Mechanical Sleeve Seals: Provide mechanical sleeve seals for sleeves located in foundation walls below grade, or in exterior walls. Loosely assemble rubber links around pipe with bolts and pressure plates located under each bolt head and nut. Push into sleeve and center. Tighten bolts until links have expanded to form watertight seal.
- F. Water Hammer Arresters: Install in upright position, in locations and of sizes in accordance with PDI Standard WH-201, and elsewhere as indicated.

3.2 INSTALLATION OF FABRICATED PIPING SPECIALTIES

- A. Drip Pans: Locate drip pans under piping passing over or within 3' (0.9 m) horizontally of electrical equipment, and elsewhere as indicated. Hang from structure with rods and building attachments, weld rods to sides of drip pan. Brace to prevent sagging or swaying. Connect 1" (25 mm) drain line to drain connection, and run to nearest drain as indicated.
- B. Pipe Sleeves: Install pipe sleeves of types indicated where piping passes through walls, floors, ceilings, and roofs. Do not install sleeves through structural members of work, except as detailed on drawings, or as reviewed by the Owner. Install sleeves accurately centered on pipe runs. Size sleeves so that piping and insulation (if any) will have free movement in sleeve, including allowance for thermal expansion; but not less than two (2) pipe sizes larger than piping run. Where insulation includes vapor-barrier jacket, provide sleeve with sufficient clearance for installation. Install length of sleeve equal to thickness of construction penetrated, and finish flush to surface; except floor sleeves. Sleeves through floors shall be flush with the floor, except for sleeves passing through equipment rooms, toilet rooms (and other wet areas) which shall extend 3/4" (20 mm) above the floor. Space between the pipe and sleeve shall be caulked. Escutcheons plates shall be constructed to conceal the ends of sleeves. Extend floor sleeves 1/4" (6 mm) above level floor finish and 3/4" (20 mm) above floor finish sloped to drain. Provide temporary support of sleeves during placement of concrete and other work around sleeves, and provide temporary closure to prevent concrete and other materials from entering sleeves.
- 1. Install sheet-metal sleeves at interior partitions and ceilings other than suspended ceilings.
 - 2. Install iron-pipe sleeves at exterior and interior foundation wall penetrations, both above and below grade. Penetrations shall be sealed weathertight.
 - 3. Install steel-pipe except as otherwise indicated.

3.3 INSTALLATION OF ELECTRIC PIPE TRACING

- A. Provide electric heat trace for all exterior piping, located above the local frost line, and including, but not limited to, fire protection piping, domestic water, and wet traps of sanitary located in the Garage of each building, etc.
- B. Install the heater linearly on the pipe after piping has been successfully pressure tested. Secure the heater to piping with cable ties or type PF-1 polyester tape.
- C. Apply "electric traced" signs to the outside of the thermal insulation.
- D. Tests:
 - 1. After installation and before and after installing the thermal insulation, subject heat to testing using a 1000 VDC megger. Minimum installation resistance should be 20 to 1000 megohms regardless of length.
- E. Insulate all piping where heat trace is required. Refer to Division-22 section, Plumbing Insulation for type and thickness.

3.4 INSTALLATION OF FLEXIBLE PIPE CONNECTORS

- A. Provide flexible pipe connectors on the inlet and outlet of piping connected to a vibrating piece of equipment. Flexible connectors shall be full line size as indicated on the drawings and should be provided with control rods.

END OF SECTION 22 05 15

SECTION 22 05 16 - EXPANSION COMPENSATION FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

- A. Extent of expansion compensation products required by this section is indicated on drawings and/or specified in other Division-22 sections.
- B. Types of expansion compensation products specified in this section include the following:
 - 1. Packless Expansion Joints:
- C. Expansion Compensators
- D. Expansion compensation products furnished as part of factory-fabricated equipment are specified as part of equipment assembly in other Division-22 sections.

1.2 QUALITY ASSURANCE

- A. Codes and Standards:
 - 1. EJMA Compliance: Construct compensation products in accordance with standards of the Expansion Joint Manufacturer's Association (EJMA).

1.3 SUBMITTALS

- A. Product Data: Submit manufacturer's technical product data, including installation instructions for each type of expansion compensation product. Submit expansion compensation schedule showing manufacturer's figure number, size, location, and features for each required expansion compensation product.
- B. Shop Drawings: Submit manufacturer's assembly-type shop drawings for each type of expansion compensation product, indicating dimensions, weights, required clearances, and methods of assembly of components.
- C. Shop Drawings: Submit shop drawings for fabricated expansion loops indicating location, dimensions, pipe sizes, and location and method of attachment of anchors.
- D. Maintenance Data: Submit maintenance data and spare parts lists for each type of expansion compensation product. Include this data, product data, and shop drawings in maintenance manual.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated in the Work include the following:
1. Flexonics Inc., Metal Hose and Expansion Joint Div.
 2. Keflex HVAC Products, Flex-Weld, Inc.
 3. Metraflex Co.
 4. Mason Industries, Inc.
 5. Vibration Mountings and Controls, Subsidiary of ARX.

2.2 PACKLESS EXPANSION JOINTS

- A. General: Provide packless expansion joints where indicated for piping systems, with materials and pressure/temperature ratings selected by installer to suit intended service. Select packless expansion joints to provide 200% absorption capacity of piping expansion between anchors.
- B. Expansion Compensators: Pressure rated for 60 (415 kPa) psi for low pressure systems, 175 psi (1200 kPa) for high pressure systems; 2-ply phosphor bronze bellows, brass shrouds and end fittings for copper piping systems, or 2-ply stainless steel bellows, carbon steel shrouds and end fittings for steel piping systems. Provide internal guides and anti-torque device, and removable end clip for proper positioning.

2.3 MISCELLANEOUS MATERIALS

- A. Pipe Alignment Guides: Provide factory-fabricated guides, of cast semi-steel or heavy fabricated steel, consisting of bolted two-section outer cylinder and base with two-section guiding spider bolted tight to pipe. Size guide and spiders to clear pipe and insulation (if any), and cylinder. Provide guides of length recommended by manufacturer to allow indicated travel.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Examine areas and conditions under which expansion compensation products are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected.

3.2 EXPANSION JOINTS

- A. General: Install expansion joints where indicated, and elsewhere as required for adequate expansion of installed piping system. Install in accordance with manufacturer's instructions. Provide pipe anchors and pipe alignment guides as indicated, and in accordance with manufacturer's recommendations. Align units properly to avoid end loading and torsional stress.

3.3 EXPANSION LOOPS

- A. General: Fabricate expansion loops as indicated, in locations indicated, and elsewhere as required for adequate expansion of installed piping system. Subject loop to cold spring which will absorb 50% of total expansion between hot and cold conditions. Provide pipe anchors and pipe alignment guides as required to properly anchor piping in relationship to expansion loops.

3.4 EXPANSION COMPENSATION FOR RISERS AND TERMINALS

- A. General: Install connection between piping mains and risers with at least five (5) pipe fittings including tee in main. Install connections between piping risers and terminal units with at least four (4) pipe fittings including tee in riser.

3.5 INSTALLATION OF ANCHORS

- A. Install anchors at proper locations to prevent stresses from exceeding those permitted by ANSI B31, and to prevent transfer of loading and stresses to connected equipment.
- B. Fabricate and install anchor by welding steel shapes, plates and bars to piping and to structure. Comply with ANSI B31 and with AWS standards.
- C. Where expansion compensators are indicated, install anchors in accordance with expansion unit manufacturer's written instructions, to limit movement of piping and forces to maximums recommended by manufacturer for each unit.
- D. Anchor Spacings: Where not otherwise indicated, install anchors at ends of principle pipe-runs, at intermediate points in pipe-runs between expansion loops and bends. Make provisions for preset of anchors as required to accommodate both expansion and contraction of piping.

END OF SECTION 22 05 16

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SECTION 22 05 19 - METERS AND GAUGES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

- A. Extent of meters and gauges required by this section is indicated on drawings and/or specified in other division-22 sections.
- B. Types of meters and gauges specified in this section include the following:
 - 1. Temperature Gauges and Fittings:
 - a. Direct Mount Dial Thermometers
 - b. Remote Reading Dial Thermometers
 - c. Thermometer Wells
 - 2. Pressure Gauges and Fittings:
 - a. Pressure Gauges
 - b. Pressure Gauge Cocks
 - c. Pressure Gauge Connector Plugs
- C. Meters and gauges furnished as part of factory-fabricated equipment are specified as part of equipment assembly in other Division-22 sections.

1.2 QUALITY ASSURANCE

- A. Codes and Standards:
 - 1. UL Compliance: Comply with applicable UL standards pertaining to meters and gauges.
 - 2. ANSI and ISA Compliances: Comply with applicable portions of American National Standards Institute (ANSI) and Instrument Society of America (ISA) standards pertaining to construction and installation of meters and gauges.
 - 3. Lead Free Compliance: All components associated with potable water systems (including, but not limited to, valves, end use devices/fixtures, pipe, pipe fittings, solder/flux, etc.) shall be "lead-free" in accordance with all local, state and federal codes, as well as NSF/ANSI 372 (NSF 61-G).
- B. Certification: Provide meters and gauges whose accuracies, under specified operating conditions, are certified by manufacturer.

1.3 SUBMITTALS

- A. Product Data: Submit manufacturer's technical product data, including installation instructions for each type of meter and gauge. Include scale range, ratings, and calibrated performance curves, certified where indicated. Submit meter and gauge schedule showing manufacturer's figure number, scale range, location, and accessories for each meter and gauge.
- B. Maintenance Data: Submit maintenance data and spare parts lists for each type of meter and gauge. Include this data in Maintenance Manual.

PART 2 - PRODUCTS

2.1 DIRECT MOUNT DIAL THERMOMETERS

- A. General: Provide direct mount dial thermometers of materials designed and constructed for use in service indicated.
- B. Type: Vapor tension, universal angle.
- C. Case: Drawn steel or brass, glass lens, 5" (125 mm) diameter. For gauges mounted above eight feet (2400 mm), 8" (200 mm) diameter gauge.
- D. Adjustable Joint: Die cast aluminum, 180 degree adjustment in vertical plane, 360 degree adjustment in horizontal plane, with locking device.
- E. Thermal Bulb: Copper with phosphor bronze bourdon pressure tube, one scale division accuracy.
- F. Movement: Brass precision geared.
- G. Scale: Progressive, satin faced, non-reflective aluminum, permanently etched markings.
- H. Stem: Copper plated steel, or brass, for separable socket, length to suit installation.
- I. Range: Conform to the following:
 - 1. Hot Water: 30°F - 240°F (-1°C - 116°C).

2.2 REMOTE READING DIAL THERMOMETERS

- A. General: Provide remote reading dial thermometers of materials designed and constructed for use in service indicated.
- B. Type: Vapor tension.
- C. Case: Drawn steel or brass, glass lens, 5" (125 mm) diameter. For gauges mounted above eight feet (2400 mm), 8" (200 mm) diameter shall be used.

- D. Movement: Brass, precision geared.
- E. Tubing: Bronze double braided armor over copper capillary, length to suit installation.
- F. Bulb: Copper with separable socket for liquids, averaging element for air.
- G. Accuracy: + one scale division.
- H. Range: Conform to the following:
 - 1. Hot Water: 30°F - 240°F (-1°C - 116°C).

2.3 THERMOMETER WELLS

- A. General: Provide thermometer wells constructed of brass or stainless steel, pressure rated to match piping system design pressure. Provide 2" (50 mm) extension for insulated piping. Provide cap nut with chain fastened permanently to thermometer well.
- B. Manufacturer: Same as thermometers.

2.4 PRESSURE GAUGES

- A. General: Provide pressure gauges of materials designed and constructed for use in service indicated.
- B. Type: General use, 1% accuracy, ANSI B 40.1 Grade A, phosphor bronze bourdon type, bottom connection.
- C. Case: Drawn steel or brass, glass lens, 5" (125 mm) diameter. For gauges mounted above eight feet (2400 mm), 8" (200 mm) gauges shall be used.
- D. Connector: Brass with 1/4" (6 mm) male NPT. Provide protective syphon when used for steam service.
- E. Scale: White coated aluminum, with permanently etched markings.
- F. Range: Conform to the following:
 - 1. Water: 0 - 100 psi (0 - 690 kPa).

2.5 PRESSURE GAUGE COCKS

- A. General: Provide pressure gauge cocks between pressure gauges and gauge tees on piping systems. Construct gauge cock of brass with 1/4" (6 mm) female NPT on each end, and "T" handle brass plug.
- B. Syphon: 1/4" (6 mm) straight coil constructed of brass tubing with 1/4" (6 mm) male NPT on each end.

- C. Snubber: 1/4" (6 mm) brass bushing with corrosion resistant porous metal disc, through which pressure fluid is filtered. Select disc material for fluid served and pressure rating.
- D. Manufacturer: Same as for pressure gauges.

2.6 PRESSURE GAUGE CONNECTOR PLUGS

- A. General: Provide pressure gauge connector plugs pressure rated for 500 psi (3448 kPa) and 200°F (93°C). Construct of brass and finish in nickel plate, equip with 1/2" (13 mm) NPS fitting, with self-sealing valve core type neoprene gasketed orifice suitable for inserting 1/8" (3 mm) O.D. probe assembly from dial type insertion pressure gauge. Equip orifice with gasketed screw cap and chain. Provide extension, length equal to insulation thickness, for insulated piping.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Examine areas and conditions under which meters and gauges are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF TEMPERATURE GAUGES

- A. General: Install temperature gauges in vertical upright position, and tilted so as to be easily read by observer standing on floor.
- B. Locations: Install direct mounted thermometers in the following locations, and elsewhere as indicated:
 - 1. At suction and discharge of each pump.
 - 2. At discharge of each domestic water heater.
- C. Remote Reading Dial Thermometers: Install on control panels as indicated. Run tubing between panel and thermometer bulb, adequately supported to prevent kinks. Select tubing length so as to not require coiling of tubing.
- D. Thermometer Wells: Install in piping tee where thermometers are indicated, in vertical upright position. Fill well with oil or graphite, secure cap.

3.3 INSTALLATION OF PRESSURE GAUGES

- A. General: Install pressure gauges in piping tee with pressure gauge cock, located on pipe at most readable position.
- B. Locations: Install in the following locations, and elsewhere as indicated:

1. At suction and discharge of each pump.
 2. At inlet and outlet of each pressure reducing valve.
 3. At incoming services (domestic water, fire and gas).
 4. At inlet and outlet of large strainers.
 5. At inlet of expansion tanks.
 6. At inlet and outlet of domestic water booster pump package.
 7. At the top of each standpipe riser.
 8. At inlet and outlet of backflow preventers.
- C. Pressure Gauge Cocks: Install in piping tee with snubber.
- D. Pressure Gauge Connector Plugs: Install in piping tee where indicated, located on pipe at most readable position. Secure cap.
- 3.4 ADJUSTING AND CLEANING
- A. Adjusting: Adjust faces of meters and gauges to proper angle for best visibility.
- B. Cleaning: Clean windows of meters and gauges and factory-finished surfaces. Replace cracked or broken windows and repair any scratched or marred surfaces with manufacturer's touch-up paint.

END OF SECTION 22 05 19

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SECTION 22 05 23 - VALVES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

- A. Extent of valves required by this section is indicated on drawings and/or specified in other Division-22 sections.
- B. Types of valves specified in this section include the following:
 - 1. Gate Valves
 - 2. Globe Valves
 - 3. Drain Valves
 - 4. Ball Valves
 - 5. Butterfly Valves
 - 6. Check Valves
- C. System Descriptions:
 - 1. Domestic Water Piping: Domestic water piping shall relate to potable and non-potable cold water, hot water piping systems.
- D. Valves furnished as part of factory-fabricated equipment, are specified as part of the equipment assembly in other Division-22 sections.

1.2 QUALITY ASSURANCE

- A. Valve Types: Provide valves of same type by same manufacturer.
- B. Valve Identification: Provide valves with manufacturer's name (or trademark) and pressure rating and size clearly marked on valve body.
- C. Codes and Standards:
 - 1. MSS Compliance: Mark valves in accordance with MSS-25 "Standard Marking System for Valves, Fittings, Flanges and Unions".
 - 2. ANSI Compliance: For face-to-face and end-to-end dimensions of flanged or welded-end valve bodies, comply with ANSI B16.10 "Face-to-Face and End-to-End Dimensions of Ferrous Valves".

3. UL and FM Compliance: Provide valves used in fire protection piping, which are UL-listed and FM approved.
4. Lead Free Compliance: All components associated with potable water systems (including, but not limited to, valves, end use devices/fixtures, pipe, pipe fittings, solder/flux, etc.) shall be "lead-free" in accordance with all local, state and federal codes, as well as NSF/ANSI 372 (NSF 61- G).

1.3 SUBMITTALS

- A. Product Data: Submit manufacturer's technical product data, including installation instructions for each type of valve. Include pressure drop curve or chart for each type and size of valve. Submit valve schedule showing manufacturer's figure number, size, location, and valve features for each required valve.
- B. Shop Drawings: Submit manufacturer's assembly-type (exploded view) shop drawings for each type of valve, indicating dimensions, weights, materials, and methods of assembly of components.
- C. Maintenance Data: Submit maintenance data and spare parts lists for each type of valve. Include this data, product data, and shop drawings in Maintenance Manual.

PART 2 - PRODUCTS

2.1 VALVES - GENERAL

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products which may be incorporated in the work, shall be limited to the following, unless otherwise noted:
 1. Milwaukee
 2. Bray
 3. Apollo
 4. DeZurik
 5. Jamesbury
 6. Watts
- B. Provide factory-fabricated valves recommended by manufacturer for use in service indicated. Provide valves of types and pressure ratings indicated; provide proper selection as determined by Installer to comply with installation requirements. Provide end connections which properly mate with pipe, tube, and equipment connections. Where more than one type is indicated, selection is Installer's option.

- C. Size: Unless otherwise indicated, provide valves of same size as upstream pipe size. Pipe size reduction shall be made after valve assembly.
- D. Valve Features: Provide the following as required:
 - 1. General: Provide valves with features indicated and, where not otherwise indicated, provide proper valve features as determined by Installer for installation requirements. Comply with ASME B31.9 for building services piping, and ASME B31.1 for power piping.
 - 2. Bypass: Comply with MSS SP-45, and except as otherwise indicated, provide manufacturer's standard bypass piping and valving.
 - 3. Drain: Comply with MSS SP-45, and provide threaded pipe plugs.
 - 4. Flanged: Valve flanges complying with ANSI B16.1 (cast iron), ANSI B16.5, (steel), or ANSI B16.24 (bronze).
 - 5. Threaded: Valve ends complying with ANSI B2.1.
 - 6. Butt-Welding: Valve ends complying with ANSI B16.25.
 - 7. Socket-Welding: Valve ends complying with ANSI B16.11.
 - 8. Solder-Joint: Valve ends complying with ANSI B16.18.
 - 9. Flangeless: Valve bodies manufactured to fit between flanges complying with ANSI B16.1 (cast iron), ANSI B16.5 (steel), or ANSI B16.24 (bronze).

2.2 GATE VALVES

- A. Comply with the following standards:
 - 1. Cast-Iron Valves: MSS SP-70.
 - 2. Bronze Valves: MSS SP-80.
 - 3. Steel Valves: ANSI B16.34.
- B. Fire Department Valves (Standpipes):
 - 1. Hose End; 2-1/2" (65 mm): FM, 175 psi (1200 kPa), bronze body, solid wedge, inside screw, non-rising stem, with cap and chain.
- C. Fire Protection and Incoming Water Services:
 - 1. Threaded End; 2" (50 mm) and Smaller: FM, UL-listed, 175 psi (1200 kPa), bronze body, solid wedge, outside screw and yoke, rising stem. Milwaukee Model 118 or equivalent.

2. Flanged End; 2-1/2" (65 mm) and Larger: FM, UL-listed, 175 psi (1200 kPa), iron body bronze mounted, solid wedge, outside screw and yoke, rising stem. Milwaukee Model F2885FP or equivalent.

2.3 GLOBE VALVES

A. Comply with the following standards:

1. Cast-Iron Valves: MSS SP-85.
2. Bronze Valves: MSS SP-80.
3. Steel Valves: ANSI B16.34.

B. Domestic Water Piping:

1. 2" (50 mm) and Smaller: Class 150, bronze body, union bonnet, integral seat, renewable TFE disc. Milwaukee Model 590T (Threaded), 1590T (Sweat) or equivalent.
2. Flanged Ends; 2-1/2" (65 mm) and Larger: Class 125, iron body, bolted bonnet, renewable seat and disc, bronze mounted. Milwaukee Model F2981A or equivalent.

2.4 DRAIN VALVES

A. Comply with the following standards:

1. Water Heater Drain Valves: ASSE 1005.

B. Domestic Water Piping:

1. 3" (75 mm) and Smaller: Class 125, bronze body ball valve with chrome plated ball, hose end with cap and chain. Milwaukee BA100H (Threaded), Milwaukee BA150H (Sweat) or equivalent.

2.5 BALL VALVES

A. Comply with the following standards:

1. Bronze Valves: MSS SP-110.
2. Potable Water: NSF-61-8.

B. Domestic Water Piping:

1. 2" (50 mm) and Smaller: Valves shall be rated 150 psi (1035 kPa) SWP and 600 psi (4140 kPa) non-shock WOG and shall have 2-piece cast ASTM B 584 bronze bodies, TFE seats, standard port, separate packing nut with adjustable stem

packing, anti-blowout stems and stainless steel ball. Valve ends shall have full depth ANSI threads or extended solder connections and be manufactured to comply with MSS-SP110. Milwaukee BA100S (Threaded), BA150S (Sweat) or equivalent. For potable water applications provide NSF/ANSI 1372 (NSF-61-G) compliant "lead free" valves; Milwaukee UPBA 100/150 or equivalent.

C. Natural Gas Service:

1. 2" (50 mm) and Smaller: 600 lb WOG, 150 lb SWP, 2 piece body style, full port, chrome plated ball, bronze body of ASTM B283 forged brass body, hex gland follower, blow out proof stem, lever handle. Valves shall be CSA, UL and FM approved. Milwaukee BA 475 (Threaded) or equivalent.
2. 2-1/2" (65 mm) and larger: Consult valve manufacturer for suggested valve over 2" for gas service (Milwaukee does not offer a gas agency approved valve over 2")

- D. Where piping is insulated, ball valves shall be equipped with 2" (50 mm) 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.

2.6 BUTTERFLY VALVES

- A. General: Comply with MSS SP-67. Where butterfly valves are used as shutoffs for terminal or equipment removal or repair, select bubble tight, lug body type valves suitable for dead end service.

B. Domestic Water Piping:

1. 2-1/2" (65 mm) to 6" (150 mm): 200 psi (1380 kPa), ductile iron, ASTM A 536 lug body. EPDM seat, 316 SS disc and stem, lever operated. Milwaukee model ML224E or equivalent. For food and beverage applications, provide Milwaukee model ML224NW or equivalent. For potable water applications provide NSF/ANSI 372 (NSF 61- G) compliant "lead free" valves; Milwaukee ML 233E (lever operated), Milwaukee ML 333E (gear operated) or equivalent.
2. All valves shall be capable of bubble tight dead end service in either direction without use of additional pinning, screws or mating flanges.

2.7 CHECK VALVES

- A. Comply with the following standards:

1. Cast-Iron Valves: MSS SP-71.
2. Bronze Valves: MSS SP-80.
3. Steel Valves: ANSI B16.34.

B. Domestic Water Piping:

1. 2" (50 mm) and Smaller: Class 150, bronze body, horizontal swing, T pattern with renewable TFE disc. Milwaukee 510T (Threaded), 1510T (Sweat) or equivalent.
 2. 2-1/2" (65 mm) and Larger: Class 125, iron body, bolted bonnet, horizontal swing, renewable seat and disc, flanged ends. Milwaukee F2974A or equivalent.
- C. Fire Protection:
1. 2-1/2" (65 mm) and Larger; FM: 175 psi (1200 kPa), iron body bronze mounted, renewable composition disc and bronze seat ring, bolted cover, flanged ends. Milwaukee F2974FP or equivalent.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. General: Except as otherwise indicated, comply with the following requirements.
1. Install valves where required for proper operation of piping and equipment, including valves in branch lines, service mains and all equipment connections. Locate valves so as to be accessible and so that separate support can be provided when necessary.
 2. Install valves with stems pointed up, in vertical position where possible, but in no case with stems pointed downward from horizontal plane unless unavoidable. Install valve drains with hose-end adapter for each valve that must be installed with stem below horizontal plane.
- B. Insulation: Where insulated, install extended-stem valves, arranged in proper manner to receive insulation.
- C. Selection of Valve Ends (Pipe Connections): Except as otherwise indicated, select and install valves with connections to match pipe fittings.
- D. Renewable Seats: Install valves with renewable seats, where applicable.
- E. Fluid Control: Except as otherwise indicated, install gate, ball, globe, and butterfly valves to comply with ANSI B31.9. Where throttling is indicated or recognized as principle reason for valve, install ball, globe or butterfly valves, as indicated.
- F. Installation of Check Valves: Install in horizontal position with hinge pin horizontally perpendicular to center line of pipe. Install for proper direction of flow.

3.2 ADJUSTING AND CLEANING

- A. Valve Adjustment: After piping systems have been tested and put into service, but before final testing, adjusting and balancing, inspect each valve for possible leaks. Adjust or replace packing to stop leaks, replace valve if leak persists.

- B. Valve Identification: Tag each valve in accordance with Division-22 section "Identification for Plumbing Piping and Equipment".
- C. Cleaning: Clean factory-finished surfaces. Repair any marred or scratched surfaces with manufacturer's touch-up paint.

END OF SECTION 22 05 23

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SECTION 22 05 29 - HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

- A. Extent of hangers and supports required by this section is indicated on drawings and/or specified in other Division-22 sections.
- B. Types of hangers and supports specified in this section include the following:
 - 1. Horizontal-Piping Hangers and Supports
 - 2. Vertical-Piping Clamps
 - 3. Hanger-Rod Attachments
 - 4. Building Attachments
 - 5. Saddles and Shields
 - 6. Spring Hangers and Supports
 - 7. Miscellaneous Materials
 - 8. Roof Equipment Supports
 - 9. Anchors
 - 10. Equipment Supports
- C. Hangers and supports furnished as part of factory-fabricated equipment are specified as part of equipment assembly in other Division-22 sections.

1.2 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of hangers and supports, of types and sizes required, whose products have been in satisfactory use in similar service for not less than five (5) years.
- B. Codes and Standards:
 - 1. Code Compliance: Comply with applicable codes pertaining to product materials and installation of hangers and supports.
 - 2. NFPA, UL, and FM Compliance: Provide products which comply with NFPA 13 listed and labeled by UL and FM where used for fire protection piping systems.

3. MSS Standard Compliance:
 - a. Provide pipe hangers and supports of which materials, design, and manufacture comply with MSS SP-58.
 - b. Select and apply pipe hangers and supports, complying with MSS SP-69.
 - c. Fabricate and install pipe hangers and supports, complying with MSS SP-89.
 - d. Terminology used in this section is defined in MSS SP-90.

1.3 SUBMITTALS

- A. Product Data: Submit manufacturer's technical product data, including installation instructions for each type of support and anchor. Submit pipe hanger and support schedule showing manufacturer's figure number, size, location, and features for each required pipe hanger and support.

PART 2 - PRODUCTS

2.1 HORIZONTAL-PIPING HANGERS AND SUPPORTS

- A. General: Except as otherwise indicated, provide factory-fabricated horizontal-piping hangers and supports complying with MSS SP-58, selected by Installer to suit horizontal-piping systems in accordance with MSS SP-69 and manufacturer's published product information. Use only one type by one manufacturer for each piping service. Select size of hangers and supports to exactly fit pipe size for bare piping, and to exactly fit around piping insulation with saddle or shield for insulated piping. Provide copper-plated hangers and supports for copper-piping systems. To avoid future electrolysis or corrosion, copper plated hangers, supports, clamps, rod attachments, and building attachments shall not be in direct contact with copper piping. A separation material shall be installed between the pipe and the copper plated hanger, support, clamp, etc. The separation material shall prohibit electrical conductance and prevent galvanic action or corrosion between dissimilar metals. Separation material shall be guaranteed for a minimum of thirty (30) years.

2.2 VERTICAL-PIPING CLAMPS

- A. General: Except as otherwise indicated, provide factory-fabricated vertical-piping clamps complying with MSS SP-58, selected by Installer to suit vertical piping systems, in accordance with MSS SP-69 and manufacturer's published product information. Select size of vertical piping clamps to exactly fit pipe size of bare pipe. Provide copper-plated hangers and supports for copper-piping systems. To avoid future electrolysis or corrosion, copper plated hangers, supports, clamps, rod attachments, and building attachments shall not be in direct contact with copper piping. A separation material shall be installed between the pipe and the copper plated hanger, support, clamp, etc. The separation material shall prohibit electrical conductance and prevent galvanic action or

corrosion between dissimilar metals. Separation material shall be guaranteed for a minimum of thirty (30) years.

2.3 HANGER-ROD ATTACHMENTS

- A. General: Except as otherwise indicated, provide factory-fabricated hanger-rod attachments complying with MSS SP-58, selected by Installer to suit horizontal-piping hangers and building attachments, in accordance with MSS SP-69 and manufacturer's published product information. Use only one type by one manufacturer for each piping service. Select size of hanger-rod attachments to suit hanger rods. Provide copper-plated hanger-rod attachments for copper-piping systems. To avoid future electrolysis or corrosion, copper plated hangers, supports, clamps, rod attachments, and building attachments shall not be in direct contact with copper piping. A separation material shall be installed between the pipe and the copper plated hanger, support, clamp, etc. The separation material shall prohibit electrical conductance and prevent galvanic action or corrosion between dissimilar metals. Separation material shall be guaranteed for a minimum of thirty (30) years.

2.4 BUILDING ATTACHMENTS

- A. General: Except as otherwise indicated, provide factory-fabricated building attachments complying with MSS SP-58, selected by Installer to suit building substrate conditions, in accordance with MSS SP-69 and manufacturer's published product information. Select size of building attachments to suit hanger rods. Provide copper-plated building attachments for copper-piping systems. Provide copper-plated hangers and supports for copper-piping systems. To avoid future electrolysis or corrosion, copper plated hangers, supports, clamps, rod attachments, and building attachments shall not be in direct contact with copper piping. A separation material shall be installed between the pipe and the copper plated hanger, support, clamp, etc. The separation material shall prohibit electrical conductance and prevent galvanic action or corrosion between dissimilar metals. Separation material shall be guaranteed for a minimum of thirty (30) years.

2.5 SADDLES AND SHIELDS

- A. General: Except as otherwise indicated, provide saddles or shields under piping hangers and supports, factory-fabricated, for all insulated piping. Size saddles and shields for exact fit to mate with pipe insulation.

2.6 SPRING HANGERS AND SUPPORTS

- A. General: Except as otherwise indicated, provide factory-fabricated spring hangers and supports complying with MSS SP-58, selected by Installer to suit piping systems, in accordance with MSS SP-69 and manufacturer's published product information. Use only one type by one manufacturer for each piping service. Select spring hangers and supports to suit pipe size and loading.

2.7 MISCELLANEOUS MATERIALS

- A. Metal Framing: Provide products complying with NEMA STD ML 1.
- B. Steel Plates, Shapes and Bars: Provide products complying with ASTM A 36.
- C. Cement Grout: Portland cement (ASTM C 150, Type I or Type III) and clean uniformly graded, natural sand (ASTM C 404, Size No. 2).
- D. Heavy-Duty Steel Trapezes: Fabricate from steel shapes selected for loads required; weld steel in accordance with AWS standards.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Examine areas and conditions under which hangers and supports are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF BUILDING ATTACHMENTS

- A. Install attachments at required locations within concrete steel for proper piping support. Space attachments within maximum piping span length indicated in MSS SP-69. Install additional building attachments where support is required for additional concentrated loads, including valves, flanges, guides, strainers, expansion joints, and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten insert securely to forms. Where concrete with compressive strength less than 2500 psi (17240 kPa) is indicated, install reinforcing bars through openings at top of inserts.

3.3 INSTALLATION OF HANGERS AND SUPPORTS

- A. General: Install hangers, supports, clamps and attachments to support piping properly from building structure; comply with MSS SP-69. Arrange for grouping of parallel runs of horizontal piping to be supported together on trapeze type hangers where possible. Install supports with maximum spacings complying with MSS SP-69. Where piping of various sizes is to be supported together by trapeze hangers, space hangers for smallest pipe size or install intermediate supports for smaller diameter pipe. Do not use wire or perforated metal to support piping, and do not support piping from other piping.
- B. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers and other accessories. Except as otherwise indicated for exposed continuous pipe runs, install hangers and supports of same type and style as installed for adjacent similar piping.
- C. Support fire-water piping independently of other piping.
- D. Prevent electrolysis in support of copper tubing by use of hangers and supports which are copper plated, or by other recognized industry methods.

- E. Provisions for Movement:
 - 1. Install hangers and supports to allow controlled movement of piping systems and to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends and similar units.
- F. Load Distribution: Install hangers and supports so that piping live and dead loading and stresses from movement will not be transmitted to connected equipment.
- G. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes, and so that maximum pipe deflections allowed by ANSI B31 Pressure Piping Codes are not exceeded.
- H. Insulated Piping: Comply with the following installation requirements.
 - 1. Clamps: Attach clamps, including spacers (if any), to piping with clamps projecting through insulation; do not exceed pipe stresses allowed by ANSI B31.
 - 2. Shields: Where low-compressive-strength insulation or vapor barriers are indicated on cold water piping, install coated protective shields.
 - 3. Saddles: Where insulation without vapor barrier is indicated, install protection saddles.
 - 4. For all insulated piping 2-1/2" (63 mm) and larger, provide insulated saddles as follows:
 - a. For domestic hot and cold water piping, provide the following:
 - b. Minimum 3.75 pcf, non-compressive, rigid, phenolic foam insulation. Fire and smoke rating shall be 25/50 or below per ASTM 84.
 - c. For cold applications below 75°F (24°C) a zero permeability, abuse resistant, vapor barrier shall be provided with matching butt strips. Apply a full coating of butyl joint sealant in addition to the butt strips for a completely sealed system.
 - d. The phenolic foam system shall have a K factor of 0.16 at a mean temperature for 75°F (24°C) and comply with ASTM Standard C1126.
 - e. Provide visible inspection sticker at the bottom of each saddle.
 - f. Pipe insulation saddles shall be Tru-Balance CoolDry Saddles as manufactured by Buckaroos, Inc. or equivalent.
- I. Spacing: Hanger spacing for piping shall not exceed 8 feet (2400 mm) on centers for pipe 1-1/4" (32 mm) or smaller, and 10 feet (3 m) for pipe 1-1/2" (40 mm) and larger. Regardless of spacing, hangers shall be provided at or near all changes in direction, both vertical and horizontal, for all piping. For cast iron soil pipe, one hanger shall be placed at each hub or bell.

3.4 ADJUSTMENT OF HANGERS AND SUPPORTS

- A. Adjust hangers and supports and place grout as required under supports to bring piping to proper levels and elevations.

3.5 EQUIPMENT SUPPORTS

- A. Provide concrete housekeeping bases for all floor mounted equipment furnished as part of the work of Division-22. Size bases to extend minimum of 4" (100 mm) beyond equipment base in any direction; and 4" (100 mm) above finished floor elevation. Construct of reinforced concrete, roughen floor slab beneath base for bond, and provide steel rod anchors between floor and base. Locate anchor bolts using equipment manufacturer's templates. Chamfer top and edge corners.
- B. Provide structural steel stands to support equipment not floor mounted or hung from structure. Construct of structural steel members or steel pipe and fittings. Provide factory-fabricated tank saddles for tanks mounted on steel stands.

3.6 PAINTING

- A. All hangers, supports, clamps and assemblies shall be primed and painted with rust inhibitors.

END OF SECTION 22 05 29

SECTION 22 05 48 - VIBRATION ISOLATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

- A. Scope: The extent of vibration isolation work to be provided under this Contract is covered by the requirements of this Section, all Division-22 specifications, and the Contract Drawings including structural, architectural, mechanical and electrical which identify equipment and systems requiring vibration isolation treatment.
- B. Types: Types of vibration isolation equipment and systems specified in this Section include:

<u>TYPE</u>	<u>DESCRIPTION</u>
1 Isolator	Ribbed Neoprene Pads
2I Isolator	Neoprene-In-Shear Type
2H Hanger	Rubber-In-Shear Type
3I Isolator	Open Spring Type
3H Hanger	Combination Spring and Neoprene Type
4 Isolator	Vertically Restrained Spring Isolators
5 Thrust	Restraints Spring Type Installed in Pairs
A Base	Directly Bolted Attachment
B Base	Structural Rails or Bases
C Base	Concrete Inertia Type

- C. Selection of Isolators: Provide isolators selected by a vibration isolator equipment specialist.

1. Conform to isolator types herein specified.
2. Examine the contract drawings for sizes, horsepowers, rotational speeds, equipment location, length of span between columns and beams and construction type to determine the isolator selection type and deflection required for each piece of mechanical equipment.
3. Conform to the requirements of the most current edition of American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) Handbook, Sound and Vibration Control.

1.2 QUALITY ASSURANCE

- A. Codes: At a minimum, conform to the most current edition of ASHRAE Handbook.
- B. Manufacturer: Isolators of the same type shall be the product of the same manufacturer. The manufacturer shall publish and maintain a full line of materials, engineering and application data and operating and maintenance instructions.

1.3 SUBMITTALS

- A. Contractor's Certification: Vibration isolator submittals shall include a certification, signed by an officer representing the Contractor and stipulating that the submittal prepared by the manufacturer has been reviewed, and checked on an item by item basis against each piece of mechanical equipment, shown or specified in the Contract Documents, which requires vibration isolation.
- B. Manufacturer's Certification: The manufacturer or manufacturers (if there are more than one) shall each certify that the selections of vibration isolation equipment are based upon the drawings and specifications, and that each piece of mechanical equipment has been examined for rotational speed, equipment type, mounting location, and supporting span between column centers, and that an appropriate isolator has been selected.
- C. Product Data: Furnish manufacturer's product data covering each isolator type for style, characteristic, and finish.
 1. Isolator quantities, dimensions, deflections, capacities and types shall remain the responsibility of the manufacturer and the Contractor.
 - a. Shop Drawings: Where coordinated shop drawings are required, provide layout drawings, drawn to a scale of not less than 1/4-inch to 1-foot (6 mm to 300 mm), showing the proposed layout of equipment and piping systems and the location and type of each vibration isolation device.
 - b. Carefully examine other sections requiring coordinated shop drawings and prepare isolation shop drawings to the same scale showing the location of each vibration isolation equipment base, pipe hanger, flexible connection, and isolator.

1.4 STORAGE AND PROTECTION

- A. Storage: Store vibration isolation equipment indoors in the manufacturer's original shipping containers. Preclude the entrance of construction dirt and debris.
 - 1. Vibration isolation equipment and bases, which show signs of rust, cement or concrete fouling, dirt and construction debris shall be disassembled and cleaned, approved or removed from the project site and replaced with new.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products which may be incorporated in the work include the following:
 - 1. Mason
 - 2. Vibration Eliminator Co.
 - 3. Kinetics Noise Control

2.2 EQUIPMENT

- A. Dimensions: The schedule shows dimensions for deflection and sizes all in inches.
- B. Spans: Where referenced, the schedule shows spans of the longest bay dimension for slabs or beams supported between columns. Dimensions are in feet.
- C. Selection: Exact mounting sizes, dimensions and quantity of isolators and static deflection required shall be determined by the isolator manufacturer based upon equipment that will be furnished and installed by the Contractor under this Contract.
 - 1. Vibration isolation specialist shall coordinate his work with that of other trades to verify that equipment speeds, in revolutions per minute (rpm), are based upon actual equipment installed at the project site.
 - 2. Verify that equipment rpm and spring deflection selected are arranged so that resonance is avoided.

2.3 ISOLATOR TYPES

- A. Type 1 Isolators: Provide pad type vibration isolators consisting of either two layers of 3/8-inch (10 mm) thick elastomer, molded to contain a pattern with non-slip characteristics in all directions, and bonded to 16 gauge (1.6 mm) galvanized steel separator plates, or 1-inch (25 mm) thick precompressed molded fiberglass isolation pads. Minimum overall thickness shall be 1-inch (25 mm). Deflection shall be limited to

0.25 inches (6 mm) or less. Loading shall not exceed 40 pounds per square inch (280 kPa).

- B. Type 2I Isolators: Provide double rubber-in-shear or elastomer-in-shear with molded-in steel reinforcement in the top and bottom portions.
 - 1. Deflections shall be limited to 0.5 inches (13 mm) or less.
 - 2. Steel bases shall be drilled with mounting holes and equipment mounting points shall be threaded male or female connections.
 - 3. Treat resilient material with antiozone and antioxidant additives.
- C. Type 2H Hangers: Provide rubber-in-compression suspension hangers, consisting of a formed steel frame and elastomer isolation element and provided with attachments for top and bottom suspension rods.
 - 1. Design for a minimum 200 percent overload without noticeable deformation or failure.
 - 2. Metal components shall be galvanized or factory painted.
- D. Type 3I Isolators: Provide adjustable, freestanding, open spring isolators with combination leveling and equipment fastening bases.
 - 1. Spring elements shall be contained in upper and lower housing assemblies and shall have a minimum Kx-Ky of 0.75.
 - 2. Design springs for a minimum travel of 50 percent beyond the rated load.
 - 3. When fully compressed and "bottomed-out", isolators shall be capable of supporting a 150 percent overload without deformation and spring failure.
 - 4. A minimum 1/4-inch (6 mm) thick non-skid isolation pad shall be bonded to the underside of the base plate.
 - 5. Size base plates to limit floor loading to 100 pounds per square inch (690 kPa).
 - 6. Drill base plates for bolting, as required.
 - 7. Provide means for anchoring the top element of the isolator to rails and equipment.
- E. Type 3H Hangers: Provide combination spring and elastomer hangers consisting of a formed steel frame with coil spring and elastomer insert in compression.
 - 1. Design hangers to be capable of supporting a 200 percent overload without noticeable deformation or failure.
 - 2. Design hangers to allow a 30 degree misalignment without binding or a reduction in hanger efficiency.
 - 3. Design hangers for connection to equipment and supporting rods.

- F. Type 4 Isolators: Provide vertically restrained, freestanding, laterally stable, open spring type isolators.
 - 1. Design for deflection exceeding 1/2-inch (13 mm).
 - 2. Provide built-in bearing and leveling provisions.
 - 3. Provide a minimum 1/4-inch (6 mm) thick non-slip elastomer vibration absorbing pad bonded to the underside of the isolator base.
 - 4. Outside diameter of each spring shall be equal to or greater than 0.9 times the operating height of the spring under rated load.
 - 5. Provide vertical limit stops to prevent hyperextension due to wind loads or upward movement when the load is removed. Limit stops shall not bind or inhibit spring movement during normal operating ranges.
 - 6. For exterior applications, steel housings shall be hot dipped galvanized and springs shall be neoprene or powder coated.

- G. Type 5 Thrust Restraints: Provide spring isolators of an adjustable, freestanding type enclosed within tubular mountings and arranged to be installed in pairs across the discharge of fan flexible connectors.
 - 1. Design restraints to resist the thrust caused by duct internal air pressure.
 - 2. Install restraints on duct systems with an internal static pressure exceeding 3 inches water gauge (750 Pa).
 - 3. Restraints shall have the same deflection as isolators installed under the fans.

2.4 BASE TYPES

- A. Type A Bases: No supplementary base is required. Vibration isolators, specified elsewhere, shall be attached directly to the supported equipment or structural system.

- B. Type B, Structural Rails or Bases: Provide bases designed and supplied by the isolation equipment manufacturer.
 - 1. Construct bases of mill rolled structural sections of sufficient dimension to limit the midpoint deflection or unsupported spans to 1/1440th of the span between isolators.
 - 2. Include equipment static loadings, power transmission, component misalignment and cantilever loadings when designing structural sections.
 - 3. When head room is limited, coordinate the design of structural rails and isolators to reduce mounting heights.
 - 4. Factory finish with two (2) coats of equipment enamel.

- C. Type C, Concrete Inertia Bases: Provide concrete inertia bases designed by the isolator manufacturer and arranged to be filled with concrete in the field.
1. Construct base of mill rolled structural steel sections, factory mitered and welded into a rigid frame and supporting No. 4 reinforcing bars welded to the structural frame 8 inches (200 mm) on centers both ways and located 2 inches (50 mm) from the bottom of the block.
 2. Arrange for outrigger isolation mountings, anchor bolts and equipment support.
 3. Field fill with 3,000 psi cured-strength concrete. Trowel to a smooth hard finish.
 4. Clean structural steel of excess concrete and field paint all steel elements with two coats equipment enamel.
 5. Configuration of inertia bases shall be rectangular to accommodate equipment supported unless otherwise indicated.
 6. Minimum thickness of inertia bases, in addition to providing suitable mass, shall be sufficient to provide stiffness to maintain equipment manufacturer's recommended alignment and duty efficiency of power transmission.
 7. Minimum thickness shall be sufficient to result in a base deflection at midpoint of unsupported span of not more than 1/1440th of the span between isolators.
 8. Minimum thickness shall be 8 percent of the longest base dimension unless otherwise specified or indicated.
 9. For centrifugal pumps, the bases shall be a minimum 6 inches (150 mm) thick.
 10. Where inertia bases are used to mount pumps, the bases shall be long enough to support piping elbows for all connections.

2.5 PIPING

- A. General: All piping in mechanical equipment rooms and within fifty feet (15 m) of the vibration source shall be isolated from the building structure with flexible vibration isolators.
1. Suspend piping on Type 3H hangers.
 2. Floor-mounted piping shall be supported with Type 4 spring isolators with deflections the same as the equipment to which the piping is attached.
- B. Reciprocating Equipment: Provide spring type hangers with deflections equal to that of reciprocating equipment, with piping arranged with offset elbows to absorb vibration.
- C. Risers: Pipe and duct risers within 100 feet (30 m) of mechanical equipment rooms shall be resiliently anchored to the building structure with Type 1 vibration isolators, near the midpoint of the risers.

1. Risers shall be isolated and supported at each second floor with pairs of Type 3H hangers, having deflections a minimum of five times the anticipated thermal movement at the support point.
2. Risers shall be guided as required with four (4) sets of Type 2I vibration isolators.

2.6 VIBRATION ISOLATION SYSTEM SELECTION

- A. General: The following selections of vibration isolation equipment systems shall be considered as a minimum. For the equipment below, the following code applies:

Letter (i.e. A, B, C) = Base type

Number (i.e. 1, 2, 3, 4) = Isolator type

Decimal number (i.e. 0.25, 1.5, etc.) = Minimum deflection

- B. Air Compressors

TYPE EQUIPMENT	BASEMENT BELOW GRADE	20 FOOT (6M) FLOOR SPAN	30 FOOT (9 M) FLOOR SPAN	40 FOOT (12 M) FLOOR SPAN
Tank Mounted	A 3 0.75	A 3 0.75	A 3 1.5	A 3 2.5
Base Mounted to 500 rpm (52 Rad/s)	C 3 0.75	C 3 0.75	C 3 0.75	C 3 1.5
Over 500 rpm (Over 52 Rad/s)	C 3 0.75	C 3 0.75	C 3 1.5	C 3 1.5

- C. Centrifugal Pumps

TYPE EQUIPMENT	BASEMENT BELOW GRADE	20 FOOT (6M) FLOOR SPAN	30 FOOT (9 M) FLOOR SPAN	40 FOOT (12 M) FLOOR SPAN
Close-coupled thru 7-1/2 hp (5.6 kW)	B or C 2 0.25	C 3 0.75	C 3 0.75	C 3 0.75
Close-coupled 10 hp & above (7.4 kW & above)	C 3 0.75	C 3 0.75	C 3 1.5	C 3 1.5
Bedplate-mounted thru 40 hp (30 kW)	C 3 0.75	C 3 0.75	C 3 1.5	C 3 1.5
50 to 125 hp	C 3 0.75	C 3 0.75	C 3 1.5	C 3 2.5

(37 to 95 kW)

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Manufacturer: All vibration isolation equipment shall be installed in accordance with the manufacturer's recommendations.
- B. Manufacturer's Representative: The vibration isolation installation and deflection testing after equipment start-up shall be conducted by a representative of the manufacturer.

3.2 TESTS AND REPORTS

- A. Testing: Each vibration isolation device shall be deflection tested. Two (2) copies of a bound report shall be submitted prior to final acceptance. The certification shall include the following:
 - 1. Certify that equipment has been isolated in accordance with Contract Drawings, specifications and submittals.
 - 2. Certify that all minimum specified deflections have been equaled or exceeded.

3.3 ANCHORING

- A. Installation: Installation shall comply with manufacturer's published recommendations and shall be installed so that isolators are plumb and are operating at a manner for which they were designed.
 - 1. Unless otherwise specified, all equipment shall be securely bolted to isolators, steel bases or concrete inertia bases.
 - 2. Indoor vibration isolators need not be attached to the structure unless required by local codes.
 - 3. Isolators installed outdoors shall be attached to building structure.

3.4 CLEANING

- A. Debris: Remove all debris from under equipment, and thoroughly clean steel bases, inertia bases and check for free movement.
- B. Adjustment: Adjust isolators as required for proper operation prior to starting equipment. Testing of vibration isolators shall be performed by a certified representative of the manufacturer as specified.

3.5 GENERAL

- A. All exterior structural steel and/or steel housings of exterior vibration isolation materials shall be hot dipped galvanized.

END OF SECTION 22 05 48

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SECTION 22 05 53 - IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

- A. Extent of plumbing identification work required by this section is indicated on drawings and/or specified in other Division-22 sections.
- B. Types of identification devices specified in this section include the following:
 - 1. Pipe Markers
 - 2. Painted Identification Materials
 - 3. Underground-Type Plastic Line Marker
 - 4. Valve Tags
 - 5. Valve Schedule Frames
 - 6. Engraved Plastic-Laminate Signs
 - 7. Plastic Equipment Markers
 - 8. Plasticized Tags
- C. Plumbing identification furnished as part of factory-fabricated equipment, is specified as part of equipment assembly in other Division-22 sections.
- D. Refer to other Division-22 sections for identification requirements at central-station mechanical control center; not work of this section.
- E. Refer to Division-26 sections for identification requirements of electrical work; not work of this section.

1.2 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Firms regularly engaged in manufacturer of identification devices of types and sizes required, whose products have been in satisfactory use in similar service for not less than five (5) years.
- B. Codes and Standards:
 - 1. ANSI Standards: Comply with ANSI A13.1 or Owner standards for lettering size, length of color field, colors, and viewing angles of identification devices.

1.3 SUBMITTALS

- A. Product Data: Submit manufacturer's technical product data and installation instructions for each identification material and device required.
- B. Schedules: Submit valve schedule for each piping system, typewritten and reproduced on 8-1/2" x 11" (213 mm X 275 mm) bond paper. Tabulate valve number, piping system, system abbreviation (as shown on tag), location of valve (room or space), and variations for identification (if any). Mark valves which are intended for emergency shut-off and similar special uses, by special "flags", in margin of schedule. In addition to mounted copies, furnish extra copies for maintenance manuals.
- C. Maintenance Data: Include product data and schedules in maintenance manuals.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers' products which may be incorporated in the work include the following:
 - 1. Brady
 - 2. Seton
 - 3. Bunting

2.2 PLUMBING IDENTIFICATION MATERIALS

- A. General: Provide manufacturer's standard products of categories and types required for each application as referenced in other Division-22 sections. Where more than single type is specified for application, selection is Installer's option but provide single selection for each product category.

2.3 PIPE MARKERS

- A. Snap-on Type: Provide pre-printed, semi-rigid, snap-on color coded identification sleeves complying with ANSI A13.1. This type shall be used for insulated pipe sizes 2" and smaller.
- B. Pressure Sensitive Type: Provide pre-printed, permanent adhesive, color coded, pressure sensitive, vinyl markers conforming to ANSI A13.1. This style marker shall be applied to all uninsulated piping; insulated piping 2-1/2" and larger.
- C. Flow Direction: Provide flow directional arrows either as part of markers, or separately attached to pipes.

2.4 PAINTED IDENTIFICATION MATERIALS

- A. Piping and Equipment Systems: Continuous color coded painting of piping and equipment shall be provided in all mechanical rooms in compliance with ANSI A13.1.

2.5 UNDERGROUND-TYPE PLASTIC LINE MARKER

- A. General: Manufacturer's standard permanent, bright-colored, continuous-printed plastic tape, intended for direct-burial service; not less than 6" (150 mm) wide x 4 mils thick. Provide tape with printing which most accurately indicates type of service of buried pipe.
 - 1. Provide multi-ply tape consisting of solid aluminum foil core between two layers of plastic tape.

2.6 VALVE TAGS

- A. Brass Valve Tags: Provide 19-gage (1.2 mm) polished brass valve tags with stamp-engraved piping system abbreviation in 1/4" (6 mm) high letters and sequenced valve numbers 1/2" (13 mm) high, and with 5/32" (4 mm) hole for fastener.
 - 1. Provide 1-1/2" (40 mm) diameter tags, except as otherwise indicated.
- B. Valve Tag Fasteners: Provide manufacturer's standard solid brass chain (wire link or beaded type), or solid brass S-hooks of the sizes required for proper attachment of tags to valves, and manufactured specifically for that purpose.

2.7 VALVE SCHEDULE FRAMES

- A. General: For each page of valve schedule, provide glazed display frame, with screws for removable mounting on masonry walls. Provide frames of finished hardwood or extruded aluminum, with lexan.
 - 1. Locate one schedule where directed. Provide second schedule to Owner framed in rigid plastic frame with rigid plastic glazing.

2.8 ENGRAVED PLASTIC-LAMINATE SIGNS

- A. General: Provide engraving stock melamine plastic laminate, complying with FS L-P-387, in the sizes and thicknesses indicated, engraved with engraver's standard letter style of the sizes and wording indicated, black with white core (letter color) except as otherwise indicated, punched for mechanical fastening except where adhesive mounting is necessary because of substrate.
 - 1. Thickness: 1/16" (1.6 mm) for units up to 20 sq. in. (12900 mm²) or 8" (200 mm) length; 1/8" for larger units.

- B. Fasteners: Self-tapping stainless steel screws, except contact-type permanent adhesive where screws cannot or should not penetrate the substrate.
- C. Duty: Accident-prevention tags with appropriate wording including large-size primary wording (as examples; DANGER, CAUTION, DO NOT OPERATE).

2.9 PLASTIC EQUIPMENT MARKERS

- A. General: Provide manufacturer's standard laminated plastic, color coded equipment markers.
- B. Nomenclature: Include the following, matching terminology on schedules as closely as possible:
 - 1. Name and schedule number
 - 2. Equipment service

2.10 LETTERING AND GRAPHICS

- A. General: Coordinate names, abbreviations and other designations used in plumbing identification work with corresponding designations shown on plans. Provide numbers, lettering and wording as indicated or, if not otherwise indicated, as recommended by manufacturers or as required for proper identification and operation/maintenance of plumbing systems and equipment.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

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

3.2 PIPING SYSTEM IDENTIFICATION

- A. General: Install pipe markers on each system indicated to receive identification, and include arrows to show normal direction of flow.
- B. Locate pipe markers as follows wherever piping is exposed to view in occupied spaces, machine rooms, accessible maintenance spaces (shafts, tunnels, plenums) exterior non-concealed, locations, and concealed gas piping.
 - 1. Near each valve and control device.

2. Near each branch, excluding short take-offs for fixtures and terminal units; mark each pipe at branch, where there could be question of flow pattern.
 3. Near locations where pipes pass through walls or floors/ceilings, or enter non-accessible enclosures.
 4. At access doors, manholes and similar access points which permit view of concealed piping.
 5. Near major equipment items and other points of origination and termination.
 6. Spaced intermediately at maximum spacing of 25 feet (7500 mm) along each piping run.
 - a. Space fire main, standpipe, and fire sprinkler main markers at intervals not exceeding 10' (3 m) on straight pipe runs unless pipe is painted red throughout.
- C. Gas Pipe: Paint exposed gas pipe throughout (except chromium plated).

3.3 UNDERGROUND PIPING IDENTIFICATION

- A. General: During back-filling/top-soiling of each exterior underground piping system, install continuous underground-type plastic line marker, located directly over buried line at 6" to 8" (150 to 200 mm) below finished grade. Where multiple small lines are buried in common trench and do not exceed overall width of 16" (400 mm), install single line marker.

3.4 VALVE IDENTIFICATION

- A. General: Provide valve tag on every valve, cock and control device in each piping system; exclude check valves, valves within factory fabricated equipment units, plumbing fixture faucets, convenience and lawn-watering hose bibs, shut-off valves at plumbing fixtures, and similar rough-in connections of end-use fixtures and units. List each tagged valve in valve schedule for each piping system.
 1. Tagging Schedule: Comply with requirements of "Valve Schedule" of this section.
 2. Fire protection valves (shutoff, test, drain, etc. shall be labeled with a rigid plastic identification sign, secured with corrosion-resistant wire or chain, per NFPA 13.

3.5 PLUMBING EQUIPMENT IDENTIFICATION

- A. General: Install engraved plastic laminate sign on or near each major item of plumbing equipment and each operational device, as specified herein if not otherwise specified for each item or device. Provide signs for the following general categories of equipment and operational devices:

1. Main control and operating valves, including safety devices and hazardous units such as gas outlets.
 2. Fuel-burning units.
 3. Pumps, compressors and similar motor driven units.
 4. Fire protection valves, as hereinbefore specified.
 5. Tanks and pressure vessels.
- B. Lettering Size: Minimum 1/4" (6 mm) lettering for name of unit where viewing distance is less than 2'- 0" (600 mm-0 mm), 1/2" (13 mm) high for distances up to 6'- 0" (1800 mm-0 mm), and proportionately larger lettering for greater distances. Provide secondary lettering 2/3 to 3/4 of size of principal lettering.
- C. Text of Signs: In addition to name of identified unit, provide lettering to distinguish between multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations.

3.6 ADJUSTING AND CLEANING

- A. Adjusting: Relocate any plumbing identification device which has become visually blocked by work of this division or other divisions.
- B. Cleaning: Clean face of identification devices, and glass frames of valve charts.

3.7 EXTRA STOCK

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

3.8 IDENTIFICATION SCHEDULE

<u>SERVICE</u>	<u>DESIGNATION</u>
Cold Water	CW
Hot Water	HW
Fire Protection	FIRE
Sprinkler	SPKR
Gas	GAS
Compressed Air	AIR

Sanitary Sewer	SAN
Vent	VENT
Storm Water	SW
Air Conditioning Drain	A/C COND
Pumped Discharge	PD

END OF SECTION 22 05 53

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SECTION 22 07 00 - PLUMBING INSULATION

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

- A. Extent of mechanical insulation required by this section is indicated on drawings and schedules, and by requirements of this section.
- B. Types of mechanical insulation specified in this section include the following:
 - 1. Piping System Insulation:
 - a. Fiberglass
 - b. Flexible Elastomeric
 - 2. Equipment Insulation:
 - a. Fiberglass
 - b. Flexible Elastomeric
- C. Refer to all other Division-22 sections.

1.2 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of mechanical insulation products, of types and sizes required, 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 five (5) years successful installation experience on projects with mechanical insulations similar to that required for this project. Provide installer's certification by the manufacturer's training program where applicable.
- C. Flame/Smoke Ratings: Provide composite mechanical insulation (insulation, jackets, coverings, sealers, mastics and adhesives) with flame-spread index of 25 or less, and smoke-developed index of 50 or less, as tested by ASTM E 84 (NFPA 255) method.

1.3 SUBMITTALS

- A. Product Data: Submit manufacturer's technical product data and installation instructions for each type of mechanical insulation. Submit schedule showing manufacturer's product number, k-value, thickness, and furnished accessories, and intended use for each mechanical system requiring insulation.

- B. Maintenance Data: Submit maintenance data and replacement material lists for each type of mechanical insulation. Include this data and product data in maintenance manual.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Deliver insulation, coverings, cements, adhesives, and coatings to site in containers with manufacturer's stamp or label, affixed showing fire hazard indexes of products.
- B. Protect insulation against dirt, water, and chemical and mechanical damage. Do not install damaged or wet insulation; remove from project site.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products which may be incorporated in the work, shall be limited to the following:
 - 1. Owens Corning
 - 2. Johns Manville
 - 3. Certainteed
 - 4. Armacell
 - 5. Knauf
 - 6. Aeroflex

2.2 PIPE INSULATION MATERIALS

- A. Fiberglass Pipe Insulation: ASTM C 547-00, Type 1 (up to 850°F) (up to 454°C), maximum k-value of 0.23 BTU-in/hr-ft²-deg F at a mean temperature of 75°F.
- B. Flexible Elastomeric Pipe Insulation: ASTM C 534, Type I (-40°F to 200°F) (-40°C to 93°C), maximum k-value of 0.25 BTU-in/hr-ft²-deg F at a mean temperature of 75°F.
- C. Jackets for Piping Insulation: Jacket assembly shall be ASTM C 1136, Type I with vapor retarder (0.02 perms).
 - 1. Encase pipe fittings insulation with one-piece premolded PVC fitting covers, fastened as per manufacturer's recommendations.
 - 2. Encase exterior piping insulation with 26 gauge embossed aluminum jacket with weather-proof construction.

- D. Bands, Wires and Cement: As recommended by insulation manufacturer for applications indicated.
- E. Adhesives, Sealer, and Protective Finishes: As recommended by insulation manufacturer for applications indicated.

2.3 EQUIPMENT INSULATION MATERIALS

- A. Rigid Fiberglass Equipment Insulation: ASTM C 612-00, Type 1A (up to 450°F) (up to 232°C).
- B. Flexible Elastomeric Cellular Sheet Insulation: ASTM C 534, Type 2, R-value of 8.0 at 2", (-40°F to 200°F) (-40°C to 93°C).
- C. Jacketing Material for Equipment Insulation: Provide 8 ounce (227 g) canvas or pre-sized glass cloth jacketing material, not less than 7.8 ounces per square yard (263 g/m²), or metal jacket at Installer's option, except as otherwise indicated
- D. Equipment Insulation Compounds: Provide adhesives, cements, sealers, mastics and protective finishes as recommended by insulation manufacturer for applications indicated.
- E. Equipment Insulation Accessories: Provide bands, wire, wire netting, tape corner angles, anchors, stud pins as recommended by insulation manufacturer for applications indicated.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Examine areas and conditions under which mechanical insulation is to be installed. Do not proceed with work until unsatisfactory conditions have been corrected.
- B. Only install mechanical insulation on systems while not in operation.

3.2 PLUMBING PIPING SYSTEM INSULATION

- A. Insulation Omitted: Omit insulation on chrome-plated exposed piping (except for handicapped fixtures), fire protection piping except for wet pipe fire mains in Garage, pre-insulated equipment and air conditioning condensate drain piping in mechanical rooms, Garage and/or on roof.
- B. Cold Piping:
 - 1. Application Requirements: Insulate the following cold plumbing piping systems:
 - a. Potable cold water piping

- b. Interior above-ground horizontal sanitary piping within 6 ft of roof.
 - c. Plumbing vents within 6 linear feet (1800 mm) of roof outlet.
 - d. Above-ground sanitary fixture traps in Garage.
 - e. Air conditioning condensate drain piping within building.
 - f. Wet Pipe Fire protection piping in Garage only.
2. Insulate each piping system specified above with one of the following types and thicknesses of insulation:
- a. Fiberglass: 1" (25 mm) thickness.
 - b. Flexible Elastomeric: 1/2" (13 mm) thickness.
- C. Hot Piping:
- 1. Application Requirements: Insulate the following hot plumbing piping systems:
 - a. Potable hot water piping.
 - 2. Insulate each piping system specified above with one of the following types and thicknesses of insulation:
 - a. Fiberglass: 1" (25 mm) thick for pipe sizes up to 1" (25 mm). 1-1/2" (40 mm) thick for 1-1/4" (32 mm) and 1-1/2" (40 mm) pipe, and 2" (50 mm) thick for pipe sizes 2" (50 mm) and larger. Note: Insulation provided for domestic hot water applications shall have a minimum R-value of 6.0.

3.3 INSTALLATION OF PIPING INSULATION

- A. General: Install insulation products in accordance with manufacturer's written instructions, and in accordance with recognized industry practices to ensure that insulation serves its intended purpose.
 - 1. Insulation materials shall not be applied until systems have been witnessed, documented, and submitted to meet pressure testing requirements indicated throughout these specifications.
- B. Install insulation on pipe systems subsequent to installation of heat tracing, testing, and acceptance of tests.
- C. Install insulation materials with smooth and even surfaces. Insulate each continuous run of piping with full-length units of insulation, with single cut piece to complete run. Do not use cut pieces or scraps abutting each other.
- D. Clean and dry surfaces prior to insulating. Butt insulation joints firmly together to ensure complete and tight fit over surfaces to be covered.

- E. Maintain integrity of vapor-barrier jackets on pipe insulation, and protect to prevent puncture or other damage. Staples shall not be used.
- F. Cover valves, fittings and similar items in each piping system with equivalent thickness and composition of insulation as applied to adjoining pipe run. Provide factory molded insulation or pre-fabricated fittings for all valves, fittings, unions, etc. Valve handles must be extended by the mechanical contractor to accommodate the insulation without reducing the thickness or integrity of the valve insulation.
- G. All water test ports shall be accessible from the insulation. In addition, water flow measuring stations require access from insulation to verify sizes and model.
- H. Extend piping insulation without interruption through pipe hangers, walls, floors and similar piping penetrations, except where otherwise indicated.
- I. Butt pipe insulation against pipe hanger insulation inserts. For hot pipes, apply 3" (75 mm) wide vapor barrier tape or band over the butt joints. For cold piping apply wet coat of vapor barrier lap cement on butt joints and seal joints with 3" (75 mm) wide vapor barrier tape or band. If using pipe hangers, follow manufacturer's instructions for installation.
- J. All exposed pipe insulation, including fittings, above 8'- 0" (2400 mm-0 mm) of finished floor shall have 8 oz. (227 g) fire retardant canvas cover neatly cut and parted seams shall be sealed.
- K. All exposed pipe insulation, including fittings, within 8' - 0" (2400 mm-0 mm) of finished floor or within a stairwell, shall be provided with aluminum or PVC protective covers. All edges shall be hemmed and all seams shall be concealed.
- L. All exterior piping shall be provided with an embossed aluminum jacket.
- M. For all insulated piping 2-1/2" (63 mm) and larger, provide insulated pipe saddles as follows:
 - 1. For domestic hot and cold water piping (up to 250°F), provide the following:
 - a. Minimum 3.75 pcf, non-compressive, rigid, phenolic foam insulation. Fire and smoke rating shall be 25/50 or below per ASTM 84.
 - b. For cold applications below 75°F (24°C) a zero permeability, abuse resistant, vapor barrier shall be provided with matching butt strips. Apply a full coating of butyl joint sealant in addition to the butt strips for a completely sealed system.
 - c. The phenolic foam system shall have a K factor of 0.16 at a mean temperature for 75°F (24°C) and comply with ASTM Standard C1126.
 - d. Provide visible inspection sticker at the bottom of each saddle.
 - e. Pipe insulation saddles shall be Tru-Balance CoolDry Saddles as manufactured by Buckaroos, Inc. or equivalent.

- f. Armacell Armafix Pipe Hangers may be used for cold water piping with flexible elastomeric insulation.

3.4 COORDINATION

- A. Coordinate size and location of supports, hangers, and insulation shields specified in Division-22 Section "Hangers and Supports for Plumbing Piping and Equipment."
- B. Coordinate clearance requirements with piping installer for piping insulation application and equipment installer for equipment insulation application. Before preparing piping shop drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

3.5 SCHEDULING

- A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.

3.6 EXISTING INSULATION REPAIR/REPLACEMENT

- A. Repair damaged sections of mechanical and plumbing insulation, damaged during this construction period. Insulation shall be as specified herein.
- B. Provide new insulation on existing mechanical and plumbing piping where insulation has been removed due to damage or repair.

3.7 PROTECTION AND REPLACEMENT

- A. Replace damaged insulation which cannot be repaired satisfactorily, including units with vapor barrier damage and moisture saturated units.
- B. Protection: Insulation Installer shall advise Contractor of required protection for insulation work during remainder of construction period, to avoid damage and deterioration.

END OF SECTION 22 07 00

SECTION 220800 - COMMISSIONING OF PLUMBING SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. The Drawings and general provisions of the Contract, including the City of Baltimore Department of Public Works Specifications (the “Green Book”) and other Division 01 Specification Sections, apply to this Section.
- B. Section includes commissioning process requirements for plumbing systems, assemblies, and equipment. This section is intended to supplement and further detail the Commissioning requirements listed in Division 1.
- C. Related Sections:
 - 1. Section 019113 - "General Commissioning Requirements"
- D. All tasks listed in this section are assumed to be the responsibility of the GC and their Sub-contractors, unless explicitly stated otherwise.
- E. The following systems and/or equipment shall be commissioned:
 - 1. Plumbing Systems and Controls

1.2 CONTRACTOR'S RESPONSIBILITIES

- A. The contractor’s responsibilities include but are not limited to the following:
 - 1. Perform commissioning tests at the direction of the Commissioning Agent (CA).
 - 2. Attend construction phase commissioning coordination meeting.
 - 3. Provide information requested by the CA for final commissioning documentation.
 - 4. Provide measuring instruments and logging devices to record test data, and provide data acquisition equipment to record data for the complete range of testing for the required test period.

1.3 COMMISSIONING DOCUMENTATION

- A. Documentation to be provided by the contractor includes, but is not limited to, the following:
 - 1. Factory testing reports
 - 2. Field testing reports
 - 3. Equipment and system startup reports
 - 4. Identification of installed systems, assemblies, equipment, and components including design changes that occurred during the construction phase.
 - 5. Test and inspection reports.
 - 6. Corrective action documents.
 - 7. Completed and signed pre-functional checklists
 - 8. Current Facility Requirements & O&M Plan (see 019113 for details)

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 TESTING PREPARATION

- A. Certify that plumbing systems, subsystems, and equipment have been installed, calibrated, and started and are operating according to the Contract Documents.
- B. Certify that plumbing instrumentation and control systems have been completed and calibrated, that they are operating according to the Contract Documents, and that pretest set points have been recorded.
- C. Set systems, subsystems, and equipment into operating mode to be tested (e.g., normal shutdown, normal auto position, normal manual position, unoccupied cycle, emergency power, and alarm conditions).
- D. Inspect and verify the position of each device and interlock identified on checklists.
- E. Testing Instrumentation: Install measuring instruments and logging devices to record test data as directed by the CA.

3.2 GENERAL TESTING REQUIREMENTS

- A. Provide technicians, instrumentation, and tools to perform commissioning test at the direction of the CA. Contractor is required to provide personnel who are capable of demonstrating all equipment functionality that is required by the contract documents. This may include, but is not limited to, installing contractor, TAB contractor, controls contractor, and authorized manufacturer's representatives.
- B. Scope of plumbing testing shall include the conditioned common areas and living spaces for this project. Testing shall include measuring capacities and effectiveness of operational and control functions.
- C. Test all operating modes, interlocks, control responses, and verify proper response of building automation system controllers and sensors.
- D. The CA along with the plumbing Subcontractor, shall prepare detailed testing plans, procedures, and checklists for plumbing systems, subsystems, and equipment.
- E. Simulated conditions may need to be imposed using an artificial load when it is not practical to test under design conditions. Provide equipment to simulate loads. Set simulated conditions as directed by the CA and document simulated conditions and methods of simulation. After tests, return settings to normal operating conditions.
- F. The CA may direct that set points be altered when simulating conditions are not practical.
- G. The CA may direct that sensor values be altered with a signal generator when design or simulating conditions and altering set points are not practical.
- H. If tests cannot be completed because of a deficiency outside the scope of the plumbing system, document the deficiency and report it to the Owner. After deficiencies are resolved, reschedule tests.
- I. If the testing plan indicates specific seasonal testing, complete appropriate initial performance tests and documentation and schedule seasonal tests.

END OF SECTION 220800

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SECTION 22 11 16 - DOMESTIC WATER PIPING

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

- A. Extent of domestic water piping systems work is indicated on drawings and schedules, and by requirements of this section.
- B. Applications for domestic water piping systems include the following:
 - 1. Domestic cold-water piping
 - 2. Domestic hot-water piping
 - 3. Exterior water piping
- C. Refer to appropriate Division-22 sections for insulation required in connection with domestic water piping; not work of this section.
- D. Refer to appropriate Division-02 sections for trenching and backfill required in conjunction with exterior water piping; not work of this section.
- E. Trenching and backfill required in conjunction with domestic water piping inside of building foundations is specified in applicable Division-02 and Division-22 sections, and is included as work of this section.
- F. Refer to other Division-22 sections for water treatment, (sterilization) not work of this section.

1.2 QUALITY ASSURANCE

- A. Qualification of Installers: The entire system shall be installed by trained workmen skilled in the installation of such systems.
- B. Plumbing Code Compliance: Comply with applicable portions of International Plumbing Code and all other applicable codes and/or Owner's requirements pertaining to plumbing materials, construction and installation of products.
- C. ANSI and ASTM Compliance: Comply with applicable standards pertaining to products and installation of domestic water piping systems.
- D. Lead Free Compliance: All components associated with potable water systems (including, but not limited to, valves, end use devices/fixtures, pipe, pipe fittings, solder/flux, etc.) shall be "lead-free" in accordance with all local, state and federal codes, as well as NSF/ANSI 372 (NSF 61-G).
- E. NSF Standard 14 Compliance: Plastic Piping components and related materials.

1.3 SUBMITTALS

- A. Product Data: Submit manufacturer's data for domestic water piping systems, materials and products.
- B. Shop Drawings: Submit scaled layout drawings as required by Division-22 Section "Basic Plumbing Requirements".

PART 2 - PRODUCTS

2.1 DOMESTIC WATER PIPING MATERIALS AND PRODUCTS

- A. General: Provide piping materials and factory-fabricated piping products of sizes, types, pressure ratings, temperature ratings, and capacities as indicated. Where not indicated, provide proper selection as determined by Installer to comply with installation requirements. Provide sizes and types matching piping and equipment connections; provide fittings of materials which match pipe materials used in domestic water piping systems. Where more than one type of materials or products is indicated, selection is Installer's option.

2.2 BASIC IDENTIFICATION

- A. General: Provide identification complying with Division-22 Section "Identification for Plumbing Piping and Equipment".

2.3 BASIC PIPE, TUBE, AND FITTINGS

- A. General: Provide pipe, tube, and fittings complying with Division-22 Section "Pipe, Tube, and Fittings for Plumbing Systems", in accordance with the following listing:
- B. Interior Domestic Hot Water Piping:
 - 1. Tube Size 2" (50 mm) and Smaller: Copper tube.
 - a. Wall Thickness: Type L, hard-drawn temper.
 - b. Fittings: Wrought-copper, solder-joints.
 - 2. Tube Sizes 2" (50 mm) and Smaller: CPVC CTS SDR 11.
 - a. All pipe and fittings to be manufactured from rigid chlorinated polyvinyl chloride (CPVC) compound, Type IV Grade 1 with a Cell Classification of 24448 (CPVC412) for pipe and 23447 for fittings as per ASTM D 1784 and conform to NSF International Standards 14 and 61. Pipe and fittings to be Copper Tube Size (CTS) manufactured to standard dimension ratio (SDR) 11, rated for 400 psi (2760 kPa) at 73 degrees F and 100 psi (690 kPa) at 180°F (82°C) , with 180°F maximum working temperature, and shall conform to ASTM D 2846. Transition fittings to have brass male or female

connections with integral CPVC socket connections. Brass alloys shall be lead-free and comply with ANSI/NSF Standards 61 and 372. Solvent cement shall conform to ASTM F493. Installation to be in accordance with manufacturer's instructions and all applicable local code requirements.

- b. Contractor shall receive approval by local authority having jurisdiction for use of CPVC in plenum rated spaces.

C. Interior Domestic Cold Water Piping:

- 1. Tube Size 2" (50 mm) and Smaller: Copper tube.
 - a. Wall Thickness: Type L, hard-drawn temper.
 - b. Fittings: Wrought-copper, solder-joints.
- 2. Tube Size 2" (50 mm) and Smaller: CPVC CTS SDR 11.
 - a. All pipe and fittings to be manufactured from rigid chlorinated polyvinyl chloride (CPVC) compound, Type IV Grade 1 with a Cell Classification of 24448 (CPVC412) for pipe and 23447 for fittings as per ASTM D 1784 and conform to NSF International Standards 14 and 61. Pipe and fittings to be Copper Tube Size (CTS) manufactured to standard dimension ratio (SDR) 11, rated for 400 psi (2760 kPa) at 73 degrees F and 100 psi (690 kPa) at 180°F, with 180°F (82°C) maximum working temperature, and shall conform to ASTM D 2846. Transition fittings to have brass male or female connections with integral CPVC socket connections. Brass alloys shall be lead-free and comply with ANSI/NSF Standards 61 and 372. Solvent cement shall conform to ASTM F493. Installation to be in accordance with manufacturer's instructions and all applicable local code requirements.
 - b. Contractor shall receive approval by local authority having jurisdiction for use of CPVC in plenum rated spaces.
- 3. Pipe Size 2-1/2" (65 mm) and Larger: Copper pipe.
 - a. Wall Thickness: Type L, hard-drawn temper.
 - b. Fittings: Wrought-copper, grooved and solder joints.
- 4. Pipe Size 2-1/2" (65 mm) and Larger: CPVC Schedule 40. For use on First Floor mains and risers only.
 - a. All pipe and fittings to be manufactured from rigid chlorinated polyvinyl chloride (CPVC) compound, Type IV Grade 1 with a Cell Classification of 24448 (CPVC412) for pipe and 23447 for fittings as per ASTM D 1784 and conform to NSF International Standards 14 and 61. Pipe and fittings to be Iron Pipe Size (IPS), rated for 400 psi (2760 kPa) at 73 degrees F and 100 psi (690 kPa) at 180°F (82°C) , with 180°F maximum working temperature, and shall conform to ASTM D 2846. Transition fittings to have brass male or female connections with integral CPVC socket connections. Brass alloys shall be lead-free and comply with ANSI/NSF Standards 61 and 372. Solvent cement shall conform to ASTM F493. Installation to be in

accordance with manufacturer's instructions and all applicable local code requirements.

- b. Contractor shall receive approval by local authority having jurisdiction for use of CPVC in plenum rated spaces.

D. Exterior and Below Grade Cold Water Piping:

- 1. Tube Size 2" (50 mm) and Smaller: Copper tube.
 - a. Wall Thickness: Type K, soft-annealed temper.
 - b. Fittings: Wrought-copper, solder-joints.
- 2. Pipe Size 2-1/2" (65 mm) and Larger: Ductile-iron pipe, with cement-mortar lining.
 - a. Pipe Weight: Schedule 150.
 - b. Fittings: Ductile-iron, with rubber-gasket joints.

E. Cold Water Piping to Trap Primers: Type M copper tubing.

2.4 BASIC PIPING SPECIALTIES

A. General: Provide piping specialties complying with Division-22 Section "Piping Specialties for Plumbing Systems", in accordance with the following listing:

- 1. Pipe escutcheons
- 2. Low-pressure Y-type pipeline strainers
- 3. Dielectric fittings
- 4. Drip pans
- 5. Pipe sleeves
- 6. Sleeve seals

2.5 SPECIAL PIPING SPECIALTIES

A. Water Hammer Arresters: Provide bellows type water hammer arresters, stainless steel casing and bellows, pressure rated for 250 psi (1725 kPa), tested and certified in accordance with PDI Standard WH-201.

B. Hose Connection Vacuum Breakers: Provide hose connection vacuum breakers where indicated for back-siphonage protection.

- 1. Brass construction, suitable for indoor or outdoor use (maximum pressure 125 psi) (maximum pressure 865 kPa).

2. Inlet shall be 3/4" (20 mm) standard female hose thread; outlets shall be 3/4" (20 mm) male hose thread.
3. Provide non-removable feature to prevent unauthorized removal from pipe system or sill cock.

2.6 BASIC SUPPORTS AND ANCHORS

- A. General: Provide supports, anchors, and seals complying with Division-22 Section "Hangers and Supports for Plumbing Piping and Equipment", in accordance with the following listing:
1. Adjustable steel clevises, adjustable roller hangers, and adjustable pipe roll stands for horizontal piping hangers and supports.
 2. Two-bolt riser clamps for vertical piping supports.
 3. Concrete inserts, C-clamps, and steel brackets for building attachments.
 4. Protection saddles for insulated piping support in hangers.
 5. Copper flashings for piping penetrations.

2.7 BASIC VALVES

- A. General: Provide valves complying with Division-22 Section "Valves for Plumbing Piping", in accordance with the following listing:
1. Sectional Valves:
 - a. 2" (50 mm) and Smaller: Ball Valves.
 - b. 2-1/2" (65 mm) and Larger: Butterfly Valves.
 2. Shutoff Valves:
 - a. 2" (50 mm) and Smaller: Ball Valves.
 - b. 2-1/2" (65 mm) and Larger: Butterfly Valves.
 3. Drain Valves:
 - a. 2" (50 mm) and Smaller: Ball Valves.
 4. Incoming Water Service:
 - a. All Sizes: OS&Y Gate Valves.
 5. Check Valves:

- a. All Sizes: Swing Check Valves.

2.8 SPECIAL VALVES

- A. General: Special valves required for domestic water piping systems include the following types:

- 1. Balance Cocks:

- a. Soldered Ends 2" (50 mm) and Smaller: Class 125, bronze body, bronze plug, screw driver operated, straight or angle pattern.

- 2. Hose Bibb:

- a. Non-freeze Hose Bibb (HB): Soldered end, bronze body, renewable composition disc, wheel handle, 3/4" (20 mm) solder inlet, 3/4" (20 mm) hose outlet with integral vacuum breaker.

- 3. Hydrants:

- a. Recessed Non-Freeze Wall Hydrants (WH): Cast-bronze box hydrant, polished bronze face plate, automatic draining with ASSE 1052 double check backflow preventer, loose tee handle key, bronze casing, length to suit wall thickness, vacuum breaker, hinged locking cover, 3/4" (20 mm) inlet, hose outlet. Wall hydrant shall be Woodford Model B67 or equivalent.

2.9 PUMPS

- A. General: Provide pumps complying with Division-22 Section "Plumbing Pumps", in accordance with the following listing:

- 1. Water pressure booster

2.10 BACKFLOW PREVENTERS (DOMESTIC WATER)

- A. General: Provide reduced pressure principle backflow preventers consisting of assembly including shutoff valves on inlet and outlet, and strainer on inlet. Backflow preventers shall include test cocks, and pressure-differential relief valve located between two (2) positive seating check valves. Construct in accordance with ASSE Standard 1013.

- B. Backflow preventer size shall not be less than the connected line size indicated.

2.11 PRESSURE REGULATING VALVES

- A. General: Provide pressure regulating valves, single seated, direct operated type, bronze body, integral strainer, complying with requirements of ANSI/ASSE Standard 1003. Size for maximum flow rate and inlet and outlet pressures indicated on drawings.

2.12 BASIC EXPANSION COMPENSATION

- A. General: Provide expansion compensation products complying with Division-22 Section "Expansion Compensation for Plumbing Piping", in accordance with the following listing:
 - 1. Pipe alignment guides.

2.13 BASIC METERS AND GAUGES

- A. General: Provide meters and gauges complying with Division-22 Section "Meters and Gauges for Plumbing Piping".

2.14 WATER METER

- A. General: Provide water meter and related piping conforming to applicable local utility company regulations and AWWA standards.
- B. General: Water meter provided by Montgomery County Department of Public Works. Provide roughing-in and bypass for meter in accordance with Montgomery County Department of Public Works requirements.

PART 3 - EXECUTION

3.1 INSTALLATION OF BASIC IDENTIFICATION

- A. General: Install mechanical identification in accordance with Division-22 Section "Identification for Plumbing Piping and Equipment".

3.2 INSTALLATION OF DOMESTIC WATER DISTRIBUTION PIPING

- A. General: Install water distribution piping in accordance with Division-22 Section "Pipe, Tube, and Fittings for Plumbing Systems".
- B. Domestic cold water tubing serving trap primers located below floor slab shall be installed in 2" (50 mm) PVC conduit.

3.3 INSTALLATION OF EXTERIOR WATER PIPING

- A. General: Install exterior water service piping system in compliance with local governing regulations.
- B. Water Service Piping: Extend water service piping of size and in location indicated to water service entrance at building. Provide sleeve in foundation wall for water service entry; make entry watertight. Provide gate valve at water service entry inside building; strainer, pressure gage, test tee with valve.

- C. Copper Tube: Install in accordance with recommended procedures of the Copper Development Association.
- D. Ductile-Iron Pipe: Install in accordance with ANSI/AWWA C-60.

3.4 INSTALLATION OF PIPING SPECIALTIES

- A. Install piping specialties in accordance with Division-22 Section "Piping Specialties for Plumbing Systems".
- B. Water Hammer Arresters: Install in upright position, in locations and of sizes in accordance with PDI Standard WH-201, and elsewhere as indicated.

3.5 INSTALLATION OF SUPPORTS, ANCHORS, AND SEALS

- A. Install supports, anchors, and seals in accordance with Division-22 Section "Hangers and Supports for Plumbing Piping and Equipment".

3.6 INSTALLATION OF VALVES

- A. Install valves in accordance with Division-22 Section "Valves for Plumbing Piping".
- B. Sectional Valves: Install on each branch and riser, close to main, where branch or riser serves two (2) or more plumbing fixtures or equipment connections, and elsewhere as indicated.
- C. Shutoff Valves: Install on inlet of each plumbing equipment item, and on inlet of each plumbing fixture, and elsewhere as indicated.
- D. Drain Valves: Install on each plumbing equipment item located to completely drain equipment for service or repair. Install at base of each riser, at base of each rise or drop in piping system, and elsewhere where indicated or required to completely drain domestic water piping system.
- E. Check Valves: Install on discharge side of each pump, and elsewhere as indicated.
- F. Hose Bibbs: Install where indicated, with vacuum breaker.
- G. Hydrants: Installed where indicated, in accordance with manufacturer's installation instructions.

3.7 INSTALLATION OF PUMPS

- A. Install pumps in accordance with Division-22 Section "Plumbing Pumps".

3.8 INSTALLATION OF BACKFLOW PREVENTERS

- A. Install backflow preventers where indicated, and where required by International Plumbing Code. Pipe relief outlet to nearest floor drain thru air gap fitting.

3.9 INSTALLATION OF PRESSURE REGULATING VALVES

- A. Install pressure regulating valves where required to reduce the pressure below the code allowable pressure. Provide inlet and outlet shutoff valves, and globe valve bypass. Provide pressure gage on valve inlet outlet.

3.10 INSTALLATION OF EXPANSION COMPENSATION PRODUCTS

- A. Install expansion compensation products in accordance with Division-22 Section "Expansion Compensation for Plumbing Piping".

3.11 INSTALLATION OF METERS AND GAUGES

- A. Install meters and gauges in accordance with Division-22 Section "Meters and Gauges for Plumbing Piping".

3.12 INSTALLATION OF WATER METER

- A. Install water meter in accordance with local utility company's installation instructions, and comply with requirements.

3.13 EQUIPMENT CONNECTIONS

- A. Piping Runouts to Fixtures: Provide hot and cold water piping runouts of sizes indicated, but in no case smaller than required by International Plumbing Code.
- B. Mechanical Equipment Connections: Connect hot and cold water piping system to mechanical equipment as indicated, and comply with equipment manufacturer's installation instructions. Provide shutoff valve and union for each connection, provide drain valve on drain connection.

3.14 SPARE PARTS

- A. Furnish to the Owner, with receipt, one valve key for each key operated hydrant, bibb, or faucet installed.

END OF SECTION 22 11 16

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SECTION 22 11 23 - PLUMBING PUMPS

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

- A. Extent of plumbing pumps work required by this section is indicated on drawings and schedules, and by requirements of this section.
- B. Types of pumps specified in this section include the following:
 - 1. Water Pressure Booster Systems
 - 2. Elevator Sump Pumps
 - 3. Submersible Sump Pumps
 - 4. Gas Booster Systems (To Be Determined)
- C. Refer to other Division-22 sections for insulation of pump housings; not work of this section.
- D. Refer to other Division-22 sections for vibration control of plumbing pumps; not work of this section.
- E. Provide the following electrical work as work of this section, complying with requirements of Division-26 sections:
 - 1. Control wiring between field-installed controls, indicating devices, and pump control panels.

1.2 QUALITY ASSURANCE

- A. Codes and Standards:
 - 1. HI Compliance: Design, manufacture, and install plumbing pumps in accordance with HI "Hydraulic Institute Standards".
 - 2. UL Compliance: Design, manufacture, and install plumbing pumps in accordance with UL 778 "Motor Operated Water Pumps".
 - 3. UL and NEMA Compliance: Provide electric motors and components which are listed and labeled by Underwriters Laboratories and comply with NEMA standards.
 - 4. SSPMA Compliance: Test and rate sump and sewage pumps in accordance with Sump and Sewage Pump Manufacturer's Association (SSPMA) and provide certified rating seal.

5. Lead Free Compliance: All components associated with potable water systems (including, but not limited to, valves, end use devices/fixtures, pipe, pipe fittings, solder/flux, etc.) shall be "lead-free" in accordance with all local, state and federal codes, as well as NSF/ANSI 372 (NSF 61-G).
 6. Department of Energy (DOE) compliance: Pump manufacturer shall comply with US Department of Energy (DOE) energy conservation standard for "clean water pumps" 1-200 horsepower, less than 459 feet of head and greater than 25 gpm. These pumps shall be evaluated using the Pump Energy Index (PEI) of equal to or lesser than 1.0. The PEI number shall appear on the pump name plate and be available for the record at <http://er.pumps.org>.
- B. Certification, Pump Performance: Provide pumps whose performances, under specified operating conditions, are certified by manufacturer.

1.3 SUBMITTALS

- A. Product Data: Submit manufacturer's pump specifications, installation and start-up instructions, and current accurate pump characteristic performance curves with selection points clearly indicated.
- B. Shop Drawings: Submit manufacturer's assembly-type shop drawings indicating dimensions, weight loadings, required clearances, and methods of assembly of components.
- C. Wiring Diagrams: Submit manufacturer's electrical requirements for power supply wiring to plumbing pumps. Submit manufacturer's ladder-type wiring diagrams for interlock and control wiring. Clearly differentiate between portions of wiring that are factory-installed and portions to be field-installed.
- D. Maintenance Data: Submit maintenance data and spare parts lists for each type of pump, control, and accessory; including "troubleshooting" maintenance guide. Include this data, product data, shop drawings, and wiring diagrams in maintenance manual.

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Handle plumbing pumps and components carefully to prevent damage, breaking, denting and scoring. Do not install damaged plumbing pumps or components; replace with new.
- B. Store plumbing pumps and components in clean dry place. Protect from weather, dirt, fumes, water, construction debris, and physical damage.
- C. Comply with Manufacturer's rigging and installation instructions for unloading plumbing pumps, and moving them to final location.

PART 2 - PRODUCTS

2.1 PUMPS

- A. General: Provide factory-tested pumps, thoroughly cleaned, and painted with one coat of machinery enamel prior to shipment. Type, size, and capacity of each pump are listed in pump schedule. Provide pumps of same type by same manufacturer.

2.2 IN-LINE RECIRCULATION PUMPS

- A. General: Provide in-line recirculation pumps where indicated, and of capacities as scheduled.
- B. Type: Horizontal, oil-lubricated, designed for 125 psi (850 kPa) working pressure, 225°F (107°C) continuous water temperature, and specifically designed for quiet operation.
- C. Body: All bronze construction.
- D. Shaft: Stainless steel, ground and polished, integral thrust collar.
- E. Bearings: Two horizontal sleeve bearings designed to circulate oil.
- F. Seal: Mechanical, with carbon seal face rotating against ceramic seat.
- G. Motor: Non-overloading at any point on pump curve, open, drip-proof, sleeve bearings, quiet operating, rubber mounted construction, built-in thermal overload protection.
- H. Coupling: One-piece spring coupling.

2.3 WATER PRESSURE BOOSTER SYSTEM

- A. General: Provide factory-fabricated and tested water pressure booster system consisting of two centrifugal pumps, power and control panels, instrumentation, and operating controls, main power disconnect, single point connection, mounted on fabricated welded steel base assembly. Provide size as indicated, capacities as scheduled.
- B. Pumps: Provide two (2) variable speed, end-suction design, cast iron, bronze fitted centrifugal pumps with mechanical shaft seals. Mount pumps on vibration isolators. Provide temperature probe and electric purge valve immediately upstream of each pressure reducing valve. Provide drip-proof motors.
- C. System Controls: Maintain system pressure with pilot-operated diagram type combination pressure regulating and non-slam check valve on each pump discharge line.
 - 1. Provide low system pressure switch located on discharge header to sense drop in system pressure, and to activate alarm and automatically start standby pump.
 - 2. Provide adjustable vane type flow switch to switch to sequence lag pump.

- D. Control Panel: Provide UL-listed, NEMA 12, hinged door, lockable control panel containing the following:
 - 1. For Each Pump:
 - a. Fused disconnect switch
 - b. Motor starter with 3-leg overload protection
 - c. Running light
 - d. Multiple position motor control switch
 - e. Discharge pressure gage
 - 2. For System:
 - a. 115V control transformer
 - b. Control power switch
 - c. Indicating lights
 - d. Relays
 - e. Visual alarm system
 - f. Suction pressure gage
 - E. Prefabrication: Factory-prefabricate booster system, mount all components on common structural stand. Provide interconnecting piping, isolation valves on suction and discharge of each pump, suction and discharge piping manifolds, shutoff cocks for gages and pressure switches, and factory-wiring.
 - F. Factory-Test: Provide electrical and hydraulic test on assembled unit prior to shipment. Provide system operating flow test from 0 to 100% design flow rate at scheduled suction and discharge pressure conditions.
- 2.4 ELEVATOR SUMP PUMPS
- A. General: Provide sump pumps in all elevator pits with the capacities as scheduled.
 - B. Type: Submersible sump pump with a stainless steel oil sensor probe mounted on the pump, 2" discharge, double mechanical seal, cast iron impeller with check valve.
 - C. Control Panel: Provide control panel in a NEMA 4X fiberglass enclosure with visual and audible alarm, auxiliary contact, overcurrent relay, terminal board, RMS relay, magnetic contactor, alarm silence, pump overload light and horn.
 - D. Provide junction box with multi-pin connector and power cord of length as required to connect to control panel.

- E. Provide Stancor elevator pit sump pump with "Oil Minder" control system or equivalent.

2.5 SUBMERSIBLE SUMP PUMPS

- A. General: Provide submersible sump pumps as indicated, of size and capacity as scheduled.
- B. Pump: Cast-iron shell, bronze impeller, stainless steel shaft, factory-sealed grease lubricated ball bearings, ceramic mechanical seal, and perforated steel strainer.
- C. Motor: Hermetically sealed, capacitor-start, with built-up overload protection, electrical characteristics as scheduled. Provide 10' (3 m) of 3-conductor PVC cord and molded grounding plug.
- D. Controls: Float-operated mercury switch.
- E. Basin: Fiberglass construction of indicated dimensions, with inlet connections of size and location as indicated. Maintain minimum of 3' (900 mm) depth below lowest inlet invert.
- F. Cover: Cast-iron or steel circular cover with manhole or handhole opening, depending on diameter. Provide openings for pump, control rod, and discharge piping.
- G. Controls: Provide NEMA 1 motor-mounted float switch complete with float, float rod, and buttons.
- H.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Examine areas and conditions under which plumbing pumps are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.2 INSTALLATION OF PUMPS

- A. General: Install plumbing pumps where indicated, in accordance with manufacturer's published installation instructions, complying with recognized industry practices to ensure that plumbing pumps comply with requirements and serve intended purposes.
- B. Access: Provide access space around plumbing pumps for service as indicated, but in no case less than that recommended by manufacturer.
- C. Support: Refer to Division-22 section "Vibration Control for Plumbing Piping and Equipment" for support and mounting requirements of plumbing pumps.
- D. Basins: Install sump pump basins in indicated locations and connect to sewer inlets. Brace interior of basin in accordance with manufacturer's instructions, to prevent

distortion or collapse during concrete placement. Refer to Architectural Division for concrete work; not work of this section. Set cover over basin, fasten to top flange of basin. Install so cover is flush with finished floor.

- E. Electrical Wiring: Install electrical devices furnished by manufacturer but not specified to be factory-mounted. Furnish copy of manufacturer's wiring diagram submittal to Electrical Installer.
 - 1. Verify that electrical wiring installation is in accordance with manufacturer's submittal and installation requirements of Division-26 sections. Do not proceed with equipment start-up until wiring installation is acceptable to equipment installer.
- F. Piping Connections: Refer to Division-22 plumbing piping sections. Provide piping, valves, accessories, gages, supports, and flexible connections as indicated.

3.3 ADJUSTING AND CLEANING

- A. Alignment: Check alignment, and where necessary, realign shafts of motors and pumps within recommended tolerances by manufacturer, and in presence of manufacturer's service representative.
- B. Start-up: Lubricate pumps before start-up. Start-up in accordance with manufacturer's instructions.
- C. Cleaning: Clean factory-finished surfaces. Repair any marred or scratched surfaces with manufacturer's touch-up paint.

END OF SECTION 22 11 23

SECTION 22 13 16 - SOIL, WASTE AND VENT PIPING

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

- A. Extent of soil and waste piping system work is indicated on drawings and schedules, and by requirements of this section.
- B. Applications for soil and waste piping systems include the following:
 - 1. Aboveground soil, waste and vent piping within buildings including soil stacks, vent stacks, horizontal branches, traps, and connections to fixtures and drains.
 - 2. Underground building drain piping including mains, branches, traps, connections to fixtures and drains, and connections to stacks, terminating at connection to sanitary sewers five feet outside of foundation wall.
- C. Exterior sanitary sewer system is specified in applicable Division-02 sections, and is included as work of this section.
- D. Refer to appropriate Division-22 sections for insulation required in connection with soil and waste piping; not work of this section.
- E. Trenching and backfilling required in conjunction with underground building drain piping is specified in applicable Division-22 sections, and is included as work of this section.

1.2 QUALITY ASSURANCE

- A. Specimen Joints: Before commencing pipe laying, Contractor shall form specimen joints to demonstrate that materials and methods employed will result in watertight joints.
- B. Qualification of Installers: The entire system shall be installed by trained workmen skilled in the installation of such systems for a minimum of five (5) years.
- C. Plumbing Code Compliance: Comply with applicable portions of International Plumbing Code pertaining to plumbing materials, construction and installation of products.
- D. ANSI Compliance: Comply with applicable American National Standards pertaining to products and installation of soil and waste piping systems.
- E. PDI Compliance: Comply with applicable Plumbing and Drainage Institute Standards pertaining to products and installation of soil and waste piping systems.

1.3 SUBMITTALS

- A. Product Data: Submit manufacturer's data for soil and waste piping systems materials and products.
- B. Shop Drawings: Submit scaled layout drawings of soil and waste pipe and fittings showing interface and spatial relationship between piping, ductwork and proximate equipment.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering cleanouts, drains and valves which may be incorporated in the Work include the following:
 - 1. Josam
 - 2. J. R. Smith
 - 3. Zurn
 - 4. Mifab
 - 5. Wade
 - 6. Watts Drainage

2.2 SOIL, WASTE AND VENT PIPING MATERIALS AND PRODUCTS

- A. General: Provide piping materials and factory-fabricated piping products of sizes, types, pressure ratings, and capacities as indicated. Where not indicated, provide proper selection as determined by Installer to comply with installation requirements. Provide sizes and types matching piping and equipment connections; provide fittings of materials which match pipe materials used in soil and waste piping systems. Where more than one (1) type of materials or products is indicated, selection is Installer's option.

2.3 BASIC IDENTIFICATION

- A. General: Provide identification complying with Division-22 section, "Identification for Plumbing Piping and Equipment".

2.4 BASIC PIPE, TUBE, AND FITTINGS

- A. General: Provide pipe, tube, and fittings complying with Division-22 section "Pipe, Tube, and Fittings for Plumbing Systems", in accordance with the following listing:

- B. Above Ground Piping Within Buildings:
1. Tube Size 8" (200 mm) and Smaller: Copper tube.
 - a. Wall Thickness: Type DWV.
 - b. Fittings: Cast-bronze, drainage pattern, solder-joint.
 2. Pipe Size 15" (400 mm) and Smaller: Cast-iron hub-and-spigot soil pipe.
 - a. Pipe and fittings to be service weight and shall comply with ASTM A 74 and bear the collective mark of the Cast Iron Soil Pipe Institute (CISPI).
 - b. Fittings: Compression gasket joints meeting the requirements of ASTM C-564, or lead and oakum joints.
 3. Pipe Size 15" (400 mm) and Smaller: Hubless cast-iron soil pipe.
 - a. Pipe and fittings shall comply with CISPI 301 and bear the collective mark of the Cast Iron Soil Pipe Institute (CISPI).
 - b. Fittings: Hubless couplings shall comply with CISPI Standard 310.
 - c. For buildings less than ten (10) floors in height, provide heavy duty shielded couplings for all aboveground piping up to the second floor level.
 - d. For buildings more than ten (10), but less than twenty (20) floors in height, provide heavy duty shielded couplings for all aboveground piping up to the fourth floor level.
 - e. Provide heavy duty shielded couplings for all aboveground piping.
 - f. Heavy Duty Shielded Couplings: Heavy duty couplings shall meet the requirements of ASTM C 1540 and gaskets shall meet the requirements of ASTM 564.
 - g. Available Manufacturers: Subject to compliance with requirements, manufacturers offering couplings which may be incorporated in the Work include the following:
 - 1) Anaco/Husky
 - 2) Mission Rubber
 - 3) Tyler Coupling
 - 4) Ideal
 4. Pipe Size 16" (400 mm) and Smaller: PVC Schedule 40.
 - a. Pipe and fittings shall be manufactured from virgin rigid polyvinyl chloride (PVC) compound with a Cell Class of 12454 per ASTM D 1784 and conform

with NSF International Standard 14. Pipe shall be Schedule 40, solid wall, iron pipe size (IPS) conforming to ASTM D 1785 and ASTM D 2665. Molded fittings shall conform to ASTM D 2665. Fabricated fittings shall conform to ASTM F 1866. Installation to be in accordance with manufacturer's instructions and all applicable local code requirements. Buried Pipe to be installed in accordance with ASTM D 2321 and ASTM F 1668. Solvent cements shall conform to ASTM D 2564. Primers shall conform to ASTM F 656. Installation to be in accordance with manufacturer's instructions and all applicable local code requirements. Foam core, cellular core, etc. shall not be accepted.

C. Underground Building Drain Piping:

1. Pipe Size 15" (400 mm) and Smaller: Cast-iron hub and spigot soil pipe.
 - a. Pipe and fittings to be service weight and shall comply with ASTM A 74 and bear the collective mark of the Cast Iron Soil Pipe Institute (CISPI).
 - b. Fittings: Compression gasket joints meeting the requirements of ASTM C 564, or lead and oakum joints.
2. Pipe Size 16" (400 mm) and Smaller: PVC Schedule 40.
 - a. Pipe and fittings shall be manufactured from virgin rigid polyvinyl chloride (PVC) compound with a cell class of 12454 per ASTM D 1784 and conform with NSF International Standard 14. Pipe shall be Schedule 40, solid wall, iron pipe size (IPS) conforming to ASTM D 1785 and ASTM D 2665. Molded fittings shall conform to ASTM D 2665. Fabricated fittings shall conform to ASTM F 1866. Installation to be in accordance with manufacturer's instructions and all applicable local code requirements. Buried Pipe to be installed in accordance with ASTM D 2321 and ASTM F 1668. Solvent cements shall conform to ASTM D 2564. Primers shall conform to ASTM F 656. Installation to be in accordance with manufacturer's instructions and all applicable local code requirements. Foam core, cellular core, etc. shall not be accepted.

2.5 BASIC PIPING SPECIALTIES

- A. General: Provide piping specialties complying with Division-22 section "Piping Specialties for Plumbing Systems", in accordance with the following listing:
1. Pipe Escutcheons
 2. Vandal-Proof Vent Caps
 3. Pipe Sleeves
 4. Sleeve Seals

2.6 SPECIAL PIPING SPECIALTIES

- A. Flashing Flanges: Cast-iron watertight stack or wall sleeve with membrane flashing ring. Provide underdeck clamp and sleeve length as required.
- B. Vent Flashing Sleeves: Cast-iron caulking type roof coupling for cast-iron stacks, cast-iron threaded type roof coupling for steel stacks.

2.7 SUPPORTS AND ANCHORS

- A. General: Provide supports and anchors complying with Division-22 sections in accordance with the following listing:
 - 1. Adjustable steel clevises, steel pipe clamps, and pipe saddle supports for horizontal piping hangers and supports.
 - 2. Two-bolt riser clamps for vertical piping supports.
 - 3. Concrete inserts, C-clamps, and steel brackets for building attachments.
 - 4. Copper flashings for piping penetrations.

2.8 SPECIAL VALVES

- A. General: Special valves required for soil and waste piping systems include the following types:
 - 1. Backwater Valves: Cast-iron body, bronze backwater valve assembly swing check type, with cleanout access cover. Provide ends to suit piping material; bolted cover.

2.9 SPECIAL EXPANSION COMPENSATION

- A. General: Special expansion compensation products required for soil and waste piping systems include the following types:
 - 1. Expansion Joints: Cast-iron body, adjustable bronze sleeve, bronze bolts with wing nuts; for vertical installation only.

2.10 CLEANOUTS

- A. General: Provide factory-fabricated drainage piping products of size and type indicated. Where not indicated, provide proper selection as determined by Installer to comply with installation requirements and governing regulations.
- B. Cleanouts in Piping: Cast-iron cleanout ferrule with bronze countersunk plug, suitable for no-hub applications.

- C. Cleanouts in finished walls and partitions shall be similar to cleanouts in piping. Provide round polished stainless steel wall access cover with screw. Finish as per Architect.
- D. Cleanouts in Tiled Floor: Cast-iron internal gasketed cleanout plug and adjustable housing with secured scoriated square satin Nickel Alloy top.
- E. Cleanouts in Non-Tiled Floor: Similar to tiled floor type with a secured scoriated round satin Nickel Alloy top.

2.11 FLOOR DRAINS

- A. General: Provide floor drains of size as indicated on drawings; and type, including features, as specified herein:
- B. Toilet Room Floor Drain: Cast-iron body and flashing collar, Nickel Alloy adjustable strainer head with secured square grate, with the following features:
 - 1. Heel-proof grate.
 - 2. 1/2" (13 mm) trap priming connection.
 - 3. Bottom outlet, no-hub for aboveground piping or, bottom outlet, hub and spigot for underground piping.
- C. Mechanical Room Floor Drain: Cast-iron body and flashing collar, heavy duty loose set grate (minimum 9" diameter) (minimum 225 mm diameter), with the following features:
 - 1. Double drainage flange with weep holes.
 - 2. Sediment bucket.
 - 3. Adjustable extension.
 - 4. 1/2" (13 mm) trap priming connection.
 - 5. Flat bottom strainer.
 - 6. Deep body.
 - 7. Bottom outlet, no-hub for aboveground piping or, bottom outlet, hub and spigot for underground piping.
 - 8. Provide funnels for drains receiving A/C condensate or elsewhere as indicated.
- D. General Purpose Floor Drain: Cast-iron body and flashing collar, Nickel Alloy adjustable strainer head with secured square grate, with the following features:
 - 1. Sediment bucket.
 - 2. Heel-proof grate.

3. 1/2" (13 mm) trap priming connection.
 4. Bottom outlet, no-hub for aboveground piping or, bottom outlet hub and spigot for underground piping.
- E. Cast-Iron Trench Drains: Cast-iron shallow hub body and loose set cast-iron grate 12" (300 mm) wide grate, assembled in standard lengths for total length as indicated, with the following features:
1. Sediment bucket.
 2. Flashing device.
 3. Vandal-proof grate.
 4. Bottom outlet, no-hub for aboveground piping or, bottom outlet, hub and spigot for underground piping.

PART 3 - EXECUTION

3.1 INSTALLATION OF BASIC IDENTIFICATION

- A. General: Install mechanical identification in accordance with Division-22 section "Identification for Plumbing Piping and Equipment".

3.2 INSTALLATION OF SOIL AND WASTE ABOVE GROUND PIPING

- A. General: Install soil and waste piping in accordance with Division-22 section "Pipe, Tube, and Fittings for Plumbing Systems", and with International Plumbing Code.

3.3 INSTALLATION OF BUILDING DRAIN PIPING

- A. General: Install underground building drains as indicated and in accordance with International Plumbing Code. Lay underground building drains 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 required gaskets in accordance with manufacturer's recommendations for use of lubricants, cements, and other special installation requirements. Clean interior of piping of dirt and other superfluous material as work progresses. Maintain swab or drag in line and pull past each joint as it is completed. Temporarily cover end of uncompleted piping at end of day or whenever work stops.
1. Install soil and vent piping pitched to drain at minimum slope of 1/8" per foot (10 mm per meter) (1%). Where possible 1/4" per foot (20 mm per meter) (2%) shall be provided.

3.4 INSTALLATION OF PIPING SPECIALTIES

- A. Install piping specialties in accordance with Division-22 section "Piping Specialties for Plumbing Systems".

3.5 INSTALLATION OF SUPPORTS AND ANCHORS

- A. Install supports and anchors in accordance with Division-22 section "Hangers and Supports for Plumbing Piping and Equipment".

3.6 INSTALLATION OF SPECIAL VALVES

- A. Backwater Valves: Install in sanitary building drain piping serving fixtures located below curb line and as required by International Plumbing Code. For interior installation, provide cleanout cover flush to floor centered over backwater valve cover, and of adequate size to remove valve cover for service. Install in such a manner to provide maximum 1/4" (6 mm) clearance between flapper and seat for air circulation.

3.7 INSTALLATION OF SPECIAL EXPANSION COMPENSATION PRODUCTS

- A. Expansion Joints: Install expansion joints on vertical risers as indicated, or as required by International Plumbing Code.

3.8 INSTALLATION OF DRAINAGE PIPING PRODUCTS

- A. Cleanouts: Install in sanitary above ground piping and sanitary building drain piping as indicated, as required by International Plumbing Code; and at each change in direction of piping greater than 45 degrees; at minimum intervals of 50 feet (15 m) for piping 4" (100 mm) and smaller and 75 feet (23 m) for larger piping; and at base of each vertical soil or waste stack. Install floor and wall cleanout covers for concealed piping, select type to match adjacent building finish.
- B. Flashing Flanges: Install flashing flange and clamping device with each stack and cleanout passing through waterproof membranes.
- C. Vent Flashing Sleeves: Install on stacks passing through roof, secure over stack flashing in accordance with manufacturer's instructions.

3.9 INSTALLATION OF FLOOR DRAINS

- A. General: Install floor drains in accordance with manufacturer's written instructions and in locations indicated.
 - 1. Coordinate with soil and waste piping as necessary to interface floor drains with drainage piping systems.

2. Install floor drains at low points of surface areas to be drained, or as indicated. Set tops of drains flush with finished floor.
3. Install drain flashing collar or flange so that no leakage occurs between drain and adjoining flooring. Maintain integrity of waterproof membranes, where penetrated.
4. Position drains so that they are accessible and easy to maintain.

3.10 EQUIPMENT CONNECTIONS

- A. Piping Runouts to Fixtures: Provide soil and waste piping runouts to plumbing fixtures and drains, with approved trap, of sizes indicated; but in no case smaller than required by International Plumbing Code.
 1. Locate piping runouts as close as possible to bottom of floor slab supporting fixtures or drains.

3.11 PIPING TESTS

- A. Test soil and waste piping system in accordance with requirements of Division-22 section "Pipe, Tube and Fittings for Plumbing Systems".

END OF SECTION 22 13 16

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SECTION 22 14 13 - STORM WATER PIPING

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

- A. Extent of storm water piping work is indicated on drawings and schedules, and by requirements of this section.
- B. Applications for storm water piping include the following:
 - 1. Storm water piping from conductor piping and area drains to storm sewers five feet outside of foundation wall.
 - 2. Foundation drainage tile and pipes.
 - 3. Air conditioning condensate piping.
 - 4. Sump pump discharge piping.
- C. Exterior storm water piping is specified in applicable Division-2 sections, and is included as work of this section.
- D. Refer to appropriate Division-22 sections for insulation required in conjunction with storm water piping; not work of this section.
- E. Trenching and backfill required in conjunction with storm building drain piping is specified in applicable Division-22 sections, and is included as work of this section.

1.2 QUALITY ASSURANCE

- A. Specimen Joints: Before commencing pipe laying, Contractor shall form specimen joints to demonstrate that materials and methods employed will result in watertight joints.
- B. Qualification of Installers: The entire system shall be installed by trained workmen skilled in the installation of such systems for a minimum of five (5) years.
- C. Plumbing Code Compliance: Comply with applicable portions of International Plumbing Code pertaining to plumbing materials, construction and installation of products.
- D. ANSI Compliance: Comply with applicable American National Standards pertaining to products and installation of soil, waste and storm water piping systems.

1.3 SUBMITTALS

- A. Product Data: Submit manufacturer's data for storm water piping systems materials and products.

- B. Shop Drawings: Submit scaled layout drawings of installed storm water pipe and fittings showing interface and spatial relationship between piping and proximate equipment.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering cleanouts, drains and valves which may be incorporated in the Work include the following:
 - 1. Josam
 - 2. J. R. Smith
 - 3. Zurn
 - 4. Wade
 - 5. Mifab
 - 6. Watts Drainage

2.2 STORM WATER PIPING MATERIALS AND PRODUCTS

- A. General: Provide piping materials and factory-fabricated piping products of sizes, types, pressure ratings, and capacities as indicated. Where not indicated, provide proper selection as determined by Installer to comply with installation requirements. Provide sizes and types matching piping and equipment connections; provide fittings of materials which match pipe materials used in storm water piping systems. Where more than one type of materials or products is indicated, selection is Installer's option.

2.3 BASIC IDENTIFICATION

- A. General: Provide identification complying with Division-22 Section "Identification for Plumbing Piping and Equipment".

2.4 BASIC PIPE, TUBE AND FITTINGS

- A. General: Provide pipe, tube, and fittings complying with Division-22 Section "Pipe, Tube, and Fittings for Plumbing Systems", in accordance with the following listing:
- B. Above Ground Piping Within Buildings:
 - 1. Tube Size 8" (200 mm) and Smaller: Copper tube.
 - a. Wall Thickness: Type DWV.

- b. Fittings: Cast-bronze, drainage pattern, solder-joints.
2. Pipe Size 15" (400 mm) and Smaller: Cast-iron hub-and-spigot soil pipe.
- a. Pipe and fittings to be service weight and shall comply with ASTM A-74 and bear the collective mark of the Cast Iron Soil Pipe Institute (CISPI).
 - b. Fittings: Compression gasket joints meeting the requirements of ASTM C 564, or lead and oakum joints.
3. Pipe Size 15" (400 mm) and Smaller: Hubless cast-iron soil pipe.
- a. Pipe and fittings shall comply with CISPI 301 and bear the collective mark of the Cast Iron Soil Pipe Institute (CISPI).
 - b. Fittings: Hubless couplings shall comply with CISPI Standard 310.
 - c. For buildings less than ten (10) floors in height, provide heavy duty shielded couplings for all aboveground piping up to the second floor level.
 - d. For buildings more than ten (10), but less than twenty (20) floors in height, provide heavy duty shielded couplings for all aboveground piping up to the fourth floor level.
 - e. Provide heavy duty shielded couplings for all aboveground piping.
 - f. Heavy Duty Shielded Couplings: Heavy duty couplings shall meet the requirements of ASTM C 1540 and gaskets shall meet the requirements of ASTM 564.
 - g. Available Manufacturers: Subject to compliance with requirements, manufacturers offering couplings which may be incorporated in the Work include the following:
 - 1) Anaco/Husky
 - 2) Mission Rubber
 - 3) Tyler Coupling
 - 4) Ideal
4. Pipe Size 16" (400 mm) and Smaller: PVC Schedule 40.
- a. Pipe and fittings shall be manufactured from virgin rigid polyvinyl chloride (PVC) compound with a cell class of 12454 per ASTM D 1784 and conform with NSF International Standard 14. Pipe shall be Schedule 40, solid wall, iron pipe size (IPS) conforming to ASTM D 1785 and ASTM D 2665. Molded fittings shall conform to ASTM D 2665. Fabricated fittings shall conform to ASTM F 1866. Installation to be in accordance with manufacturer's instructions and all applicable local code requirements. Buried Pipe to be installed in accordance with ASTM D 2321 and ASTM F 1668. Solvent cements shall conform to ASTM D 2564. Primers shall conform to ASTM F

656. Installation to be in accordance with manufacturer's instructions and all applicable local code requirements. Foam core, cellular core, etc. shall not be accepted.

C. Underground Drain Piping:

1. Pipe Size 15" (400 mm) and Smaller: Cast-iron hub and spigot soil pipe.
 - a. Pipe and fittings to be service weight and shall comply with ASTM A 74 and bear the collective mark of the Cast Iron Soil Pipe Institute (CISPI).
 - b. Fittings: Compression gasket joints meeting the requirements of ASTM C 564, or lead and oakum joints.
2. Pipe Size 16" (400 mm) and Smaller: PVC Schedule 40.
 - a. Pipe and fittings shall be manufactured from virgin rigid polyvinyl chloride (PVC) compound with a cell class of 12454 per ASTM D 1784 and conform with NSF International Standard 14. Pipe shall be Schedule 40, solid wall, iron pipe size (IPS) conforming to ASTM D 1785 and ASTM D 2665. Molded fittings shall conform to ASTM D 2665. Fabricated fittings shall conform to ASTM F 1866. Installation to be in accordance with manufacturer's instructions and all applicable local code requirements. Buried Pipe to be installed in accordance with ASTM D 2321 and ASTM F 1668. Solvent cements shall conform to ASTM D 2564. Primers shall conform to ASTM F 656. Installation to be in accordance with manufacturer's instructions and all applicable local code requirements. Foam core, cellular core, etc. shall not be accepted.

D. Foundation Drainage Tile and Pipe Fittings, and Accessories:

1. Corrugated High Density Polyethylene Drainage (Perforated) Pipe: Piping shall be single wall and perforated with holes, applicable for storm drainage.
2. Fittings for Accessories for Drainage Tile and Pipe: Unless otherwise indicated, match and of same material as pipe units; comply with same standards, where applicable, except fittings need not be perforated where pipe is required to be perforated.

E. Air Conditioning Condensate (above floor/roof):

1. 2" (50 mm) and Smaller: Copper.
 - a. Wall Thickness: Type M.
 - b. Fittings: Solder-joint.
2. All sizes: PVC Schedule 80.
 - a. Pipe and fittings shall be manufactured from virgin rigid polyvinyl chloride (PVC) compound with a cell class of 12454 per ASTM D 1784 and conform with NSF International Standard 14. Pipe shall be Schedule 80, solid wall, iron pipe size (IPS) conforming to ASTM D 1785. Molded fittings shall

conform to ASTM D 2467. Installation to be in accordance with manufacturer's instructions and all applicable local code requirements. Buried Pipe to be installed in accordance with ASTM D 2774 and ASTM F 1668. Solvent cements and primers shall conform to ASTM D 2564. Installation to be in accordance with manufacturer's instructions and all applicable local code requirements.

- b. PVC shall not be used in plenum rated spaces.

F. Sump Pump Discharge:

- 1. 2" (50 mm) and Smaller: Copper.
 - a. Wall Thickness: Type M.
 - b. Fittings: Solder-joint.
- 2. All sizes: PVC Schedule 80.
 - a. Pipe and fittings shall be manufactured from virgin rigid polyvinyl chloride (PVC) compound with a cell class of 12454 per ASTM D 1784 and conform with NSF International Standard 14. Pipe shall be Schedule 80, solid wall, iron pipe size (IPS) conforming to ASTM D 1785. Molded fittings shall conform to ASTM D 2467. Installation to be in accordance with manufacturer's instructions and all applicable local code requirements. Buried Pipe to be installed in accordance with ASTM D 2774 and ASTM F 1668. Solvent cements and primers shall conform to ASTM D 2564. Installation to be in accordance with manufacturer's instructions and all applicable local code requirements.

2.5 BASIC PIPING SPECIALTIES

- A. General: Provide piping specialties complying with Division-22 Section, "Piping Specialties for Plumbing Systems", in accordance with the following listing:
 - 1. Pipe Escutcheons
 - 2. Drip-Pans
 - 3. Pipe Sleeves
 - 4. Sleeve Seals

2.6 SUPPORTS AND ANCHORS

- A. General: Provide supports and anchors complying with Division-22 Section, "Hangers and Supports for Plumbing Piping and Equipment".

2.7 SPECIAL VALVES

- A. General: Special valves required for storm water piping systems include the following types:
 - 1. Backwater Valves: Cast-iron body, bronze backwater valve assembly swing check type, with cleanout access cover. Provide ends to suit piping material; bolted cover.

2.8 SPECIAL EXPANSION COMPENSATION

- A. General: Special expansion compensation products required for storm water piping systems include the following types:
 - 1. Expansion Joints: Cast-iron body, adjustable bronze sleeve, bronze bolts with wing nuts; for vertical installation only.

2.9 SPECIAL PIPING SPECIALTIES

- A. Flashing Flanges: Cast-iron watertight stack or wall sleeve with membrane flashing ring. Provide underdeck clamp and sleeve length as required.

2.10 CLEANOUTS

- A. General: Provide factory-fabricated cleanouts of size and type indicated. Where not indicated, provide proper selection as determined by Installer to comply with installation requirements and governing regulations.
- B. Cleanouts in Piping: Cast-iron cleanout ferrule with bronze countersunk plug, suitable for no-hub applications.
- C. Cleanouts in finished walls and partitions shall be similar to cleanouts in piping. Provide round polished stainless steel wall access cover with screw. Finish as per Architect.
- D. Cleanouts in Tiled Floor: Cast-iron internal gasketed cleanout plug and adjustable housing with secured scoriated square satin Nickel Alloy top.
- E. Cleanouts In Non-Tiled Floor: Similar to tiled floor type with a secured scoriated round satin Nickel Alloy top.

2.11 ROOF DRAINS

- A. General: Provide roof drains of size as indicated on drawings; and type, including features, as specified herein:
 - 1. Roof Drain: Cast-iron body and combined flashing collar, cast-iron dome, integral gravel stop with following features:
 - a. Underdeck clamp with support ring.

- b. Adjustable extension.
- c. Large sump with anchor flange.
- d. Vandal-proof dome.
- e. Bottom outlet, no-hub.
- f. Perforated gravel guard, on ballasted roofs
- g. Overflow ring dam for overflow roof drains; coordinate height with structural engineer

PART 3 - EXECUTION

3.1 INSTALLATION OF BASIC IDENTIFICATION

- A. General: Install mechanical identification in accordance with Division-16 Section "Identification for Plumbing Piping and Equipment".

3.2 INSTALLATION OF STORM WATER PIPING ABOVE GROUND

- A. General: Install storm water piping in accordance with Division-22 Section, "Pipe, Tube, and Fittings for Plumbing Systems", and with International Plumbing Code.

3.3 INSTALLATION OF BUILDING DRAIN PIPING

- A. General: Install storm building drains as indicated and in accordance with International Plumbing Code. Lay storm building drains 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 required gaskets in accordance with manufacturer's recommendations for use of lubricants, cements, and other special installation requirements. Clear interior of piping of dirt and other superfluous material as work progresses. Maintain swab or drag in line and pull past each joint as it is completed. Place plugs in ends of uncompleted piping at end of day or whenever work stops.
- B. Air conditioning (A/C) condensate piping shall be extended from all A/C condensate source equipment (air handling units, fan coil units, split system A/C units, etc.) and connected to the nearest storm water pipe/drain location. Size per manufacturer.
- C. Install storm water piping pitched to drain at minimum slope of 1/8" per foot (10 mm per meter) (1%). Where possible, 1/4" per foot (20 mm per meter) (2%) shall be provided.

3.4 INSTALLATION OF PIPING SPECIALTIES

- A. Install piping specialties in accordance with requirements of Division-22 Section, "Piping Specialties for Plumbing Systems".

3.5 INSTALLATION OF SUPPORTS AND ANCHORS

- A. Install supports and anchors in accordance with Division-22 Section, "Hangers and Supports for Plumbing Piping and Equipment".

3.6 INSTALLATION OF SPECIAL VALVES

- A. Backwater Valves: Install in storm water piping as indicated, and as required by International Plumbing Code. For interior installation, provide cleanout cover flush to floor centered over backwater valve cover, and of adequate size to remove valve cover for service. Install in such a manner to provide a maximum 1/4" (6 mm) clearance between flapper and seat for air circulation.

3.7 INSTALLATION OF SPECIAL EXPANSION COMPENSATION PRODUCTS

- A. Expansion Joints: Install expansion joints on vertical risers as indicated, or as required by International Plumbing Code.

3.8 INSTALLATION OF DRAINAGE PIPING PRODUCTS

- A. Cleanouts: Install in conductor piping and storm building drain piping as indicated, as required by International Plumbing Code; at each change in direction of piping greater than 45 degrees; at minimum intervals of 50 feet (15 m) for piping 4" (100 mm) and smaller and 75 feet (23 m) for larger piping; and at base of each conductor. Install floor and wall cleanout covers for concealed piping, select type to match adjacent building finish.
- B. Flashing Flanges: Install flashing flange and clamping device with each cleanout passing through waterproof membrane.

3.9 INSTALLATION OF DRAINS

- A. General: Install drains in accordance with manufacturer's written instructions and in locations indicated.
- B. Coordinate with roofing as necessary to interface roof drains with roofing work.
- C. Coordinate with storm water piping as necessary to interface drains with drainage piping systems.
 - 1. Install drains at low points of surface areas to be drained, or as indicated.
 - 2. Install drain flashing collar or flange so that no leakage occurs between drain and adjoining roofing. Maintain integrity of waterproof membranes, where penetrated.
- D. Position drains so that they are accessible and easy to maintain.

3.10 PIPING TESTS

- A. Test storm water piping system in accordance with requirements of Division-23 Section, "Testing, Adjusting and Balancing".

END OF SECTION 22 14 13

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SECTION 22 30 00 - PLUMBING EQUIPMENT

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

- A. Extent of plumbing equipment work is indicated on drawings and provisions of this section, including schedules and equipment lists associated with either drawings or this section.
- B. Types of plumbing equipment required for project include the following:
 - 1. Domestic Water Heaters:
 - a. Commercial gas-fired water heaters
 - 2. Domestic Water Expansion Tanks
 - 3. Interceptors:
 - a. Oil/water interceptors

1.2 QUALITY ASSURANCE

- A. UL and NEMA Compliance: Provide electric motors and electrical components required as part of plumbing equipment, which have been listed and labeled by Underwriters Laboratories and comply with NEMA standards.
- B. NEC Compliance: Comply with National Electrical Code (ANSI/NFPA 70) as applicable to installation and electrical connections of ancillary electrical components of plumbing equipment.
- C. ANSI Compliance: Comply with ANSI Z223.1 (NFPA 54) "National Fuel Gas Code", as applicable to installation of gas-fired water heaters.
- D. ANSI Testing Standard: Water heaters shall comply with ANSI Z21.10.3 testing standard.
- E. AGA and NSF Labels: Provide water heaters which have been listed and labeled by American Gas Association and National Sanitation Foundation.
- F. ASME Code Symbol Stamps: For the following equipment, comply with ASME Boiler and Pressure Vessel Code for construction, and stamp with ASME Code symbol:
 - 1. Commercial water heaters
 - 2. Domestic water expansion tank

- G. ASME Relief Valve Stamps: Provide water heaters with safety relief valves bearing ASME valve markings.
- H. Water heaters shall comply with the Energy Policy Act of 2005 (EPACT-2005) and ASHRAE Standard 90.1b regarding energy efficiency. Minimum thermal efficiency shall be 78%.
- I. Lead Free Compliance: All components associated with potable water systems (including, but not limited to, valves, end use devices/fixtures, pipe, pipe fittings, solder/flux, etc.) shall be "lead-free" in accordance with all local, state and federal codes, as well as NSF/ANSI 372 (NSF 61-G).

1.3 SUBMITTALS

- A. Product Data: Submit manufacturer's plumbing equipment specifications, installation and start-up instructions, and capacity and ratings, with selection points clearly indicated.
- B. Shop Drawings: Submit assembly type shop drawings indicating dimensions, weights, required clearances, and methods of assembly of all components.
- C. Wiring Diagrams: Submit ladder-type wiring diagrams for all components, clearly indicating all required field electrical connections.
- D. Maintenance Data: Submit maintenance data and parts lists for each item of plumbing equipment. Include "trouble-shooting" maintenance guides. Include this data in maintenance manual.

PART 2 - PRODUCTS

2.1 DOMESTIC WATER HEATERS

- A. Commercial Gas-Fired Water Heaters:
 - 1. General: Provide commercial gas-fired water heaters of size and capacity as indicated on schedule. Comply with ANSI/ASHRAE/IES 90A for energy efficiency. Provide certification of design by AGA under Volume III tests for commercial water heaters. Provide approval by NSF.
 - 2. Heater: Working pressure of 150 psi (1020 kPa); boiler-type hand hole cleanout; magnesium anode rod; 3/4" (20 mm) tapping for relief valve; glass lining on internal surfaces exposed to water.
 - 3. Safety Controls: Equip with automatic gas shutoff device to shut off entire gas supply in event of excessive temperature in tank; and pilot safety shutoff.
 - 4. Draft Hood: Equip with AGA certified draft hood.
 - 5. Jacket: Insulate tank with vermin-proof glass fiber insulation. Provide outer steel jacket with baked enamel finish over bonderized undercoating.

6. Warranty: Furnish three (3) year limited warranty for tank leakage.
7. Accessories: Provide brass drain valve; 3/4" (20 mm) pressure and temperature relief valve; radiant floor shield.
8. Controls: Provide gas pressure regulator with atmospheric vent; pilot gas regulator; thermostat.

2.2 DOMESTIC WATER EXPANSION TANK

A. Commercial Potable Water Expansion Tank:

1. General: Provide commercial non-ASME potable water expansion tank suitable for use with potable water systems and with all wetted surfaces/components of the Food and Drug Administration approved materials.
2. Removable and replaceable heavy-duty butyl bladder.
3. Suitable for operating temperature up to and including 240°F (116°C).
4. Working pressure 150 PSIG (1034.4 Kpa) minimum. Shall be pre-charged to capacities as shown in schedule or shall be pre-charged to 60 PSI if no schedule is shown on the drawings.
5. Shall have charging valve with pressure gauge, lifting ring and 1" NPT drain connection on the side and on the bottom with plugs. Shall be suitable for horizontal or vertical mounting.
6. Acceptance capacities shall be as shown on the drawings.

2.3 INTERCEPTORS

PART 3 - EXECUTION

3.1 INSTALLATION OF DOMESTIC WATER HEATERS

A. Water Heaters (General):

1. General: Install water heaters as indicated, in accordance with manufacturer's installation instructions, and in compliance with applicable codes.
2. Support: Set units on concrete pads, orient so controls and devices needing service and maintenance have adequate access. Level and plumb unit.
3. Piping: Connect hot and cold water piping to units with unions. Provide shut off valve on cold water line. Connect recirculating water line to unit with shut off valve, check valve, and union.

3.2 INSTALLATION OF DOMESTIC WATER EXPANSION TANK

- A. Domestic water expansion tank shall be securely suspended from the structure above or shall be pad mounted on a 4" high concrete pad.
- B. Tie piping connection into cold water feed line to domestic water heater between shut-off valve and inlet of domestic water heater, or as indicated on the drawings. Provide shut-off valve and union on connecting pipe to allow service and inspection of expansion tank.

END OF SECTION 22 30 00

SECTION 22 40 00 - PLUMBING FIXTURES

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

- A. Extent of plumbing fixture work required by this section is indicated on drawings and schedules, and by requirements of this section.
- B. Types of plumbing fixtures specified in this section include the following:
 - 1. Water Closets
 - 2. Lavatories
 - 3. Sinks
 - 4. Mop Basins
 - 5. Electric Water Coolers
- C. Refer to Division-22 sections for potable water systems used in conjunction with plumbing fixtures; not work of this section.
- D. Refer to Division-22 sections for soil and waste systems used in conjunction with plumbing fixtures; not work of this section.
- E. Refer to Division-26 sections for field-installed electrical wiring required for water coolers and other plumbing fixtures; not work of this section.

1.2 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of plumbing fixtures of type, style and configuration required, whose products have been in satisfactory use in similar service for not less than five (5) years.
- B. Codes and Standards:
 - 1. Plumbing Fixture Standards: Comply with applicable portions of National Standard Plumbing Code pertaining to materials and installation of plumbing fixtures.
 - 2. ANSI Standards: Comply with applicable ANSI standards pertaining to plumbing fixtures and systems.
 - 3. PDI Compliance: Comply with standards established by PDI pertaining to plumbing fixture supports.

4. Federal Standards: Comply with applicable FS WW-P-541/-Series sections pertaining to plumbing fixtures.
5. UL Compliance: Construct water coolers in accordance with UL Standards and provide UL listing and label.
6. ASHRAE Compliance: Test and rate water coolers in accordance with ASHRAE Standard 18 "Method of Testing for Rating Drinking Water Coolers with Self-Contained Mechanical Refrigeration Systems".
7. ARI Compliance: Construct and install water coolers in accordance with ARI Standard 1010 "Drinking-Fountains and Self-Contained Mechanically-Refrigerated Drinking-Water Coolers", and provide Certification Symbol.
8. ANSI Compliance: Construct and install barrier-free plumbing fixtures in accordance with ANSI Standard A117.1 "Specifications for Making Buildings and Facilities Accessible To and Usable By Physically Handicapped People".
 - a. Comply with Public Law 90-480, known as the Architectural Barriers Act of 1968.
9. ADA Compliance: Comply with provisions set forth in the "Americans with Disabilities Act Accessibility Guidelines."
10. Lead Free Compliance: All components associated with potable water systems (including, but not limited to, valves, end use devices/fixtures, pipe, pipe fittings, solder/flux, etc.) shall be "lead-free" in accordance with all local, state and federal codes, as well as NSF/ANSI 372 (NSF 61-G).

1.3 SUBMITTALS

- A. Product Data: Submit manufacturer's technical product data, including rated capacities of selected model clearly indicated, furnished specialties and accessories; and installation instructions.
- B. Shop Drawings: Submit manufacturer's assembly-type shop drawings indicating dimensions, roughing-in requirements, required clearances, and methods of assembly of components and anchorages.
- C. Maintenance Data: Submit maintenance data and parts lists for each type of plumbing fixture and accessory; including "trouble-shooting" maintenance guide. Include this data, product data, and shop drawings in maintenance manual.

1.4 DELIVERY, STORAGE AND HANDLING

- A. Deliver plumbing fixtures individually wrapped in factory-fabricated containers.
- B. Handle plumbing fixtures carefully to prevent breakage, chipping and scoring fixture finish. Do not install damaged plumbing fixtures; replace and return damaged units to equipment manufacturer.

PART 2 - PRODUCTS

2.1 PLUMBING FIXTURES

- A. General: Provide factory-fabricated fixtures of type, style and material indicated. For each type of fixture unless otherwise noted, provide fixture manufacturer's standard trim, carrier, seats, and valves as indicated by their published product information; either as designed and constructed, or as recommended by manufacturer, and as required for complete installation.

Where more than one type is indicated, selection is Installer's option. All fixtures of same type must be furnished by single manufacturer. Where type is not otherwise indicated, provide fixtures complying with governing regulations.

L-1 - Lavatory – Wall-mounted, Vitreous china, bowl dimension 15-1/2" x 13-1/2" (520 mm x 540 mm) x 5" deep (127 mm), recessed self-draining deck, concealed arm or wall support, rear overflow, center hole. Fixture shall be just American Standard "Murro Universal Design" Model 0955.001EC and 0059.020EC (shroud) or equivalent. Faucet shall be American Standard Selectronic Cast Proximity Metering Faucet with Battery, WaterSense Labeled.

S-1 - Single Compartment Sink (Common Area): 18" x 14" (457 mm x 355 mm) bowl dimensions, 6-3/8" deep, 18-gauge (1.3 mm) type 304 stainless steel single hole compartment sink with rear center drain. Provide high gooseneck single handle deck mounted faucet with pulldown spray with 68" braided hose, classic stainless-steel finish, 1.5 gpm (.12 L/s) (max) aerator, chrome basket strainer, flexible supplies, tailpiece and cast brass P-trap. Sink shall be Just SL-ADA-1921-A-65-J. Faucet shall be CFG Edgestone 46201.

EWC-1 - Electric Water Cooler with Bottle Filler – Bi-Level Wall Mounted - ADA Compliant, non-filtered Refrigerated: Stainless steel, Antimicrobial, Green Ticker, Hands Free, Laminar Flow, Real Drain. Furnished with Flexi-Guard Safety Bubbler, Electronic Bottle Filler Sensor with mechanical front bubbler button activation. Unit shall be UL Certified. Unit shall be Elkay Model EZWS-ERPBM28K with wall mounting plate. Electric water cooler shall be capable of producing 8 gph (80°F-50°F) at 115V, 5A rating.

MB-1 - Mop Basin - Floor Mounted: One piece, white molded from high impact resistant Durastone structural fiberglass, 24" x 24" x 10" deep, factory installed integral drain body with stainless steel strainer. Provide Mustee Duraguard stainless steel wall plates, Fiat 24" vinyl bumper guards, wall mounted faucet with vacuum breaker spout, Mustee mop hanger and service hose and hose holder. Mop sink shall be Mustee Model 63M. Faucet shall be Moen Model 8230 or equivalent.

WC-1 - Water Closet - Flushometer Valve: Vitreous china, floor mounted, water saver toilet (1.28 gal/flush) (4.9 L /flush), High efficiency, low consumption, Powerful direct-fed siphon jet action, elongated bowl with open front seat, 1-1/2" (40 mm) top spud with Sloan: Royal II #111-1.28-CO flush valve (complete with VBF-72-A trap primer where indicated on drawings) and wall brackets. American Standard "Madera FloWise 15" Height" water closet or equivalent.

WC-2 - Water Closet - Flushometer Valve – ADA Compliant: Vitreous china, floor mounted, high efficiency, low consumption toilet (1.28 gal/flush) (4.9 L /flush) with

powerful direct-fed siphon jet action, elongated bowl with open front seat, seat height 16-1/2", 1-1/2" (40 mm) top spud with Sloan: Royal II #111-1.28 flush valve (complete with VBF-72-A trap primer where indicated on drawings) and wall brackets. American Standard "Madera FloWise 16-1/2 height" water closet or equivalent.

WC-3 – Water Closet – Flushometer Valve – Vitreous china, floor mounted, high efficiency, low consumption toilet (1.28 gal/flush) (4.9 L/flush) with siphon jet action, 10-1/4" rim height, elongated bowl, fully glazed trapway, 1-1/2" inlet top spud with Sloan: Royal II #111-1.28 flush valve (complete with VBF-72-A trap primer were indicated on drawings) and wall brackets. American Standard Baby DeVoro 2282.001 or equivalent.

- B. All plumbing fixtures indicated to be ADA compliant on the mechanical or architectural drawings shall comply with the "Americans with Disabilities Act Accessibility Guidelines". ADA compliant plumbing fixtures shall meet the latest ADA requirements and installation guidelines shall include, but not be limited to, the following:

Water Closets: Top of seat greater than 17 inches (425 mm) but not to exceed 19" (475 mm) above finished floor. Flush valve not to exceed 44" (1100 mm) above finished floor.

Lavatories: Top of rim or counter shall not exceed 34" (850 mm) above finished floor. Faucets may be lever operated, push button or electronically controlled; however, the faucet must remain open for a minimum of 10 seconds. Faucets also must not require more than five pounds of force to activate the control, and the control must be operable without tight grasping, pinching or twisting of the wrist. Where piping is exposed beneath the lavatory, provide manufactured premolded insulated pipe for exposed hot water, cold water and sanitary drain piping; Lavguard or equivalent.

Water Coolers: Waterspout height shall not exceed 36" (900 mm) above finished floor.

2.2 MATERIALS

- A. General: Unless otherwise specified, comply with applicable Federal Specification WW-P-541 Series sections pertaining to plumbing fixtures, fittings, trim, metals and finishes. Comply with requirements of WW-P-541 specification relative to quality of ware, glazing, enamel, composition and finish of metals, air gaps, and vacuum breakers, even though some plumbing fixtures specified in this section are not described in WW-P-541.
- B. Provide materials which have been selected for their surface flatness and smoothness. Exposed surfaces which exhibit pitting, seam marks, roller marks, foundry sand holes, stains, discoloration, or other surface imperfections on finished units are not acceptable.
- C. Where fittings, trim and accessories are exposed or semi-exposed, provide bright chrome-plated or polished stainless steel units. Provide copper or brass where not exposed.
- D. Stainless Steel Sheets: ASTM A 167, Type 302/304, hardest workable temper.
1. Finish: No. 4, bright, directional polish on exposed surfaces.
- E. Steel Sheets for Baked Enamel Finish: ASTM A591, coating Class C, galvanized-bonderized.

- F. Steel Sheets for Porcelain Enamel Finish: ASTM A424, commercial quality, Type I.
- G. Galvanized Steel Sheet: ASTM A526, except ASTM A527 for extensive forming; ASTM A525, G90 zinc coating, chemical treatment.
- H. Aluminum: ASTM B209/B221 sheet, plate and extrusions, as indicated; alloy, temper and finish as determined by manufacturer, except 0.40 mil natural anodized finish on exposed work unless another finish is indicated.
- I. Plastic Laminate: NEMA LD3, general purpose high pressure type, 0.050" thick, smooth (non-textured) white unless another texture and color are indicated or selected by the Owner.
- J. Vitreous China: High quality, free from fire cracks, spots, blisters, pinholes and specks; glaze exposed surfaces, and test for crazing resistance in accordance with ASTM C 554.
- K. Fiberglass: ANSI Z124, smooth surfaced, with color selected by the Owner.
- L. Synthetic Stone: High quality, free from defects, glaze on exposed surfaces, stain resistant.

2.3 PLUMBING FITTINGS, TRIM AND ACCESSORIES

- A. Water Outlets: At locations where water is supplied (by manual, automatic or remote control), provide commercial quality faucets, valves, or dispensing devices, of type and size indicated, and as required to operate as indicated. Include manual shutoff valves and connecting stem pipes to permit outlet servicing without shut-down of water supply piping systems.
 - 1. Vacuum Breakers: Provide with flush valves where required by governing regulations, including locations where water outlets are equipped for hose attachment.
- B. P-Traps: Include removable P-traps where drains are indicated for direct connection to drainage system.
- C. Provide cast-iron supports for fixtures of either graphitic gray iron, ductile iron, or malleable iron as required.
- D. Fixture Bolt Caps: Provide manufacturer's standard exposed fixture bolt caps finished to match fixture finish.
- E. Escutcheons: Where fixture supplies and drains penetrate walls in exposed locations, provide chrome-plated sheet steel escutcheons with friction clips.
- F. Aerators: Provide aerators of types approved by the Owner, and complying with flow constrictions, hereinbefore specified.
- G. Comply with additional fixture requirements contained in fixture schedule indicated on the Drawings.

2.4 TRAP PRIMERS

- A. Prime all floor drain traps with trap seal primer valve having integral vacuum breaker.
- B. Install primer valve in cold water service line to nearest plumbing fixture and extend in concealed copper piping to trap.
- C. Provide automatic timer operated trap priming systems in the mechanical utility rooms where indicated and connect to all floor drains associated with mechanical utility area.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Examine roughing-in work of potable water and waste piping systems to verify actual locations of piping connections prior to installing fixtures. Also examine floors and substrates, and conditions under which fixture work is to be accomplished. Correct any incorrect locations of piping, and other unsatisfactory conditions for installation of plumbing fixtures. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.2 INSTALLATION OF PLUMBING FIXTURES

- A. General: Install plumbing fixtures of types indicated where shown and at indicated heights; in accordance with fixture manufacturer's written instructions, roughing-in drawings, and with recognized industry practices. Ensure that plumbing fixtures comply with requirements and serve intended purposes. Comply with applicable requirements of National Standard Plumbing Code pertaining to installation of plumbing fixtures.
- B. Fasten plumbing fixtures securely to indicated supports or building structure; and ensure that fixtures are level and plumb. Secure plumbing supplies behind or within wall construction so as to be rigid, and not subject to pull or push movement.
- C. Protect installed fixtures from damage during remainder of construction period.

3.3 FIELD QUALITY CONTROL

- A. Upon completion of installation of plumbing fixtures and after units are water pressurized, test fixtures to demonstrate capability and compliance with requirements. When possible, correct malfunctioning units at site, then retest to demonstrate compliance; otherwise, remove and replace with new units and proceed with retesting.
- B. Inspect each installed unit for damage to finish. If feasible, restore and match finish to original at site; otherwise, remove fixture and replace with new unit. Feasibility and match to be judged by the Owner. Remove cracked or dented units and replace with new units.

3.4 ADJUSTING AND CLEANING

- A. Clean plumbing fixtures, trim, and strainers of dirt and debris upon completion of installation.
- B. Adjust water pressure at water coolers, faucets, shower valves, and flush valves to provide proper flow stream and specified gpm.
- C. Adjust or replace washers to prevent leaks at faucets and stops.

3.5 EXTRA STOCK

- A. General: Furnish special wrenches and other devices necessary for servicing plumbing fixtures and trim to the Owner with receipt. Furnish one (1) device for every ten (10) units.

END OF SECTION 22 40 00

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SECTION 22 63 00 - NATURAL GAS SYSTEMS

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

- A. Extent of natural gas systems work is indicated on drawings and schedules, and by requirements of this section.
- B. Refer to Division-02 sections for trenching and backfill required in conjunction with gas service piping; not work of this section.

1.2 QUALITY ASSURANCE

- A. Specimen Joints: Before commencing pipe laying, Contractor shall form specimen joints to demonstrate, to the satisfaction of the Owner, that materials and methods employed will result in watertight joints.
- B. Qualification of Installers: The entire gasket system shall be installed by trained workmen skilled in the installation of such systems.
- C. Codes and Standards:
 - 1. ASME Compliance: Fabricate and install natural gas piping in accordance with ASME B31.2 "Fuel Gas Piping".
 - 2. NFPA Compliance: Fabricate and install natural gas systems in accordance with NFPA 54 "National Fuel Gas Code".
 - 3. Utility Compliance: Fabricate and install natural gas systems in accordance with local gas utility company.
 - 4. UMC Compliance: Fabricate and install natural gas systems in accordance with IAPMO "Uniform Mechanical Code".

1.3 SUBMITTALS

- A. Product Data: Submit manufacturer's technical product data and installation instructions for natural gas systems materials and products.
- B. Maintenance Data: Submit maintenance data and parts lists for natural gas systems materials and products. Include this data, product data, shop drawings, and record drawings in maintenance manual.

PART 2 - PRODUCTS

2.1 MATERIALS AND PRODUCTS

- A. General: Provide piping materials and factory-fabricated piping products of sizes, pipes, pressure ratings, and capacities as indicated. Where not indicated, provide proper selection as determined by Installer to comply with installation requirements. Provide materials and products complying with NFPA 54 where applicable and base pressure rating on natural gas piping system maximum design pressures. Provide sizes and types matching piping and equipment connections; provide fittings of materials which match pipe materials use in natural gas systems. Where more than one type of materials or products is indicated, selection is Installer's option.

2.2 BASIC IDENTIFICATION

- A. General: Provide identification complying with Division-22 sections "Basic Plumbing Materials and Methods" and "Identification for Plumbing Piping and Equipment", in accordance with the following listing:
 - 1. Building Distribution Piping: Plastic pipe markers.
 - 2. Gas Valves: Plastic valve tags.

2.3 BASIC PIPES AND PIPE FITTINGS

- A. General: Provide pipes and pipe fittings complying with Division-22 sections "Basic Plumbing Materials and Methods" and "Pipe, Tube and Fittings for Plumbing Systems", in accordance with the following listing:
- B. Gas Service Piping:
 - 1. All Pipe Sizes: Black steel pipe; Schedule 40; wrought-steel buttwelding.
 - a. Wrapping: Machine wrap pipe using 50% overlap wrap, with polyvinyl chloride tape. Hand wrap fittings using 100% overlap wrap extending 6" (150 mm) beyond fitting onto wrapped pipe. Comply with tape manufacturer's installation instructions.
- C. Building Distribution Piping:
 - 1. Pipe Size 2" (50 mm) and Smaller: Black steel pipe; Schedule 40; malleable-iron threaded fittings.
 - 2. Pipe Size 2-1/2" (65 mm) and Larger: Black steel pipe; Schedule 40; wrought-steel buttwelding fittings.

2.4 BASIC PIPING SPECIALTIES

- A. General: Provide piping specialties complying with Division-22 sections "Basic Plumbing Materials and Methods" and "Piping Specialties for Plumbing Systems", in accordance with the following listing:
1. Pipe escutcheons
 2. Vandal-proof vent caps
 3. Dielectric fittings
 4. Pipe sleeves
 5. Sleeve seals

2.5 BASIC SUPPORTS AND ANCHORS

- A. General: Provide supports and anchors complying with Division-22 sections "Basic Plumbing Materials and Methods" and "Hangers and Supports for Plumbing Piping and Equipment", in accordance with the following listing:
1. Adjustable swivel pipe rings for horizontal-piping hangers and supports.
 2. Two-bolt riser clamps for vertical piping supports.
 3. Concrete inserts, C-clamps, and steel brackets for building attachments.

2.6 SPECIAL VALVES

- A. General: Special valves required for natural gas systems include the following types:
1. Gas Cocks:
 - a. Gas Cocks 2" (50 mm) and Smaller: 150 psi (1020 kPa) non-shock WOG, bronze straightway cock, flat or square head, threaded ends.
 - b. Gas Cocks 2-1/2" (65 mm) and Larger: 125 psi (850 kPa) non-shock WOG, iron body bronze mounted, straightway cock, square head, flanged ends.
 2. Control Valves:
 - a. Master Gas Control Valve: Bronze body, packless, single seat, explosion-proof, solenoid operated, normally closed, UL approved, automatic reset, 120 volt.

2.7 PRESSURE REGULATING VALVES

- A. General: Where required, provide single stage, steel jacketed, corrosion-resistant gas pressure regulators; with atmospheric vent, elevation compensator; with threaded ends for 2" (50 mm) and smaller, flanged ends for 2-1/2" (65 mm) and larger; for inlet and outlet gas pressures, specific gravity, and volume flow indicated.

2.8 INCOMING NATURAL GAS/ GAS METER ASSEMBLY

- A. General: Incoming gas service and gas meter assembly shall be provided by local utility company. Refer to drawings for location of meter assembly.

PART 3 - EXECUTION

3.1 INSPECTION

- A. General: Examine areas and conditions under which natural gas systems materials and products are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF BASIC IDENTIFICATION

- A. General: Install mechanical identification in accordance with Division-22 sections "Basic Plumbing Materials and Methods" and "Identification for Plumbing Piping and Equipment".

3.3 INSTALLATION OF NATURAL GAS PIPING

- A. General: Install natural gas piping in accordance with Division-22 sections "Basic Plumbing Materials and Methods" and "Pipe, Tube and Fittings for Plumbing Systems"; and in accordance with applicable codes and local Utility Company requirements.
 1. Use sealants on metal gas piping threads which are chemically resistant to natural gas. Use sealants sparingly, and apply to only male threads of metal joints.
 2. Remove cutting and threading burrs before assembling piping.
 3. Do not install defective piping or fittings. Do not use pipe with threads which are chipped, stripped or damaged.
 4. Plug each gas outlet, including valves, with threaded plug or cap immediately after installation and retain until continuing piping, or equipment connections are completed.
 5. Ground gas piping electrically and continuously within project, and bond tightly to grounding connection.

6. Install drip-legs in gas piping where indicated, and where required by regulation.
7. Install "Tee" fitting with bottom outlet plugged or capped, at bottom of pipe risers.
8. Use dielectric fittings where dissimilar metals are joined together.
9. Install piping with 1/64" per foot (1.3 mm per meter) (1/8%) downward slope in direction of flow.
10. Install piping parallel to other piping, but maintain minimum of 12" (300 mm) clearance between gas piping and steam or hydronic piping above 200°F (93°C).
11. For piping running through ducts or air plenums, install in welded conduit, ventilated on both ends.
12. For risers running through concrete or asphalt, install through minimum 6" (150 mm) pipe sleeve. Fill annular space with gravel.
13. Install magnesium anodes for underground steel pipe, one 5-lb (2.3 L) anode for up to 100' (30 m) in length and one 5-lb (2.3 L) anode for each additional 100' (30 m).
14. Install magnesium anodes for each underground steel or malleable iron fitting, isolated between two (2) sections of plastic pipe; one 3-lb (1.4 L) anode for each fitting.

3.4 GAS SERVICE

- A. General: Arrange with Local Utility Company to provide gas service to indicated location with shutoff at terminus. Consult with Utility as to extent of its work, costs, fees and permits involved. Pay such costs and fees; obtain permits.
 1. Extend service pipe from Utility's terminus to inside building wall, under Utility's direction.
 2. Provide shutoff in gas service pipe at entry in building, extend pipe to gas meter location indicated; provide parts and accessories required by Utility to connect meter.

3.5 INSTALLATION OF PIPING SPECIALTIES

- A. Install piping specialties in accordance with Division-22 sections "Basic Plumbing Materials and Methods" and "Piping Specialties for Plumbing Systems".

3.6 INSTALLATION OF HANGERS AND SUPPORTS

- A. Install supports and anchors in accordance with Division-22 sections "Basic Plumbing Materials and Methods" and "Hangers and Supports for Plumbing Piping and Equipment".

3.7 INSTALLATION OF VALVES

- A. Gas Cocks: Provide at connection to gas train for each gas-fired equipment item; and on risers and branches where indicated.
 - 1. Locate gas cocks where easily accessible, and where they will be protected from possible injury.
- B. Control Valves: Install as indicated. Refer to Division-26 for wiring; not work of this section.
- C. Pressure Regulating Valves: Install as required to reduce pressure to meet the requirements of each piece of equipment. Valve shall comply with utility requirements. Pipe atmospheric vent to outdoors, full size of outlet. Install gas shutoff valve upstream of each pressure regulating valve.

3.8 INSTALLATION OF GAS METER

- A. Install gas meter in accordance with local utility company's installation instructions, and comply with requirements.
 - 1. Set meter on concrete pad as indicated.
 - 2. Hang meter on wall brackets as indicated.

3.9 EQUIPMENT CONNECTIONS

- A. General: Connect gas piping to each gas-fired equipment item, with drip leg, shutoff gas cock and pressure regulating valve. Comply with equipment manufacturer's instructions.

3.10 FIELD QUALITY CONTROL

- A. Piping Tests: Inspect, test, and purge natural gas systems in accordance with NFPA 54, and local utility requirements.

3.11 ADJUSTING AND CLEANING

- A. Cleaning and Inspecting: Clean and inspect natural gas systems in accordance with requirements of Division-22 sections "Basic Plumbing Materials and Methods" and "Pipe, Tube and Fittings for Plumbing Systems".

3.12 SPARE PARTS

- A. Valve Wrenches: Furnish to the Owner, with receipt, two (2) valve wrenches for each type of gas valve installed, requiring same.

END OF SECTION 22 63 00

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SECTION 23 01 00 - BASIC HVAC REQUIREMENTS

PART 1 - GENERAL

1.1 CONTRACT DOCUMENTS

- A. Unless otherwise modified, provisions of General Conditions, Supplementary Conditions and Division-01 govern work under the Mechanical Divisions.
- B. Contract drawings for mechanical work are diagrammatic, intended to convey scope and general arrangement. Contractor shall review and coordinate routing of new work to clear existing piping, duct, electrical, structure, etc. at no cost to the Owner. All dimensions of existing conditions shall be considered approximate (for information only). All dimensions shall be verified prior to construction.
- C. Contract Document Interpretation/Discrepancies:
 - 1. Should the Contractor discover any discrepancies or omissions on the drawings or in the specifications, he shall notify the Architect/Engineer (A/E) of such conditions prior to the bid date. Otherwise, it will be understood that the drawings and specifications are clear as to what is intended and shall be as interpreted by the A/E.
 - 2. In addition, should any contradiction, ambiguity, inconsistency, discrepancy or conflict appear in or between any of the Contract Documents, the Contractor, shall, before proceeding with the work in question, notify the A/E and request an interpretation. In no case shall he proceed with the affected work until advised by the A/E.
 - 3. If the Contractor fails to make a request for interpretation of discrepancies or conflicts in the drawings or specifications, no excuse will be accepted for failure to carry out the work in a satisfactory manner, as interpreted by the A/E. In all cases, the Contractor will be deemed to have estimated the most stringent materials and methods (i.e. the highest quality materials and most expensive manner of completing the work) unless he has requested and obtained written authorization as to which methods or materials will be required.
 - 4. Each and every trade or subcontractor will be deemed to have familiarized himself with all drawings of this project, including Site/Civil, Architectural, Structural, Mechanical, Electrical, Plumbing, Fire Protection, Information Technology (IT), etc. so as to avoid coordination errors, omissions, and misinterpretations. No additional compensation will be authorized for alleged errors, omissions, and misinterpretation, whether they are a result of failure to observe these requirements or not.
- D. The complete set of Architectural, Structural, Civil, Mechanical, Electrical, Plumbing, Fire Protection and IT drawings, specifications, and addenda apply to this work.

1.2 SCOPE

- A. The work in Division-23 includes furnishing and installing the mechanical systems complete and ready for satisfactory service.
- B. Requirements specified govern work in all sections of Division-23.

1.3 REFERENCES

- A. References to standards, codes, catalogs and recommendations are latest edition in effect on date of invitation to bid.
- B. Refer to applicable contract drawings, specifications and addenda pertaining to other divisions for conditions affecting work.
- C. Refer to Division-01 for description of alternates.
- D. Refer to Division-01 for description of allowance items.
- E. Refer to Division-01 for description of base bid items.
- F. Refer to Division-01 for description of demolition items.

1.4 DEFINITIONS

- A. Following are definitions of terms and expressions used in this Division:
 - 1. "Approve" - to permit use of material, equipment or methods conditional upon compliance with contract document requirements.
 - 2. "Concealed" - hidden from normal sight; includes work in crawl spaces, above ceilings, and in building shafts.
 - 3. "Directed" - directed by Engineer.
 - 4. "Ductwork" - includes ducts, fittings, housings, dampers, supports and accessories comprising a system.
 - 5. "Equal, equivalent" - possessing the same performance qualities and characteristics and fulfilling the same utilitarian function.
 - 6. "Exposed" - not concealed.
 - 7. "Indicated" - indicated in Contract Documents.
 - 8. "Piping" - includes pipe, fittings, valves, supports and accessories comprising a system.
 - 9. "Provide" - furnish and install.

10. "Removable" - detachable from the structure or system without physical alteration of materials or equipment or disturbance to other construction.
11. "Review" - limited observation or checking to ascertain general conformance with design concepts and general compliance with contract document requirements. Such action does not constitute a waiver or alteration of the contract requirements. Verification of quantities and dimensions shall be the responsibility of the Contractor.
12. "Appurtenances" - a device or assembly installed in the referenced system which performs some useful referenced function in the operation, maintenance, servicing, economy or safety of the system. Some examples include, but are not limited to aerators, anchors, supports, gauges, backflow preventers, expansion tanks, filters, flow controls, heat exchangers, interceptors, meters, pressure reducing valves, relief valves, dampers, separators and similar devices.
13. "Record Documents" - drawings, plans and specifications that indicate the nature and location of work reported by Contractors, but not verified by Consultant. Record documents cannot be considered reliable; as they are based on information reported by the Contractor only and is not verified by the Architect or Engineer (A/E).

1.5 RIGGING REQUIREMENTS

- A. Prior to bidding, the Contractor shall verify that all equipment can be physically rigged to the proposed location without disturbance or dismantling of any existing or new physical obstacles. Should the rigging of any new equipment appear to be an issue, the Contractor shall inform the Architect or Engineer (A/E) seven (7) days prior to the bid date that the rigging of the new equipment may present a problem. Otherwise, the Contractor shall, in accordance with the manufacturer's approval and without voiding warranties and/or certifications, have the equipment "broken down" into sections as required to install the equipment in its proposed location without disturbance or dismantling of any existing or new physical obstacles.
- B. Failure to inform the Architect or Engineer (A/E) seven (7) days prior to the bid of any rigging problems will result in the Contractor accepting full responsibility for all modifications to the equipment or the physical obstacles required to install the equipment in its proposed location without additional cost to the Owner.

1.6 CONTRACTOR'S INSTALLATION DRAWINGS

- A. Prior to fabrication and installation, submit shop drawings (min. scale - 1/4" = 1' - 0") illustrating all mechanical, electrical and plumbing (MEP) system elements (including but not limited to: ductwork, HVAC piping, plumbing piping, insulation, lighting fixtures, cable tray, conduit, expansion loops, supports, alignment guides, fire protection, etc.) coordinated with each other as well as the architectural and structural building elements. Installation drawings shall be based upon project specific, approved, product information for each of the MEP elements listed above (as well as architectural, structural, etc. systems), and shall be prepared at a minimum BIM LOD 400 (Building Information Modeling Level of Development 400) level of detail. Installation drawings shall be reviewed by Owner's representative prior to fabrication and installation of any new work and prior to the ordering of any mechanical equipment.

- B. Should the Contractor not provide the coordinated installation drawings required above, the following shall apply:
 - 1. The Contractor shall accept full and absolute responsibility for the coordination of all project materials and equipment to be installed as indicated on the contract documents.
 - 2. Proposed change orders and/or time extensions will not be accepted for any additional work that results from coordination related changes.
 - 3. A credit shall be issued to the Owner for the value of the coordinated installation drawings; the value of the credit to the Owner shall be as determined by the A/E.
- C. Electronic files (AutoCad or Revit) of mechanical, electrical and plumbing (MEP) drawings may be made available upon receipt of a signed copy of the Engineer's Electronic Document Disclaimer (available upon request). The electronic files shall not be utilized for the preparation of coordination/installation/fabrication shop drawings. Coordination/installation/fabrication shop drawings shall be created independently from the electronic MEP files (i.e. AutoCad drawings and/or Revit model). Please note: the electronic MEP Revit model (where applicable) was created at a level of detail similar to BIM LOD 300; however, some MEP elements were modified to provide clarity and legibility to the two-dimensional construction documents. In addition, the electronic files may include delegated design elements that may differ as a result of the final delegated design to be completed by the Contractor (this may include all disciplines including architectural, structural, etc.). Modifications of the MEP systems to accommodate those delegated design elements shall be provided by the Contractor at no additional cost to the Owner.

1.7 MATERIAL, EQUIPMENT AND SUBSTITUTION REQUIREMENTS

- A. Use products of one manufacturer where two or more items of same kind of equipment are required.
- B. Materials and equipment shall have a record of two (2) years successful field use.
- C. Where a specific manufacturer is listed on the drawings, that manufacturer shall be considered the basis of design for that particular item of equipment. Only the basis of design manufacturer has been verified to meet the project requirements (i.e. dimensions, weights, service clearances, electrical requirements, etc.).
- D. Where the drawings and/or specifications indicate more than one manufacturer for a particular item of equipment, only those listed may submit products and services to be included in the work; manufacturers other than those listed will not be acceptable. Should the Contractor choose to use one of the specified manufacturers other than the basis of design, it shall be the responsibility of the Contractor to verify that the equipment meets all project requirements including, but not limited to, verification of all dimensions, weights, service clearances, electrical requirements, etc. All changes incurred shall be the responsibility of the Contractor and shall be provided at no additional cost to the Owner.
- E. Substitutions must be submitted for consideration seven (7) days prior to the original bid date. Consideration of substitutions shall be at the sole discretion of the Engineer. Substitution submittals shall include all information required in the "Submittals" paragraph

of this specification section, as well as all other requirements indicated through the Division-23 specifications. Substitutions will not mitigate, in any way, the Contractor's responsibility in complying with the coordination, contract requirements or design intent. Any additional electrical, structural or special requirements, etc. shall be the responsibility of the Contractor. Also, any additional cost incurred as a result of substitution shall be the responsibility of the Contractor.

- F. Nameplate: For each piece of power operated mechanical equipment provide a permanent operational data nameplate 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.

1.8 MATERIAL AND EQUIPMENT LIST

- A. Within thirty (30) days after award of the contract, submit for Engineer's review a list of subcontractors' and manufacturers' names for items proposed for this project.

1.9 SUBMITTALS

- A. Where the drawings and/or specifications indicate more than one allowable manufacturer for a particular piece of equipment and/or product, only those manufacturers indicated may submit products and services to be included in the work. Unless otherwise indicated, manufacturers other than those listed will not be acceptable.
- B. Submit shop drawings, manufacturer's data and certificates for equipment, materials and finish, and pertinent details for each system where specified in each individual section, and obtain approval before procurement, fabrication, or delivery of the items to the job site. Partial submittals are not acceptable and will be returned without review.
- C. Shop Drawings: Drawings shall include floor plans, sectional views, wiring diagrams, and installation details of equipment. Include equipment spaces identifying and indicating proposed location, layout and arrangement of items of equipment, control panels, accessories, piping, ductwork, and other items that must be shown to assure a coordinated installation. Wiring diagrams shall identify circuit terminals, and indicate the internal wiring for each item of equipment and the interconnection between each item of equipment. Drawings shall indicate adequate clearance for operation, maintenance, and replacement of operating equipment devices. If equipment is disapproved, drawings shall be revised to show acceptable equipment and be resubmitted. All equipment and/or products shall be submitted by an authorized factory representative of that particular product.
- D. Manufacturer's Data: Submittals for each manufactured item shall be manufacturer's descriptive literature of cataloged products, equipment drawings, diagrams, performance and characteristic curves, and catalog cuts.
- E. Standards Compliance: When materials or equipment must conform to the standards of organizations such as the American National Standards Institute (ANSI), American Society for Testing and Materials (ASTM), National Electrical Manufacturers Association (NEMA), American Society of Mechanical Engineers (ASME), American Gas Association (AGA), American Refrigeration Institute (ARI), and Underwriters' Laboratories (UL), proof of such conformance shall be submitted to the Engineer for review. If an organization uses a label or listing to indicate compliance with a particular standard, the label or listing

will be acceptable evidence, unless otherwise specified in the individual sections. In lieu of the label or listing, the Contractor shall submit a certificate from an independent testing organization, which is competent to perform acceptable testing. The certificate shall state that the item has been tested in accordance with the specified organization's test methods and that the item conforms to the specified organization's standard. For materials and equipment whose compliance with organizational standards or specifications is not regulated by an organization using its own listing or label as proof of compliance, a certificate of compliance from the manufacturer shall be submitted for review. The certificate shall identify the manufacturer, the product, and the referenced standard and shall simply state that the manufacturer certifies that the product conforms to all requirements of the project specification and of the referenced standards listed.

- F. Contractor shall thoroughly review and stamp all submittals to indicate compliance with contract requirements prior to submission and coordinate installation requirements for equipment submitted, including, a) the verification of equipment weights relative to the existing and/or new structural support system and b) the verification of equipment dimensions relative to existing and/or new architectural conditions. Contractor shall be responsible for correctness of all submittals.
- G. Submittals will be checked only for general conformance with the design concept and are subject to the original contract documents, as well as any corrections and comments noted. Comments noted, if any, will not be considered a complete list of all omissions, deviations and corrections necessary to meet the requirements of the contract documents. The Contractor will be responsible to confirm that the final product and installation will be in conformance with the contract documents in their entirety, including the responsibility to fully coordinate all work with other trades and to confirm the correctness of dimensions, quantities, and capacities. Submittal review does not authorize or constitute a change to the contract requirements and does not release the Contractor of responsibility to conform to the contract requirements. Requirements of the contract are not waived by review of any and all substitutions. The Contractor must fulfill the terms of the contract.
- H. Compliance Review Form: Each equipment submittal must include a Compliance Review Form formatted as follows:
 - 1. Section 1: Certify that the submittal is in complete compliance with the plans and specifications, except for the numbered and footnoted deviations and exceptions as defined herein. Deviations or exceptions taken in a cover letter or by contradiction or omission shall not constitute a release from the requirement that the equipment be in complete compliance with the plans and specifications.
 - 2. Section 2: Provide a detailed paragraph by paragraph annotation of the specification with an individual "C", "D", or "E" noted in the margin, as follows:
 - a. "C" shall mean compliance with no exceptions. Provide a numbered footnote (i.e. C1, C2, C3, etc.) for each comment or clarification.
 - b. "D" shall mean compliance with deviations. For each deviation, provide a numbered footnote (i.e. D1, D2, D3, etc.) with a detailed explanation of how the intent of this specification is to be satisfied.
 - c. "E" shall mean exception. The equipment offered is not in compliance with the specifications. For each exception, provide a numbered footnote (i.e. E1, E2, E3, etc.) with a detailed description of the exception.

- I. Electronic Submittals: Should the Contractor elect to submit electronic shop drawings/submittals, the procedure shall be as follows:
 - 1. Provide a transmittal with the electronic shop drawing/submittal indicating that the document was transmitted electronically. Transmittal shall also include verification of the Contractor's review indicating compliance with the contract documents in accordance with paragraph 1.09.F of this section.
 - 2. Sequentially number all pages on the electronic shop drawing/submittal. The total number of pages shall be reflected in the transmittal.
 - 3. Submittal review comments shall be transmitted electronically. Large documents will be scanned with comments as necessary and returned electronically.
 - 4. All shop drawings such as, but not limited to: coordination drawings, ductwork shop drawings, fire alarm drawings, ductbank layouts, etc. shall be submitted in hard copy, full size format.
 - 5. Provide hard copy of the shop drawing/submittal for each of the Operations and Maintenance Manuals.
 - 6. Failure to comply with the above will result in the submittal being returned and marked "Not Reviewed".

- J. Submittals will be reviewed for general compliance with design concept in accordance with contract documents. Dimensions, quantities, weights, or other details will not be verified by the A/E; this is the responsibility of the Contractor.

- K. Acceptance will not constitute waiver of contract requirements unless deviations are specifically indicated and clearly noted.

- L. Review Period: BKM shall be allotted two (2) weeks for the processing, review and return of all submittals. It shall be incumbent upon the Contractor to include this time period in their schedule.
 - 1. Resubmittals: BKM shall be allotted an additional two weeks (14 days) for the review of each resubmittal. Again, it shall be the Contractor's responsibility to submit the appropriate materials in a timely fashion.
 - 2. Contract Extension: No extension in contract time will be authorized as a result of the timeline addressed above.

- M. Submittal Identifications:
 - 1. Place a permanent label or title block on each submittal for identification.
 - 2. Indicate name of firm or entity that prepared each submittal on label or title block.
 - 3. Provide a space approximately 4 by 5 inches on label or beside title block to record Contractor's review and approval markings and action taken by A/E.
 - 4. Include the following information on label for processing and recording action taken:

- a. Project name
 - b. Date
 - c. Name and address of A/E
 - d. Name and address of Contractor
 - e. Name and address of subcontractor
 - f. Name and address of supplier
 - g. Name of manufacturer
 - h. Unique identifier, including revision number
 - i. Number and title of appropriate specification section
 - j. Drawing number and detail references, as appropriate
 - k. Other necessary identification
 - l. Example: 230700-01-0
 - 1) 230700 references the spec section
 - 2) 01 indicates this is the first submittal from this spec section
 - 3) 0 indicates this is the original submittal (where 1 would indicate this is the first re-submittal)
- N. The Engineer will provide a maximum of two (2) submittal reviews per equipment submittal; the initial review plus one (1) re-submittal. Should the re-submittal be returned "Not Acceptable" or "Revise and Resubmit", the Contractor shall choose one of the following courses of action:
- 1. Provide the exact manufacturer and model indicated in the contract documents as the basis of design, or
 - 2. Reimburse the Engineer for all additional review time required to achieve a submittal review from the Engineer of "No Exceptions Taken."
 - 3. Should the Contractor choose option 2 above, the Engineer shall be reimbursed at an hourly rate of \$175 per hour with payment due prior to the return of the final submittal. In addition, the Contractor shall accept complete responsibility for all delays resulting from the submittal review process extending beyond two (2) reviews per equipment submittal.
- O. Resubmittals: Resubmittals shall comply with paragraph 1.09 of this section and the following additional requirements.

1. Resubmittals shall include a written response to each submittal comment. Provide a detailed comment by comment annotation of the submittal review comments with an individual "C", "D", or "E" as follows:
 - a. "C" shall mean compliance with no exceptions. Provide a numbered footnote (i.e. C1, C2, C3, etc.) for each comment or clarification.
 - b. "D" shall mean compliance with deviations. For each deviation, provide a numbered footnote (i.e. D1, D2, D3, etc.) with a detailed explanation of how the intent of this specification is to be satisfied.
 - c. "E" shall mean exception. The equipment offered is not in compliance with the specifications. For each exception, provide a numbered footnote (i.e. E1, E2, E3, etc.) with a detailed description of the exception.

1.10 MANUFACTURER'S RECOMMENDATIONS

- A. Installation procedures are required to be in accordance with the recommendations of the manufacturer of the material being installed.

1.11 ACCESSIBILITY

- A. Install equipment and materials to provide required access for servicing and maintenance. Coordinate the final location of concealed equipment and devices requiring access with final location of required access panels and doors. Allow ample space for removal of all parts that require replacement or servicing.

1.12 SAFETY REQUIREMENTS

- A. Belts, pulleys, chains, gears, couplings, projecting setscrews, keys, and other rotating parts located so that any person can come in close proximity thereto shall be fully enclosed or properly guarded in accordance with OSHA. High-temperature equipment and piping so located as to endanger personnel or create a fire hazard shall be properly guarded or covered with insulation of a type as specified herein. Items such as catwalks, ladders, and guardrails shall be provided where required for safe operation and maintenance of equipment.

1.13 WORKMANSHIP

- A. Remove and replace, at no extra cost, all work not orderly, reasonably neat, or workmanlike.
- B. Coordinate all work and cooperate with other trades to facilitate execution of work.

1.14 SITE EXAMINATION/EXISTING CONDITIONS VERIFICATION

- A. Failure to visit site and become familiar with existing conditions prior to bidding will not relieve the Contractor of responsibility for complying with the Contract documents.

- B. Contractor shall field verify existing services and direction of flow of piping and ductwork prior to connection. Existing mechanical identification shall not constitute proper verification of service or direction of flow.

1.15 REGULATIONS AND PERMITS

- A. Comply with all applicable codes and regulations.
- B. All equipment provided shall be in accordance with all applicable local, state, and federal codes, guidelines and standards, as well as the authority having jurisdiction. Equipment and installation shall be in compliance with all applicable energy codes including the most current version of ASHRAE Standard 90.1.
- C. Obtain and pay for all required permits.

1.16 CUTTING AND PATCHING

- A. Unless otherwise directed, do all cutting and patching. Damaged work, including fireproofing and waterproofing shall be repaired by skilled mechanics of the trade involved.
- B. Do not cut walls, floors, roofs, reinforced concrete or structural steel without structural Engineer's permission. Install services without affecting reinforcing steel.
- C. In precast concrete plank drill all holes with a Carboloy tipped drill. Follow instructions of structural Engineer. Cut no reinforcing bars.

1.17 LINTELS

- A. Under this Section provide all lintels not provided elsewhere which are required for openings for the installations of mechanical work. Lintels shall meet the requirements of the structural sections.

1.18 CLEANING UP

- A. Keep premises free from accumulation of debris.
- B. Remove tools, scaffolding, surplus material, debris, and leave premises broom clean.
- C. On discontinuance of part of the work, place all debris in containers and promptly remove them from the Owner's property.
- D. Leave all areas broom clean.
- E. Final clean-up shall be performed.

1.19 AREAS REQUIRING SPECIAL FINISHES/PAINTING

- A. In kitchens, cafeterias, dining rooms, serving pantries and utility rooms [polish chromium or nickel plate] all exposed and uninsulated piping including valves, traps, strainers and appurtenant items; and exposed electrical work including conduit, boxes, switches starters and disconnects. Finish shall not be applied to nameplates, pushbuttons. Stainless steel housing and plates require no plating or paints.
- B. Provide surface preparation, priming and painting of all mechanical and boiler room floors to provide a smooth, cleanable surface. Primer and paint shall be appropriate for concrete slab surfaces. Where painting over existing surfaces, coatings, or where the floor is soiled, degrease and follow manufacturer's recommendations for surface preparation, priming and painting. See specification sections "Painting" and "HVAC Related Work", where applicable, for additional painting requirements. Color shall be selected by the A/E.

1.20 PROTECTION

- A. Protect mechanical and electrical material and equipment from the elements or other injury as soon as delivered on premises.
- B. Cap or plug openings in equipment, piping, duct, and conduit systems to exclude dirt and other foreign material. Rags, wool, cotton, paper, waste or similar materials shall not be used for plugging.
- C. Unless approved by Owner, HVAC equipment shall not be used for temporary heating or ventilation during construction.
- D. Contractor shall protect all existing mechanical, electrical and architectural equipment, materials, finishes, etc. located within or adjacent to the work environment. Contractor shall be responsible for restoration of all existing mechanical, electrical and architectural items to remain. All equipment to remain must be restored to its pre-existing condition prior to the start of work. Restoration and/or replacement shall be at no cost to the Owner.
- E. Contractor shall provide temporary cooling and heating as required to protect all construction materials from the potential adverse effects of high or low temperature and humidity. Upon delivery of ceiling and other finish materials to a location within the building, environmental conditions in all spaces where the materials will be either stored or installed shall be permanently maintained at 75°F (+2°F) and 50% RH (+5%). Should the HVAC include a reheat system, the reheat system shall be energized to provide temperature and humidity control whenever the HVAC system is energized. Contractor shall pay for all utility, fuel, operational, maintenance and repair costs associated with providing the environmental conditions indicated above until the Owner accepts occupancy of the building.

1.21 CLEANING OF SYSTEMS

- A. After satisfactory completion of pressure tests and before permanently connecting fixtures, equipment, traps, strainers and other accessory items, thoroughly clean all systems. Blow out and flush piping until interiors are free of foreign matter.
- B. Flush piping in recirculating water systems to remove all cutting oil, excess pipe joint compound and other foreign materials. Furnish necessary temporary pumping equipment

to thoroughly clean the water piping. Do not use any system pump until after cleaning and flushing has been accomplished to the satisfaction of the Engineer. Employ chemical cleaners, including a non-foaming detergent, not harmful to system components. After cleaning operation, final flushing and refilling the residual alkalinity shall not exceed 300 parts per million. Work shall be performed or supervised by a qualified water treatment service company with personnel skilled in the safe and proper use of chemicals and in testing procedures. After completion, submit a certificate of completion to Engineer stating name of the service company used.

- C. Leave strainers and dirt pockets in clean condition.
- D. Clean fans, ductwork, enclosures, flues, registers, grilles and diffusers at completion of work. Vacuum or swab clean low pressure ducts and outlets supplying operating rooms, delivery rooms, nurseries.
- E. Permanent air systems operated for temporary heating during construction shall only be operated with filters installed of equal efficiency to those specified. Prior to acceptance and after cleaning of system, replace with clean filters as specified. Return air openings shall be equipped with filter cloth to protect against debris entering the ductwork.
 - 1. If upon periodic inspection, it is determined that the permanent ductwork has become contaminated with construction debris, then the Contractor shall be required to procure the services of a professional duct cleaning agency prior to substantial completion, at no additional cost to the Owner.
- F. Should any system become clogged with construction refuse after acceptance, the Contractor shall pay for all labor and materials required to locate and remove the obstruction and replace and repair work disturbed.
- G. Leave all systems clean, and in complete running order.
- H. Equipment that has been subjected to the elements shall be cleaned of all rust, dirt and debris and repainted to match original finish.

1.22 FUNCTIONAL PERFORMANCE TESTING AND VERIFICATION

- A. General: In addition to the tests required during and after installation of all mechanical systems, as well as any other formal commissioning requirements, the Contractor shall perform functional performance tests to verify that all systems are designed, installed, calibrated and adjusted to perform as required in the Contract.
- B. Comply with all applicable specification sections including, but not be limited to, "Basic HVAC Requirements", "Testing, Adjusting and Balancing", "Automatic Temperature Controls" and "Commissioning", where applicable.
- C. Prior to functional performance testing, all indicating, recording and control devices shall be calibrated. A verification calibration report shall be provided with the final test report.
- D. Provide functional performance testing to verify proper operation of each and every control sequence indicated throughout the contract documents.
- E. Failure of Tests: Should any test, verification, or demonstration fail to meet the specification requirements, the component of the system causing the failure shall be

repaired, replaced or readjusted. The failed test, verification, or demonstration shall then be repeated.

- F. A "Functional Performance Test Verification Form" is included at the end of Section 230900. This form (electronic version is available upon request) shall be completed for all mechanical equipment provided under this contract. This shall include, but not be limited to each chiller, boiler, air handling unit, fan, pump, VAV terminal, fan coil unit, unit ventilator, DX cooling equipment, miscellaneous heating equipment, etc.
- G. Test Report: Upon satisfactory verification of calibration and functional performance tests, a copy of the final test results shall be bound in the operations and maintenance manual. The final report shall also include a full compliance statement, on company letterhead, indicating that all systems are installed and functioning per the contract requirements including drawings, specifications, control sequences and accepted submittals.
- H. The mechanical systems shall not be considered complete until all functional performance verification forms, calibration reports and compliance statement have been submitted and reviewed. Submit in accordance with the submittal requirements indicated elsewhere in these specifications.

1.23 OPERATING AND MAINTENANCE MANUAL

- A. Submit Operation and Maintenance Manuals as follows:
 - 1. Provide an electronic version for review by the Owner and A/E, including bookmarks of all section and subsections.
 - 2. After acceptance of the electronic copy, produce hard copies in three-ring binders with each section separated by tab divider. Include protective plastic sleeves for any software or folded large documents submitted. Provide a minimum of two (2) copies to the Owner.
- B. At a minimum, the manual shall contain the following:
 - 1. Title page
 - 2. Table of contents
 - 3. Contractor and sub-contractor contact information
 - 4. Supplier contact information for all mechanical equipment
 - 5. Copies of manufacturer's and Contractor's warranty information (project and equipment) for all mechanical equipment.
 - 6. Submittal log for all mechanical equipment
 - 7. One (1) reviewed copy of each shop drawing or submittal incorporating all A/E and Owner submittal review comments.
 - 8. Copy of inspector acceptance certificates / documents.

9. Provide an 11 x 17 fold-out drawing of each floor plan and indicate locations of the following:
 - a. System shutoff valves
 - b. Fire/smoke dampers
10. All duct, pipe and equipment pressure test reports complete with 11 x 17 fold-out drawing, indicating all systems tested.
11. Final Test and Balance (TAB) Reports. Do not include reports that have not been accepted by the A/E. Pencil or partial copies will not be acceptable.
12. Maintenance procedures for each item of mechanical equipment to include frequency and type of maintenance, spare parts and attic/stock list. This shall include the manufacturer's literature indicating operating and maintenance instructions, parts list, illustrations and diagrams.
13. An itemized list of all spare parts and specialty tools shall be transmitted to the Owner.
14. A report of the training procedures and content provided as well as the attendance log.
15. Valve tag chart
16. Mechanical systems functional performance verification forms, calibration reports and compliance statement indicating that all systems are installed and functioning per the contract requirements.

1.24 TOOLS AND LUBRICANTS

- A. Furnish and turn over to the Owner, special tools not readily available commercially, that are required for disassembly or adjustment of equipment and machinery furnished.
- B. Grease Guns with Attachments for Applicable Fittings: One for each type of grease required for each motor or other equipment.
- C. Tool Containers: Hardwood or metal, permanently identified for intended service and mounted, or located, where directed by the Owner.
- D. Lubricants: A minimum of one quart (.9 L) of oil, and one pound (450 g) of grease, of equipment manufacturer's recommended grade and type, in unopened containers and properly identified as to use for each different application.

1.25 FIELD INSTRUCTION

- A. Upon completion of work, instruct Owner's representative in the proper operation and maintenance of the mechanical and electrical systems.

- B. Instruction periods specified below shall be in addition to instruction specified for certain items elsewhere in the specifications.
- C. Instructions shall be given by persons expert in the following systems and equipment and shall include descriptions and demonstration of procedures, data logging, and analysis.
 - 1. Cooling Plant - Including refrigeration plant, cooling tower, pumps, related equipment, water treatment, safety controls. Provide 8 hours of instruction.
 - 2. Air Systems - Including air handling units, heating and cooling coils, filters, fans, safety controls and other air handling equipment. Provide 8 hours of instruction.
 - 3. Automatic Control - Including operating controls for all heating, cooling, ventilating systems, control centers, panels, compressed air system. Provide 8 hours of instruction.
 - 4. General Instructions - Including review of written operating instructions and balancing report, miscellaneous instructions. Provide 8 hours of instruction.
- D. Instructions shall be given by persons expert in the operation and maintenance and shall be for a period of not less than 5 eight hour days.
- E. Prepare statement(s) for signing by Owner's representative indicating date of completion of instructions and hours expended. Furnish copy of signed statement to Engineer.
- F. Final mechanical demonstration of all mechanical equipment shall be recorded in DVD compatible format. Provide DVDs to the Owner.

1.26 RECORD DOCUMENTS

- A. The Contractor shall maintain a record set of mechanical prints at the project site and shall indicate thereon any changes made to the contract drawings, including, but not limited to addenda, field sketches, RFI responses, supplemental drawings, sketches, etc. Where changes are made that are reflective of supplemental instructions, revisions, RFI responses, etc., the Contractor shall make clear references to those changes.
- B. A separate set of neat, legible mechanical contract prints shall be kept at the project site at all times during the construction of the work for the express purpose of showing any and all changes indicated in paragraph A. above. The prints shall be marked up daily showing all changes to the original documents. The prints shall be marked up in a neat, legible manner using a red pen. Periodic review of the Record Documents will be conducted by the Owner's Representative or A/E. Should this review indicate that the Record Documents are deficient or not up to date, the Contractor shall immediately bring the documents into compliance and make the corrections.
- C. Upon completion of the project and before final close-out, the Contractor shall be responsible for producing a final set of record documents in the same electronic format as the construction documents (i.e. AutoCad or Revit). One (1) set of full size prints, one (1) CD of the electronic files, along with the red-lined marked up field set shall be delivered to the Owner upon completion. If requested, the electronic files shall be uploaded to the Owner's FTP site. The final documents shall indicate in the title or revision block "RECORD DOCUMENTS" along with the date completed. The electronic format shall be compatible with the Owner's preferred version of AutoCad or Revit. Coordinate

with the Owner before producing the CD or uploading to the FTP site. Not acceptable are Contractor installation drawings, shop drawings or multi-layers of work on a single drawing. The final as-built product shall mirror the contract bid documents using the project page layout, format and project title block.

- D. Electronic files (AutoCad or Revit) of mechanical, electrical, plumbing and fire protection (MEP) drawings may be made available upon receipt of a signed copy of the Engineer's Electronic Document Disclaimer (available upon request).
- E. Should the Contractor's electronic Record Documents not be considered complete, they will be returned for completion and/or correction.

1.27 DEMOLITION

- A. All demolition of existing mechanical and electrical piping, auxiliaries and equipment, shall be as specified under the Architectural "Demolition" section, of these specifications, as shown on the drawings, and as required to complete the new and renovated installations and shall be performed by the respective mechanical and electrical contractors.
- B. This work shall include the disconnection and capping of existing services, relocation of certain equipment, and the removal of existing piping, wiring, fittings, equipment, including heat transfer units, air handling units, fans, electrical controls and panelboxes, ductwork, etc., not reused in the new work or required to complete the renovation work. Contractor shall note the drawings specify certain existing equipment to be reused.
- C. Where supports and piping are removed, holes remaining in floors, walls and ceilings must be patched and refinished to match the adjoining original surfaces and finishes.
- D. Any removed items requested by the Owner shall remain the property of the Owner. Contractor shall remove equipment and store on site as directed by the Owner. All other equipment or material shall become the property of the Contractor and shall be removed from the site. Contractor shall meet Federal EPA Laws, Regulations and Guidelines in regard to removal of asbestos insulation.
- E. The Contractor shall use care when performing selective building and site demolition. The Contractor shall be responsible for damage inclusive of but not limited to: building finishes, lighting (interior and exterior), furniture, structure, site, utilities (above and below ground), mechanical, plumbing, telecommunications and electrical equipment / systems. Should any damage occur or should any remedial work be required, the Contractor shall be responsible to repair and or replace the damaged item(s) to the Owner's satisfaction at no additional cost. The Contractor shall be responsible for surveying (including contacting Miss Utility), photo documenting and restoring the surrounding work site(s) to the original pre-demolition condition and / or to the Owner's satisfaction upon completion of the work at no additional cost.

1.28 OUTAGES

- A. All mechanical outages which will interfere with the normal use of the building in any manner shall be done at such times as shall be mutually agreed upon by the Contractor and the Owner's Representative.

- B. Unless otherwise specified, outages of any services required for the performance of this contract and affecting areas other than the immediate work area shall be scheduled at least ten (10) days in advance with the Owner's Representative. All such outages shall be performed during other than normal duty hours.
- C. The Contractor shall include in his price the cost of all premium time required for outages and other work which interferes with the normal use of the building, which will be performed, in most cases, during other than normal work time and the convenience of the using agency.

1.29 LEED CERTIFICATION

- A. This project is required to obtain a LEED certification. The Contractor shall provide all required LEED documentation as required to achieve the construction related LEED credits.
- B. The project includes both LEED Fundamental and Enhanced Commissioning. Provide all services as required for compliance with the Fundamental and Enhanced Commissioning requirements. Coordinate with the Commissioning Agent as required. Refer to the Commissioning specification sections for additional information.

1.30 GUARANTEE/WARRANTY

- A. Each Contractor shall furnish a guarantee covering all labor and materials furnished by him for a period of two (2) years from the date of final acceptance of his work, and he shall agree to repair and make good at his own expense any and all defects which may appear in his work during that time if, in the judgment of the Engineer, such defects arise from defective workmanship and/or imperfect or inferior material.
- B. The above shall not in any way void or abrogate equipment manufacturer's guarantee or warranty. Certificates of guarantee shall be delivered to the Owner.
- C. Within the two (2) year warranty/guarantee period, manufacturer's recommended maintenance shall be provided by the Contractor.
- D. In addition to the warranties indicated above, provide a five (5) year parts and labor warranty for each of the following:
 - 1. Chillers
 - 2. All air conditioning unit related compressors (i.e. rooftop DX units, all air cooled condensing units for VRV systems, split system units, etc.).

1.31 UTILITY REBATE

- A. Utility Rebate Application: The mechanical contractor shall provide and submit a utility rebate application to the local utility (BGE Smart Energy Program, or other local utility serving this project area) for the major HVAC equipment (such as chillers, packaged A/C units, variable refrigerant flow systems, etc.). The rebate application shall include all information required by the utility company program administrator (ICF International, or other rebate administrator) including, but not limited to, the application, supporting

calculations, analysis, comparison of the proposed equipment to baseline equipment or system., etc.; all as defined and/or required by the program administrator. The Owner shall be indicated on the application as the recipient for the full rebate.

PART 2 - PRODUCTS

Not Applicable

PART 3 - EXECUTION

Not Applicable

END OF SECTION 23 01 00

SECTION 23 05 00 - BASIC HVAC MATERIALS AND METHODS

PART 1 - GENERAL

1.1 CONTRACT DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-01 Specification Sections, apply to this Section.
- B. Requirements specified in Division-23 Section "Basic HVAC Requirements" apply to this Section.

1.2 SUMMARY

- A. This Section includes limited scope general construction materials and methods for application with mechanical installations as follows:
 - 1. Mechanical equipment nameplate data.
 - 2. Firestopping: Provide seals for all openings (new and existing) through fire-rated walls, floors, or ceilings used as passage for mechanical and electrical components such as piping, ductwork, conduit, etc.
 - 3. Selective demolition including:
 - a. Nondestructive removal of materials and equipment for reuse or salvage as indicated.
 - b. Dismantling mechanical materials and equipment made obsolete by these installations.
 - 4. Excavation for underground utilities and services, including underground piping (under the building and from building to utility connection), tanks, basins, and equipment up to five (5) feet (1500 mm) outside the building.
 - 5. Miscellaneous metals for support of mechanical materials and equipment.
 - 6. Wood grounds, nailers, blocking, fasteners, and anchorage for support of mechanical materials and equipment.
 - 7. Joint sealers for sealing around mechanical materials and equipment; and for sealing penetrations in fire and smoke barriers, floors, and foundation walls.
 - 8. Access panels and doors in walls, ceilings, and floors for access to mechanical materials and equipment.

1.3 DEFINITIONS

A. The following definitions apply to excavation operations:

1. Additional Excavation: Where excavation has reached required subgrade elevations, if unsuitable bearing materials are encountered, continue excavation until suitable bearing materials are reached. The Contract Sum may be adjusted by an appropriate Contract Modification.
2. Subbase: As used in this Section refers to the compacted soil layer used in pavement systems between the subgrade and the pavement base course material.
3. Subgrade: As used in this Section refers to the compacted soil immediately below the slab or pavement system.
4. Unauthorized excavation consists of removal of materials beyond indicated subgrade elevations or dimensions without specific direction from the Architect.

B. The following definitions apply to firestopping:

1. Assembly: Particular arrangement of materials specific to given type of construction described or detailed in referenced documents.
2. Barriers: Time rated fire walls, smoke barrier walls, time rated ceiling/floor assemblies and structural floors.
3. Firestopping: Methods and materials applied in penetrations and unprotected openings to limit spread of heat, fire, gases and smoke.
4. Penetration: Opening or foreign material passing through or into barrier or structural floor such that full thickness of rated materials is not obtained.
5. Construction Gaps: Gaps between adjacent sections of walls, exterior walls, at wall tops between top of wall and ceiling, and structural floors or roof decks; and gaps between adjacent sections of structural floors.
6. System: Specific products and applications classified and numbered by Underwriters Laboratories, Inc. to close specific barrier penetrations.
7. Sleeve: Metal fabrication or pipe section extending through thickness of barrier and used to permanently guard penetration. Sleeves are described as part of penetrating system in other sections and may or may not be required.

1.4 SUBMITTALS

A. General: Submit the following in accordance with Conditions of Contract and Division-01 Specification Sections.

B. Product data for the following products:

1. Access panels and doors

- 2. Joint sealers
- C. Firestopping: Indicate dimensions, description of materials and finishes, general construction, specific modifications, component connections, anchorage methods, hardware, and installation procedures.
 - 1. Provide details of each proposed assembly identifying intended products and applicable UL system number, or UL classified devices.
 - 2. Provide drawings relating to non-standard applications as needed.
- D. Shop drawings detailing fabrication and installation for metal fabrications, and wood supports and anchorage for mechanical materials and equipment.
- E. Coordination drawings for access panel and door locations in accordance with Division-23 sections.
- F. Samples of joint sealer, consisting of strips of actual products showing full range of colors available for each product.
- G. Welder certificates, signed by Contractor, certifying that welders comply with requirements specified under "Quality Assurance" article of this Section.
- H. Schedules indicating proposed methods and sequence of operations for selective demolition prior to commencement of Work. Include coordination for shut-off of utility services and details for dust and noise control.
 - 1. Coordinate sequencing with construction phasing and Owner occupancy specified in Division-01 Section "Summary of Work."

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Engage an Installer for the installation and application of joint sealers, access panels and doors, and firestopping materials with at least two years' experience with installations.
- B. Qualify welding processes and welding operators in accordance with AWS D1.1 "Structural Welding Code - Steel."
 - 1. Certify that each welder has satisfactorily passed AWS qualification tests for welding processes involved and, if pertinent, has undergone recertification.
- C. Fire-Resistance Ratings: Where a fire-resistance classification is indicated, provide access door assembly with panel door, frame, hinge, and latch from manufacturer listed in the UL "Building Materials Directory" for rating shown.
 - 1. Provide UL Label on each fire-rated access door.
- D. Local and State Regulatory Requirements: Submit forms or acceptance for proposed assemblies not conforming to specific UL firestop system numbers, or UL classified devices.

1.6 DELIVERY, STORAGE AND HANDLING

- A. Deliver joint sealer materials in original unopened containers or bundles with labels informing about manufacturer, product name and designation, color, expiration period for use, pot life, curing time, and mixing instructions for multi-component materials.
- B. Store and handle joint sealer materials in compliance with the manufacturers' recommendations to prevent their deterioration and damage.

1.7 PROJECT CONDITIONS

- A. Conditions Affecting Selective Demolition: The following project conditions apply:
 - 1. Protect adjacent materials indicated to remain. Install and maintain dust and noise barriers to keep dirt, dust, and noise from being transmitted to adjacent areas. Remove protection and barriers after demolition operations are complete.
 - 2. Locate, identify, and protect mechanical services passing through demolition area and serving other areas outside the demolition limits. Maintain services to areas outside demolition limits. When services must be interrupted, install temporary services for affected areas.
- B. Environmental Conditions: Apply joint sealers under temperature and humidity conditions within the limits permitted by the joint sealer manufacturer. Do not apply joint sealers to wet substrates.

1.8 SEQUENCE AND SCHEDULING

- A. Coordinate the shut-off and disconnection of utility services with the Owner and the utility company.
- B. Notify the Architect at least five (5) days prior to commencing demolition operations.
- C. Perform demolition in phases as indicated.

PART 2 - PRODUCTS

2.1 MECHANICAL EQUIPMENT NAMEPLATE DATA

- A. Nameplate: For each piece of power operated mechanical equipment provide a permanent operational data nameplate 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.

2.2 FIRESTOPPING

- A. All penetrations through fire barriers (new and existing) shall be firestopped with an approved material that is capable of maintaining the fire resistance rating of the barrier.

All firestop sealants shall conform to ASTM E 814, ASTM E 119, UL 1479, UL 2079 CAN/ULC S115, and CAN/ULC S101.

- B. Firestop material shall be latex based, intumescent caulk intended for use for all thru-penetrations with piping, ducts, cable trays, conduit, and cables.
- C. When exposed to high temperatures or fires, the caulk shall expand in volume to quickly close off voids left by melting or burning construction materials. Caulk shall be applied by a standard caulk gun and remain flexible after curing.
- D. Acceptable products shall be limited to Johns Manville "Firetemp-C1;" Hilti "FS-One;" or 3M "CP25WB+." Coordinate with General Contractor such that a single manufacturer/product is utilized throughout the project for all fire and smoke stopping materials.

2.3 SMOKE STOPPING

- A. All penetrations through smoke barriers, smoke partitions, or any other surface required to resist the passage of smoke (new and existing) shall be provided with a smoke stop sealant and/or system that has been independently tested to provide an acceptable smoke seal that will resist the passage of smoke. Smoke stop systems (including product and installation) shall conform to all applicable standards (including but not limited to ASTM, UL and NFPA), as well as all other local, state or federal requirements.
- B. Acceptable manufacturers shall be limited to the manufacturers that may provide firestopping materials/systems (see paragraph 2.02 of this section). Coordinate with the General Contractor such that a single manufacturer/product is utilized throughout the project for all fire and smoke stopping materials.

2.4 MISCELLANEOUS METALS

- A. Steel plates, shapes, bars, and bar grating: ASTM A 36.
- B. Cold-Formed Steel Tubing: ASTM A 500.
- C. Hot-Rolled Steel Tubing: ASTM A 501.
- D. Steel Pipe: ASTM A 53, Schedule 40, welded.
- E. Non-shrink, Non-metallic Grout: Premixed, factory-packaged, non-staining, non-corrosive, non-gaseous grout, recommended for interior and exterior applications.
- F. Fasteners: Zinc-coated, type, grade, and class as required.

2.5 MISCELLANEOUS LUMBER

- A. Framing Materials: Standard Grade, light-framing-size lumber of any species. Number 3 Common or Standard Grade boards complying with WCLIB or AWPA rules, or Number 3 boards complying with SPIB rules. Lumber shall be preservative treated in accordance with AWPB LP-2, and kiln dried to a moisture content of not more than 19 percent.

- B. Construction Panels: Plywood panels; APA C-D PLUGGED INT, with exterior glue; thickness as indicated, or if not indicated, not less than 15/32 inches (12 mm).

2.6 JOINT SEALERS

- A. General: Joint sealers, joint fillers, and other related materials compatible with each other and with joint substrates under conditions of service and application.
- B. Colors: As selected by the Architect from manufacturer's standard colors.
- C. Elastomeric Joint Sealers: Provide the following types:
 - 1. One-part, nonacid-curing, silicone sealant complying with ASTM C 920, Type S, Grade NS, Class 25, for uses in non-traffic areas for masonry, glass, aluminum, and other substrates recommended by the sealant manufacturer.
 - 2. One-part, mildew-resistant, silicone sealant complying with ASTM C 920, Type S, Grade NS, Class 25, for uses in non-traffic areas for glass, aluminum, and nonporous joint substrates; formulated with fungicide; intended for sealing interior joints with non-porous substrates; and subject to in-service exposure to conditions of high humidity and temperature extremes.
- D. Acrylic-Emulsion Sealants: One-part, non-sag, mildew-resistant, paintable complying with ASTM C 834 recommended for exposed applications on interior and protected exterior locations involving joint movement of not more than plus or minus 5 percent.
- E. Fire-Resistant Joint Sealers: Two-part, foamed-in-place, silicone sealant formulated for use in through-penetration fire-stopping around cables, conduit, pipes, and duct penetrations through fire rated walls and floors. Sealants and accessories shall have fire resistance ratings indicated, as established by testing identical assemblies in accordance with ASTM E 814, by Underwriters' Laboratories, Inc., or other testing and inspection agency acceptable to authorities having jurisdiction.

2.7 ACCESS DOORS

- A. Steel Access Doors and Frames: Factory-fabricated and assembled units, complete with attachment devices and fasteners ready for installation. Joints and seams shall be continuously welded steel, with welds ground smooth and flush with adjacent surfaces.
- B. Frames: 16-gage (1.6 mm) steel, with a 1-inch (25 mm) wide exposed perimeter flange for units installed in unit masonry, pre-cast, or cast-in-place concrete, ceramic tile, or wood paneling.
 - 1. For Installation in Masonry, Concrete, Ceramic Tile, or Wood Paneling: 1-inch (25 mm) wide exposed perimeter flange and adjustable metal masonry anchors.
 - 2. For Gypsum Wallboard or Plaster: Perforated flanges with wallboard bead.
 - 3. For Full-Bed Plaster Applications: Galvanized expanded metal lath and exposed casing bead, welded to perimeter of frame.

- C. Flush Panel Doors: 14-gage (2 mm) sheet steel, with concealed spring hinges or concealed continuous piano hinge set to open 175 degrees (3.05 Radians); factory-applied prime paint.
 - 1. Fire-Rated Units: Insulated flush panel doors, with continuous piano hinge and self-closing mechanism.
- D. Locking Devices: Flush, screwdriver-operated cam locks. [Common use]
- E. Locking Devices: Where indicated, provide 5-pin or 5-disc type cylinder locks, individually keyed; provide two (2) keys. [Secured areas only: note as such].

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting installation and application of joint sealers and access panels. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 FIRESTOP INSTALLATION

- A. Install penetration seal materials in accordance with printed instructions of the UL Fire Resistance Directory and in accordance with manufacturer's instruction.
- B. Seal new and existing holes or voids made by penetrations to ensure an effective smoke barrier.
- C. Where floor openings without penetrating items are more than four inches (100 mm) in width and subject to traffic or loading, install firestopping materials capable of supporting same loading as floor.
- D. Protect materials from damage on surface subject to traffic.
- E. Place firestopping in annular space around fire dampers before installation of damper's anchoring flanges which are installed in accordance with fire damper manufacturer's recommendations.
- F. Where large openings are created in walls or floors to permit installation of pipes, ducts, cable tray, bus duct or other items, close unused portions of opening with firestopping material tested for the application.
- G. Install smoke stopping as specified for firestopping (new and existing).
- H. Where rated walls are constructed with horizontally continuous air space, double width masonry, or double stud frame construction, provide vertical, 12 inch (300 mm) wide fiber dams for full thickness and height of air cavity at maximum 15 foot (4500 mm) intervals.

3.3 PREPARATION FOR JOINT SEALERS

- A. Surface Cleaning for Joint Sealers: Clean surfaces of joints immediately before applying joint sealers to comply with recommendations of joint sealer manufacturer.
- B. Apply joint sealer primer to substrates as recommended by joint sealer manufacturer. Protect adjacent areas from spillage and migration of primers, using masking tape. Remove tape immediately after tooling without disturbing joint seal.

3.4 SELECTIVE DEMOLITION

- A. General: Demolish, remove, demount, and disconnect abandoned mechanical materials and equipment indicated to be removed and not indicated to be salvaged or saved.
- B. Materials and Equipment to be Salvaged: Remove, demount, and disconnect existing mechanical materials and equipment indicated to be removed and salvaged, and deliver materials and equipment to the location designated for storage.
- C. Disposal and Cleanup: Remove from the site and legally dispose of demolished materials and equipment not indicated to be salvaged.
- D. Mechanical Materials and Equipment: Demolish, remove, demount, and disconnect the following items:
 - 1. Inactive and obsolete piping, fittings and specialties, equipment, ductwork, controls, fixtures, and insulation.
 - 2. Piping and ducts embedded in floors, walls, and ceilings may remain if such materials do not interfere with new installations. Remove materials above accessible ceilings. Drain and cap piping and ducts that are allowed to remain.
 - 3. Perform cutting and patching required for demolition in accordance with Division-1 Section "Cutting and Patching."

3.5 ERECTION OF METAL SUPPORTS AND ANCHORAGE

- A. Cut, fit, and place miscellaneous metal fabrications accurately in location, alignment, and elevation to support and anchor mechanical materials and equipment.
- B. Field Welding: Comply with AWS "Structural Welding Code."

3.6 ERECTION OF WOOD SUPPORTS AND ANCHORAGE

- A. Cut, fit, and place wood grounds, nailers, blocking, and anchorage accurately in location, alignment, and elevation to support and anchor mechanical materials and equipment.
- B. Select fastener sizes that will not penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections between members. Install fasteners without splitting wood members.

- C. Attach to substrates as required to support applied loads.

3.7 APPLICATION OF JOINT SEALERS

- A. General: Comply with joint sealer manufacturers' printed application instructions applicable to products and applications indicated, except where more stringent requirements apply.
 - 1. Comply with recommendations of ASTM C 962 for use of elastomeric joint sealants.
 - 2. Comply with recommendations of ASTM C 790 for use of acrylic emulsion joint sealants.
- B. Tooling: Immediately after sealant application and prior to time shinning or curing begins, tool sealants to form smooth, uniform beads; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint. Remove excess sealants from surfaces adjacent to joint. Do not use tooling agents that discolor sealants or adjacent surfaces or are not approved by sealant manufacturer.

3.8 INSTALLATION OF ACCESS DOORS

- A. Provide access doors (minimum 18" x 18") as required to provide maintainable access to all mechanical equipment including, but not limited to, valves, dampers, air terminals, etc.
- B. Set frames accurately in position and securely attached to supports, with face panels plumb and level in relation to adjacent finish surfaces.
- C. Adjust hardware and panels after installation for proper operation.

END OF SECTION 23 05 00

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SECTION 23 05 13 - ELECTRICAL PROVISIONS FOR HVAC EQUIPMENT

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

- A. Extent of electrical provisions to be provided as mechanical work is indicated in all other Division-23 sections, on drawings, and as further specified in this section.
- B. Types of work normally recognized as electrical, but provided as mechanical, specified or partially specified in this section, include but are not necessarily limited to the following:
 - 1. Motors for mechanical equipment.
 - 2. Motor starters and Variable Frequency Drives (VFDs) for mechanical equipment.
 - 3. Wiring from motors to disconnect switches or junction boxes for motors of mechanical equipment, but only where specifically indicated to be furnished integrally with equipment.
 - 4. Wiring of field-mounted float control switches, flow control switches, and similar mechanical-electrical devices provided for mechanical systems, to equipment control panels.
 - 5. Electrical heating coils and similar elements in mechanical equipment.
- C. Refer to requirements of Division-26 sections.

1.2 QUALITY ASSURANCE

- A. Coordination with Electrical Work: Wherever possible, match elements of electrical provisions of mechanical work with similar elements of electrical work specified in Division-26 sections for electrical work of this section which is not otherwise specified.
- B. Standards: For electrical equipment and products, comply with applicable NEMA standards, and refer to NEMA standards for definitions of terminology herein. Comply with National Electrical Code (NFPA 70) for workmanship and installation requirements.

1.3 SUBMITTALS

- A. Listing, Motors of Mechanical Work: Concurrently, with submittal of mechanical products listing (Basic Mechanical and Division-1 requirements), submit separate listing showing rating, power characteristics, application (connected equipment), and general location of every motor to be provided with mechanical work. Submit updated information promptly when and if initial data is revised.
 - 1. Include in listing of motors, notations of whether motor starter is furnished or installed integrally with motor or equipment containing motor.

- B. Coordination with Electrical Submittals: Where a Power System Study is provided under Division 26, coordinate with the general contractor and electrical contractor as required to submit the Power System Study submittal prior to the chiller submittal. Short circuit current information is required in order to complete the review of the chiller submittal. If chiller is procured prior to receipt of the power system study, all chiller modifications shall be provided as required at no cost to owner.

PART 2 - PRODUCTS

2.1 MOTORS

- A. Motor Characteristics: Except where more stringent requirements are indicated, and except where required item of mechanical equipment cannot be obtained with fully complying motor, comply with the following requirements for motors of mechanical work:
- B. Temperature Rating: Rated for 113 degrees F (40 degrees C) environment with maximum 122 degrees F (50 degrees C) temperature rise for continuous duty at full-load (Class B Insulation).
- C. Starting Capability: Provide each motor capable of making starts as frequently as indicated by automatic control system, and not less than five (5) starts per hour for manually controlled motors.
- D. Phases and Current Characteristics: Provide squirrel cage induction polyphase motors for 1/2 hp (.4 kW) and larger, and provide capacitor-start single-phase motors for 1/3 hp (.25 kW) and smaller, except 1/6 hp (.1 kW) and smaller may, at equipment manufacturer's option, be split-phase type. Coordinate current characteristics with power specified in Division-26 sections, and with individual equipment requirements specified in other Division-23 requirements. For 2-speed motors provide two (2) separate windings on polyphase motors. Do not purchase motors until power characteristics available at locations of motors have been confirmed, and until rotation directions have been confirmed.
- E. Service Factor: 1.15 for polyphase motors and 1.35 for single-phase motors.
- F. Motor Construction: Provide general purpose, continuous duty motors, Class F insulation, Design "B" except "C" where required for high starting torque.
 - 1. Bearings: Ball or roller bearings with inner and outer shaft seals, regreasable except permanently sealed where motor is normally inaccessible for regular maintenance. Where belt drives and other drives produce lateral or axial thrust in motor, provide bearings designed to resist thrust loading. Refer to individual sections of Division-23 for fractional-hp light-duty motors where sleeve-type bearings are permitted.
 - 2. Enclosure Type: Except as otherwise indicated, provide open drip-proof motors for indoor use where satisfactorily housed or remotely located during operation, and provide guarded drip-proof motors where exposed to contact by employees or building occupants. Provide weather-protected Type I for outdoor use, Type II where not housed. Refer to individual sections of Division-23 for other enclosure requirements.

3. Overload Protection: Provide built-in thermal overload protection and, where indicated, provide internal sensing device suitable for signaling and stopping motor at starter.
4. Noise Rating: Provide industry standard "Quiet" rating on motors.
5. Efficiency: For motors 1 horsepower (.7 kW) or higher, provide motors with minimum efficiencies as follows in accordance with IEEE Standard 112, Test Method B:

a. Open Motors (ODP)

	MOTOR HP (KW)	MINIMUM EFFICIENCY *		
		<u>1200 RPM</u>	<u>1800 RPM</u>	<u>3600 RPM</u>
	1 (.7)	82.5%	85.5%	77.0%
	1.5 (1.1)	86.5%	86.5%	84.0%
	2 (1.5)	87.5%	86.5%	85.5%
	3 (2.2)	88.5%	89.5%	85.5%
	5 (4)	89.5%	89.5%	86.5%
	7.5 (5.6)	90.2%	91.0%	88.5%
	10 (8)	91.7%	91.7%	89.5%

* Required Full Load Nominal Efficiency shall be in accordance with EISA 2007. Where efficiency listed above is higher than the EISA 2007 requirement, provide the higher efficiency indicated.

b. Enclosed Motors (TEFC)

	MOTOR HP (KW)	MINIMUM EFFICIENCY *		
		<u>1200 RPM</u>	<u>1800 RPM</u>	<u>3600 RPM</u>
	1 (.7)	82.5%	85.5%	77.0%
	1.5 (1.1)	87.5%	86.5%	84.0%
	2 (1.5)	88.5%	86.5%	85.5%
	3 (2.2)	89.5%	89.5%	86.5%
	5 (4)	89.5%	89.5%	88.5%
	7.5 (5.6)	91.0%	91.7%	89.5%
	10 (8)	91.0%	91.7%	90.2%

* Required Full Load Nominal Efficiency shall be in accordance with EISA 2007. Where efficiency listed above is higher than the EISA 2007 requirement, provide the higher efficiency indicated.

- c. Where fan or pump motors are used in conjunction with, or controlled by, a variable frequency drive (VFD), motors shall be suitable for VFD operation (inverter duty motors).
 - d. For motors less than 1 horsepower (.7 kW), provide motors with higher efficiency than "average standard industry motors," in accordance with IEEE Standard 112, test method B.
- G. Nameplate: Provide metal nameplate on each motor, indicating full identification of manufacturer, ratings, characteristics, construction, special feature and similar information.
- H. Motor Modifications: In cases where the equipment submitted requires additional motors and/or controls, circuiting and related equipment shall be provided as approved and in accordance with the National Electrical Code. All costs relative to these electrical changes shall be included under the Section in which the equipment is furnished and installed and shall be coordinated with the electrical work at no expense to the Owner.
- I. Power Factor: All motors one (1) horsepower and above shall have a minimum power factor of 0.90.
- J. All motors operated on variable frequency drives shall be equipped with a maintenance free, conductive microfiber, shaft grounding ring with a minimum of two (2) rows of circumferential microfibers to discharge electrical shaft currents within the motor and/or its bearings. Motors up to 100 HP shall be provided with a minimum of one (1) shaft grounding ring installed either on the drive end or non-drive end. Motors over 100 HP shall be provided with an insulated bearing on the non-drive end and a shaft grounding ring on the drive end of the motor. Grounding rings shall be provided and installed by the motor pump manufacturer or contractor and shall be installed in accordance with the manufacturer's recommendations.

2.2 MOTOR STARTERS AND VARIABLE FREQUENCY DRIVES (VFDS)

- A. Where motor starters and/or variable frequency drives (VFDS) are indicated for mechanical equipment, they shall comply with all requirements outlined with the electrical specifications for motor starters and VFDS. Where motor starters and/or VFDS are provided by the mechanical contractor, or as a portion of a packaged mechanical unit, the electrical specifications shall also apply. All VFDS for the project, whether provided by the mechanical or electrical contractor, shall be provided by a single manufacturer, and shall include the same features and options.

2.3 MECHANICAL EQUIPMENT

- A. Electrical Heating Elements: Where electrical resistance coils and other heating elements are included in mechanical equipment or otherwise indicated as mechanical work, and except as otherwise indicated, provide 120-volt units where rating is less than 2 kW, higher-voltage single phase units where rating is 2 kW but less than 5 kW, and higher-voltage 3-phase units where rating is 5 kW and greater.

- B. All packaged roof top units and/or DOAS units electrical components shall have an overall short circuit withstanding rating of at least 65,000 Ampere Interrupting Capacity and be UL listed as such.
- C. All mechanical equipment shall be approved and listed by Underwriters' Laboratories (UL) and shall bear nameplate indicating same.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install motors on motor mounting systems in accordance with motor manufacturer's instructions, securely anchored to resist torque, drive thrusts, and other external forces inherent in mechanical work. Secure sheaves and other drive units to motor shafts with keys and Allen set screws, except motors of 1/3 hp (.25 kW) and less may be secured with Allen set screws on flat surface of shaft. Unless otherwise indicated, set motor shafts parallel with machine shafts.
- B. Deliver starters and wiring devices which have not been factory installed on equipment unit to electrical Installer for installation.
- C. Install furnished under Division-26 starter panels and wiring devices at locations indicated, securely supported and anchored, and in accordance with manufacturer's installation instructions. Locate in accordance with National Electric Code for installation requirements.

END OF SECTION 23 05 13

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SECTION 23 05 29 - HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

- A. Extent of hangers and supports required by this section is indicated on drawings and/or specified in other Division-23 sections.
- B. Types of hangers and supports specified in this section include the following:
 - 1. Horizontal-Piping Hangers and Supports
 - 2. Vertical-Piping Clamps
 - 3. Hanger-Rod Attachments
 - 4. Building Attachments
 - 5. Saddles and Shields
 - 6. Spring Hangers and Supports
 - 7. Miscellaneous Materials
 - 8. Roof Equipment Supports
 - 9. Anchors
 - 10. Equipment Supports
- C. Hangers and supports furnished as part of factory-fabricated equipment are specified as part of equipment assembly in other Division-23 sections.

1.2 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of hangers and supports, of types and sizes required, whose products have been in satisfactory use in similar service for not less than five (5) years.
- B. Codes and Standards:
 - 1. Code Compliance: Comply with applicable codes pertaining to product materials and installation of hangers and supports.
 - 2. NFPA, UL, and FM Compliance: Provide products which comply with NFPA 13 listed and labeled by UL and FM where used for fire protection piping systems.
 - 3. MSS Standard Compliance:

- a. Provide pipe hangers and supports of which materials, design, and manufacture comply with MSS SP-58.
- b. Select and apply pipe hangers and supports, complying with MSS SP-69.
- c. Fabricate and install pipe hangers and supports, complying with MSS SP-89.
- d. Terminology used in this section is defined in MSS SP-90.

1.3 SUBMITTALS

- A. Product Data: Submit manufacturer's technical product data, including installation instructions for each type of support and anchor. Submit pipe hanger and support schedule showing manufacturer's figure number, size, location, and features for each required pipe hanger and support.

PART 2 - PRODUCTS

2.1 HORIZONTAL-PIPING HANGERS AND SUPPORTS

- A. General: Except as otherwise indicated, provide factory-fabricated horizontal-piping hangers and supports complying with MSS SP-58, selected by Installer to suit horizontal-piping systems in accordance with MSS SP-69 and manufacturer's published product information. Use only one type by one manufacturer for each piping service. Select size of hangers and supports to exactly fit pipe size for bare piping, and to exactly fit around piping insulation with saddle or shield for insulated piping. Provide copper-plated hangers and supports for copper-piping systems. To avoid future electrolysis or corrosion, copper plated hangers, supports, clamps, rod attachments, and building attachments shall not be in direct contact with copper piping. A separation material shall be installed between the pipe and the copper plated hanger, support, clamp, etc. The separation material shall prohibit electrical conductance and prevent galvanic action or corrosion between dissimilar metals. Separation material shall be guaranteed for a minimum of thirty (30) years.

2.2 VERTICAL-PIPING CLAMPS

- A. General: Except as otherwise indicated, provide factory-fabricated vertical-piping clamps complying with MSS SP-58, selected by Installer to suit vertical piping systems, in accordance with MSS SP-69 and manufacturer's published product information. Select size of vertical piping clamps to exactly fit pipe size of bare pipe. Provide copper-plated hangers and supports for copper-piping systems. To avoid future electrolysis or corrosion, copper plated hangers, supports, clamps, rod attachments, and building attachments shall not be in direct contact with copper piping. A separation material shall be installed between the pipe and the copper plated hanger, support, clamp, etc. The separation material shall prohibit electrical conductance and prevent galvanic action or corrosion between dissimilar metals. Separation material shall be guaranteed for a minimum of thirty (30) years.

2.3 HANGER-ROD ATTACHMENTS

- A. General: Except as otherwise indicated, provide factory-fabricated hanger-rod attachments complying with MSS SP-58, selected by Installer to suit horizontal-piping hangers and building attachments, in accordance with MSS SP-69 and manufacturer's published product information. Use only one type by one manufacturer for each piping service. Select size of hanger-rod attachments to suit hanger rods. Provide copper-plated hanger-rod attachments for copper-piping systems. To avoid future electrolysis or corrosion, copper plated hangers, supports, clamps, rod attachments, and building attachments shall not be in direct contact with copper piping. A separation material shall be installed between the pipe and the copper plated hanger, support, clamp, etc. The separation material shall prohibit electrical conductance and prevent galvanic action or corrosion between dissimilar metals. Separation material shall be guaranteed for a minimum of thirty (30) years.

2.4 BUILDING ATTACHMENTS

- A. General: Except as otherwise indicated, provide factory-fabricated building attachments complying with MSS SP-58, selected by Installer to suit building substrate conditions, in accordance with MSS SP-69 and manufacturer's published product information. Select size of building attachments to suit hanger rods. Provide copper-plated building attachments for copper-piping systems. Provide copper-plated hangers and supports for copper-piping systems. To avoid future electrolysis or corrosion, copper plated hangers, supports, clamps, rod attachments, and building attachments shall not be in direct contact with copper piping. A separation material shall be installed between the pipe and the copper plated hanger, support, clamp, etc. The separation material shall prohibit electrical conductance and prevent galvanic action or corrosion between dissimilar metals. Separation material shall be guaranteed for a minimum of thirty (30) years.

2.5 SADDLES AND SHIELDS

- A. General: Except as otherwise indicated, provide saddles or shields under piping hangers and supports, factory-fabricated, for all insulated piping. Size saddles and shields for exact fit to mate with pipe insulation.

2.6 SPRING HANGERS AND SUPPORTS

- A. General: Except as otherwise indicated, provide factory-fabricated spring hangers and supports complying with MSS SP-58, selected by Installer to suit piping systems, in accordance with MSS SP-69 and manufacturer's published product information. Use only one type by one manufacturer for each piping service. Select spring hangers and supports to suit pipe size and loading.

2.7 MISCELLANEOUS MATERIALS

- A. Metal Framing: Provide products complying with NEMA STD ML 1.
- B. Steel Plates, Shapes and Bars: Provide products complying with ASTM A 36.

- C. Cement Grout: Portland cement (ASTM C 150, Type I or Type III) and clean uniformly graded, natural sand (ASTM C 404, Size No. 2).
- D. Heavy-Duty Steel Trapezes: Fabricate from steel shapes selected for loads required; weld steel in accordance with AWS standards.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Examine areas and conditions under which hangers and supports are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF BUILDING ATTACHMENTS

- A. Install attachments at required locations within concrete or steel for proper piping support. Space attachments within maximum piping span length indicated in MSS SP-69. Install additional building attachments where support is required for additional concentrated loads, including valves, flanges, guides, strainers, expansion joints, and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten insert securely to forms. Where concrete with compressive strength less than 2500 psi (17240 kPa) is indicated, install reinforcing bars through openings at top of inserts.

3.3 INSTALLATION OF HANGERS AND SUPPORTS

- A. General: Install hangers, supports, clamps and attachments to support piping properly from building structure; comply with MSS SP-69. Arrange for grouping of parallel runs of horizontal piping to be supported together on trapeze type hangers where possible. Install supports with maximum spacings complying with MSS SP-69. Where piping of various sizes is to be supported together by trapeze hangers, space hangers for smallest pipe size or install intermediate supports for smaller diameter pipe. Do not use wire or perforated metal to support piping, and do not support piping from other piping.
- B. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers and other accessories. Except as otherwise indicated for exposed continuous pipe runs, install hangers and supports of same type and style as installed for adjacent similar piping.
- C. Support fire-water piping independently of other piping.
- D. Prevent electrolysis in support of copper tubing by use of hangers and supports which are copper plated, or by other recognized industry methods.
- E. Provisions for Movement:
 - 1. Install hangers and supports to allow controlled movement of piping systems and to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends and similar units.

- F. Load Distribution: Install hangers and supports so that piping live and dead loading and stresses from movement will not be transmitted to connected equipment.
- G. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes, and so that maximum pipe deflections allowed by ANSI B31 Pressure Piping Codes are not exceeded.
- H. Insulated Piping: Comply with the following installation requirements.
 - 1. Clamps: Attach clamps, including spacers (if any), to piping with clamps projecting through insulation; do not exceed pipe stresses allowed by ANSI B31.
 - 2. Shields: Where low-compressive-strength insulation or vapor barriers are indicated on chilled water piping, install coated protective shields.
 - 3. Saddles: Where insulation without vapor barrier is indicated, install protection saddles.
 - 4. For all insulated piping 2-1/2" (63 mm) and larger, provide insulated saddles as follows:
 - a. For chilled water and condenser water, as well as heating water and low pressure steam (up to 250°F), provide the following:
 - 1) Minimum 3.5 pcf, non-compressive, rigid, phenolic foam insulation. Fire and smoke rating shall be 25/50 or below per ASTM 84.
 - 2) For cold applications below 75°F (24°C) a zero permeability abuse resistant vapor barrier shall be provided with matching butt strips. Apply a full coating of butyl joint sealant in addition to the butt strips for a completely sealed system.
 - 3) The phenolic foam system shall have a K factor of 0.16 at a mean temperature for 75°F (24°C) and comply with ASTM Standard C1126.
 - 4) Provide visible inspection sticker at the bottom of each saddle.
 - 5) Pipe insulation saddles shall be Tru-Balance CoolDry Saddles as manufactured by Buckaroos, Inc. or equivalent.
 - b. For medium and high pressure steam operating above 250°F, provide the following:
 - 1) Non-compressive, rigid calcium silicate insulation. Fire and smoke rating shall be 25/50 or below per ASTM E84.
 - 2) The calcium silicate insulation shall have a compression rating of 100 psi or higher and thermal conductivity K factor of 0.50 at a mean temperature of 300°F per ASTM Standard C533.
 - 3) The insulation shall be protected with an abuse resistant vapor/moisture barrier. Seal the longitudinal and butt joints with matching tape.

- 4) Secure the insulated saddle with metal banding on both sides. Provide visible inspection sticker at the bottom of each saddle.
 - 5) Pipe insulation saddles shall be Tru-Balance 1200E as manufactured by Buckaroos, Inc. or equivalent.
- I. Spacing: Hanger spacing for piping shall not exceed 8 feet (2400 mm) on centers for pipe 1-1/4" (32 mm) or smaller, and 10 feet (3 m) for pipe 1-1/2" (40 mm) and larger. Regardless of spacing, hangers shall be provided at or near all changes in direction, both vertical and horizontal, for all piping. For cast iron soil pipe, one hanger shall be placed at each hub or bell.

3.4 ADJUSTMENT OF HANGERS AND SUPPORTS

- A. Adjust hangers and supports and place grout as required under supports to bring piping to proper levels and elevations.

3.5 EQUIPMENT SUPPORTS

- A. Provide concrete housekeeping bases for all floor mounted equipment furnished as part of the work of Division-23. Size bases to extend minimum of 4" (100 mm) beyond equipment base in any direction; and 4" (100 mm) above finished floor elevation. Construct of reinforced concrete, roughen floor slab beneath base for bond, and provide steel rod anchors between floor and base. Locate anchor bolts using equipment manufacturer's templates. Chamfer top and edge corners.
- B. Provide structural steel stands to support equipment not floor mounted or hung from structure. Construct of structural steel members or steel pipe and fittings. Provide factory-fabricated tank saddles for tanks mounted on steel stands.

3.6 PAINTING

- A. All hangers, supports, clamps and assemblies shall be primed and painted with rust inhibitors.

END OF SECTION 23 05 29

SECTION 23 05 48 - VIBRATION ISOLATION FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

- A. Scope: The extent of vibration isolation work to be provided under this Contract is covered by the requirements of this Section, all other Division-23 sections and the Contract Drawings including structural, architectural, mechanical and electrical which identify equipment and systems requiring vibration isolation treatment.
- B. Types: Types of vibration isolation equipment and systems specified in this Section include:

<u>TYPE</u>	<u>DESCRIPTION</u>
1 Isolator	Ribbed Neoprene Pads
2I Isolator	Neoprene-In-Shear Type
2H Hanger	Rubber-In-Shear Type
3I Isolator	Open Spring Type
3H Hanger	Combination Spring and Neoprene Type
4 Isolator	Vertically Restrained Spring Isolators
5 Thrust	Restraints Spring Type Installed in Pairs

- C. Selection of Isolators: Provide isolators selected by a vibration isolator equipment specialist.
 - 1. Conform to isolator types herein specified.
 - 2. Examine the contract drawings for sizes, horsepower, rotational speeds, equipment location, length of span between columns and beams and construction type to determine the isolator selection type and deflection required for each piece of mechanical equipment.
 - 3. Conform to the requirements of the most current edition of American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) Handbook, "HVAC Applications", Sound and Vibration Control.

1.2 QUALITY ASSURANCE

- A. Codes: At a minimum, conform to the most current edition of ASHRAE Handbook, "HVAC Applications".

- B. Manufacturer: Isolators of the same type shall be the product of the same manufacturer. The manufacturer shall publish and maintain a full line of materials, engineering and application data and operating and maintenance instructions.

1.3 SUBMITTALS

- A. Contractor's Certification: Vibration isolator submittals shall include a certification, signed by an officer representing the Contractor and stipulating that the submittal prepared by the manufacturer has been reviewed, and checked on an item by item basis against each piece of mechanical equipment, shown or specified in the Contract Documents, which requires vibration isolation.
- B. Manufacturer's Certification: The manufacturer or manufacturers (if there are more than one) shall each certify that the selections of vibration isolation equipment are based upon the drawings and specifications, and that each piece of mechanical equipment has been examined for rotational speed, equipment type, mounting location, and supporting span between column centers, and that an appropriate isolator has been selected.
- C. Product Data: Furnish manufacturer's product data covering each isolator type for style, characteristic, and finish.
 - 1. Isolator quantities, dimensions, deflections, capacities and types shall remain the responsibility of the manufacturer and the Contractor.
- D. Shop Drawings: Where coordinated shop drawings are required, provide layout drawings, drawn to a scale of not less than 1/4-inch to 1-foot (6 mm to 300 mm), showing the proposed layout of equipment and piping systems and the location and type of each vibration isolation device.
 - 1. Carefully examine other sections requiring coordinated shop drawings and prepare isolation shop drawings to the same scale showing the location of each vibration isolation equipment base, pipe hanger, flexible connection, and isolator.

1.4 STORAGE AND PROTECTION

- A. Storage: Store vibration isolation equipment indoors in the manufacturer's original shipping containers. Preclude the entrance of construction dirt and debris.
 - 1. Vibration isolation equipment and bases, which show signs of rust, cement or concrete fouling, dirt and construction debris shall be disassembled and cleaned, approved or removed from the project site and replaced with new.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products which may be incorporated in the work include the following:

1. Mason
2. Vibration Eliminator Co.
3. Kinetics Noise Control

2.2 EQUIPMENT

- A. Dimensions: The schedule shows dimensions for deflection and sizes all in inches.
- B. Spans: Where referenced, the schedule shows spans of the longest bay dimension for slabs or beams supported between columns. Dimensions are in feet.
- C. Selection: Exact mounting sizes, dimensions and quantity of isolators and static deflection required shall be determined by the isolator manufacturer based upon equipment that will be furnished and installed by the Contractor under this Contract.
 1. Vibration isolation specialist shall coordinate his work with that of other trades to verify that equipment speeds, in revolutions per minute (rpm), are based upon actual equipment installed at the project site.
 2. Verify that equipment rpm and spring deflection selected are arranged so that resonance is avoided.

2.3 ISOLATOR TYPES

- A. Type 1 Isolators: Provide pad type vibration isolators consisting of either two layers of 3/8-inch (10 mm) thick elastomer, molded to contain a pattern with non-slip characteristics in all directions, and bonded to 16 gauge (1.6 mm) galvanized steel separator plates, or 1-inch (25 mm) thick precompressed molded fiberglass isolation pads. Minimum overall thickness shall be 1-inch (25 mm). Deflection shall be limited to 0.25 inches (6 mm) or less. Loading shall not exceed 40 pounds per square inch (280 kPa).
- B. Type 2I Isolators: Provide double rubber-in-shear or elastomer-in-shear with molded-in steel reinforcement in the top and bottom portions.
 1. Deflections shall be limited to 0.5 inches (13 mm) or less.
 2. Steel bases shall be drilled with mounting holes and equipment mounting points shall be threaded male or female connections.
 3. Treat resilient material with antiozone and antioxidant additives.
- C. Type 2H Hangers: Provide rubber-in-compression suspension hangers, consisting of a formed steel frame and elastomer isolation element and provided with attachments for top and bottom suspension rods.
 1. Design for a minimum 200 percent overload without noticeable deformation or failure.

2. Metal components shall be galvanized or factory painted.
- D. Type 3I Isolators: Provide adjustable, freestanding, open spring isolators with combination leveling and equipment fastening bases.
1. Spring elements shall be contained in upper and lower housing assemblies and shall have a minimum Kx-Ky of 0.75.
 2. Design springs for a minimum travel of 50 percent beyond the rated load.
 3. When fully compressed and "bottomed-out", isolators shall be capable of supporting a 150 percent overload without deformation and spring failure.
 4. A minimum 1/4-inch (6 mm) thick non-skid isolation pad shall be bonded to the underside of the base plate.
 5. Size base plates to limit floor loading to 100 pounds per square inch (690 kPa).
 6. Drill base plates for bolting, as required.
 7. Provide means for anchoring the top element of the isolator to rails and equipment.
- E. Type 3H Hangers: Provide combination spring and elastomer hangers consisting of a formed steel frame with coil spring and elastomer insert in compression.
1. Design hangers to be capable of supporting a 200 percent overload without noticeable deformation or failure.
 2. Design hangers to allow a 30 degree misalignment without binding or a reduction in hanger efficiency.
 3. Design hangers for connection to equipment and supporting rods.
- F. Type 4 Isolators: Provide vertically restrained, freestanding, laterally stable, open spring type isolators.
1. Design for deflection exceeding 1/2-inch (13 mm).
 2. Provide built-in bearing and leveling provisions.
 3. Provide a minimum 1/4-inch (6 mm) thick non-slip elastomer vibration absorbing pad bonded to the underside of the isolator base.
 4. Outside diameter of each spring shall be equal to or greater than 0.9 times the operating height of the spring under rated load.
 5. Provide vertical limit stops to prevent hyperextension due to wind loads or upward movement when the load is removed. Limit stops shall not bind or inhibit spring movement during normal operating ranges.
 6. For exterior applications, steel housings shall be hot dipped galvanized and springs shall be neoprene or powder coated.

- G. Type 5 Thrust Restraints: Provide spring isolators of an adjustable, freestanding type enclosed within tubular mountings and arranged to be installed in pairs across the discharge of fan flexible connectors.
 - 1. Design restraints to resist the thrust caused by duct internal air pressure.
 - 2. Install restraints on duct systems with an internal static pressure exceeding 3 inches water gauge (750 Pa).
 - 3. Restraints shall have the same deflection as isolators installed under the fans.

2.4 PIPING AND DUCTWORK

- A. General: All ductwork and piping in mechanical equipment rooms and within fifty feet (15 m) of the vibration source (i.e. mechanical equipment such as air handling units, chillers, pumps, cooling towers, air compressors, etc.) shall be isolated from the building structure with flexible vibration isolators. Air handling units with less than two inches (500 Pa) of external static pressure shall be excluded from this requirement.
 - 1. Suspend ductwork on Type 3H hangers.
 - 2. Suspend piping on Type 3H hangers.
 - 3. Floor-mounted ductwork and piping shall be supported with Type 4 spring isolators with deflections the same as the equipment to which the piping is attached.
- B. Reciprocating Equipment: Provide spring type hangers with deflections equal to that of reciprocating equipment, with piping arranged with offset elbows to absorb vibration.
- C. Risers: Pipe and duct risers within 100 feet (30 m) of mechanical equipment rooms shall be resiliently anchored to the building structure with Type 1 vibration isolators, near the midpoint of the risers.
 - 1. Risers shall be isolated and supported at each second floor with pairs of Type 3H hangers, having deflections a minimum of five times the anticipated thermal movement at the support point.
 - 2. Risers shall be guided as required with four (4) sets of Type 2I vibration isolators.
 - 3. Provide flexible neoprene or canvas connectors as specified in sheet metal ductwork at the connection point to all air moving equipment.
 - 4. Support ductwork with an internal pressure exceeding 3 inches (750 Pa) water with Type 3H hangers on maximum 10 foot (3 m) centers with deflections equal to the equipment isolators.

2.5 VIBRATION ISOLATION SYSTEM SELECTION

- A. General: The following selections of vibration isolation equipment systems shall be considered as a minimum. For the equipment below, the following code applies:

Letter (i.e. A, B, C) = Base type

Number (i.e. 1, 2, 3, 4) = Isolator type

Decimal number (i.e. 0.25, 1.5, etc.) = Minimum deflection

B. Air-Cooled Condensing Units:

20 FOOT (6 M) ROOF SPAN	30 FOOT (9 M) ROOF SPAN	40 FOOT (12 M) ROOF SPAN
A 2 0.25	A 2 0.35	A 2 0.5

C. Low-Pressure AHU Locations (To 3-Inch W.G.) (750 Pa):

TYPE EQUIPMENT	BASEMENT BELOW GRADE	20 FOOT (6M) FLOOR SPAN	30 FOOT (9 M) FLOOR SPAN	40 FOOT (12 M) FLOOR SPAN
Thru 10 hp (7.5 kW)	A 2 0.25	A 3 0.75	A 3 1.0	A 3 1.0
15 hp & over (11 kW & over) 250 to 500 rpm (26 to 52 Rad/s)	A 2 0.35	A 2 1.5	A 3 1.75	A 3 1.75
500 rpm (52 Rad/s)	A 2 0.35	A 3 1.0	A 3 1.5	A 3 1.75

Note: Where floor mounted air handling units are provided with internal vibration isolation for all vibration producing components, provide 3/4" neoprene pads.

D. Air Moving Device Locations:

Vibration isolation provisions apply to housed or unhoused freestanding fans of any pressure rating, located in field-erected central-station units or in unhoused return air or supply air service.

TYPE EQUIPMENT	BASEMENT BELOW GRADE	20 FOOT (6M) FLOOR SPAN	30 FOOT (9 M) FLOOR SPAN	40 FOOT (12 M) FLOOR SPAN
Up to 5 hp (Up to 3.7 kW)	A or B 2 0.25	B 3 1.0	B 3 1.0	B 3 1.5
5 thru 40 hp (3.7 thru	B 3 1.5	B 3 1.5	B 3 1.5	B 3 2.5

29.8 kW) 200 to 500 rpm (21 to 52 Rad/s)					
500 rpm (52 Rad/s) & over)	B or C 3 0.75	C 3 0.75	C 3 1.5	C 3 2.5	
Over 40 hp (Over 29.8 kW) 250 to 500 rpm (26 to 52 Rad/s)	B 3 0.75	C 2 1.5	C 3 2.5	C 3 2.5	
500 rpm and over (52 Rad/s and over	B 3 0.75	C 3 1.5	C 3 1.5	C 3 2.5	
Fan powered boxes and fan coil units	A 3 0.75	A 3 0.75	A 3 0.75	A 3 0.75	

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Manufacturer: All vibration isolation equipment shall be installed in accordance with the manufacturer's recommendations.
- B. Manufacturer's Representative: The vibration isolation installation and deflection testing after equipment start-up shall be conducted by a representative of the manufacturer.

3.2 TESTS AND REPORTS

- A. Testing: Each vibration isolation device shall be deflection tested. Two (2) copies of a bound report shall be submitted prior to final acceptance. The certification shall include the following:
 - 1. Certify that equipment has been isolated in accordance with Contract Drawings, specifications and submittals.
 - 2. Certify that all minimum specified deflections have been equaled or exceeded.

3.3 ANCHORING

- A. Installation: Installation shall comply with manufacturer's published recommendations and shall be installed so that isolators are plumb and are operating at a manner for which they were designed.
 - 1. Unless otherwise specified, all equipment shall be securely bolted to isolators, steel bases or concrete inertia bases.

2. Indoor vibration isolators need not be attached to the structure unless required by local codes.
3. Isolators installed outdoors shall be attached to building structure.

3.4 CLEANING

- A. Debris: Remove all debris from under equipment, and thoroughly clean steel bases, inertia bases and check for free movement.
- B. Adjustment: Adjust isolators as required for proper operation prior to starting equipment. Testing of vibration isolators shall be performed by a certified representative of the manufacturer as specified.

3.5 GENERAL

- A. All exterior structural steel and/or steel housings of exterior vibration isolation materials shall be hot dipped galvanized.

END OF SECTION 23 05 48

SECTION 23 05 53 - IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

- A. Extent of mechanical identification work required by this section is indicated on drawings and/or specified in other Division-23 sections.
- B. Types of identification devices specified in this section include the following:
 - 1. Pipe and Duct Markers
 - 2. Painted Identification Materials
 - 3. Underground-Type Plastic Line Marker
 - 4. Valve Tags
 - 5. Valve Schedule Frames
 - 6. Engraved Plastic-Laminate Signs
 - 7. Plastic Equipment Markers
 - 8. Plasticized Tags
- C. Refer to requirements of Division-26.

1.2 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Firms regularly engaged in manufacturer of identification devices of types and sizes required, whose products have been in satisfactory use in similar service for not less than five (5) years.
- B. Codes and Standards:
 - 1. ANSI Standards: Comply with ANSI A13.1 or Owner standards for lettering size, length of color field, colors, and viewing angles of identification devices.

1.3 SUBMITTALS

- A. Product Data: Submit manufacturer's technical product data and installation instructions for each identification material and device required.
- B. Schedules: Submit valve schedule for each piping system, typewritten and reproduced on 8-1/2" x 11" (213 mm x 275 mm) bond paper. Tabulate valve number, piping system, system abbreviation (as shown on tag), location of valve (room or space), and variations

for identification (if any). Mark valves which are intended for emergency shut-off and similar special uses, by special "flags", in margin of schedule. In addition to mounted copies, furnish extra copies for maintenance manuals.

- C. Maintenance Data: Include product data and schedules in maintenance manuals.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers' products which may be incorporated in the work include the following:

1. Brady
2. Seton
3. Bunting
4. Brimar

2.2 MECHANICAL IDENTIFICATION MATERIALS

- A. General: Provide manufacturer's standard products of categories and types required for each application as referenced in other Division-23 sections. Where more than single type is specified for application, selection is Installer's option but provide single selection for each product category.

2.3 PIPE AND DUCT MARKERS

- A. Snap-on Type: Provide pre-printed, semi-rigid, snap-on color coded identification sleeves complying with ANSI A13.1. This type shall be used for insulated pipe sizes 2" and smaller.
- B. Pressure Sensitive Type: Provide pre-printed, permanent adhesive, color coded, pressure sensitive, vinyl markers conforming to ANSI A13.1. This style marker shall be applied to all uninsulated piping; insulated piping 2-1/2" and larger, and all ductwork.
- C. Flow Direction: Provide flow directional arrows either as part of markers, or separately attached to pipes and ducts.

2.4 PAINTED IDENTIFICATION MATERIALS

- A. Piping and Equipment Systems: Continuous color coded painting of piping and equipment shall be provided in all mechanical rooms in compliance with ANSI A13.1.

2.5 VALVE TAGS

- A. Brass Valve Tags: Provide 19-gage (1.2 mm) polished brass valve tags with stamp-engraved piping system abbreviation in 1/4" (6 mm) high letters and sequenced valve numbers 1/2" (13 mm) high, and with 5/32" (4 mm) hole for fastener.
 - 1. Provide 1-1/2" (40 mm) diameter tags, except as otherwise indicated.
- B. Valve Tag Fasteners: Provide manufacturer's standard solid brass chain (wire link or beaded type), or solid brass S-hooks of the sizes required for proper attachment of tags to valves, and manufactured specifically for that purpose.

2.6 VALVE SCHEDULE FRAMES

- A. General: For each page of valve schedule, provide glazed display frame, with screws for removable mounting on masonry walls. Provide frames of finished hardwood or extruded aluminum, with lexan.
 - 1. Locate one schedule where directed. Provide second schedule to Owner framed in rigid plastic frame with rigid plastic glazing.

2.7 ENGRAVED PLASTIC-LAMINATE SIGNS

- A. General: Provide engraving stock melamine plastic laminate, complying with FS L-P-387, in the sizes and thicknesses indicated, engraved with engraver's standard letter style of the sizes and wording indicated, black with white core (letter color) except as otherwise indicated, punched for mechanical fastening except where adhesive mounting is necessary because of substrate.
 - 1. Thickness: 1/16" (1.6 mm) for units up to 20 sq. in. (12900 mm²) or 8" (200 mm) length; 1/8" for larger units.
- B. Fasteners: Self-tapping stainless steel screws, except contact-type permanent adhesive where screws cannot or should not penetrate the substrate.
- C. Duty: Accident-prevention tags with appropriate wording including large-size primary wording (as examples; DANGER, CAUTION, DO NOT OPERATE).

2.8 PLASTIC EQUIPMENT MARKERS

- A. General: Provide manufacturer's standard laminated plastic, color coded equipment markers.
- B. Nomenclature: Include the following, matching terminology on schedules as closely as possible:
 - 1. Name and schedule number

2. Equipment service

2.9 LETTERING AND GRAPHICS

- A. General: Coordinate names, abbreviations and other designations used in mechanical identification work with corresponding designations shown on plans. Provide numbers, lettering and wording as indicated or, if not otherwise indicated, as recommended by manufacturers or as required for proper identification and operation/maintenance of mechanical systems and equipment.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

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

3.2 DUCTWORK IDENTIFICATION

- A. General: Identify air supply, return, exhaust, intake and relief ductwork with pressure sensitive markers and arrows, showing ductwork service and direction of flow.
- B. Location: In each space where ductwork is exposed, or concealed only by removable ceiling system, locate signs near points where ductwork originates or continues into concealed enclosures (shaft, underground or similar concealment), and at 25 foot (7500 mm) spacings.
- C. Access Doors: Provide duct markers on each access door in ductwork and housings, indicating purpose of access (to what equipment) and other maintenance and operating instructions, and appropriate safety and procedural information.

3.3 PIPING SYSTEM IDENTIFICATION

- A. General: Install pipe markers on each system indicated to receive identification, and include arrows to show normal direction of flow.
- B. Locate pipe markers as follows wherever piping is exposed to view in occupied spaces, machine rooms, accessible maintenance spaces (shafts, tunnels, plenums) exterior non-concealed, locations, and concealed gas piping.
 1. Near each valve and control device.
 2. Near each branch, excluding short take-offs for fixtures and terminal units; mark each pipe at branch, where there could be question of flow pattern.

3. Near locations where pipes pass through walls or floors/ceilings, or enter non-accessible enclosures.
 4. At access doors, manholes and similar access points which permit view of concealed piping.
 5. Near major equipment items and other points of origination and termination.
 6. Spaced intermediately at maximum spacing of 25 feet (7500 mm) along each piping run.
- C. Gas Pipe: Paint exposed gas pipe throughout (except chromium plated).
- D.

3.4 VALVE IDENTIFICATION

- A. General: Provide valve tag on every valve, cock and control device in each piping system; exclude check valves, valves within factory fabricated equipment units, HVAC terminal devices and similar rough-in connections of end-use fixtures and units. List each tagged valve in valve schedule for each piping system.
1. Tagging Schedule: Comply with requirements of "Valve Schedule" of this section.

3.5 MECHANICAL EQUIPMENT IDENTIFICATION

- A. General: Install engraved plastic laminate sign on or near each major item of mechanical equipment and each operational device, as specified herein if not otherwise specified for each item or device. Provide signs for the following general categories of equipment and operational devices:
1. Main control and operating valves, including safety devices and hazardous units such as gas outlets.
 - 2.
 3. Fans and blowers.
 4. Packaged HVAC central-station and air handling units.
- B. Lettering Size: Minimum 1/4" (6 mm) lettering for name of unit where viewing distance is less than 2'- 0" (600 mm - 0 mm), 1/2" (13 mm) high for distances up to 6'- 0" (1800 mm - 0 mm), and proportionately larger lettering for greater distances. Provide secondary lettering 2/3 to 3/4 of size of principal lettering.
- C. Text of Signs: In addition to name of identified unit, provide lettering to distinguish between multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations.

3.6 ADJUSTING AND CLEANING

- A. Adjusting: Relocate any mechanical identification device which has become visually blocked by work of this division or other divisions.
- B. Cleaning: Clean face of identification devices, and glass frames of valve charts.

3.7 EXTRA STOCK

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

3.8 IDENTIFICATION SCHEDULE

SERVICE

DESIGNATION

Refrigeration Suction

SUCTION

Refrigeration Liquid

LIQ

END OF SECTION 23 05 53

SECTION 23 05 93 - TESTING, ADJUSTING AND BALANCING

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

- A. Extent of testing, adjusting, and balancing (TAB) work required by this section is indicated on drawings and schedules, and by requirements of this section, and is defined to include, but is not necessarily limited to, air distribution systems, hydronic distribution systems, and associated equipment and apparatus of mechanical work. The work consists of setting speed and volume (flow), adjusting facilities provided for systems, recording data, conducting tests, preparing and submitting reports to achieve the capacities or setpoints indicated on the contract documents, and recommending modifications to work as required to achieve the capacities or setpoints indicated on the contract documents.
- B. Component types of testing, adjusting, and balancing specified in this section shall include, but not be limited to, the following as applied to mechanical equipment:
 - 1. Building automated systems
 - 2. Fans
 - 3. Air handling units
 - 4. Ductwork systems
 - 5. Piping systems
 - 6. Terminal units
 - 7. Air devices
 - 8. Domestic hot water recirc pump and associated balance valves
- C. Refer to requirements of Division-26.

1.2 QUALITY ASSURANCE

- A. Tester's Qualifications: A firm certified by Associated Air Balance Council (AABC) who is not Installer of system to be tested.
 - 1. AABC Compliance: Comply with the current AABC's Manual "AABC National Standards", as applicable to mechanical air and hydronic distribution systems, and associated equipment and apparatus.
 - 2. Industry Standards: Comply with AABC recommendations pertaining to measurements, instruments, and testing, adjusting, and balancing, except as otherwise indicated.

3. ASHRAE Standard 111: Comply with current edition of ASHRAE 111, "Measurement, Testing, Adjusting and Balancing of HVAC Systems".
 4. Independence: TAB contractor shall be independently owned and operated with no affiliation with the general contractor, mechanical contractor, sheet metal contractor, design engineer, etc.
 5. Experience: Each technician shall demonstrate a minimum of three years of actual test and balance field experience.
- B. Pipe Testing Procedures: Contractor shall pressure test all piping systems in accordance with the following:
1. ASME Code for Pressure Piping B31, most current edition.
 2. National Fire Protection Association (NFPA), all applicable sections, most current edition.

1.3 SUBMITTALS

- A. Qualification: TAB contractor qualifications shall be provided as a formal submittal for review to demonstrate conformance with all qualifications indicated throughout the contract documents.
- B. Submit certified test reports, signed by the AABC Test and Balance technician who performed the TAB work. In addition, the report shall be certified by an AABC certified Test and Balance Engineer (T.B.E.) who is familiar with the project.
 1. Include identification and types of instruments used, and their most recent calibration date with submission of final test report.
- C. The Contractor shall maintain a copy of AABC standards on the site during all TAB work. Said document(s) shall be made available to Owner representatives for reference as to minimum requirements.
- D. Maintenance Data: Include in maintenance manuals, copies of certified test reports, identification of instruments.

1.4 JOB CONDITIONS

- A. Do not proceed with testing, adjusting, and balancing work until work has been completed, tested, operable, and all balancing devices indicated on the contract documents have been installed. Ensure that there is no residual work still to be completed on the equipment to be tested.
- B. Do not proceed until work scheduled for testing, adjusting, and balancing is clean and free from debris, dirt and discarded building materials.

PART 2 - PRODUCTS

2.1 PATCHING MATERIALS

- A. Except as otherwise indicated, use same products as used by original Installer for patching holes in insulation, ductwork and housings which have been cut or drilled for test purposes, including access for test instruments, attaching jigs, and similar purposes.
 - 1. Factory fabricated plastic plugs shall be used to patch drilled holes in ductwork and housings.

2.2 TEST INSTRUMENTS

- A. Utilize test instruments and equipment for TAB work required, of type, precision, and capacity as recommended in the following TAB standards:
 - 1. AABC's Manual "AABC National Standards".
 - 2. Wherever permanently installed measuring equipment is provided, such as air volume monitors, flow meters, temperature and pressure gages, etc., these shall be used in addition to TAB instrumentation. Any discrepancies in accuracy shall be brought to the attention of the Owner. Where permanently installed instrumentation meets accuracy requirements for TAB work, they may be used provided TAB Contractor can verify calibration of installed instruments.
- B. The Contractor shall employ manufactured enclosure type cones, capable of air volume direct readings, for all diffuser air flow measurements.

PART 3 - EXECUTION

3.1 FIELD WORK

- A. Prior to the mechanical installation, the mechanical and TAB contractors shall review the design documents for "balanceability" to confirm that all devices required to properly balance each system are to be provided under this contract. Recommended modifications and/or additions shall be made directly to the engineer and a minimum of 30 days prior to the installation of mechanical equipment.
- B. Examine installed work and conditions under which testing is to be done to ensure that work has been completed, cleaned, operable and accessible. Do not proceed with TAB work until unsatisfactory conditions have been corrected.
- C. Test, adjust and balance environmental systems and components, as indicated, in accordance with procedures outlined in applicable AABC standards. All systems and components shall be balanced within $\pm 5\%$ of design air and water flows.
- D. Test, adjust and balance system during summer season for cooling and during winter season for heating systems, including operation at outside conditions within 3°F (2°C) wet bulb temperature of maximum summer design condition, and within 10°F (6°C) dry

bulb temperature of minimum winter design condition. When seasonal operation does not permit measuring final temperatures, then take final temperature readings when seasonal operation does permit.

- E. For fan systems, provide sheave replacements where required to achieve specified air flows.
- F. Patch holes in insulation, ductwork and housings, which have been cut or drilled for test purposes, in manner recommended by original Installer.

3.2 REPORTS

- A. Prepare report of test results, including instrumentation calibration reports, in format recommended by AABC standards. Provide a System Summary page(s) at the front of the report.
- B. An interim/preliminary handwritten report shall be submitted to the Engineer for review prior to the formal submission of the report.
- C. Test reports shall include, but not be limited to, the following information:
 - 1. Air Handling Equipment Test:
 - a. Air handling equipment shall include, but not be limited to, all fans (supply, exhaust, return, relief, make-up, ventilation, etc.), air handling units, fan coil units, unit ventilators, VRF terminals, chilled beams. etc.).
 - b. Design Conditions: CFM, static pressure, motor h.p., outside air CFM (where applicable), fan and motor RPM and fan motor h.p. for each fan.
 - c. Installed Equipment: Manufacturer, size, arrangement, class, motor h.p., volts, phase, cycles, and full load amps.
 - d. Field Test Results: Fan CFM, fan RPM, fan motor voltage, fan motor operating amps, fan motor operating b.h.p., total static pressure for each fan. In addition, where applicable provide external static pressure, air pressure drop across each coil, filter bank, attenuator, etc. (ie. provide total static pressure profile of each system), as well as leaving air temperature, outside air conditions (dry bulb/wet bulb) at time of test, coil flow data (GPM), coil entering and leaving air temperatures, coil entering and leaving water temperatures, coil water pressure drop, VFD settings at final test conditions, and duct static pressure setpoint. Air temperature difference measurements will not be acceptable.
 - 2. Air Distribution Test: Main and major branch ducts and individual supply, return and exhaust terminals (VAV terminals, terminal reheat units, diffusers, registers and grilles):
 - a. Design Conditions: Ductwork: CFM, duct size. Air terminals, diffusers, registers, grilles: CFM, module size and inlet size.

- b. Field Test Results: Ductwork: CFM, duct size, number of velocity readings, average velocity reading. Air terminals, diffusers, registers, grilles: CFM, module size and inlet size.
- 3. Miscellaneous Test Results:
 - a. All Coils: Air pressure drop, water pressure drop, water flow (GPM), air flow (CFM), entering water temperature, leaving water temperature, entering air temperature, leaving air temperature and outside air temperature at time of test (where applicable) and BTU calculations. Air temperature difference methods will not be acceptable.
 - b. Air Flow Monitors (AFM): Provide verification of AFM accuracy including set-up and adjustment required to verify proper operation and accuracy of each AFM system.
 - c. Sound Readings: Provide ten (10) sound power level readings at locations to be selected by the Engineer.
 - d. Balance Valves: All balance valves (including hydronic and domestic water) shall be adjusted and balanced to include water flow (GPM) and pressure drop (where applicable). Indicate manufacturer/model of each valve type.

3.3 TESTS - PIPING

- A. Prior to the balancing of systems by the AABC certified balancing contractor, the mechanical contractor shall air and/or hydrostatically test the following systems in accordance with the latest ASME B31 (ASME Code for Pressure Piping) and NFPA requirements.
 - 1. Air Test:
 - a.
 - b. Refrigeration Liquid and Suction Line
- B. Pressure tests shall also be performed prior to the installation of all insulation materials.
- C. Air Test:
 - 1. Air, gas and vacuum piping shall be air tested at 200 psi (1380 kPa).
 - 2. Refrigerant piping shall be air tested at 550 psi (3800 kPa) as follows:
 - a. Pressure Test (Air Tight Test): Pressurize the suction gas pipe, high/low pressure gas pipe and liquid pipe with dry nitrogen to a minimum pressure as per the system manufacturer. Pressure test duration shall be a minimum of 24 hours. If the pressure does not drop within the 24 hour period, the system passes. If there is a drop in pressure, check for leaks, make repairs and re-test as prescribed above.
 - b. Evacuation Test (Vacuum Drying): Evacuate the system from the suction gas pipe, high/low pressure gas pipe and liquid pipe to a minimum vacuum

pressure as per the system manufacturer. Vacuum pressure shall be maintained in accordance with manufacturer's minimum duration recommended. If it rises, the system may either contain moisture or have leaks, if so, make repairs and re-test as prescribed above.

- c. Refer to the Refrigerant Leakage Test Summary Form at the end of this section to document test results. No other form will be acceptable. Submit results for all systems for review.
 - D. Repair or replace refrigerant piping as required to eliminate leaks, and retest as specified to demonstrate compliance.
 - E. Refer to Division-23 section "Testing, Adjusting and Balancing" for additional specific test criteria and test form to be completed.
 - F. Sanitary and Storm Water Piping Systems:
 - 1. All soil, waste, vent and storm water piping shall be tested by the Contractor and reviewed by the Architect before acceptance. All piping located underground shall be tested before backfilling. The costs of all equipment required for tests are to be included under the contract price.
 - 2. The entire new drainage system and venting system shall have all necessary openings plugged and filled with water to the level of the highest vent stack above the roof. The system shall hold this water for four (4) hours without showing a drop in water level. Where a portion of the system is to be tested, the test shall be conducted in the same manner as described for the entire system, except a vertical stack 10 feet (3000 mm) above the highest horizontal line to be tested may be installed and filled with water to maintain sufficient pressure, or a pump may be used to supply the required pressure.
 - G. Drain test water from piping systems after testing and repair work has been completed.
 - H. Repair piping systems sections which fail required piping test, by disassembly and re-installation, using new materials to extent required to overcome leakage. Do not use chemicals, stop-leak compounds, mastics, or other temporary repair methods.
 - I. Contractor shall submit piping leakage test results to the A/E within 72 hours of completed tests. Only test results that meet the specified leakage requirements shall be submitted. Piping test results shall be recorded on the "Piping Leakage Test Summary Form (Hydronic and Air)" and "Piping Leakage Test Summary Form (Plumbing)" located at the end of this section; no other forms will be accepted. In addition, the pipe leakage submittals shall include 11x17 drawing(s) as required to clearly indicate the full extent of the piping test section (each piping test section shall be numbered and color coded).
- 3.4 TESTS - DUCTWORK
- A. Prior to the balancing of systems by the AABC certified balancing contractor, all high and low pressure systems shall be tested by the mechanical contractor for duct leakage. Duct leakage shall not exceed 1%. In addition, current SMACNA and AABC Standards shall apply, where applicable, to meet the maximum 1% leakage. Duct leakage shall not exceed 1% of design cfm for a duration of ten (10) minutes. Test pressures shall be not less than the following:

Ductwork systems less than 2.0 in. wg E.S.P.:

(Duct Pressure Class 2): Test to 2 in. wg

- B. Insulation materials shall not be applied until systems have been witnessed, documented, and submitted to meet the above testing requirements.
- C. The balance contractor shall witness and certify all duct pressure tests.
- D. Contractor shall submit duct leakage test results to the A/E within 72 hours of completed tests. Only test results that meet the specified leakage requirements shall be submitted. Duct test results shall be recorded on the attached "Air Duct Leakage Test Summary Form" at the end of this section; no other forms will be accepted. In addition, the duct leakage submittals shall include 11x17 drawing(s) as required to clearly indicate the full extent of the duct test section (each duct test section shall be numbered and color coded).
- E. All duct leakage test results shall be included with the final TAB report and the O&M manual. The orifice tube calibration chart shall also be included with the final duct leakage test report information.

3.5 TESTS - EQUIPMENT

- A. The contractor shall verify calibration of all indicating, recording, controlling and controlled devices throughout the mechanical system. Verify the proper function of all installed equipment and devices and the interlocking of all new systems as required by the contract documents.
- B. A report including successful calibration and function performance verification of all items indicated above shall be included in the Operations and Maintenance Manual.

3.6 FUNCTIONAL PERFORMANCE TESTING AND VERIFICATION

- A. General: In addition to the tests required during and after installation of all mechanical systems, as well as any other formal commissioning requirements, the Contractor shall perform functional performance tests to verify that all systems are designed, installed, calibrated and adjusted to perform as required in the Contract.
- B. Comply with all applicable specification sections including, but not be limited to, "Basic HVAC Requirements", "Testing, Adjusting and Balancing", "Automatic Temperature Controls" and "Commissioning", where applicable.
- C. Prior to functional performance testing, all indicating, recording and control devices shall be calibrated. A verification calibration report shall be provided with the final test report.
- D. Provide functional performance testing to verify proper operation of each and every control sequence indicated throughout the contract documents.
- E. Failure of Tests: Should any test, verification, or demonstration fail to meet the specification requirements, the component of the system causing the failure shall be repaired, replaced or readjusted. The failed test, verification, or demonstration shall then be repeated.

- F. A "Functional Performance Test Verification Form" is included at the end of Section 230900. This form (electronic version is available upon request) shall be completed for all mechanical equipment provided under this contract. This shall include, but not be limited to each chiller, boiler, air handling unit, fan, pump, VAV terminal, fan coil unit, unit ventilator, DX cooling equipment, miscellaneous heating equipment, etc.
- G. Test Report: Upon satisfactory verification of calibration and functional performance tests, a copy of the final test results shall be bound in the operations and maintenance manual. The final report shall also include a full compliance statement, on company letterhead, indicating that all systems are installed and functioning per the contract requirements including drawings, specifications, control sequences and accepted submittals.
- H. The mechanical systems shall not be considered complete until all functional performance verification forms, calibration reports and compliance statement have been submitted and reviewed. Submit in accordance with the submittal requirements indicated elsewhere in these specifications.

3.7 FINAL TESTS, INSPECTION AND ACCEPTANCE

- A. At time of final inspection, Contractor shall recheck, in presence of Owner's Representative, random selections of data (water and air quantities, air motion, and sound levels) recorded in Certified Report. In addition, courtrooms, auditoriums, and conference rooms shall be rechecked. [Laboratories shall be rechecked for satisfactory air flow and motion in vicinity of and through hoods.]
 - 1. Points and areas for recheck shall be selected by Owner's Representative.
 - 2. Measurement and test procedures shall be same as approved for work forming basis of Certified Report.
 - 3. Selection for recheck (specific plus random), in general, will not exceed 25 percent of total number tabulated in report, except that special air systems may require a complete recheck for safety reasons.
- B. Retests: If random tests elicit a measured flow deviation of 10 percent or more from, or a sound level of 2 db or more, greater than that recorded in Certified Report listings, at 10 percent or more of the rechecked selections, report shall automatically be rejected. In the event the report is rejected, systems shall be readjusted and tested, new data recorded, new Certified Reports submitted, and new inspection tests made, at no additional cost to the Owner.
- C. Marking of Settings: Settings of valves, splitters, dampers, and other adjustment devices shall be permanently marked by the Contractor so that adjustment can be restored if disturbed at any time.

END OF SECTION 23 05 93

AIR DUCT LEAKAGE TEST SUMMARY FORM

Project Name: _____ Project Number: _____ Page ___ of ___

DESIGN DATA				FIELD TEST DATA RECORD										
Duct Section (No./Color)	Air System	Total System CFM	Test Section CFM	Allowable Leakage %	Allowable Leakage CFM	Diameter		Pressure (in. w.g.)		Actual Leakage CFM	Actual Leakage %	Test Result Pass/Fail	Test Performed By (initials)	Test Witnessed By (initials)
						Orifice	Tube	Duct(1)	Across Orifice					
				1.0%										
				1.0%										
				1.0%										
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Testing Performed By: _____
 (Company/Individual Name)

Witnessed/Certified By: _____
 (Company/Individual Name)

(1) Duct test pressure shall be 6.0 in. w.g. for High/Medium Pressure ductwork, or 2.0 in. w.g. for Low Pressure ductwork.

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PIPING LEAKAGE TEST SUMMARY FORM
(HYDRONIC AND AIR)

Project Name: _____ Project Number: _____ Page _____ of _____

System Tested	Sections Tested (1)	System Operating Pressure	Test Pressure (2)	Duration (3)	Pressure Drop (4)	Pass/Fail

Name of Testing Agency/Company: _____
 Date of Test(s): _____
 Test Conducted By (Print/Sign): _____

- (1) Identified by an 11 x 17 numbered and color coded test section plan. Plan shall accompany this test report.
- (2) 150% of operating pressure but not less than 100 psi (hydraulic), 200 psi (air, gas and vacuum) and 400 psi (refrigerant).
- (3) Four (4) hours minimum.
- (4) Shall not exceed 0.0%.

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PIPING LEAKAGE TEST SUMMARY FORM
(REFRIGERANT PRESSURE TEST)

Project Name: _____ Project Number: _____ Page _____ of _____

System/Unit Tested (1)	Test Location	Test Pressure (2)	Actual Test Pressure	Test Start		Test Completion		Pressure Drop (4)	Pass/Fail
				Time	Temperature	Pressure	Time		

Name of Testing Agency/Company: _____

Date of Test(s): _____

Test Conducted By (Print/Sign): _____

- (1) Equipment designation.
- (2) Per manufacturer's recommendation.
- (3) Twenty-four hours minimum from start to completion.
- (4) Shall not exceed 0.0%.

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PIPING LEAKAGE TEST SUMMARY FORM
(PLUMBING)

Project Name: _____ Project Number: _____ Page _____ of _____

System Tested	Sections Tested (1)	System Operating Pressure	Test Pressure (PSI/FT-HD) (2)	Duration (3)	Pressure Drop (4)	Pass/Fail

Name of Testing Agency/Company: _____

Date of Test(s): _____

Test Conducted By (Print/Sign): _____

- (1) Identified by an 11 x 17 numbered and color coded test section plan. Plan shall accompany this test report.
- (2) 150% of operating pressure but not less than 100 psi , 200 psi for air-gas-vacuum, 10 ft. static head pressure or to the maximum rating of the joint. Include joint cut sheets showing their ratings.
- (3) Four (4) hours minimum.
- (4) Shall not exceed 0.0%.

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SECTION 23 07 00 - HVAC INSULATION

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

- A. Extent of mechanical insulation required by this section is indicated on drawings and schedules, by requirements of this section, and all other Division-23 sections.
- B. Types of mechanical insulation specified in this section include the following:
 - 1. Piping System Insulation:
 - a. Fiberglass
 - b. Flexible Elastomeric
 - 2. Ductwork System Insulation:
 - a. Fiberglass
 - b. Flexible Elastomeric
 - c. Polyisocyanurate
 - 3. Equipment Insulation:
 - a. Fiberglass
 - b. Flexible Elastomeric

1.2 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of mechanical insulation products, of types and sizes required, 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 five (5) years successful installation experience on projects with mechanical insulations similar to that required for this project. Provide installer's certification by the manufacturer's training program where applicable.
- C. Flame/Smoke Ratings: Provide composite mechanical insulation (insulation, jackets, coverings, sealers, mastics and adhesives) with flame-spread index of 25 or less, and smoke-developed index of 50 or less, as tested by ASTM E 84 (NFPA 255) method.

1.3 SUBMITTALS

- A. Product Data: Submit manufacturer's technical product data and installation instructions for each type of mechanical insulation. Submit schedule showing manufacturer's product number, k-value, thickness, and furnished accessories, and intended use for each mechanical system requiring insulation.
- B. Maintenance Data: Submit maintenance data and replacement material lists for each type of mechanical insulation. Include this data and product data in maintenance manual.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Deliver insulation, coverings, cements, adhesives, and coatings to site in containers with manufacturer's stamp or label, affixed showing fire hazard indexes of products.
- B. Protect insulation against dirt, water, and chemical and mechanical damage. Do not install damaged or wet insulation; remove from project site.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products which may be incorporated in the work, shall be limited to the following:
 - 1. Owens Corning
 - 2. Johns Manville
 - 3. Certainteed
 - 4. Armacell
 - 5. Knauf
 - 6. Aeroflex

2.2 PIPE INSULATION MATERIALS

- A. Fiberglass Pipe Insulation: ASTM C 547, Type 1 (up to 850°F) (up to 454°C), maximum k-value of 0.23 BTU-in/hr-ft²-deg F at a mean temperature of 75°F.
- B. Flexible Elastomeric Pipe Insulation: ASTM C 534, Type I (-40°F to 200°F) (-40°C to 93°C), maximum k-value of 0.25 BTU-in/hr-ft²-deg F at a mean temperature of 75°F.
- C. Jackets for Piping Insulation: Jacket assembly shall be ASTM C 1136, Type I with vapor retarder (0.02 perms). All service jackets shall have a polymer coated exterior facing, shall resist water staining and shall not support mold or mildew growth. All service jackets shall be Owens Corning ASJ Max with SSLII closure system, or equivalent.

1. All fittings shall be provided with pre-molded insulation with equivalent thickness and composition of insulation applied to the adjoining piping. Encase pipe fittings insulation with one-piece premolded PVC fitting covers, fastened as per manufacturer's recommendations.
 2. Encase exterior piping insulation with 26 gauge embossed aluminum jacket with weather-proof construction.
- D. Bands, Wires and Cement: As recommended by insulation manufacturer for applications indicated.
- E. Adhesives, Sealer, and Protective Finishes: As recommended by insulation manufacturer for applications indicated.

2.3 DUCTWORK INSULATION MATERIALS (INDOOR)

- A. Rigid Fiberglass Ductwork Insulation: ASTM C 612-00, Type 1A (up to 450°F) (up to 232°C), minimum k-value of 0.27 BTU-in/hr-ft²-deg F at a mean temperature of 75°F (24°C).
- B. Flexible Fiberglass Ductwork Insulation: ASTM C 553, Type I, maximum k-value of 0.27 BTU-in/hr-ft²-deg F or minimum "out of package" R-value of 6.7 at a mean temperature of 75°F. For ductwork in ceiling space directly below roof, provide insulation with maximum k-value of 0.25 and minimum "out of package" R-value of 8.0 (1.5 LBS/FT³ density).
- C. Flexible Elastomeric Duct Wrap Insulation ASTM C 534, Type II, R-value of 8.0 at 2", (-40°C to 93°C).
- D. Ductwork Insulation Accessories: Provide bands, wires, tape, anchors, corner angles, and similar accessories as recommended by insulation manufacturer for applications indicated.
- E. Ductwork Insulation Compounds: Provide cements, adhesives, coatings, sealers, protective finishes and similar compounds as recommended by insulation manufacturer for applications indicated.

2.4 OUTDOOR DUCT INSULATION SYSTEM (PRE-MANUFACTURED)

- A. Pre-manufactured panel system shall consist of four (4) piece interlocking panels.
- B. The interlocking panels shall be constructed of Dow Thermax polyisocyanurate insulation, ASDTM D-1622, nominal 2 pcf; water vapor transmission permeance less than 0.03, per ASTM E-96; water absorption less than 0.3% (24 hours), per ASTM C-209; flexural strength more than 40 psi, per ASTM C-203
- C. Operating temperature range of -100°F to +250°F.
- D. Insulation shall be laminated in two (2) layers to provide an installed system value of R-16 at 2 inch thickness, per ASTM C-236/C-518.

- E. The insulation shall be clad with 0.032" thick embossed aluminum and sealed with vapor barrier compound. All joints shall interlock to ensure a thermal seal with no pass through seams.
- F. Panels shall be secured with #10 self-tapping stainless screws with weather seal washers.
- G. Manufacturer: Techna-Duc Insulation System as manufactured by P.T.M. Manufacturing, L.L.C., Newark, Delaware.

2.5 OUTDOOR DUCT INSULATION SYSTEM (FIELD INSTALLED)

- A. Field-installed insulation system shall consist of two inches of elastomeric foam insulation clad in 0.032 embossed aluminum weather barrier delivering an installed thermal value of R-8.
- B. The insulation material shall be elastomeric foam insulation, ASTM C-534, water vapor transmission permeance 0.08, per ASTM E-96, procedure A; water absorption 0.2% (24 hours), per ASTM C-209.
- C. Operating range of -100°F to +250°F.
- D. Insulation shall provide an installed value of R-8 at 2 inch thickness, per ASTM C-236/C-518. Insulation shall be fully adhered to the cleaned, oil free duct substrate utilizing an approved contact adhesive. All butt edge seams shall be likewise fully adhered.
- E. The insulation shall be clad with 0.032" thick embossed aluminum, either factory applied or field applied, and sealed with vapor barrier compound. All joints shall interlock to ensure a thermal seal with no pass through seams.
- F. Metal jacketing shall be secured with #10 self-tapping stainless screws or stainless steel pop rivets.
- G. Manufacturers: Armacell, K-Flex

2.6 EQUIPMENT INSULATION MATERIALS

- A. Rigid Fiberglass Equipment Insulation: ASTM C 612-00, Type 1A (up to 450°F) (up to 232°C).
- B. Flexible Elastomeric Cellular Sheet Insulation: ASTM C 534, Type 2, R-value of 8.0 at 2", (-40°F to 200°F) (-40°C to 93°C).
- C. Jacketing Material for Equipment Insulation: Provide 8 ounce (227 g) canvas or pre-sized glass cloth jacketing material, not less than 7.8 ounces per square yard (263 g/m²), or metal jacket at Installer's option, except as otherwise indicated.
- D. Equipment Insulation Compounds: Provide adhesives, cements, sealers, mastics and protective finishes as recommended by insulation manufacturer for applications indicated.

- E. Equipment Insulation Accessories: Provide bands, wire, wire netting, tape corner angles, anchors, stud pins as recommended by insulation manufacturer for applications indicated.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Examine areas and conditions under which mechanical insulation is to be installed. Do not proceed with work until unsatisfactory conditions have been corrected.
- B. Only install mechanical insulation on systems while not in operation.

3.2 HVAC PIPING SYSTEM INSULATION

- A. Insulation Omitted: Omit insulation on hot piping within radiation enclosures and air conditioning condensate piping in mechanical rooms and/or on roofs.
- B. Refrigerant Piping (0 Degrees F - 200 Degrees F) (-18 Degrees C –93 Degrees C):
 - 1. Application Requirements: Insulate the following HVAC piping systems:
 - a. All refrigerant piping (gas and liquid).
 - 2. Insulate piping system(s) specified above with the following type and thickness of insulation:
 - a. Flexible Elastomeric: 1" (25 mm) thick.
- C. Insulation of Piping Exposed to Weather: Protect outdoor insulation from weather by installing outdoor protective finish or jacketing as recommended by the manufacturer.

3.3 DUCTWORK SYSTEM INSULATION

- A. Insulation Omitted: Do not insulate fibrous glass ductwork, or lined ductwork located inside the building.
- B. Cold Ductwork:
 - 1. Application Requirements: Insulate the following cold ductwork:
 - a. Unconditioned outdoor air intake ductwork between air entrance and fan inlet or HVAC unit inlet.
 - b. HVAC supply air ductwork from air handling unit/fan discharge to diffuser or register, including all duct accessories (sound attenuators, etc.).
 - c. HVAC conditioned outside air ductwork connected to DOAS (dedicated outside air) system from unit discharge to diffuser or register.

- d. HVAC return ductwork located in ceiling directly adjacent to roof, including all duct accessories (sound attenuators, etc.).
 - e. HVAC exhaust ductwork located in ceiling directly adjacent to roof, connected to DOAS (dedicated outside air) system.
 - f. HVAC plenums and unit housings not preinsulated at factory or lined.
 - g. Insulate neck and bells of supply diffusers.
 - h. External portions of air terminal (VAV, TRU's) heating coils.
2. Insulate each ductwork system specified above with the following type and thickness of insulation:
- a. Flexible Fiberglass: 2" (50 mm) thick with R-value of 6.7 (provide 2" thick with minimum R-value of 8.0 for supply ductwork located in ceiling space directly below roof), application limited to concealed locations.
 - b. Rigid Fiberglass: 2" (50 mm) thick, application limited to ductwork exposed to view, including mechanical rooms.
- C. Hot Ductwork (Above Ambient Temperature):
- 1. Application Requirements: Insulate the following hot ductwork:
 - a. Hot supply and return ductwork between fan discharge, or heating unit discharge, and room diffuser/register; except omit insulation on return ductwork located in return air ceiling plenums.
 - b. Heating plenums and unit housings not pre-insulated at factory.
 - 2. Insulate each ductwork system specified above with the following type and thickness of insulation:
 - a. Flexible Fiberglass: 2" (50 mm) thick.
- D. Outdoor Ductwork:
- 1. Application Requirements: Insulate the following ductwork:
 - a. All outdoor ductwork (including lined or double wall lined ductwork).
 - 2. Insulate all outdoor ductwork in accordance with paragraph 2.4 or 2.5 of this section.
- 3.4 EQUIPMENT INSULATION
- A. Cold Equipment (Below Ambient Temperature):
- 1. Application Requirements: Insulate the following cold equipment:

- a. Drip pans under chilled equipment
2. Insulate each item of equipment specified above with the following type and thickness of insulation:
 - a. Flexible Elastomeric: 2" (50 mm) thick for surfaces above 35°F (2°C) and 3" (75 mm) thick for surfaces 35°F (2°C) and lower.
- B. Breeching, Stack, and Emergency Generator Insulation:
 1. Application Requirements: Insulate the following breechings and stacks:
 - a. Breechings between heating equipment outlet and stack or chimney connection, except for double wall or factory insulated breechings.
 - b. Stacks from bottom to top except for factory insulated stacks.
 - c. Emergency generator exhaust.
 2. Insulate each breeching, stack and generator exhaust specified above with one of the following types and thicknesses of insulation:
 - a. Rigid Fiberglass: 3-1/2" (89 mm) thick.

3.5 INSTALLATION OF PIPING INSULATION

- A. General: Install insulation products in accordance with manufacturer's written instructions, and in accordance with recognized industry practices to ensure that insulation serves its intended purpose.
 1. Insulation materials shall not be applied until systems have been witnessed, documented, and submitted to meet pressure testing requirements indicated throughout these specifications.
- B. Install insulation on pipe systems subsequent to installation of heat tracing, testing, and acceptance of tests.
- C. Install insulation materials with smooth and even surfaces. Insulate each continuous run of piping with full-length units of insulation, with single cut piece to complete run. Do not use cut pieces or scraps abutting each other.
- D. Clean and dry surfaces prior to insulating. Butt insulation joints firmly together to ensure complete and tight fit over surfaces to be covered.
- E. Maintain integrity of vapor-barrier jackets on pipe insulation, and protect to prevent puncture or other damage. Staples shall not be used.
- F. Cover valves, fittings and similar items in each piping system with equivalent thickness and composition of insulation as applied to adjoining pipe run. Provide factory molded insulation or pre-fabricated fittings for all valves, fittings, unions, etc. Valve handles must be extended by the mechanical contractor to accommodate the insulation without reducing the thickness or integrity of the valve insulation.

- G. All water test ports shall be accessible from the insulation. In addition, water flow measuring stations require access from insulation to verify sizes and model.
- H. Extend piping insulation without interruption through pipe hangers, walls, floors and similar piping penetrations, except where otherwise indicated.
- I. Butt pipe insulation against pipe hanger insulation inserts. For hot pipes, apply 3" (75 mm) wide vapor barrier tape or band over the butt joints. For cold piping apply wet coat of vapor barrier lap cement on butt joints and seal joints with 3" (75 mm) wide vapor barrier tape or band. If using pipe hangers, follow manufacturer's instructions for installation.
- J. All exposed pipe insulation, including fittings, above 8' - 0" (2400 mm - 0 mm) of finished floor shall have 8 oz. (227 g) fire retardant canvas cover neatly cut and parted seams shall be sealed.
- K. All exposed pipe insulation, including fittings, within 8' - 0" (2400 mm - 0 mm) of finished floor or within a stairwell, shall be provided with aluminum or PVC protective covers. All edges shall be hemmed and all seams shall be concealed.
- L. All exterior piping shall be provided with an embossed aluminum jacket.
- M. For all insulated piping 2-1/2" (63 mm) and larger, provide insulated saddles as follows:
 - 1. For chilled water and condenser water, as well as heating water and low pressure steam (up to 250°F), provide the following:
 - a. Minimum 3.5 pcf, non-compressive, rigid, phenolic foam insulation. Fire and smoke rating shall be 25/50 or below per ASTM 84.
 - b. For cold applications below 75°F (24°C) a zero permeability abuse resistant vapor barrier shall be provided with matching butt strips. Apply a full coating of butyl joint sealant in addition to the butt strips for a completely sealed system.
 - c. The phenolic foam system shall have a K factor of 0.16 at a mean temperature for 75°F (24°C) and comply with ASTM Standard C1126.
 - d. Provide visible inspection sticker at the bottom of each saddle.
 - e. Pipe insulation saddles shall be Tru-Balance CoolDry Saddles as manufactured by Buckaroos, Inc. or equivalent.
 - f. Armacell Armafix Pipe Hangers may be used for cold water piping with flexible elastomeric insulation.
 - 2. For medium and high pressure steam operating above 250°F, provide the following:
 - a. Non-compressive, rigid calcium silicate insulation. Fire and smoke rating shall be 25/50 or below per ASTM E84.

- b. The calcium silicate insulation shall have a compression rating of 100 psi or higher and thermal conductivity K factor of 0.50 at a mean temperature of 300°F per ASTM Standard C533.
- c. The insulation shall be protected with an abuse resistant vapor/moisture barrier. Seal the longitudinal and butt joints with matching tape.
- d. Secure the insulated saddle with metal banding on both sides. Provide visible inspection sticker at the bottom of each saddle.
- e. Pipe insulation saddles shall be Tru-Balance 1200E as manufactured by Buckaroos, Inc. or equivalent.

3.6 INSTALLATION OF DUCTWORK INSULATION

- A. General: Install insulation products in accordance with manufacturer's written instructions, and in accordance with recognized industry practices to ensure that insulation serves its intended purpose.
 - 1. Insulation materials shall not be applied until systems have been witnessed, documented, and submitted to meet pressure testing requirements indicated throughout these specifications.
 - 2. Install insulation materials with smooth and even surfaces.
 - 3. Clean and dry ductwork prior to insulating. Butt insulation joints firmly together to ensure complete and tight fit over surfaces to be covered.
 - 4. Maintain integrity of vapor-barrier on ductwork insulation, and protect it to prevent puncture and other damage. Seal all joints with vapor barrier material.
 - 5. Extend ductwork insulation without interruption through walls, floors and similar ductwork penetrations, except where otherwise indicated.
- B. Lined Ductwork: Except as otherwise indicated, omit insulation on ductwork where internal insulation or sound lining has been specified.
- C. Corner Angles: Except for oven and hood exhaust duct insulation, install corner angles on external corners of insulation on ductwork in exposed finished spaces before covering with jacketing.
- D. All balancing damper handles shall be exposed and visible on externally insulated ductwork.

3.7 INSTALLATION OF EQUIPMENT INSULATION

- A. General: Install equipment thermal insulation products in accordance with manufacturer's written instructions, and in compliance with recognized industry practices to ensure that insulation serves intended purpose.

1. Insulation materials shall not be applied until systems have been witnessed, documented, and submitted to meet pressure testing requirements indicated throughout these specifications.
 2. Install insulation materials with smooth and even surfaces and on clean and dry surfaces. Redo poorly fitted joints. Do not use mastic or joint sealer as filler for gaping joints and excessive voids resulting from poor workmanship.
 3. Maintain integrity of vapor-barrier on equipment insulation and protect it to prevent puncture and other damage.
 4. Do not apply insulation to equipment, breechings, or stacks while equipment is operating.
 5. Apply insulation using staggered joint method for both single and double layer construction, where feasible. Apply each layer of insulation separately.
 6. Coat insulated surfaces with layer of insulating cement, troweled in workmanlike manner, leaving smooth continuous surface. Fill in scored block, seams, chipped edges and depressions, and cover over wire netting and joints with cement of sufficient thickness to remove surface irregularities.
 7. If using fiberglass insulation, cover insulated surfaces with all-service jacketing neatly fitted and firmly secured. Lap seams at least 2" (50 mm). Apply over vapor barrier where applicable.
 8. Do not insulate boiler manholes, handholes, cleanouts, ASME stamp, and manufacturer's nameplate. Provide neatly beveled edge at interruptions of insulation.
 9. Provide removable insulation sections to cover parts of equipment which must be opened periodically for maintenance; include metal vessel covers, fasteners, flanges, frames and accessories.
- B. Equipment Exposed to Weather: Protect outdoor insulation from weather by installation of weather-barrier mastic protective finish, or jacketing, as recommended by manufacturer.

3.8 COORDINATION

- A. Coordinate size and location of supports, hangers, and insulation shields specified in Division-23 Section "Hangers and Supports for HVAC Piping and Equipment."
- B. Coordinate clearance requirements with piping Installer for piping insulation application, duct Installer for duct insulation application, and equipment Installer for equipment insulation application. Before preparing piping and ductwork Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

3.9 SCHEDULING

- A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.

3.10 EXISTING INSULATION REPAIR/REPLACEMENT

- A. Repair damaged sections of existing mechanical insulation, either previously damaged or damaged during this construction period. Insulation shall be as specified herein.
- B. Provide new insulation on existing mechanical piping where existing insulation has been removed due to damage, repair or abatement of existing hazardous materials.

3.11 PROTECTION AND REPLACEMENT

- A. Replace damaged insulation which cannot be repaired satisfactorily, including units with vapor barrier damage and moisture saturated units.
- B. Protection: Insulation Installer shall advise Contractor of required protection for insulation work during remainder of construction period, to avoid damage and deterioration.

END OF SECTION 23 07 00

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SECTION 23 0800 - COMMISSIONING OF HVAC SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. The Drawings and general provisions of the Contract, including the City of Baltimore Department of Public Works Specifications (the “Green Book”) and other Division 01 Specification Sections, apply to this Section.
- B. Section includes commissioning process requirements for HVAC systems, assemblies, and equipment. This section is intended to supplement and further detail the Commissioning requirements listed in Division 1.
- C. Related Sections:
 - 1. Section 019113 - "General Commissioning Requirements"
- D. All tasks listed in this section are assumed to be the responsibility of the GC and their Sub-contractors, unless explicitly stated otherwise.
- E. The following systems and/or equipment shall be commissioned:
 - 1. All HVAC equipment and systems
 - 2. Building Automation System

1.2 CONTRACTOR'S RESPONSIBILITIES

- A. The contractor’s responsibilities include but are not limited to the following:
 - 1. Perform commissioning tests at the direction of the Commissioning Agent (CA).
 - 2. Attend construction phase commissioning coordination meeting.
 - 3. Provide information requested by the CA for final commissioning documentation.
 - 4. Provide measuring instruments and logging devices to record test data, and provide data acquisition equipment to record data for the complete range of testing for the required test period.

1.3 COMMISSIONING DOCUMENTATION

- A. Documentation to be provided by the contractor includes, but is not limited to, the following:
 - 1. Factory testing reports
 - 2. Field testing reports
 - 3. Equipment and system startup reports
 - 4. Identification of installed systems, assemblies, equipment, and components including design changes that occurred during the construction phase.
 - 5. Test and inspection reports.

6. Corrective action documents.
7. Completed and signed pre-functional checklists
8. Completed TAB pencil copy and final reports, by system.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 TESTING PREPARATION

- A. Certify that HVAC systems, subsystems, and equipment have been installed, calibrated, and started and are operating according to the Contract Documents.
- B. Certify that HVAC instrumentation and control systems have been completed and calibrated, that they are operating according to the Contract Documents, and that pretest set points have been recorded.
- C. Certify that testing, adjusting, and balancing procedures have been completed and that testing, adjusting, and balancing reports have been submitted, discrepancies corrected, and corrective work approved.
- D. Set systems, subsystems, and equipment into operating mode to be tested (e.g., normal shutdown, normal auto position, normal manual position, unoccupied cycle, emergency power, and alarm conditions).
- E. Inspect and verify the position of each device and interlock identified on checklists.
- F. Testing Instrumentation: Install measuring instruments and logging devices to record test data as directed by the CA.

3.2 TESTING AND BALANCING VERIFICATION

- A. Notify the CA at least 3 days in advance of testing and balancing Work, and provide access for the CA to witness testing and balancing Work.
- B. Provide technicians, instrumentation, and tools to verify testing and balancing of HVAC systems at the direction of the CA.
 1. The CA will notify testing and balancing Subcontractor 3 days in advance of the date of field verification. Notice will not include data points to be verified.
 2. The testing and balancing Subcontractor shall use the same instruments (by model and serial number) that were used when original data were collected.
 3. Failure of an item includes a deviation of more than the allowable tolerance specified in the "Test and Balance" Specification Section, or 10%, whichever is more stringent. Failure of more than 10 percent of selected items shall result in rejection of final testing, adjusting, and balancing report.
 4. Remedy the deficiency and notify the CA so verification of failed portions can be performed.

3.3 GENERAL TESTING REQUIREMENTS

- A. Provide technicians, instrumentation, and tools to perform commissioning test at the direction of the CA.
- B. Scope of HVAC&R testing shall include the conditioned common areas and living spaces for this project. Testing shall include measuring capacities and effectiveness of operational and control functions.
- C. Test all operating modes, interlocks, control responses, and verify proper response of building automation system controllers and sensors.
- D. The CA along with the HVAC Subcontractor, testing and balancing Subcontractor, and HVAC Instrumentation and Control Subcontractor shall prepare detailed testing plans, procedures, and checklists for HVAC systems, subsystems, and equipment.
- E. Simulated conditions may need to be imposed using an artificial load when it is not practical to test under design conditions. Provide equipment to simulate loads. Set simulated conditions as directed by the CA and document simulated conditions and methods of simulation. After tests, return settings to normal operating conditions.
- F. The CA may direct that set points be altered when simulating conditions is not practical.
- G. The CA may direct that sensor values be altered with a signal generator when design or simulating conditions and altering set points are not practical.
- H. If tests cannot be completed because of a deficiency outside the scope of the HVAC system, document the deficiency and report it to the Owner. After deficiencies are resolved, reschedule tests.
- I. If the testing plan indicates specific seasonal testing, complete appropriate initial performance tests and documentation and schedule seasonal tests.

3.4 HVAC SYSTEMS, SUBSYSTEMS, AND EQUIPMENT TESTING PROCEDURES

- A. HVAC Instrumentation and Control System Testing: Field testing plans and testing requirements are specified on the mechanical drawings. Assist the CxA with preparation of testing plans.
- B. The commissioning plan lists the specific equipment to be commissioned.

END OF SECTION 230800

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SECTION 23 09 00 - AUTOMATIC CONTROL SYSTEMS (ELECTRIC-ELECTRONIC)

PART 1 - GENERAL

1.1 SUMMARY

- A. Scope: The extent of automatic controls work is indicated on the drawings and schedules and by the requirements of this Section, and all other Division-23 sections. The work includes, but is not limited to the following:
1. The provision of a complete and operational control system, including all devices necessary to perform the functions herein described or indicated on the drawings.
 2. The provision of 120 and 208 volt line voltage and 5 and 24 volt low voltage wiring and conduit types shall be installed in accordance with Division-26 of these specifications.
 3. The ATC contractor shall furnish and install all electrical wiring and conduit from power source, including termination, to all required ATC related power connections including, but not limited to, DDC controllers (provide low voltage controllers for air terminal units including transformers and disconnect switches as required), sensors, valve and damper actuators (including smoke dampers), air flow monitors, ATC panels, etc. The ATC contractor shall obtain a separate electrical permit as required by the local authority. The ATC contractor shall be wholly responsible for all power requirements necessary for a complete installation from the power source to all ATC related connections. All electrical work shall be installed in accordance with Division-26 of these specifications.
 4. The ATC contractor shall interface with fire alarm devices as required to accomplish equipment shutdown, alarms, etc. indicated in sequences.
 5. The ATC contractor shall coordinate and verify that all controllers, devices, and accessories are provided as required to accomplish all control functions and sequences indicated in the contract documents. Where control related devices are not provided by an equipment manufacturer, it shall be the responsibility of the ATC contractor to provide the control devices required to accomplish the functions and sequences indicated.
 6. All drilling, cutting and patching associated with the installation of control systems.
- B. Types: Provide automatic control systems of the following types:
1. Direct Digital Control (DDC) with electric actuation of valve and damper actuators.
 2. The automatic temperature control system shall include remote interface and web access capability. All building management system control features including, but not limited to, points, alarms, scheduling, graphics, trending, etc. shall be available for control and monitoring through web

access as well as remote interface (coordinate exact location with the using agency, where applicable).

1.2 QUALITY ASSURANCE

- A. Systems Engineering: The systems engineering phase shall include the selection and integration of components into a complete system which will meet the performance and prescriptive requirements of the Contract, together with drawings, specifications, descriptions of operation, diagrams and other materials listed under "Submittals" paragraph of this Section.
- B. Testing and Adjusting During and After Installation:
 - 1. The testing and adjusting includes the submission of a test plan which shall describe in detail the method by which each component, subsystem, and system will be tested, calibrated, adjusted, and retested after installation in accordance with the specified sequences of operation and other characteristics of the control system. A report on test results, including set points and operating ranges of all components shall be submitted.
 - 2. The testing specified in this paragraph shall not replace the testing specified in "Commissioning Tests and Verification" article of this Section.
- C. Commissioning Testing and Verifications: The final phase of the quality assurance program of the project is the commissioning testing and verifications. This phase is to assure that the project is fully completed and that the systems are performing in accordance to specifications from end to end of the control systems. Demonstrations of the automatic control systems to the commissioning team in accordance to the requirements specified in Part 3 of this Section are required. A report on test results, including set points and operating ranges of all components, shall be submitted.
- D. Testing: The testing phase of quality assurance includes the submission of a test plan which shall describe in detail the method by which each component, subsystem, and system will be tested, calibrated and retested after installation to perform in accordance with the specified sequences of operation and other characteristics of the control system.
- E. Reporting and Demonstration: This phase shall include the submission of a written report describing the "actions taken during the testing" phase, and including the set points and operating ranges of all equipment and a demonstration that the system performs in accordance with contract requirements.
- F. Operating Instructions and Training: This phase of quality assurance includes the training of operating personnel utilizing written operating instructions prepared and approved under the "Submittals" paragraph of this Section, and the mounting of laminated control diagrams where directed.
- G. Maintenance Manuals: This phase includes the submission of four hard bound copies of all manufacturers' cuts, maintenance and operating instructions, test reports and demonstration material, copies of control diagrams, and copies of the manufacturers' certifications.

1.3 SUBMITTALS

- A. Shop Drawings: For each system to be controlled, prepare a drawing which includes a system flow diagram, control diagram, sequence of operation and schedule of components. Control diagrams shall be complete with end-to-end connections of piping and wiring from component terminal.
- B. Manufacturer's Data: For each manufactured device or subsystem submit manufacturers' specifications and printed photograph of the proposed device or subsystem. Include engineering descriptions, principle of operation and application, and proposed model, style or size clearly indicated.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. The automatic temperature controls shall be furnished, installed, commissioned and warranted by one of the following acceptable providers:
 - 1. Johnson Controls, Inc.
 - 2. Siemens Building Technologies
 - 3. Honeywell
 - 4. Trane
- B. No distributors, wholesalers or manufacturers' representatives other than those listed above will be acceptable. In addition, manufacturers not listed above will not be acceptable.

2.2 SYSTEMS INTEGRATION

- A. Control Loop Characteristics: Carefully evaluate the characteristics of each control loop, the time constants, equipment characteristics, control accuracy, and reliability and provide a system which will operate smoothly, without hunting, and within the accuracies specified.
- B. System Components: Select components including sensors, transmitters, controllers, control devices, actuators, and instrumentation considering such factors as hysteresis, relaxation time, span, limits, and response time.

2.3 CONTROLLERS

- A. General: Provide electric or electronic controllers for each local control loop.
 - 1. Provide controllers with local adjustable setpoint, adjustable proportional band for analog controllers or adjustable differential for two position controllers.
 - 2. Provide adjustable secondary input authority for dual input controllers with remote setpoint adjustment.
 - 3. Provide integral or test connections for measuring input and output signal.

- B. Electric/Electronic System Characteristics: Provide a system of control which shall have all of the following system characteristics. Systems which do not conform to all of the following requirements will not be acceptable.
1. The system shall consist of multiple, field adjustable controllers. The controller, power supplies, input/output and other components specified, including metal cabinet will be referred to as a "Field Panel."
 2. The field panel shall be capable of performing its assigned local loop control and other functions as a standalone unit. It shall perform all specified local loop control functions without interaction to other field panels, except for shared functions such as central time programs, heating-cooling changeover, etc.
 3. The field panel shall utilize control algorithms that permit proportional, integral, and derivative control as required. Control algorithms shall permit one, two or three mode control as specified or indicated on the drawings.
 4. Each field panel shall be capable of handling multiple control loops, with one or more controllers.
 5. The system shall utilize industry standard sensors.
 6. The field panel shall provide both analog and binary output control. Analog outputs shall be compatible with industry standard transducers. Provide a modulating analog output control signal. Binary output control commands shall be implemented through interposing control relays.
 7. Field panels shall be of modular construction. The system shall utilize interchangeable components. The modular construction of the system shall permit quick repair, ease of expansion, and the use of standard controls.
 8. Each field panel with sensors and controlled devices shall be capable of automatic, unattended restart in the event of electrical power failure. In the event of electrical power failure all controlled devices shall move to their predetermined "normal" positions. By normal, it is meant that spring-close valves shall close, spring-open devices shall open, spring return devices will return and magnetically held devices will move to the position dictated by the force of gravity. Upon the restoration of electrical power, the field panel shall automatically restart and provide control to its connected systems after power failures of up to 72 hours.
 9. The field panel operating system shall reside in nonvolatile memory.
 10. Site specific application data, setpoints and operator entered data shall be stored in volatile memory.
 11. Nonvolatile memory shall include PROM, EPROM, EAROM, ROM and RAM.
 12. The preceding terms describe a class of solid state semi-conductor memories manufactured with LSI (large-scale-integration) techniques. These terms are expanded as follows:

- a. PROM - Programmable Read Only Memory
 - b. EPROM - Erasable PROM
 - c. EAROM - Electrically Alterable ROM
 - d. ROM - Read Only Memory
 - e. RAM - Random Access Memory
- C. Field Panels: Provide field panels as follows.
1. Each field panel shall consist of a controller, power supplies, input/output modules, and other components specified.
 2. Provide field panels where indicated. Provide additional controllers, if required, to support the control loops specified, the sequence of operations, number of monitoring points or other criteria to permit the field panel capacity to meet the specified functional requirements of the project.
 3. Each field panel shall be capable of operation as a completely independent unit.
 4. Each field panel or controller shall include its own operator's keypad or other means of adjustment on site by the operator.
 5. Each field panel shall receive signals from industry standard sensors and input devices. Each panel shall have the capability to monitor the following types of inputs:
 - a. Analog inputs: 4 to 20 mA and 0 to 10 V DC.
 - b. Binary inputs: Dry contact closure and pulse accumulator.
 - c. Provide transducers and/or signal conditioning to adapt other sensor types.
 - d. Field panels that permit the direct connection of resistance type sensors will be acceptable if the system accuracy, data resolution, value accuracy and sensor interchangeability, comply with all other requirements of the specification.
 6. The field panel shall directly control actuators and control devices. Each field panel shall be able to provide the following control outputs:
 - a. Binary outputs: Contact closure
 - b. Analog outputs: 4 to 20 mA, 0 to 10 V DC and 0 to 135 OHM.
 - c. Systems that do not provide direct analog outputs will be acceptable providing that they generate the specified output signal through transducers.

7. Each field panel shall perform control functions and other routines, specified under Sequences of Operation.
 8. Each field panel shall accept binary inputs, on-off, open-close, or other two state data. Provide isolation and protection against input voltage up to 180 VAC peak.
 9. Each field panel shall provide Binary Output by contact closures for momentary and maintained operation of field devices. Provide electromagnetic interference suppression on all output lines to limit transients to non-damaging levels. Provide isolation and protection against voltage up to 180 VAC peak. Provide contacts rated for 2 A at 24 VAC.
 10. Each field panel shall be enclosed in a metal cabinet. The cabinet shall be constructed of 16 US gauge sheet steel, Provide sufficient access for wire and conduit to enter the cabinet. The cabinet shall have a hinge door and a pin tumbler lock. All field panel locks for the project shall be keyed alike. The cabinet shall be shipped to the project for installation without electronics. The electronics shall be added at the time of wire termination and system commissioning. All control wiring and system communications shall be electrically terminated inside the field panel.
 11. Provide a 15A duplex receptacle inside or immediately adjacent to the field panel. The receptacle shall be energized when power is disconnected from the field panel.
 12. Ground the field panel and power supply with a minimum No. 12 THHN unbroken ground wire to the building earth ground system. There shall be a maximum of 5 ohms measured between the ground at the field panel and the building ground system.
 13. Provide a master electrical power disconnect switch inside the field panel to disconnect all external power to the cabinet for maintenance and repair. The disconnect switch shall not affect the duplex receptacle hereinbefore specified.
 14. Provide screw type terminal strips in the field panel for the termination of all field wiring. Lay out terminal strips in a neat and orderly fashion and label each termination. All wiring entering the panel shall be routed through the panel wireways in a neat and workmanlike manner, properly tied or laced and terminated.
 15. Provide conduit and wire to connect the field panel to the nearest adequate source of emergency electric power.
- D. Wire/Cable Labeling: Label wire and cable as follows.
1. Label each cable and each conductor within 6 inches (150 mm) of the termination point. Cable and wire identification shall match the wiring identification shown on the installation and record drawings.

2. Wire identification labels shall be securely affixed to the wire and shall be of the preprinted type providing a durable vinyl or plastic covering over the printed lettering.
 3. Wire identification through color coding, embossed label tape, paper tags attached with string and handwritten labeling will not be acceptable.
- E. Transient Protection: Provide transient protection as required by the manufacturer.
- F. System Accuracy: Provide system accuracy in accordance with the following.
1. Each local system shall maintain end-to-end accuracy for one year from sensor to controlled device for the applications specified.
 2. Space temperature with a range of 50°F to 85°F (10°C to 29°C) plus or minus 0.75°F (.4°C) for conditioned space; 30°F to 130°F (-1°C to 54°C) plus or minus 1.0°F (.6°C) for unconditioned space.
 3. Duct temperature with a range of 40°F to 140°F (4°C to 60°C) plus or minus 1.0°F (.6°C).
 4. Outside air (OA) temperature with a range of minus 30°F to plus 130°F (minus -1°C to plus 54°C) plus or minus 2.0°F; with a subrange of plus 30°F to plus 100°F (plus -1°C to plus 38°C) plus or minus 1.0°F (.6°C).
 5. Water temperature with a range of 33°F to 100°F (1°C to 38°C) plus or minus 0.75°F (.4°C); the range of 100°F to 250°F (38°C to 121°C) plus or minus 2.0°F (1.2°C); and water temperatures for the purpose of performing BTU calculations using differential temperatures to plus or minus 0.5°F (.3°C) using matched sensors.
 6. High temperature water with a range of 0°F to 500°F (-18°C to 260°C) plus or minus 3.0°F (1.6°C).
 7. Pressure with a range for the specific application plus or minus 2.0 percent of range.
 8. Flow with a range for the specific application plus or minus 3.0 percent of range, and flows for the purpose of BTU calculations to plus or minus 2.0 percent of range.
- G. Accuracy and Stability: Equipment shall be selected for the appropriate range of the application. Equipment selected with ranges in excess of the application will be replaced at the Contractor's expense.

2.4 SENSORS

- A. General: Provide analog sensors for temperature controllers. Provide sensors with an output signal that varies continuously with the sensed temperature, within a specified range, of the thermistor or resistance type.
- B. Manufacturer: Temperature sensors shall be made by one manufacturer.

- C. Space Sensors: Provide space or room sensors with base plates thru-bolted into masonry or wall studs, brushed cast aluminum or 16 gauge (1.6 mm) ground and polished Type 316 stainless steel covers.
- D. Insertion Type: Stem or extended surface sensitive type with screw mounting plate and galvanized sheet steel insulation mounting box.
- E. Immersion Type: Stem or tip sensitive type with threaded immersion well base.
- F. Sensing Elements: Hermetically seal, except for bimetal type for room thermostats. Stem, tip or extended element shall be Type 304 stainless steel or annealed copper.
- G. Casing: Casing shall be constructed of watertight, vibration-proof, heat resistant high strength phenolic or 316 stainless steel.
- H. Sensor Wells: Provide 304 stainless steel, bronze, copper or monel machined wells, compatible with the immersion medium, and heat sensitive transfer material or liquid between sensor and well surface.

2.5 ELECTRONIC ANALOG SENSORS

- A. Range: Sensors shall operate within the range of minus 30°F to plus 220°F (minus -34°C to plus 104°C) for heating, ventilating and air conditioning (HVAC) systems.
- B. High Temperature Sensors: For high temperature water applications provide sensors with a range of 0°F to 500°F (-18°C to 260°C).
- C. Accuracy: Provide electronic analog sensors with an accuracy of plus or minus 0.25°F (.14°C).
- D. Time Constant Response: Provide sensors with a time constant response to achieve 60 percent of a step temperature change in six (6) seconds in air or water flowing at 3 feet per second (.9 m/s).
- E. Interchangeability: Sensors of the same type shall be interchangeable without calibration.

2.6 PRESSURE SENSORS

- A. Overpressure Protection: Provide pressure sensors impervious to instantaneous pressure changes of 150 percent of working pressure but not less than plus or minus 50 psig (340 kPa).
- B. Adjustment: Provide sensors with external adjustable span, adjustable zero and pulsation suppression.
- C. Finished Spaces: Conceal pressure sensors in recessed stainless steel housing with removable perforated brushed stainless steel cover.
- D. Sensor Characteristics: Provide pressure sensors with the following characteristics:
 - 1. Ambient Temperature: 40°F to 140°F (4°C to 60°C).

2. Isolation Valves: Provide pressure sensors with stainless steel needle isolation valves between each sensor and sensor pressure source. Provide differential pressure sensors with 3-valve manifold for isolation and nulling.
3. Siphon: On steam systems provide pressure sensors with a pigtail siphon between the sensor isolation valve and sensor. Provide condensate wells and blowdown valves for differential pressure sensors.
4. Provide switching type sensors with platinum alloy, silver alloy or gold plated wiping contacts rated for the application, voltage and power levels.
5. Provide valved calibration taps adjacent to each pressure sensor for calibration.

2.7 STATIC PRESSURE ANALOG SENSORS

- A. Types: Provide diaphragm sensors with solid state pre-amplifier electronic systems.
- B. Characteristics: Provide analog sensors with the following characteristics:
 1. Sensor span shall be not less than 150 percent and not more than 300 percent of the working pressure.
 2. Accuracy shall be 0.5 percent of calibrated span including combined effects of linearity, hysteresis and repeatability.

2.8 DIFFERENTIAL PRESSURE ANALOG SENSORS

- A. Types: Provide differential pressure analog sensors of the solid state pre-amplifier types for electronic systems.
- B. Characteristics: Provide sensors with the following characteristics:
 1. Sensor span not less than 150 percent nor more than 300 percent of the working differential pressure.
 2. Accuracy of 0.5 percent of calibrated span, including combined effects of linearity, hysteresis and repeatability.
 3. Pressure sensor shall withstand overpressure of not less than 200 percent working pressure and full vacuum underpressure without damage, changes in sensor accuracy or deformation.

2.9 DEW POINT AND RELATIVE HUMIDITY SENSORS

- A. Dew Point Sensors: Provide analog salt-phase transition or dual cooled mirror type sensors with an accuracy of plus or minus 3°F (1.6°C) dew point over the range of 10°F to 100°F (-12°C to 38°C) dew point.
- B. Relative Humidity Sensors: Provide analog precision resistance or hydro-mechanical gauge type relative humidity sensors, with an accuracy of plus

or minus 2 percent of relative humidity over a range of 10 to 90 percent relative humidity.

- C. Shields: Provide 316 stainless steel weatherhoods and shields to protect outdoor sensors from sunlight, snow, ice, wind and rain and provide fan powered aspirator complete with wiring if recommended by the manufacturer.
- D. Indoor Covers: Sensors located in public spaces shall have brushed 16 gauge (1.6 mm) 316 stainless steel covers or recessed aspirating boxes with Allen head screw mounting plate.

2.10 THERMOSTATS

- A. Types: Provide electronic thermostats which operate in an analog proportional or binary two-position mode as required by the sequence of operation.
- B. Mounting: Mount thermostats in non-public spaces except room thermostats.
- C. Electric Analog Thermostats: Provide electric analog thermostat with the following characteristics:
 - 1. Sensor shall be of the bulb or capillary type which shall actuate a 135 ohm 3-wire potentiometer for 0-10 VDC, or 4-20 milliamp proportioning control action of balanced bridge motor actuators.
 - 2. Sensor shall have adjustable setpoint range of not less than 80°F (27°C) throughout the range of 0°F to plus 250°F (-18°C to plus 121°C).
 - 3. Adjustable proportional band ranges from 3°F to 25°F (-16°C to -4°C) and capillary length of not less than 5 feet (1500 mm) shall be provided.
- D. Electric Two Position Duct and Immersion Thermostats: Provide thermostats with bimetal or bulb and capillary type sensor actuating one or more switching contacts.
 - 1. Contact shall be rated for the imposed load or shall be a pilot duty type and provided with a control relay.
 - 2. Thermostats shall have adjustable setpoint throughout the range 0°F to plus 250°F (-18°C to plus 124°C).
 - 3. Differential shall be adjustable from 3°F to 10°F (-16°C to -12°C) for each contact for refrigeration, boiler and industrial applications.
 - 4. Fixed differential thermostats with differentials of 3 may be provided for On-Off control of unit heaters, ventilating fans and similar applications.
 - 5. Provide capillary tubes in the 5 to 20 feet (1500 to 6000 mm) lengths to suit applications.
- E. Freeze Protection Thermostats: Electric freeze protection thermostats shall be provided with capillary elements, and special purpose insertion elements not less than 20 feet (6000 mm) in length for the face of coils up to 80 square feet (7.4 m²). Freeze protection thermostats shall have the following characteristics:

1. A freezing condition at any one foot length increment anywhere along the sensing element shall activate the thermostatic switch.
 2. Switch shall require manual reset.
- F. Weather Shields: Provide weather shields and outside air sensing elements with the following characteristics:
1. Mount elements and shields on the north face of the building or location out of direct sunlight.
 2. Construct shields of 16 gauge (1.6 mm) 316 stainless steel with flanges bolted to a backplate with not less than four 1/4-inch (6 mm) diameter stainless steel bolts. Mount backplate to the building structure with expansion bolts.
 3. Construct shields to inhibit solar effects. Construct shields in a rectangular box configuration with ventilating raintight louvers to preclude the entrance of snow, ice and rain. Design for crossflow and vertical air circulation.
 4. Mount shields accessible for maintenance.
 5. Seal wall penetration watertight.
 6. All space thermostats shall provide local adjustability and programmable at the BAS, including override of local adjustability of the BAS

2.11 PRESSURE CONTROLLERS

- A. Types: Provide electric electronic pressure controllers of the analog or two-position type as required by the sequence of operation.
- B. Analog Controllers: Provide controllers with proportional action plus integral and derivative control modes.
1. Provide sensing elements of the differential type measuring controlled medium and standard reference pressures.
 2. Air static pressure controllers shall have slack diaphragms with standard ranges 0 to 6 inches water column (0 to 1500 Pa) and an adjustable proportional band range of 0.02 to 0.5 inches water column (5 to 125 Pa).
 3. Sensing elements for duct applications shall be damped to preclude pulsation.
 4. Water differential pressure controllers shall have a minimum range of 0 to 50 psig (0 to 345 kPa) or 0 to 250 psig (0 to 1725 kPa) as required by the application with adjustable proportional band of one to 25 psig (170 kPa). Sensing elements shall be diaphragm type with 3-valve manifold. Provide siphons and pressure snubbers.

2.12 ELECTRIC PRESSURE SWITCHES

- A. Type: Provide bourdon tube or diaphragm type electric pressure switches with tamperproof adjustable set point and differential settings. Design switches for 200 percent overpressure and full vacuum underpressure without damage or accuracy impairment.

2.13 DAMPERS

- A. Standards: Provide opposed blade and parallel blade factory fabricated dampers of extruded aluminum, galvanized steel or stainless steel with metallic anti-friction non-ferrous bearing in accordance with Sheet Metal and Air Conditioning Contractors' National Association (SMACNA) standards.
- B. Types: Use parallel blade dampers in mixing chambers and plenums. Use opposed blade dampers for volume control, face and bypass dampers, smoke dampers, fan discharge, and variable air volume control.
- C. Pressure Rating: For fan systems less than 10-inch water gauge (2490 Pa) static pressure, design and construct dampers to withstand a pressure of 150 pounds per square foot (7.1 kPa) without damage, leakage, flexure, or distortion.
- D. Leakage: Maximum air leakage rate for all dampers shall not exceed 10 cubic feet of air per minute per square foot (50 L/s/m²) at atmospheric pressure when closed against a 4-inch water gauge (1000 Pa) static pressure.
- E. Operators: Damper operators shall have sufficient power to open and close the dampers and limit the leakage to the specified rate. Power wiring shall be extended to operator by this contractor.
- F. Shafts and Bearings: Provide cadmium plated steel shafts in permanently lubricated bronze sleeve bearings or permanently lubricated ball bearings.
- G. Blade Sizes: Reinforced or ribbed blades shall not exceed 8 inches (200 mm) in width nor 48 inches (1200 mm) in length.
 - 1. Flat or unreinforced blades will not be acceptable.
 - 2. Damper sections exceeding 4 feet (1200 mm) in width or 4 feet (1200 mm) in height shall be constructed with multiple frames and linkages.
- H. Frames: Construct frames of factory welded galvanized steel hot dipped after construction or bolted extruded aluminum frames.
 - 1. Dampers larger than 8 square feet (.7 m²) in area shall have corner bracing gussets at each corner welded to the damper frame.
- I. Linkages: Provide linkages to uniformly transmit damper operating forces to each damper blade.
 - 1. Construct linkages of galvanized or cadmium plated steel or stainless steel.

2. Bearings and joints shall be ball and socket or sleeve bearings of brass, bronze or stainless steel, with plated bolts and locking nuts.
- J. Seals: Provide mechanically attached elastomer or neoprene blade tip seal along the full length of each blade edge and flexible stainless steel seals along damper blade ends where the blades abut the frame. Adhesives or staples will not be acceptable.
- K. Damper Mounting: Mount dampers to casings and ductwork in conformance with SMACNA standards. Provide welded or bolted galvanized steel structural supports for dampers larger than 20 square feet (1.9 m²). Through bolt damper frames to structural supports.

2.14 ELECTRIC ACTUATORS

- A. General: Provide electric motor driven actuators (operators) arranged "Fail Safe" in the event of power failure. Unless indicated otherwise, the fail position of each valve shall be the "last position" or "current position" at the time of failure. Design operators to be quiet in operation and function within a range 85 to 100 percent input power potential.
- B. Electric Actuators: Provide hydraulic or gear type electric actuators.
 1. When operated at rated voltage each actuator shall deliver the torque required for continuous uniform movement of the control device from limit to limit.
 2. Provide an end switch to limit travel and design the actuator to continuously stroke without damage.
 3. Operators shall function properly within a range of 85 to 120 percent of line voltage. For actuators with input power greater than 100 watts, gears shall be ground steel, oil immersed, shaft shall be hardened steel running in bronze, copper alloy or ball bearing and operator and gear trains shall be totally enclosed in dustproof cast iron, cast steel or cast aluminum housing.
 4. Actuators with input power less than 100 watts may use fiber or reinforced nylon gears with steel shaft, copper alloy or nylon bearings and pressed steel enclosures.
 5. Two position actuators shall be of the single direction, spring return or reversing type.
 6. Proportioning operators shall be capable of stopping at all points in the cycle and starting in either direction from any point.
 7. Reversing and proportioning operators shall have limit switches to limit travel in either direction.
 8. For actuators with greater than 400 watts input, provide totally enclosed reversible induction motors with auxiliary hand crank and permanently lubricated bearings.

9. All valve and damper actuators shall be 24 volt. Use of 120 volt actuators will be considered for selective applications such as: large valves (approximately 8-inch and larger), or line voltage control for unit heaters, cabinet heaters, etc. where acceptable to the using agency. In all cases (24 volt and 120 volt), power for valve and damper actuators shall be provided by the ATC contractor.

C. Damper Operator Mounting: Mount damper operators where accessible for maintenance.

1. If located outside the duct or casing, mount operators on a 14 gauge (2.0 mm) reinforced support plate arranged to allow insulation between the support plate and the face of the duct or casing.

2. Brace damper operators rigid to show no deflection or movement over the full range of the damper stroke.

2.15 CONTROL PANELS AND CABINETS

A. Local Panels and Cabinets: Provide local control cabinets for each air handling unit, automatically controlled equipment such as pumps, fans, heaters and convertors, or groups of such equipment in a single mechanical equipment room.

B. Standards: Construct panels in conformance with UL 50, "Cabinets and Boxes," or similar approved construction, with backbox, full-sized piano hinged face, stainless steel lockable latch, and secure to the building construction.

1. Internally mount all controllers, relays, terminal boards, and miscellaneous control devices, on a removable panel.

2. Flush mount in the door all indicators, selector switches, remote setpoint adjusters, and pilot lights.

3. Cabinet internals may be factory or field wired and piped. Wire shall be neat, braced, and strapped flat to present a neat appearance and to easily trace wiring and piping from one device to another.

4. Floor mounted panels shall be bolted to 1-1/2-inch by 1-1/2-inch (40 mm by 40 mm) structural support channel, bolted to the floor and braced at the top.

2.16 SYSTEM DIAGRAMS

A. Mounting: Mount control diagrams adjacent to each local control panel on a furniture steel extension either bolted to wall or to an extension of the control cabinet structural support.

1. Control diagrams shall include system one-line diagram, system control diagram, sequence of operations, and schedule of control devices.

2. Diagrams shall be hermetically sealed in laminated 16 gauge (1.6 mm) plastic.

3. Diagrams shall be permanent, black on white background, not subject to fading when subjected to artificial or natural light. Diazo prints are not acceptable.
4. Diagrams shall represent the current, "as-built" status of the control system, after acceptance by the representative of the Owner.
5. Obsolete, out of date, or field modified diagrams shall be removed, and new current diagrams furnished.
6. Diagrams and devices on local control panels shall be identified with engraved phenolic nameplates, white on black, minimum 1/4-inch (6 mm) high block capital lettering, screwed or bolted to panel or mounting plate face. Adhesive attachments are not acceptable.

2.17 WIRING

- A. General: Provide a complete system of electric wiring for temperature control apparatus including control power transformers and wiring to the transformer primary.
- B. All wiring shall be installed in conduit. Refer to Division-26 section, "Raceways." MC cable is prohibited in all locations.
- C. Wiring: Wire for low voltage AC shall be minimum 300 volt insulated copper No. 18 AWG or larger conforming to NFPA 70, Type MTW, THHN or TFFN, installed in accordance with Division-26 of these specifications.
 1. For low voltage DC and an electronic circuit carrying less than 0.5 amperes, cables of two or more conductors not smaller than No. 18 AWG solid copper or No. 18 AWG solid copper if not shielded may be used in lieu of individual wires.
 2. Cables carrying analog signals shall be shielded, if required by the manufacturer.
 3. Cables shall be terminated in solder or screw type terminal strips.
 4. Cables shall not be tapped at any intermediate points.
 5. All wire shall be color coded or numbered for identification. Identify as indicated on shop drawings and "as-built" drawings.
 6. Wire terminating in screw type terminal strips shall have pressure connectors conforming to UL 486A, "Wire Connectors and Soldering Lugs for Use with Copper Conductors," or UL 486B, "Wire Connectors for Use with Aluminum Conductors."
 7. Wire terminations without connectors or traveling pressure pads will not be accepted.
- D. The contractor shall in no case combine control wiring (line or low voltage) with power wiring in the same conduit.

2.18 ACCESSORIES

- A. Provide a PC based operator's workstation within the building at a location determined by the owner, including a flat screen monitor (minimum 21") and a color laser printer. Provide color graphics of all systems to be controlled, monitored and alarmed by the EMCS. Computer hardware and software shall be compatible with the most current version of the ATC vendor's software and graphics packages.
- B. Provide a portable operating terminal for connection to the main DDC control panel. In addition, main panel shall be provided with modem connection.

2.19 FLOW SENSORS

- A. General: Provide sensors for measuring flow in piping and ductwork that are compatible with static pressure and differential pressure analog of the electronic controllers served.
- B. Turndown: Provide sensors with an output characteristic which gives a continuous mathematical function over the full range of flow from maximum to minimum required.
- C. See specifications, this section, for required air and/or water flow monitor measurement characteristics.
- D. Provide all necessary power and control wiring as required for complete and operational flow measurement systems interlocked with the building EMCS.

2.20 AIRFLOW MEASUREMENT SYSTEMS (AIRFLOW MONITORS)

- A. The airflow measurement system (AFMS), including airflow monitor, sensors, controllers, transmitters, etc., indicated on the plans shall be capable of continuously monitoring airflow rates at each measurement location. The system shall consist of one or more airflow measuring devices and a single microprocessor based transmitter. The number of sensing points shall be as per manufacturer's recommendation for the specified application. The AFMS shall not require recalibration or adjustment over the life of the equipment. If the technology provided is vortex shedding or the pitot tube type the system shall be calibrated on a semi-annual basis during the construction phase through the end of the warranty. The manufacturer is responsible for all cost associated with recalibration.
- B. Upon request, the manufacturer shall provide for approval and verification a written copy of the following:
 - 1. 16 point NIST traceable report of calibration used for the reference standard.
 - 2. UL/cUL 873 report listing the AFMS as a complete assembly.
 - 3. Independent laboratory test report results of 100% survival rate in a 30 day saltwater and acid vapor test.
- C. The AFMS shall produce a single, linear, analog output signal for airflow, which can be measured by the host control system. The system shall have the ability to perform self-diagnostics and automatic zeroing to adjust the signal to zero at pre-

determined time intervals, which eliminates all output signal drift due to thermal, electronic and mechanical effects. In the event of sensor failure, the system shall ignore the failed sensor(s), average the remaining sensors and continue to operate.

- D. The total accuracy from the airflow measurement to the host controls, including sensing point averaging error, the sum of the sensor and electronic (transmitter) errors, etc. shall not exceed +/-2% of reading at both minimum and maximum airflow rates based on the manufacturer's published performance specifications for all devices. In addition, total system performance including sampling error, shall not exceed +/-5% of actual airflow. The installed accuracy, in accordance with manufacturer's recommendations, without field adjustment shall be as follows throughout the operating range:
1. Ducts and plenums: +/- 3% of reading
 2. Outside air intakes: +/-5% of reading
 3. Fan inlets: +/- 10% of reading
- E. The sensors and electronics shall operate over a temperature range of -20 to 120°F for ducted supply or return applications and -20 to 120°F for outside air applications. The sensors and electronics shall operate at a relative humidity range of 0 to 95% (non-condensing) for ducted supply and return applications and 0-99% (non-condensing) for outside air applications. Each sensor node shall be individually calibrated at 16 measurement points to airflow standards directly calibrated at NIST to the NIST Laser Doppler Anemometer (LDA) primary velocity standard and have an accuracy of +2% of reading over the entire calibrated airflow range of 0 to 5,000 FPM for ducted applications. Upon request, a working demos shall be provided to the design team to display that the system can work at low flows.
- F. For standard applications, sensors shall be constructed of materials that resist corrosion due to moisture or salt in the airstream. Aluminum probes shall be provided. For laboratory exhaust applications, provide stainless steel sensors with stainless steel casing. Each sensor probe shall be provided with an integral, FEP jacket, plenum rated CMP/2CL2P, UL/cUL listed cable rated for exposures from -67°F to 392°F (-55°C to 200°C) and continuous and direct UV exposure. Plenum rated PVC jacket cables are not acceptable. Devices that have electronic signal processing components on or in the sensor probe are not acceptable. Where the electronics are installed in a location exposed to potential wind driven rain or snow (including outside air plenum) provide a NEMA 4 enclosure for all electronics. In addition, a visual display shall be provided to illustrate airflow (CFM) and temperature. The transmitter must also be able to display individual sensor reading and each individual flow for each fan on a fan array.
- G. Analog signal capability shall include two output terminals: the first (AO1), shall provide the total airflow rate; while the second output (AO2) shall be field configurable to provide one of the following: temperature, low and/or high airflow user-defined set point alarm, individual fan alarm (for fan arrays) or system status alarm.
- H. Airflow measuring devices shall be UL listed as an entire assembly. The transmitter shall include fused protection.

- I. The manufacturer's authorized representative shall review and approve placement and operating airflow rates for each measurement location indicated on the plans for conformance with installed accuracy requirements. A written report shall be submitted to the consulting mechanical engineer if any measurement locations will not result in specified installed accuracy requirements.
- J. Prior to purchase or installation of the air flow monitor (AFM), the Contractor and/or AFM Product Representative shall review each equipment and/or duct mounted location to verify suitability for installation. Should there be any discrepancy regarding installation or performance, the Contractor shall notify the Engineer immediately.
- K. Provide all necessary power and control wiring as required for a complete and operational air flow measurement system interlocked with the building EMCS. Network communications RS 485 (BACnet MS/TP or Modbus RTU) or Ethernet (BACnet Ethernet or BACnet IP, Modbus TCP and TCP/IP) shall provide: the average airflow rate, temperature, high and/or low airflow set point alarm, system status alarm, individual sensor node airflow rates (individual fan airflow rates for fan arrays) and individual sensor node temperatures. Individual node airflow rates and temperatures shall be available via the network with Lon.
- L. Airflow measurement system manufacturers shall be limited to the following:
 - 1. Ebtron (Gold)
 - 2. Air Monitor Valo-probe with Veltron II transmitter
 - 3. Tek Aire Vortek VT-5000

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Wiring and Conduit: Provide wiring and conduit to connect the automatic control system components for an operational system.
 - 1. Provide wiring in accordance with requirements indicated in this section.
 - 2. Run conduit in straight lines, parallel to the lines of the building, and rack on factory furnished mounting blocks attached to the building structure. Where run buried in slabs provide long sweep rigid conduit bends extending 6 inches (150 mm) above the slab at slab penetrations.
 - 3. Do not bury or conceal wiring beneath building insulation.
 - 4. Locate wiring clear of access doors, accessible ceilings, lighting fixtures, walkways, or any location subject to damage or abrasion.
- B. Identification: Label or code each field wire at each end, and each controller and controlled device.
 - 1. Identification shall be permanent, robust, not subject to fading, and flameproof.

2. Permanently mark terminal blocks at wire termination points.
 3. Identify each control device with an engraved laminated phenolic nameplate, white on black, lettering not less than 1/8-inch (3 mm) height, on 1-1/2-inch (40 mm) by 1-inch (25 mm) tag and brass interlocked chain secured to the control device. Name shall correspond with identification on the shop drawings.
 4. Identify sensors, controllers, relays, either mounted in local or central control panels, or remote mounted with a similar name tag as specified above. Attach to or adjacent to controllers with stainless steel or brass screws or rivets. Adhesives will not be acceptable. Do not attach to removable controller covers.
- C. Valves: Install valves in piping with stems as vertical as possible but in no case less than 45 degrees from vertical. For soldered or welded connections, remove valve internals before mounting.
- D. Electric Valves: Wire electric valves in accordance with NFPA 70 with not less than 2 feet (610 mm) of flexible liquidtight connector with watertight bushings at the valve actuator. Brace conduit to the building structure.
- E. Pressure and Temperature Sensors: Install pressure and temperature sensors as follows.
1. Locate pressure and temperature sensing points sufficiently downstream from the control device to increase control loop time constant and minimize hunting.
 2. Locate shut-off valves and 3-valve bypasses as specified in "Sensors" paragraph of this Section.
 3. Locate sensors where accessible for maintenance and replacement.
 4. Do not cover or conceal sensors with insulation.
- F. Space Sensors: Install space sensors as follows.
1. Space sensor including space thermostats, aspirating thermostats, humidistats, pressure or differential pressure sensors shall be enclosed in cast brushed aluminum or 16 gauge (1.6 mm) brushed and ground stainless steel enclosures. Enclosures shall be tamperproof. Setpoint adjustment or settings shall not be visible or adjustable from outside sensor enclosure. Sensors shall be securely mounted and rigid.
 2. Locate room thermostats and other room sensors approximately 48 inches (1200 mm) above the floor (or otherwise as required to meet the most current ADA guidelines) on inside wall where they will respond to average conditions in the space.
 3. Sensors mounted on outside walls, if unavoidable, shall be mounted on factory made insulated brushed stainless steel bases.

4. Provide thermostat/sensor guards in all areas subject to potential damage. Thermostat/sensor guards shall be clear, impact resistant lockable plastic or approved equivalent. Thermostat/sensor guards shall be provided in the following areas and other similar type spaces subject to potential damage: gymnasium, multi-purpose rooms, fitness areas, activity rooms, mechanical rooms, electrical rooms, etc.
- G. Air Handling Unit Temperature Indicators: For each factory assembled central station air handling unit and field erected air handling unit, provide temperature indicators in the following locations. In addition, unless indicated otherwise by the Owner, provide thermostat/sensor guards wherever students have access, including but not limited to: classrooms, corridors, cafeteria, media center, auditorium, etc.
1. Each outside air plenum.
 2. Each return air plenum.
 3. Each cooling coil inlet and discharge.
 4. Each heating coil discharge.
 5. Temperature indicators shall be so located that they may be read by an operator standing on the operator floor. Indicators more than 8 feet (2400 mm) above the floor shall be remote bulb type.
- H. Duct Sensors: Select duct sensor locations to properly sense average air conditions, minimize vibration, avoid dead air spaces, and within velocity limits required by the manufacturer.
1. Provide velocity shields where required.
 2. Securely mount or clamp averaging elements, maximum 3 feet (900 mm) on centers to the leaving side of coils and equipment. Insulate averaging elements from equipment and protect from vibration.
 3. Provide separate duct flanges for each sensing device.
 4. Provide gaskets or sealant where elements penetrate duct walls.
 5. Mount sensor to allow easy removal and servicing without disturbing insulation or vapor barrier. Mount on standoff brackets to avoid condensation.
 6. Coordinate the location for duct access doors downstream from each duct sensor.
- I. The ATC contractor shall interface with smoke detectors, smoke dampers and fire alarm devices as required to accomplish equipment shutdown, alarms, etc., as indicated in sequences.
- J. For single phase motors, provide relays and/or contactors of appropriate horsepower and voltage rating as required to energize/de-energize equipment as indicated in sequences.

3.2 TEST PLAN

- A. Test Plan: Prepare a written test plan indicating in a step-by-step, logical fashion, the procedures by which the automatic control system will be tested, adjusted, and checked.
- B. Pre-Approval: Not less than six (6) weeks prior to testing, provide four (4) copies of the proposed test plan for approval. Meet and discuss the test plan, and make agreed changes to the written plan.
- C. Content: Plan shall include, as a minimum, for each system and sub-system of the automatic control work the following:
 - 1. System name.
 - 2. List of devices with brief description of functional purpose of each.
 - 3. A description of the expected signal values transmitted by the sensor.
 - 4. A description of the expected signal values transmitted by the controller to the control device or actuator.
 - 5. A description of the expected values of the control medium from limit-to-limit.
 - 6. A description of the instrumentation required to test the system.
 - 7. A description of the expected field adjustments for transmitter, controller, and control actuator should control parameters fall outside of expected values.
 - 8. A log sheet or sheets on which expected and field read values will be recorded and final field read values indicating that the system is operating in accordance with contract requirements.

3.3 TESTS DURING AND AFTER INSTALLATION

- A. Instrumentation and Control: Calibration test each controller as follows:
 - 1. Disconnect the sensor input signal to the controller and provide a compatible test signal generator.
 - 2. Simulate expected transmitter values and input to the controller. Record controller branch line values.
 - 3. Examine control device and determine that the device is responding.
 - 4. Simulate maximum and minimum transmitter signal values and verify minimum and maximum controller output values and control device minimum and maximum stroke range.
 - 5. Record all values and recalibrate controller as necessary to conform with specified control ramps, reset schedule, proportional relationship, reset relationship, and derivative reaction.

6. When the controller and control device portion of each loop are responding as designed, reconnect the sensor transmitter input line.
7. After mechanical equipment control becomes operational, perform an operational test of each control loop recording sensor, transmitter, controller input, controller output and control medium parameter.
8. Entire test shall be witnessed by an owner's representative.
9. Upon satisfactory test a copy of final test results shall be bound in the operating and maintenance manual.

3.4 FUNCTIONAL PERFORMANCE TESTING AND VERIFICATION

- A. General: In addition to the tests required during and after installation of all mechanical systems, as well as any other formal commissioning requirements, the Contractor shall perform functional performance tests to verify that all systems are designed, installed, calibrated and adjusted to perform as required in the Contract.
- B. Comply with all applicable specification sections including, but not be limited to, "Basic HVAC Requirements", "Testing, Adjusting and Balancing", "Automatic Temperature Controls" and "Commissioning", where applicable.
- C. Prior to functional performance testing, all indicating, recording and control devices shall be calibrated. A calibration verification report shall be provided with the final test report.
- D. Provide functional performance testing to verify proper operation of each and every control sequence indicated throughout the contract documents.
- E. Failure of Tests: Should any test, verification, or demonstration fail to meet the specification requirements, the component of the system causing the failure shall be repaired, replaced or readjusted. The failed test, verification, or demonstration shall then be repeated.
- F. A "Functional Performance Test Verification Form" is included at the end of this section. This form (electronic version is available upon request) shall be completed for all mechanical equipment provided under this contract. This shall include, but not be limited to each air handling unit, fan, pump, VAV terminal, fan coil unit, unit ventilator, DX cooling equipment, miscellaneous heating equipment, etc.
- G. Test Report: Upon satisfactory verification of calibration and functional performance tests, a copy of the final test results shall be bound in the operations and maintenance manual. The final report shall also include a full compliance statement, on company letterhead, indicating that all systems are installed and functioning per the contract requirements including drawings, specifications, control sequences and accepted submittals.
- H. The mechanical systems shall not be considered complete until all functional performance verification forms, calibration reports and compliance statement have been submitted and reviewed. Submit in accordance with the submittal requirements indicated elsewhere in these specifications.

3.5 DEMONSTRATION AND TRAINING

- A. Demonstration: After completion of testing as hereinbefore specified, provide demonstration and training of designated operating personnel (refer to Division-1).
1. Demonstration shall be performed.
 2. Demonstration shall include the operation of the entire mechanical system under the control of the Contractor and shall include the start-up, operation, and shutdown of the system in accordance with the sequence of operation.
 3. The operation of each device shall be performed in accordance with the written instructions contained in the operation and maintenance manual, a copy of which shall be available ten (10) working days prior to the test. No deviation from procedures in the operating manual will be permitted.
- B. Failure to Perform: Should the system fail to perform in accordance with the requirements of the operation and maintenance manual, the system shall be repaired, recalibrated, retested as necessary, and a second demonstration performed.
1. Subsequent demonstrations shall occur until the automatic control system and all associated mechanical and electrical equipment are operating in accordance with contract requirements.
 2. All testing, retesting, and recalibration shall be at no additional expense. The Contractor shall reimburse the expenses of the commissioning team for each test after the first.

3.6 INSTRUCTING OPERATING PERSONNEL

- A. Instructors and Superintendent: Upon completion of the work and acceptance by the representative of the Owner, provide the services of an Instructor, who together with the superintendent specialist shall instruct designated operating personnel in the operation and maintenance of the automatic control system.
1. The services of the Instructor shall be available for not less than four 4-hour days of instruction.
 2. The services of the superintendent specialist shall be available for not less than two 4-hour days.
 3. Instructions shall be based upon the use of the operating and maintenance manual together with copies of the laminated control diagrams affixed adjacent to each local control panel.
 4. Training and instruction will be witnessed. The witness shall monitor the entire training program and prepare a written report on the competency and effectiveness of instructors and the level of expertise of designated operators. A report will be submitted recommending additional training at additional cost, if such is deemed necessary.

3.7 BUILDING MANAGEMENT AND CONTROL SYSTEM DEVICES AND POINTS

- A. Provide all building management and ATC system controllers, devices, points, etc. as required to accomplish the control sequences and equipment functions indicated throughout the contract documents, including drawings and specifications. In addition, provide all controllers, devices, points, etc. as required to control, operate, monitor and alarm all equipment and devices indicated on the contract documents (including but not limited to: pumps, air handling units, fans, variable frequency drives, air volume terminal units, humidifiers, valves, dampers, flow measuring devices, sensors, carbon monoxide (CO) detection devices, etc.). All points shall be available through the Energy Management Control System (EMCS). See attached points list (where applicable).
- B. Building management and control points shall include status for all mechanical equipment with equipment failures alarmed at the EMCS. In addition, furnish and install all points required to provide complete, color, system graphics of all mechanical systems and components indicated throughout the contract documents. All equipment and devices indicated throughout the contract documents shall be indicated at the operator's workstation (where applicable) and all end devices shall be individually controlled unless specifically indicated otherwise.
- C. Building management and control system features for equipment and devices shall include, but not be limited to, the following where applicable: runtime, trend data, optimal start, scheduling, paging, system graphics, and internet access to graphic and text-based displays.

END OF SECTION 230900

FUNCTIONAL PERFORMANCE TEST VERIFICATION FORM

Name: _____

Project _____

FUNCTIONAL VERIFICATION FOR: _____ (Insert Equipment Name, i.e. AHU, Fan, Pump, VAV, etc.)					
SEQUENCE OF OPERATION	Controlling Specified (Y/N)	as	ATC Technician Initials	Date	Notes
(Insert complete sequence of operation as indicated in approved ATC submittal)					
Example: Air Handling Unit Control					
1. General:					
1.1 Supply and return fans shall be interlocked. Fans shall operate continuously in the occupied mode. HOA switch shall be in the AUTO position.					
1.2 Occupied-Unoccupied shall be as determined by the EMCS.					
2. Temperature Control:					
2.1 Occupied					
A. When the outside air enthalpy is above the return air enthalpy, D-1, D-2 and D-3 shall modulate as follows:					

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SECTION 23 23 00 - REFRIGERANT PIPING

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

- A. Extent of refrigerant piping work is indicated by requirements of this section and all other Division-23 sections.
- B. Refer to requirements of Division-26.

1.2 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of refrigerant piping products, of types, materials, and sizes required, whose products have been in satisfactory use in similar service for not less than five (5) years.
- B. Installer's Qualifications: Specialist with at least five (5) years of successful installation experience on projects with refrigerant piping work similar to that required for project.
- C. Codes and Standards:
 - 1. ASME Compliance: Fabricate and install refrigerant piping in accordance with ASME B31.5, "Refrigeration Piping", and extend applicable lower pressure limits to pressures below 15 psig (100 kPa).
 - 2. IMC Compliance: Fabricate and install refrigerant piping in accordance with "International Mechanical Code".
 - 3. ASHRAE Compliance: Fabricate and install refrigerant piping in accordance with ASHRAE 15 "Safety Code for Mechanical Refrigeration".

1.3 SUBMITTALS

- A. Product Data: Submit manufacturer's technical product data and installation instructions for refrigerant piping materials and products.
- B. Brazing Certification: Certify brazing procedures, brazers and operators in accordance with ASME standards (ASME B31.5).
- C. Shop Drawings: Submit scaled layout drawings of refrigerant pipe and fittings including, but not necessarily limited to, pipe and tube sizes, locations, elevations and slopes of horizontal runs, wall and floor penetrations, and connections. Show interface and spatial relationship between piping and proximate equipment.
- D. Maintenance Data: Submit maintenance data and parts lists for refrigerant piping materials and products. Include this data, product data, shop drawings, and record drawings in maintenance manual.

PART 2 - PRODUCTS

2.1 MATERIALS AND PRODUCTS

- A. General: Provide piping materials and factory-fabricated piping products of sizes, types, pressure ratings, temperature ratings, and capacities as indicated. Where not indicated, provide proper selection as determined by Installer to comply with installation requirements. Provide materials and products complying with ASME B31.5 Code for Refrigeration Piping where applicable, base pressure rating on refrigerant piping system maximum design pressures. Provide sizes and types matching piping and equipment connections; provide fittings of materials which match pipe materials used in refrigerant piping systems. Where more than one type of materials or products are indicated, selection is Installer's option.

2.2 BASIC IDENTIFICATION

- A. General: Provide identification complying with Division-23 sections "Basic HVAC Materials and Methods" and "Identification for HVAC Piping and Equipment", in accordance with the following listing:
 - 1. Refrigerant Piping: Plastic pipe markers.

2.3 BASIC PIPES AND PIPE FITTINGS

- A. General: Provide pipes and pipe fittings complying with Division-23 sections "Basic HVAC Materials and Methods" and "Pipe, Tube and Fittings for HVAC Systems", in accordance with the following listing:
 - 1. Tube Size 4-1/8" (105 mm) and Smaller: Copper tube; Type ACR, hard drawn temper; wrought-copper fittings; brazed joints.
 - 2. Tube Size 1/2" (13 mm) and Smaller: Copper tube; Type ACR, soft annealed temper; wrought-copper fittings, brazed joints.
 - 3. Brazed Joints: Braze joints using American Welding Society (AWS) classification BCuP-5 for brazing filler metal.

2.4 BASIC PIPING SPECIALTIES

- A. General: Provide piping specialties complying with Division-23 sections "Basic HVAC Materials and Methods" and "Piping Specialties for HVAC Systems", in accordance with the following listing:
 - 1. Pipe escutcheons
 - 2. Drip pans
 - 3. Sleeves

4. Sleeve seals

2.5 BASIC HANGERS AND SUPPORTS

- A. General: Provide hangers and supports complying with Division-23 sections "Basic HVAC Materials and Methods" and Hangers and Supports for HVAC Piping and Equipment", in accordance with the following listing:

1. Adjustable steel clevises, adjustable roller hangers, and adjustable pipe roll stands for horizontal piping hangers and supports.
2. Two-bolt riser clamps for vertical piping supports.
3. Concrete inserts, C-clamps, and steel brackets for building attachments.
4. Protection shields for insulated piping support in hangers.
5. Copper flashings for piping penetrations.

2.6 SPECIAL REFRIGERANT VALVES

- A. General: Special valves required for refrigerant piping include the following types:

1. Globe and Check Valves:
 - a. Globe Shutoff Valves: Forged brass, packed, back seating, winged seal cap, 300°F (149°C) temperature rating, 500 psi (3450 kPa) working pressure.
 - b. Check Valves: Forged brass, accessible internal parts, soft synthetic seat, fully guided brass piston and stainless steel spring, 250°F (121°C) temperature rating, 500 psi (3450 kPa) working pressure.
2. Solenoid Valves:
 - a. 2-Way Solenoid Valves: Forged brass, designed to conform to ARI 760, normally closed, teflon valve seat, NEMA 1 solenoid enclosure, 24 volt, 60 Hz., UL-listed, 1/2" (13 mm) conduit adapter, 250°F (121°C) temperature rating, 400 psi (2720 kPa) working pressure.
 - 1) Manual Operator: Provide manual operator to open valve.
3. Ball Valves:
 - a. Ball Valve with Access Port: Compatible with all CFC, HCFC and HFC refrigerants and oils, designed for pressures up to 775 psig, and temperature range of -40°F (-40°C) to 300°F (149°C), full port construction to match line size ID, internally equalized ball design, rupture-proof encapsulated stem, UL listed.
 - 1) Confirm compatibility with selected VRF/equipment manufacturer.

2.7 REFRIGERANT SPECIALTIES

- A. Refrigerant Strainers: Brass shell and end connections, brazed joints, monel, screen, 100 mesh, UL-listed, 350 psi (2380 kPa) working pressure.
- B. Moisture-Liquid Indicators: Forged brass, single port, removable polished optical glass, solder connections, UL-listed, 200°F (93°C) temperature rating, 500 psi (3450 kPa) working pressure.
- C. Refrigerant Filter-Driers: Steel shell, ceramic fired desiccant core, solder connections, UL-listed, 500 psi (3450 kPa) working pressure.
- D. Refrigerant Filter-Driers: Corrosion-resistant steel shell, steel flange ring and spring, wrought copper fittings, ductile iron cover plate with steel cap screws, replaceable filter-drier core, 500 psi (3450 kPa) working pressure.
- E. Evaporator Pressure Regulators: Provide corrosion-resistant, spring loaded, stainless steel springs, pressure operated, evaporator pressure regulator, in size and working pressure indicated, with copper connections.
- F. Refrigerant Discharge Line Mufflers: Provide discharge line mufflers as recommended by equipment manufacturer for use in service indicated, UL-listed.

2.8 BASIC VIBRATION CONTROL

- A. General: Provide vibration control products complying with Division-23 sections "Basic HVAC Materials and Methods" and "Vibration Isolation for HVAC Piping and Equipment", in accordance with the following listing:
 - 1. Isolation hangers
 - 2. Riser isolators
 - 3. Riser support isolators
 - 4. Flexible pipe connectors

PART 3 - EXECUTION

3.1 INSPECTION

- A. General: Examine areas and conditions under which refrigerant piping systems materials and products are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.2 INSTALLATION OF BASIC IDENTIFICATION

- A. General: Install mechanical identification in accordance with Division-23 sections "Basic HVAC Materials and Methods" and "Identification for HVAC Piping and Equipment".

3.3 INSTALLATION OF REFRIGERANT PIPING

- A. General: Install refrigerant piping in accordance with Division-23 sections "Basic HVAC Materials and Methods" and "Pipe, Tube and Fittings for HVAC Systems", and in compliance with equipment manufacturer's recommendations.
- B. Install refrigerant piping with 1/4" per foot (6 mm per meter) (1%) downward slope in direction of oil return to compressor. Provide oil traps and double risers where indicated, and where required to provide oil return.
- C. Clean refrigerant piping by swabbing with dry lintless (linen) cloth, followed by refrigerant oil soaked swab. Remove excess oil by swabbing with cloth soaked in high flash point petroleum solvent, squeezed dry.
- D. Bleed dry nitrogen through refrigerant piping during brazing operations.

3.4 INSTALLATION OF PIPING SPECIALTIES

- A. Install piping specialties in accordance with requirements of Division-23 sections "Basic HVAC Materials and Methods" and "Piping Specialties for HVAC Systems".

3.5 INSTALLATION OF HANGERS AND SUPPORTS

- A. Install supports and anchors in accordance with requirements of Division-23 sections "Basic HVAC Materials and Methods" and "Hangers and Supports for HVAC Piping and Equipment".

3.6 INSTALLATION OF SPECIAL REFRIGERANT VALVES

- A. General: Install refrigerant valves where indicated, and in accordance with manufacturer's instructions. Remove accessible internal parts before soldering or brazing, replace after joints are completed.
 - 1. Solenoid Valves: Install in refrigerant piping as indicated with stem pointing upwards.
 - a. Wiring of solenoid valves is specified in applicable Division-26 sections, and is included as work of this section.

3.7 INSTALLATION OF REFRIGERANT ACCESSORIES

- A. Refrigerant Strainers: Install in refrigerant lines as indicated, and in accessible location for service.
- B. Moisture-Liquid Indicators: Install as indicated on refrigerant liquid lines, in accessible location.
- C. Refrigerant Filter-Dryers: Install in refrigerant lines as indicated, and in accessible location for service.

- D. Evaporator Pressure Regulators: Install in refrigerant suction lines or evaporator outlets as indicated. Adjust, if required, for proper evaporator pressure.
- E. Refrigerant Discharge Line Mufflers: Install as indicated, in horizontal or downflow portion of hot-gas lines, immediately after leaving compressor; not in riser.

3.8 EQUIPMENT CONNECTIONS

- A. General: Connect refrigerant piping to mechanical equipment as indicated, and comply with equipment manufacturer's instructions where not otherwise indicated.

3.9 FIELD QUALITY CONTROL

- A. Refrigerant Piping Leak Test: Prior to initial operation, clean and test refrigerant piping in accordance with ASME B31.5, "Refrigeration Piping". Perform initial test with dry nitrogen, using soap solution to test all joints. Refrigerant piping shall be pressure tested and evacuated in accordance with the system manufacturer's recommendations, and /or as follows (whichever is more stringent):
 - 1. Pressure Test (Air Tight Test): Pressurize the suction gas pipe, high/low pressure gas pipe and liquid pipe with dry nitrogen to a minimum pressure as per the system manufacturer. Pressure test duration shall be a minimum of 24 hours. If the pressure does not drop within the 24 hour period, the system passes. If there is a drop in pressure, check for leaks, make repairs and re-test as prescribed above.
 - 2. Evacuation Test (Vacuum Drying): Evacuate the system from the suction gas pipe, high/low pressure gas pipe and liquid pipe to a minimum vacuum pressure as per the system manufacturer. Vacuum pressure shall be maintained in accordance with manufacturer's minimum duration recommended. If it rises, the system may either contain moisture or have leaks, if so, make repairs and re-test as prescribed above.
 - 3. Refer to the Refrigerant Leakage Test Summary Form to document test results. No other form will be acceptable. Submit results for all systems for review.
- B. Repair or replace refrigerant piping as required to eliminate leaks, and retest as specified to demonstrate compliance.
- C. Refer to Division-23 section "Testing, Adjusting and Balancing" for additional specific test criteria and test form to be completed.

3.10 DEHYDRATION AND CHARGING SYSTEM

- A. Install core in filter dryer after leak test but before evacuation.
- B. Evacuate refrigerant system with vacuum pump, until temperature of 35°F (2°C) is indicated on vacuum dehydration indicator.
- C. During evacuation, apply heat to pockets, elbows, and low spots in piping.

- D. Maintain vacuum on system for minimum of five (5) hours after closing valve between vacuum pump and system.
- E. Break vacuum with refrigerant gas, allow pressure to build up to 2 psi (14 kPa).
- F. Complete charging of system, using new filter dryer core in charging line. Provide full operating charge.

3.11 ADJUSTING AND CLEANING

- A. Cleaning and Inspecting: Clean and inspect refrigerant piping systems in accordance with requirements of Division-23 section "Pipe, Tube and Fittings for HVAC Systems".

END OF SECTION 23 23 00

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SECTION 23 31 13 - LOW PRESSURE DUCTWORK

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

- A. Extent of low pressure ductwork is indicated on drawings and in schedules, and by requirements of this section and all other Division-23 sections. Low pressure duct systems shall be defined as those duct systems which have an external static pressure (E.S.P.) of less than two-inches (2") water gauge (wg) (500 Pa). See schedules on drawings for external static pressure information.
- B. Types of low pressure ductwork which may be required for this project include the following:
 - 1. Return air ductwork
 - 2. Outdoor air ductwork (conditioned or unconditioned)
 - 3. Exhaust ductwork
 - 4. Supply air ductwork (downstream of air terminal units or systems without air terminal units)
 - 5. Air transfer ductwork
- C. Pressure Classification:
 - 1. All ductwork provided under this section shall be "Duct Pressure Class 2" as defined by SMACNA Standards.

1.2 QUALITY ASSURANCE

- A. Installer: A firm with a minimum of five (5) years of successful installation experience on projects with low pressure ductwork systems similar to that required for project.
- B. SMACNA Standards: Comply with latest edition of SMACNA Standards for fabrication, storage and installation of low pressure ductwork. In addition, all new ductwork shall comply with SMACNA's "Duct Cleanliness for New Construction Guidelines." The "Duct Cleanliness Level" for all ductwork shall meet the requirements of the "Advanced Level."
- C. ASHRAE Standards: Comply with ASHRAE Standards for fabrication and installation of low pressure ductwork.
- D. NFPA Compliance: Comply with ANSI/NFPA 90A "Standard for the Installation of Air-Conditioning and Ventilating Systems" and ANSI/NFPA 90B "Standard for the Installation of Warm Air Heating and Air-Conditioning Systems."

- E. Field Reference Manual: Have available at project field office, copy of SMACNA Standards - latest edition.

1.3 SUBMITTALS

- A. Product Data: Submit manufacturer's specifications on manufactured products used for work of this section.
- B. Shop Drawings: Submit dimensioned layouts of ductwork showing both the accurately scaled ductwork and its relation to space enclosure as required by Division-23 Section, "Basic HVAC Requirements". Show modifications of indicated requirements, made to conform to local shop practice, and how those modifications ensure that free area, materials, and rigidity are not reduced.
- C. Record Drawings: At project closeout, submit record drawings of installed ductwork, duct accessories, and outlets and inlets.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Protect shop-fabricated ductwork, accessories and purchased products from damage during shipping, storage and handling. Prevent end damage and prevent dirt and moisture from entering ducts and fittings.
- B. All ductwork shall be shipped to the site with covered ends. The ductwork shall be covered with 3-mil (minimum) shrink wrap, with a minimum 2-inch overlap on all sides, to provide a water-tight seal at each opening. The covered ends shall remain intact until installation.
- C. Store ductwork, accessories and purchased products inside and protect from weather.
- D. Ductwork fittings and accessories stored on site for installation shall be covered with protective tarps and elevated a minimum of four inches until installed.
- E. Provide periodic (weekly) photographs of the jobsite storage to document that the ductwork is stored in accordance with the criteria outlined in this specification section.
- F. Lined ductwork not stored in accordance with the above criteria shall be replaced in its entirety. Unlined ductwork not stored in accordance with the above criteria shall be cleaned and inspected by the Owner's representative prior to installation. Contractor shall clean unlined ductwork to the satisfaction of the Owner, or replace at the Owner's discretion.

PART 2 - PRODUCTS

2.1 DUCTWORK MATERIALS

- A. Exposed Ductwork Materials: Where ductwork is indicated to be exposed to view in occupied spaces, provide materials which are free from visual imperfections including pitting, seam marks, roller marks, oil canning, stains and discolorations, and other

imperfections, including those which would impair painting. Provide interior lining or double wall duct as indicated on the drawings and/or these specifications.

- B. Sheet Metal: Except as otherwise indicated, fabricate ductwork from galvanized sheet steel complying with ANSI/ASTM A 527, lockforming quality, with ANSI/ASTM A 525, G90 zinc coating.
- C. Stainless Steel Sheet: Where indicated (S/S), provide stainless steel complying with ANSI/ASTM A 167; AISI Type 302/304/316 with No. 4 directional polish where exposed to view in occupied spaces. Protect finished surfaces with mill-applied adhesive protective paper, maintained through fabrication and installation.
- D. Aluminum Sheet: Where indicated (Al-), provide aluminum complying with ANSI/ASTM B 209, Alloy 3003, Temper H14.
- E. Copper Sheet: Where indicated (Cp-), provide copper complying with ANSI/ASTM B 370 cold-rolled, except where soft temper required for unusual forming.

2.2 MISCELLANEOUS DUCTWORK MATERIALS

- A. General: Provide miscellaneous materials and products of types and sizes indicated. Provide type and size required to comply with ductwork system requirements including proper connection of ductwork and equipment.
- B. Duct Liner: Minimum one inch (25 mm) thick (unless otherwise noted) fiberglass, minimum R-value of 4.2 (k-value 0.24 or better), complying with ASTM C 1071, ASTM G 21, ASTM G 22, NFPA 90A, NFPA 90B and UL 181. Duct lining shall contain an EPA registered antimicrobial agent which resists the growth of bacteria and fungi as proven by tests in accordance with ASTM G21 and G22. Liner noise reduction coefficient (NRC) shall be 0.70 or better. Surface of liner shall have water repellent properties. Duct liner shall be Johns Manville Linacoustic RC or equivalent by Certainteed, Knauf or Owens Corning.
- C. Duct Liner Adhesive: Comply with Adhesive and Sealant Council, Inc. (ASC) and ASTM C916.
- D. Duct Liner Fasteners: Comply with SMACNA Standards. Fasteners shall not compress liner by more than 1/8".
- E. Duct Sealant: Non-hardening, non-migrating, oil based mastic or liquid elastic sealant (type applicable for fabrication and installation) as compounded and recommended by manufacturer specifically for sealing joints and seams in ductwork. Sealant shall be solvent (oil) based, water based or silicone based as follows:
 - 1. Solvent (oil) based sealant shall be used for indoor applications on all new construction installations. In addition, for indoor renovation projects, solvent (oil) based sealant shall be included in the contractor's bid and utilized wherever the sealant odor is not objectionable to the owner. Contractor shall coordinate with the owner's representative prior to the duct installation.
 - 2. Water based sealant shall be utilized for indoor renovation applications where the odor from solvent (oil) based sealant is objectionable to the owner. Contractor shall coordinate with the owner's representative prior to the duct installation.

3. Silicone based solvent shall be utilized for all outdoor duct installation applications.
 4. Regardless of duct sealant type, maximum duct leakage requirements outlined in these Division-23 specifications shall be maintained.
- F. Duct Cement: Non-hardening migrating mastic or liquid neoprene based cement (type applicable for fabrication/installation detail) as compounded and recommended by manufacturer specifically for cementing fitting components, or longitudinal seams in ductwork.
- G. Ductwork Support Materials: Except as otherwise indicated, provide hot-dipped galvanized steel fasteners, anchors, rods, straps, trim and angles for support of ductwork.
1. Except where space is indicated as "High Humidity" area, interior support materials of not less than 1/4" (6 mm) diameter or 3/16" (4.8 mm) thickness may be plain (not galvanized).

2.3 FABRICATION

- A. Shop fabricate ductwork in 4 (1200 mm), 8 (2400 mm), 10 (3000 mm) or 12-foot (3600 mm) lengths, unless otherwise indicated or required to complete runs. Pre-assemble work in shop to greatest extent possible, so as to minimize field assembly of systems. Disassemble systems only to extent necessary for shipping and handling. Match-mark sections for reassembly and coordinated installation.
- B. Shop fabricate ductwork of gauges and reinforcement complying with SMACNA Standards - latest edition.
- C. Shop fabricate ductwork of gauges and reinforcement complying with ASHRAE Standards.
- D. Fabricate duct fittings to match adjoining ducts, and to comply with duct requirements as applicable to fittings. Except as otherwise indicated, fabricate elbows with center-line radius equal to one and one-half times the associated duct width; and fabricate to include turning vanes in elbows where shorter radius is necessary. Limit angular tapers to 30 degrees for contracting tapers and 20 degrees for expanding tapers.
- E. Fabricate ductwork with accessories installed during fabrication to the greatest extent possible. Refer to Division-23 section "Ductwork Accessories" for accessory requirements.
- F. Fabricate ductwork with duct liner in each section of duct where indicated. Laminate liner to internal surfaces of duct in accordance with instructions by manufacturers of lining and adhesive, and fasten with mechanical fasteners.
- G. Low pressure rectangular ductwork, fittings, etc., shall be constructed, installed and supported in accordance with current SMACNA Standards of gauges not less than the following:

<u>Maximum Side</u>	<u>Minimum Gauge</u>
Up to 12" (Up to 300 mm)	26 (.5 mm)
13" to 30" (325 mm to 750 mm)	24 (.7 mm)
31" to 60" (775 mm to 1500 mm)	22 (.8 mm)

61" to 84" (1525 mm to 2100 mm)	20 (1.0 mm)
Over 84" (Over 2100 mm)	18 (1.3 mm)

- H. All factory or shop fabricated ductwork shall be constructed as required to meet the testing requirements indicated in this section and Division-23 section "Testing, Adjusting and Balancing."

2.4 SPIRAL DUCTWORK

- A. Spiral duct shall have locked seams equivalent to United McGill "Uni-Seal," so made as to eliminate any leakage under the pressures for which this system has been designed. Spiral duct shall be manufactured of galvanized steel meeting ASTM A-527 by the spiral lockseam method and in the minimum gauges listed:

<u>Diameter</u>	<u>Minimum Gauge</u>
3" thru 26" (75 mm thru 650 mm)	26 (.5 mm)
28" thru 36" (700 mm thru 900 mm)	24 (.7 mm)
38" thru 50" (950 mm thru 1250)	22 (0.8 mm)
52" thru 60" (1300 mm thru 1500)	20 (1.8 mm)
62" and larger (1550 mm and larger)	18 (1.2 mm)

1. All fittings are to have continuous welds along all seams. All divided flow fittings are to be manufactured as separate fittings, not as tap collars welded into spiral duct sections. Fittings and couplings shall be of the following minimum gauges:

<u>Diameter</u>	<u>Minimum Gauge</u>
3" thru 26" (75 mm thru 650 mm)	24 (.7 mm)
28" thru 36" (675 mm thru 900 mm)	22 (1.0 mm)
38" thru 50" (950 mm thru 1250)	20 (1.0 mm)
52" thru 60" (1300 mm thru 1500)	18 (1.2 mm)
62" and larger (1550 mm and larger)	16 (1.4 mm)

2. Branch fittings supplying linear bar diffusers shall be "lo-loss" conical type saddle taps.
3. All 90 degree tees and 45 degree laterals, either full size or reducing, shall be conical pattern for 90 degree and straight pattern for 45 degree laterals, produced by machine or press forming. The entrance shall be free of weld build-up, burrs or irregularities. Provide tangential tees where required.
4. Elbows in diameters 3" (75 mm) through 12" (300 mm) shall be two section die-stamped elbows. All other elbows shall be gored construction with all seams continuous-welded. Elbows shall be fabricated to a centerline radius of 1.5 times the cross section diameter. All elbows not die-stamped shall be fabricated according to the following schedule:

<u>Elbow Angle</u>	<u>Number of Gores</u>
Less than 45°	2
46° thru 60°	2
Over 61°	3

5. The reduction of divided flow fittings shall be conical spun section in the thirty-six reductions in sizes 4" (100 mm) through 22" (550 mm).

6. Spun bellmouth connections shall be used at each round take-off from the high pressure plenum.
7. Offset fittings shall be constructed so that length of offset is not less than two (2) duct diameters.
8. Galvanized areas that have been damaged by welding shall be coated with corrosion resistant aluminum paint, minimum two (2) coats.
9. Supports and sealants shall conform to applicable portions of SMACNA.
10. Flexible ductwork shall be as previously specified for low pressure duct systems.

2.5 FLEXIBLE DUCTWORK

- A. General: Provide insulated flexible ductwork where indicated on drawings, as manufactured by Flex Master Type 6B, or equivalent. Flexible ductwork shall be in compliance with UL-181 Class 1 Air Duct, fabricated with an acoustically transparent nylon inner fabric.
 1. Liner: Nylon fabric, mechanically locked without adhesives.
 2. Helix: Corrosion resistant galvanized steel; formed and mechanically locked to fabric.
 3. Vapor Barrier: Black fire retardant, polyethylene.
 4. Insulation: 1" thick. R-value of 6.0.
 5. Pressure Rating: 6" wg positive.

Sound Attenuation: Flexible ductwork shall have minimum sound attenuating capabilities as indicated below for nominal three feet of straight duct:

Duct Diameter	Insertion Loss (db)					
	125 (2)	250 (3)	500 (4)	1000 (5)	2000 (6)	4000 (7)
6	9	10	11	12	12	12
8	9	9	10	10	12	12
10	9	9	9	10	11	10
12	9	8	8	9	11	8

2.6 FRESH AIR INTAKE PLENUMS

- A. Fresh air intake plenums shall be double wall construction (minimum 18 gauge exterior wall, 20 gauge interior wall) with 2" (50 mm) thick, three pound density insulation.

2.7 OUTDOOR DUCTWORK

- A. All outdoor ductwork shall be double walled duct with 2" flexible elastomeric liner. In addition, duct shall be provided with an outdoor duct insulation system (see Division-23 section "HVAC Insulation" of these specifications) suitable for outdoor applications and U/V exposure. Provide aluminum saddles between duct insulation and duct supports to protect insulation. Contractor shall fasten ductwork to equipment supports as required to withstand windloading. Design of fastening system to withstand windloading shall be approved by a registered structural engineer.

PART 3 - EXECUTION

3.1 INSTALLATION OF DUCTWORK

- A. General: Assemble, install, support and seal ductwork in accordance with recognized industry practices which will achieve air tight (not to exceed 1% leakage) and noiseless (no objectionable noise) systems, capable of performing each indicated service. Install each run with minimum of joints. Align ductwork accurately at connections, within 1/8" (3 mm) misalignment tolerance and with internal surfaces smooth. Support ducts rigidly with suitable ties, braces, hangers and anchors of type which will hold ducts true-to-shape and to prevent buckling.
- B. Seal ductwork to SMACNA Standard Seal Class "A" and provide additional sealant as required to meet duct test requirements of this section.
- C. Install concrete inserts as required, for support of ductwork in coordination with formwork, as required to avoid delays in work.
- D. Complete fabrication of work at project as necessary to match shop-fabricated work and accommodate installation requirements.
- E. Locate ductwork runs, except as otherwise indicated, vertically and horizontally and avoid diagonal runs wherever possible. Locate runs as indicated by diagrams, details and notations or, if not otherwise indicated, run ductwork in shortest route which does not obstruct usable space or block access for servicing building and its equipment. Hold ducts close to walls, overhead construction, columns, and other structural and permanent-enclosure elements of building. Limit clearance to 1/2" (13 mm) where furring is shown for enclosure or concealment of ducts, but allow for insulation thickness, if any. Where possible, locate insulated ductwork for 1" (25 mm) clearance outside of insulation. Wherever possible in finished and occupied spaces, conceal ductwork from view, by locating in mechanical shafts, hollow wall construction or above suspended ceilings. Do not encase horizontal runs in solid partitions, except as specifically shown. Coordinate layout with suspended ceiling and lighting layouts and similar finished work.
- F. Electrical Equipment Spaces: Do not run ductwork through transformer vaults and their electrical equipment spaces and enclosures.

- G. Where ducts pass through interior partitions and exterior walls, conceal space between construction opening and duct or duct-plus-insulation with sheet metal flanges of same gauge as duct. Overlap opening on four (4) sides by at least 1-1/2" (40 mm).
- H. Coordinate duct installations with installation of accessories, dampers, coil frames, equipment, controls and other associated work of ductwork system.
- I. Support ductwork in manner complying with SMACNA Standards - latest edition of hangers and supports section.
- J. Unless indicated otherwise, all stainless steel ductwork shall be welded.
- K. Where vapors will be exhausted (dishwasher, cart wash, tunnel wash, canopy hood over sterilizers, etc.), ductwork shall be sloped back toward the source of moisture.
- L. All exposed ductwork (in non-mechanical rooms) shall be primed and painted with paint appropriate for sheet metal surfaces. See architectural section "Painting".
- M. Provide gasketed duct access doors as required to provide maintainable access to the upstream side of coils, humidifiers, etc.

3.2 INSTALLATION OF LINED DUCTWORK

- A. Provide lined ductwork at the following locations, and as otherwise indicated:
 - 1. All ductwork (supply, return, conditioned outside air, DOAS/ERU exhaust return) within the Mechanical Room.
 - 2. All ductwork within 25 feet upstream and downstream of air handling equipment (in all directions, including all duct branches and mains within 25 feet of equipment), including return air fans, with the exception of unconditioned outdoor air intake ductwork.
 - 3. Supply air ductwork downstream of air terminals.
 - 4. All air transfer ductwork, unless otherwise indicated.
- B. Dimensions on drawings indicate inside clear dimensions.
- C. Fiberglass liner exposed to the air stream shall not be utilized for outdoor air intake ductwork.
- D. Where ductwork is exposed to view in occupied areas, rectangular ductwork shall be lined and round ductwork shall be double wall duct with internal lining, unless otherwise noted.

3.3 INSTALLATION OF FLEXIBLE DUCTWORK

- A. Where indicated, provide factory insulated flexible ductwork between low pressure supply ductwork and round inlet ceiling diffusers. Provide side take-off fitting with damper (Flexmaster USA, model STOD or equivalent) between the flexible duct and the low

pressure supply ductwork. Extend rigid sheet metal ductwork between the fitting and the flexible ductwork as required. The maximum length of flexible duct shall be 3'- 0" (915 mm).

- B. Connections to round neck diffusers shall include a rigid 45 degree sheet metal elbow at the diffuser inlet.

3.4 CLEANING AND PROTECTION

- A. Prior to installation, thoroughly clean ductwork internally of dust and debris. Clean external surfaces of foreign substances which might cause corrosive deterioration of metal or might interfere with painting or cause paint deterioration.
- B. Temporary Closure: At ends of ducts which are not connected to equipment or air distribution devices at time of ductwork installation, install sheet metal temporary closures which will prevent entrance of dust and debris until the time all connections are to be completed.
- C. Provide MERV 13 filter media at all return air inlet locations throughout the duration of construction. Filter media shall not be removed until final filters are installed in the air handling units.

3.5 DUCT TESTING

- A. Prior to the balancing of systems by the AABC certified balancing contractor, all low pressure ductwork shall be tested by the mechanical contractor for duct leakage. Duct leakage shall not exceed 1%. In addition, current SMACNA and AABC Standards shall apply, where applicable, to meet the maximum 1% leakage. Duct leakage shall not exceed 1% of design cfm for a duration of ten (10) minutes. Test pressures shall be not less than the following:
 - 1. Ductwork systems less than 2.0 in. wg E.S.P.: Test to 2 in. wg
- B. Insulation materials shall not be applied until systems have been witnessed, documented, and submitted to meet the above testing requirements.
- C. The balance contractor shall witness and certify all duct pressure tests.
- D. Contractor shall submit duct leakage test results to the A/E within 72 hours of completed tests. Only test results that meet the specified leakage requirements shall be submitted. Duct test results shall be recorded on the "Air Duct Leakage Test Summary Form" located at the end of Section 230593; no other forms will be accepted. In addition, the duct leakage submittals shall include 11x17 drawing(s) as required to clearly indicate the full extent of the duct test section (each duct test section shall be numbered and color coded).
- E. All duct leakage test results shall be included with the final TAB report and the O&M Manual. The orifice tube calibration chart shall also be included with the final duct leakage test report information.

3.6 BALANCING

- A. Refer to Division-23 section "Testing, Adjusting and Balancing" for air distribution balancing of low pressure ductwork; not work of this section.

END OF SECTION 23 31 13

SECTION 23 33 00 - DUCTWORK ACCESSORIES

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

- A. Extent of ductwork accessories work is indicated on drawings and in schedules, and by requirements of this section and all other Division-23 sections.
- B. Types of ductwork accessories required for project include the following:
 - 1. Dampers:
 - a. Low pressure manual dampers
 - b. Control dampers
 - c. Counterbalanced dampers
 - 2. Fire and smoke dampers
 - 3. Turning vanes
 - 4. Duct hardware
 - 5. Duct access doors
 - 6. Flexible connections
 - 7. Penetration seals
 - 8. Sound attenuators

1.2 QUALITY ASSURANCE

- A. Codes and Standards:
 - 1. SMACNA Compliance: Comply with applicable portions of latest edition of SMACNA Standards. In addition, all duct accessories shall comply with SMACNA's "Duct Cleanliness for New Construction Guidelines." The "Duct Cleanliness Level" for all ductwork shall meet the requirements of the "Advanced Level."
 - 2. Industry Standards: Comply with ASHRAE recommendations pertaining to construction of ductwork accessories, except as otherwise indicated.
 - 3. UL Compliance: Construct, test, and label fire, smoke and combination fire/smoke dampers in accordance with UL Standards 555 and 555S.

4. NFPA Compliance: Comply with applicable provisions of NFPA 90A "Air Conditioning and Ventilating Systems", pertaining to installation of ductwork accessories.

1.3 SUBMITTALS

- A. Product Data: Submit manufacturer's technical product data for each type of ductwork accessory, including dimensions, capacities, materials of construction and installation instructions.
- B. Shop Drawings: Submit manufacturer's assembly-type shop drawings for each type of ductwork accessory showing interfacing requirements with ductwork, method of fastening or support, and methods of assembly of components.
- C. Maintenance Data: Submit manufacturer's maintenance data including parts lists for each type of duct accessory. Include this data, product data, and shop drawings in maintenance manual.
- D. Duct cleaning contractor shall submit proposed approach, methodology and detailed cleaning and sanitizing process for each system listed above for approval prior to work being performed. In addition, provide documentation of NADCA certification, as well as five (5) years of successful performance.

PART 2 - PRODUCTS

2.1 DAMPERS

- A. Low Pressure Manual Dampers: Provide dampers of single blade type or multiblade type, constructed in accordance with the latest edition of SMACNA Standards. Provide damper extender rods as required to compensate for external duct insulation. Air pressure drop shall not exceed 0.10" at 1500 FPM.
- B. Control Dampers: Refer to Division-23 section "Automatic Control Systems" for control dampers; not work of this section.
- C. Counterbalanced Dampers: Provide dampers with parallel blades, counterbalanced and factory-set to relieve at indicated static pressure. Construct blades of 16-gauge (1.6 mm) aluminum. Provide 1/2" (13 mm) diameter ball bearings, 1/2" (13 mm) diameter steel axles spaced on 9" (230 mm) centers. Construct frame of 2" x 1/2" x 1/8" ((50 mm x 13 mm x 3 mm) steel channel for face areas 25 sq. ft. (2.3 m²) and under; 4" x 1-1/4" x 16-gauge (100 mm x 30 mm x 1.6 mm) channel for face areas over 25 sq. ft. (2.3 m²). Provide galvanized steel finish on frame with aluminum touch-up. Air pressure drop shall not exceed 0.10" at 1500 FPM.

2.2 FIRE AND SMOKE DAMPERS

- A. Fire Dampers: Provide fire dampers where indicated and where required by NFPA and local authorities. Provide Type "C" fire dampers. Construction shall be in accordance with NFPA 90A and UL 555, and be UL labeled accordingly. Provide fusible link rated at 160°F to 165°F (71°C to 74°C) unless otherwise indicated. Provide damper with positive lock in

closed position. Damper blades shall be fully out of the air stream. Horizontal installations shall have damper blades and closure spring out of air stream. Provide the following features:

1. Damper Blade Assembly: Curtain or multiple blade type.
 2. Blade Material: Match casing and ductwork where installed.
 3. Provide factory sleeve. Construction shall be minimum 20 gauge. Should duct be heavier than 20 gauge, provide sleeve and frame to match duct and material construction. Sleeves shall be sufficient in length to protrude on both sides of the wall to allow for access door on one side and UL approved breakaway duct connection on both sides.
- B. Motor Driven Combination Fire/Smoke Dampers: Provide motor driven fire/smoke dampers in types and sizes indicated and where required by NFPA and local authorities as indicated on the drawings. Dampers shall be multi-blade type with frames and blades constructed of galvanized steel. Dampers shall be UL 555 and 555S listed with Class I leakage characteristics at 250°F (8 CFM/ft² at 4" WG). Dampers located in medium pressure systems shall have air foil blades. Dampers in low pressure systems are to be standard "V" groove type. Dampers shall have factory sleeves meeting the requirements of UL. Electric actuators shall be provided by the damper manufacturer and installed at the factory externally on the damper sleeve. Actuators shall be UL approved as an assembly with the damper. Provide end position indicator switches for use by ATC. Duct type smoke detectors shall be furnished under Division-28.
1. Coordinate the damper voltage with the smoke/duct detector relay voltage.
 2. See drawings for additional information regarding wiring of smoke and fire/smoke dampers.
- C. Dampers shall be as manufactured by Ruskin, Greenheck, Nailor, Air Balance, Pottorff, or United Enertech, subject to compliance with requirements indicated.
- D. All dampers shall have a maximum air pressure drop of 0.10" at 1500 FPM.
- 2.3 TURNING VANES
- A. Manufactured Turning Vanes: Provide turning vanes constructed of 1-1/2" (40 mm) wide curved blades set at 3/4" o.c. (20 mm), supported with bars perpendicular to blades set at 2" o.c. (50 mm), and set into side strips suitable for mounting in ductwork.
- 2.4 DUCT HARDWARE
- A. General: Provide duct hardware, manufactured by one manufacturer for all items on project, for the following:
1. Test Holes: Provide duct test holes in ductwork at fan inlet and outlet, and elsewhere as indicated, consisting of slot and cover, for instrument tests.
 2. Quadrant Locks: Provide for each damper, quadrant lock device on one end of shaft; and end bearing plate on other end for damper lengths over 12" (300 mm).

Provide extended quadrant locks and end extended bearing plates for externally insulated ductwork.

2.5 DUCT ACCESS DOORS

- A. General: Provide duct access doors where required for duct accessory access. Provide access doors for fire dampers, smoke dampers and smoke detectors. Install access doors upstream of duct type smoke detectors.
- B. Construction: Construct of same or greater gage as ductwork served and provide insulated doors for insulated ductwork. Provide flush frames for uninsulated ductwork and extended frames for externally insulated duct. Provide one side hinged, other side with one handle-type latch for doors 12" (300 mm) high and smaller, 2 handle-type latches for larger doors.

2.6 FLEXIBLE CONNECTIONS

- A. General: Provide flexible duct connections wherever ductwork connects to vibration isolated equipment. Construct flexible connections of neoprene-coated flame retardant fabric crimped into duct flanges for attachment to duct and equipment. Make airtight joint. Provide adequate joint flexibility to allow for thermal, axial, transverse, and torsional movement, and also capable of absorbing vibrations of connected equipment.

2.7 PENETRATION SEALS

- A. Provide seals for all openings through fire-rated walls, floors or ceilings used as passage for mechanical components such as ductwork. See Division-23 section "Basic HVAC Materials and Methods" for penetration seals and firestopping requirements.
- B. Provide seals for all openings through walls, floors or ceilings used as passage for mechanical components such as ductwork.

2.8 SOUND ATTENUATORS (SILENCERS)

- A. General:
 - 1. Sound attenuator manufacturer shall provide testing in accordance with ASTM E-477-2013.
 - 2. Sound attenuator inlet and outlet connection dimensions must be equal to the duct sizes shown on the drawings. Duct transitions at sound attenuators are not permitted unless shown on the contract drawings.
- B. Materials:
 - 1. General:

- a. Rectangular Attenuators: All rectangular attenuators shall be constructed with a 22 gauge galvanized steel outer casing and 26 gauge galvanized perforated steel inner wall.
 - b. Elbow Attenuators: All elbow attenuators shall be constructed with an 18 gauge galvanized steel outer casing and 22 gauge galvanized perforated steel inner wall. All acoustical splitters shall be internally radiused and aerodynamically designed for efficient turning of the air. Half and full splitters are required as necessary to achieve the scheduled insertion loss. All elbow attenuators with a turning cross-section dimension greater than 48" shall have at least two half splitters and one full splitter.
 - c. Circular Attenuators: All circular attenuators shall be constructed based on the following constraints:
 - 1) Silencers with a diameter less than 18 inches shall be constructed of no less than 22 gauge casing and 26 gauge perforated metal.
 - 2) Silencers with a diameter between 18 inches and 30 inches shall be constructed of no less than 20 gauge casing and 26 gauge perforated metal.
 - 3) Silencers with a diameter between 30 inches and 54 inches shall be constructed of no less than 18 gauge casing and 22 gauge perforated metal.
 - 4) Silencers with a diameter greater than 54 inches shall be constructed of no less than 18 gauge casing and 22 gauge perforated metal.
 - d. Access Doors: Where required, attenuators shall be supplied with an access door(s) to permit fire damper service. Access doors shall be supplied as an integral part of the attenuator by the attenuator manufacturer.
2. Dissipative Silencers:
- a. Acoustic Media: Media shall be treated with an EPA registered non-toxic anti-microbial agent to protect against mold, mildew, bacteria and fungi. The media shall not contain formaldehydes, phenolic resins or volatile organic compounds (VOC's). The media shall comply with UL 181 and NFPA 90A.
 - b. Combustion Ratings: Attenuator materials, including glass fiber shall have maximum combustion ratings as noted below when tested in accordance with ASTM E84, NFPA 255 or UL 723.

Flame Spread Index:	10
Smoke Developed Index:	50
3. Film Lined Silencers:
- a. The acoustic media shall be completely wrapped with Vibar™ film to help prevent shedding, erosion and impregnation.

- b. Combustion Ratings: Attenuator materials, including glass fiber shall have maximum combustion ratings as noted below when tested in accordance with ASTM E84, NFPA 255 or UL 723.

Flame Spread Index:	25
Smoke Developed Index:	50

C. Construction:

1. Sound attenuators shall be constructed in accordance with ASHRAE and SMACNA standards for the pressure and velocity classification specified for the air distribution system in which it is installed.
2. Material gauges noted in Paragraph B, are minimums.
3. Material gauges shall be increased as required for the system pressure and velocity classification. The attenuators shall not fail structurally when subjected to a differential air pressure of 8 inches water gauge.
4. Where required, silencer shall be constructed from stainless steel or aluminum.
5. Casings shall be lockformed and sealed, except as noted in Paragraph B, to provide leakage-resistant construction. Airtight construction shall be achieved by use of a duct-sealing compound supplied and installed by the contractor at the jobsite.
6. All perforated steel shall be adequately stiffened to insure flatness and form. All spot welds shall be painted.

D. Acoustic Performance:

1. Sound attenuator dynamic insertion loss shall not be less than that listed in the attenuator schedule.
2. Sound attenuator generated noise shall not be greater than that listed in the attenuator schedule.
3. Acoustic performance shall include dynamic insertion loss and generated noise for forward flow (air and noise in same direction) or reverse flow (air and noise in opposite direction) in accordance with the project's air distribution system requirements.
4. All attenuator ratings shall be determined in a duct-to-reverberant room test facility which provides for airflow in both directions through the test attenuator in accordance with the ASTM E-477-06a test standard. The test set-up, procedure and facility shall eliminate all effects due to flanking, directivity, end reflection, standing waves and reverberation room absorption.

E. Aerodynamic Performance:

1. Attenuator pressure drops shall not exceed those listed in the attenuator schedule. Attenuator pressure drop measurements shall be made in accordance with the ASTM E-477-06a test standard. Tests shall be conducted and reported on the identical units for which acoustical data is presented.

- F. Submittals:
1. Provide acoustical system calculations for all duct systems with attenuators to demonstrate that the resultant ductborne sound levels of the equipment as measured in the occupied spaces meet the specified criteria. In the absence of specified background sound level criteria, the guidelines as expressed in Table 34 of Chapter 47, "Sound and Vibration Control" of the 2003 ASHRAE Handbook - HVAC Applications, shall be used.
 2. The manufacturer shall supply certified test data for each scheduled attenuator. The data shall include dynamic insertion loss, generated noise and pressure drop for forward or reverse flow, matching the project's air distribution system requirement. All ratings shall be conducted in the same facility and shall utilize the same attenuator.
- G. Manufacturers: Subject to compliance with requirements, manufacturers offering products which may be incorporated in the work shall be limited to Vibro-Acoustics or Semco.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Examine areas and conditions under which ductwork accessories will be installed. Do not proceed with work until unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF DUCTWORK ACCESSORIES

- A. Install ductwork accessories in accordance with manufacturer's installation instructions, with applicable portions of details of construction as shown in SMACNA standards, and in accordance with recognized industry practices to ensure that products serve intended function.
- B. Provide fire dampers where ducts penetrate a floor slab, and elsewhere as indicated.
- C. Install balancing dampers where indicated, and at each ducted air inlet and outlet. Dampers are not required where a single air outlet occurs downstream of an air terminal (VAVs, fan powered boxes, etc.).
- D. Install turning vanes in square or rectangular elbows (45 degrees and greater) in supply, return and exhaust air systems, and elsewhere as indicated.
- E. Install airtight access doors to open against system air pressure, with latches operable from either side, except outside only where duct is too small for person to enter. Duct access panels shall be adequately sized to provide access to all fire and/or smoke damper fusible links.
- F. All electrical connections to smoke damper actuators and smoke detectors (duct or ceiling mounted) shall be provided by the ATC contractor.

- G. Coordinate with other work, including ductwork, as necessary to interface installation of ductwork accessories properly with other work.

3.3 DUCT CLEANING

- A. Prior to cleaning or sanitizing ductwork/equipment, all equipment utilized to perform those processes shall be sanitized. Examine ductwork/equipment prior to performing work and provide new duct openings where required to provide visual inspection of the duct interior.
- B. Unless indicated otherwise, the systems shall be cleaned and sanitized in the following order:
 - 1. Exhaust systems
 - 2. Return systems
 - 3. Air handling unit(s)
 - 4. Air handling unit supply systems
- C. Duct cleaning of the above systems listed shall include air devices, terminal reheat units, etc.
- D. Cleaning Process:
 - 1. General:
 - a. Systems shall be de-energized while duct cleaning and sanitizing are in progress.
 - b. HEPA filter vacuums shall be used to keep room air clean. Ceiling tile shall be handled with care, and repaired or replaced as required to restore to the original condition.
 - 2. Air Handler Cleaning Procedures:
 - a. Vacuum completely, beginning with the area upstream of the filters. Filters shall be replaced at the completion of the work.
 - b. Vacuum the fan and fan chamber.
 - c. Wash/degrease fan blades as required.
 - d. Wash/degrease chamber upstream of the coils as required.
 - e. Clean coils.
 - f. Sanitize.
 - 3. Coil Cleaning Procedure: The procedure shall be customized to the situation encountered. The most heavily soiled coils may take a more complicated procedure of solution/pressure spraying. Most require only low pressure

application of special cleaning solution and rinsing after they are first fully vacuumed.

4. Furniture Coverage from Incidental Dirt: As required, drape surrounding instruments, computers and areas with plastic to protect them from any incidental dirt generated during the cleaning process. Work environment shall be clean at all times. Floor shall be vacuumed as needed.
5. Duct Cleaning: Cleaning shall be accomplished by mechanical means in conjunction with the use of High CFM HEPA style vacuums and three (3) filtered canister vacuums. Mechanical means may include vacuum brushing of the duct interior, auger style mechanical devices, or high pressure air activated in duct cleaning devices to scrape off any dirt adhered to duct walls. Cleaning may be accomplished by a combination of these methods. Where possible, clean a full run or section before beginning another to insure full cleaning coverage. All material in the vacuum shall be disposed of daily after being treated with a sanitizer.
6. Sanitizing Process: Sanitizing shall be accomplished in two stages. First, it shall be done as each section of the air system is cleaned. The sanitization process shall be repeated again after the complete system has been cleaned. All sanitizing shall be completed before access is sealed. Diffusers shall be cleaned and sanitized. EPA recognized/registered sanitizers only shall be used. MSDS information shall be supplied for materials selected. Sanitizers/encapsulants shall not be used as a substitute for proper cleaning.
7. Clean Tests: Tests for bacteria/fungi shall be performed after all cleaning and sanitizing is completed to insure the clean standards have been met. This shall be done while the system is in operation and shall be a minimum of forty-eight (48) hours after the last sanitation has been completed.
8. Closing and Sealing: Provide galvanized sheet metal plate(s) to be used as access for the majority of locations. Square cut 22 gauge metal shall be used with each plate to lap its edges by one inch all around. Screws shall be placed at four inch (100 mm) intervals and the plate shall be sealed with a water-based fireproof sealant to ensure proper seal of the system to match existing pressure classification.
9. Encapsulation: There may be times when it is necessary to use an encapsulant on interior lined duct. It should be used only if circumstances require it (for example, the lining may be breaking down), and shall be agreed to in advance by the client. It shall not be used as a substitute for cleaning.
10. Duct cleaning shall be performed by Applied Building Technologies, Inc. or equivalent.

3.4 FIELD QUALITY CONTROL

- A. Operate installed duct accessories to demonstrate compliance with requirements. Test for air leakage while system is operating. Repair or replace faulty accessories, as required to obtain proper operation and leakproof performance.

3.5 ADJUSTING AND CLEANING

- A. Adjusting: Adjust ductwork accessories for proper settings, install fusible links in fire dampers and adjust for proper operation.
 - 1. Final positioning of manual dampers is specified in Division-23 section "Testing, Adjusting and Balancing."
- B. Cleaning: Clean factory-finished surfaces. Repair any marred or scratched surfaces with manufacturer's touch-up paint.
- C. Provide MERV 13 filter media at all return air inlet locations throughout the duration of construction. Filter media shall not be removed until final filters are installed in the air handling units.

3.6 EXTRA STOCK

- A. Furnish extra fusible links to the Owner; one (1) link for every ten (10) installed of each temperature range.

END OF SECTION 23 33 00

SECTION 23 37 00 - AIR OUTLETS AND INLETS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-01 Specification sections, apply to work of this section.

1.2 DESCRIPTION OF WORK

- A. Extent of air outlets and inlets work is indicated by drawings and schedules, and by requirements of this section and all other Division-23 sections.
- B. Types of air outlets and inlets required for project include the following:
 - 1. Ceiling air diffusers
 - 2. Registers and grilles

1.3 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of air outlets and inlets of types and capacities required, whose products have been in satisfactory use in similar service for not less than five (5) years.
- B. Codes and Standards:
 - 1. ARI Compliance: Test and rate air outlets and inlets in accordance with ARI 650 "Standard for Air Outlets and Inlets".
 - 2. ASHRAE Compliance: Test and rate air outlets and inlets in accordance with ASHRAE 70 "Method of Testing for Rating the Air Flow Performance of Outlets and Inlets".
 - 3. ADC Compliance: Test and rate air outlets and inlets in certified laboratories under requirements of ADC 1062 "Certification, Rating and Test Manual".
 - 4. ADC Seal: Provide air outlets and inlets bearing ADC Certified Rating Seal.
 - 5. NFPA Compliance: Install air outlets and inlets in accordance with NFPA 90A "Standard for the Installation of Air Conditioning and Ventilating Systems".

1.4 SUBMITTALS

- A. Product Data: Submit manufacturer's technical product data for air outlets and inlets including the following:

1. Schedule of air outlets and inlets indicating drawing designation, room location, number furnished, model number, size, Noise Criteria (NC) levels, static pressure loss, and accessories furnished.
 2. Data sheet for each type of air outlet and inlet, and accessory furnished; indicating construction, finish, and mounting details.
 3. Performance data for each type of air outlet and inlet furnished, including aspiration ability, temperature and velocity traverses, throw and drop, and noise criteria ratings. Indicate selections on data.
- B. Shop Drawings: Submit manufacturer's assembly-type shop drawing for each type of air outlet and inlet, indicating materials and methods of assembly of components.
- C. Maintenance Data: Submit maintenance data, including cleaning instructions for finishes, and spare parts lists. Include this data, product data, and shop drawings in maintenance manuals.
- 1.5 PRODUCT DELIVERY, STORAGE AND HANDLING
- A. Deliver air outlets and inlets wrapped in factory-fabricated fiber-board type containers. Identify on outside of container type of outlet or inlet and location to be installed. Avoid crushing or bending and prevent dirt and debris from entering and settling in devices.
- B. Store air outlets and inlets in original cartons and protect from weather and construction work traffic. Where possible, store indoors; when necessary to store outdoors, store above grade and enclose with waterproof wrapping.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products which may be incorporated in the work shall be limited to the following:
1. Titus
 2. Krueger
 3. Price
 4. Nailor
 5. Anemostat
 6. Metal Air

2.2 CEILING AIR DIFFUSERS

- A. General: Except as otherwise indicated, provide manufacturer's standard ceiling air diffusers where shown; of size, shape, capacity and type indicated; constructed of materials and components as indicated, and as required for complete installation.
- B. Performance: Provide ceiling air diffusers that have, as a minimum, temperature and velocity traverses, throw and drop, and noise criteria ratings for each size device as listed in manufacturer's current data.
- C. Ceiling Compatibility: Provide diffusers with border styles that are compatible with adjacent ceiling systems, and that are specifically manufactured to fit into ceiling module with accurate fit and adequate support. Refer to general construction drawings and specifications for types of ceiling systems which will contain each type of ceiling air diffuser.
- D. Types: Provide ceiling diffusers of type, capacity, and with accessories and finishes as listed on diffuser schedule. The following requirements shall apply to nomenclature indicated on schedule:
- E. Diffuser Materials:
 - 1. Steel Construction: Manufacturer's standard stamped sheet steel frame and adjustable blades.
 - 2. Aluminum Construction: Manufacturer's standard extruded aluminum frame and adjustable blades.
- F. Diffuser Faces:
 - 1. Square: Square housing, core of square concentric louvers, square or round duct connection. (See drawings).
 - 2. Rectangular: Rectangular housing, core of rectangular concentric louvers, square or round duct connection. (See drawings).
 - 3. Perforated: Square, housing covered with removable perforated panel in frame. Conceal air pattern devices above panel.
 - 4. Linear: Extruded aluminum continuous slot, single or multiple.
- G. Diffuser Mountings:
 - 1. Stepped-Down: Diffuser housing below ceiling with perimeter flange and gasket to seal against ceiling construction.
 - 2. Flush: Diffuser housing above ceiling surface with flush perimeter flange and gasket to seal against ceiling.
 - 3. Lay-In: Diffuser housing sized to fit between ceiling exposed suspension tee bars and rest on top surface of tee bar.
- H. Diffuser Patterns:

1. 1-Way: Fixed louver face for 1-direction air flow, direction indicated on drawings.
2. 2-Way: Fixed louver face for 2-direction air flow, directions indicated on drawings.
3. 3-Way: Fixed louver face for 3-direction air flow, directions indicated on drawings.
4. 4-Way: Fixed louver face for 4-direction air flow, directions indicated on drawings.
5. Induction: Internal aspirator designed to mix air drawn into center core with conditioned air.

I. Diffuser Dampers:

1. Fire Damper: Where indicated, provide combination adjustable opposed blade damper and fusible link fire damper with UL approved link and assembly designed to meet requirements of NFPA 90A.

J. Diffuser Finishes:

1. Aluminum Enamel: Air-dried aluminum enamel prime finish.
2. White Enamel: Semi-gloss white enamel prime finish.
3. Aluminum Anodize: Aluminum etched and anodized, covered with clear lacquer finish.

2.3 REGISTERS AND GRILLES

- A. General: Except as otherwise indicated, provide manufacturer's standard registers and grilles where shown; of size, shape, capacity and type indicated; constructed of materials and components as indicated, and as required for complete installation.
- B. Performance: Provide registers and grilles that have, as a minimum, temperature and velocity traverses, throw and drop, and noise criteria ratings for each size device as listed in manufacturer's current data.
- C. Surface Compatibility: Provide registers and grilles with border styles that are compatible with adjacent surfaces, and that are specifically manufactured to fit with accurate fit and adequate support. Refer to general construction drawings and specifications for types of construction which will contain each type of register and grille.
- D. Types: Provide registers and grilles of type, capacity, and with accessories and finishes as listed on register and grille schedule. The following requirements shall apply to nomenclature indicated on schedule:
 1. Register and Grille Materials:
 - a. Steel Construction: Manufacturer's standard stamped sheet steel frame and adjustable blades.
 - b. Aluminum Construction: Manufacturer's standard extruded aluminum frame and adjustable blades.

2. Register and Grille Faces:
 - a. Horizontal Fixed Blades: Horizontal blades, fixed at 35 degrees, with 3/4" (20 mm) spacing. Blades shall be parallel to long dimension.
3. Register and Grille Patterns:
 - a. Single Deflection: 1-set of blades in face.
4. Register and Grille Finishes:
 - a. Aluminum Enamel: Air-dried aluminum enamel prime finish.
 - b. White Enamel: Semi-gloss white enamel prime finish.
 - c. Aluminum Anodize: Aluminum etched and anodized, covered with clear lacquer finish.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Examine areas and conditions under which air outlets and inlets are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. General: Install air outlets and inlets in accordance with manufacturer's written instructions. Air outlets and inlets shall be independently supported from the structure at two (2) locations and in accordance with recognized industry practices to ensure that products serve intended functions. The ceiling or ceiling grid shall not be considered as a means of support.
- B. Coordinate with other work, including ductwork and duct accessories, as necessary to interface installation of air outlets and inlets with other work.
- C. Locate ceiling air diffusers, registers, and grilles, as indicated on general construction "Reflected Ceiling Plans". Unless otherwise indicated, locate units in center of acoustical ceiling modules.
- D. Provide MERV 13 filter media at all return air inlet locations throughout the duration of construction. Filter media shall not be removed until final filters are installed in the air handling units.

END OF SECTION 23 37 00

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SECTION 23 62 00 - AIR COOLED CONDENSING UNITS

PART 1 - GENERAL

1.1 SUMMARY

- A. Scope: Extent of condensing unit work required by this Section is indicated on drawings and schedules, by requirements of this Section, and all other Division-23 Sections.
- B. Types: Types of condensing units specified in this Section include the following:
 - 1. Air cooled condensing units (1 to 7 tons)
 - 2. Air cooled condensing units (7 to 80 tons)

1.2 QUALITY ASSURANCE

- A. Codes and Standards: Provide condensing units conforming to the following requirements:
 - 1. Air-Conditioning and Refrigeration Institute (ARI): Rate in conformance with ARI 210, "Standard for Unitary Air-Conditioning Equipment," and ARI 270, "Standard for Sound Rating of Outdoor Unitary Equipment" for units up to 7 tons capacity.
 - a. ARI: Rate and test in conformance with ARI 520, "Standard for Positive Displacement Refrigerant Compressors, Compressor Units and Condensing Units" for units up to 200 tons capacity.
 - 2. American National Standards Institute (ANSI): Construct and rate in accordance with ANSI B19.1, "Safety Standard for Air Compressor Systems."
 - 3. American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE): Construct and rate in conformance with ASHRAE 15, "Safety Code for Mechanical Refrigeration."
 - 4. Underwriters Laboratories, Inc. (UL) or Electrical Testing Laboratories (ETL): Provide units with UL or ETL listing and label.
- B. Commissioning Tests: Condensing units shall meet commissioning requirements of paragraphs in Part 3 of this Section.

1.3 SUBMITTALS

- A. Product Data: Submit manufacturer's product data, including rated capacities, weights, furnished specialties and accessories and installation and start-up instructions.
- B. Drawings: Submit manufacturer's drawings indicating dimensions, required clearances, and refrigeration component balance diagram.

- C. Wiring Diagrams: Submit ladder-type wiring diagrams for power and control wiring. Differentiate between portions of wiring that are factory-installed and portions to be field-installed.
- D. Maintenance Data: Submit maintenance data and parts list for each condensing unit, control, and accessory.
- E. Commissioning Test Plan: Submit test plan for condensing unit tests specified in Part 3 of this Section. Plan shall include test schedules and names and titles of the test personnel who will be participating in the commissioning tests. The test personnel must be employees of the condensing manufacturer, the manufacturer's designated representatives or employees of an independent testing agency regularly engaged in testing of similar equipment. Plan shall include false loading of condensing units, if the anticipated building loads at the time of test do not meet condensing unit capacity requirements. Submittal shall have detailed layout for temporary equipment, if such equipment are needed even if they are not specified or shown on drawings.

1.4 DELIVERY, STORAGE AND HANDLING

- A. Delivery: Handle condensing units carefully to prevent damage, denting and scoring. Do not install damaged condensing units or components; replace with new.
- B. Storage: Store condensing units and components in a clean dry place. Protect from weather, dirt, water, and construction debris.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Condensing unit manufacturer shall be the same manufacturer as the air handling unit manufacturer where the associated DX coil is located.

2.2 AIR COOLED CONDENSING UNITS: 1 TO 7 TONS

- A. General: Provide factory-assembled and tested air cooled condensing units of quantities and capacities scheduled on the drawings, and matched, by the manufacturer, to the evaporator characteristics.
- B. Casing: Provide casings of 18-gauge galvanized steel with baked enamel or air-dried powder finish, cadmium plated bolts or wing nuts, removable panels for internal access, louvered protection over condenser fins and cadmium plated or corrosion resistant fan guard.
- C. Compressor: Provide welded hermetic compressor with stator thermal overload protector, spring or neoprene isolators, internal pressure relief or high pressure cut out, and crankcase heater.
- D. Accessories: Provide the following accessories:

1. Low pressure cutouts
 2. High pressure cutout or internal relief
 3. Brass cap seal service valves with gauge taps
 4. Timed temperature sensitive compressor cycling relay
 5. Refrigerant line filter dryer
 6. NEMA motor contactor
 7. Refrigerant and oil charge
- E. Condenser: Provide an air cooled condenser with copper or aluminum tubes and aluminum fins, 400 psig design pressure, direct drive aluminum fans and totally enclosed motor with thermal overload switch, conforming to NEMA MG 1.
1. Provide low ambient cooling controls to 50 degrees F.
 2. Provide low ambient cooling controls to 30 degrees F.
 3. Provide low ambient cooling controls to 0 degrees F.
- F. Piping: Provide pre-charged and insulated suction and liquid tubing of copper conforming to American Society of Testing and Materials (ASTM) B 88, "Standard Specification for Seamless Copper Water Tube."

2.3 AIR COOLED CONDENSING UNITS: 7 TO 80 TONS

- A. General: Provide factory-assembled and tested air cooled condensing units, of type, quantity and size indicated on the schedules and the drawings, and suitable for operation in the locations indicated.
- B. Casing: Provide casings as follows:
1. Weatherproof for outside installation.
 2. Construct of 18 gauge galvanized steel, zinc phosphatized with baked enamel or air dried powder factory finish and removable access panels to compressors, controls and all serviceable components.
 3. Provide hinged or lift-out doors with handles and twist-lock hardware. Sheet metal screws will not be acceptable.
 4. Provide removable cadmium plated or corrosion resistant fan guards and condenser coil inlet guards.
 5. Provide lifting lugs welded to a rigid galvanized steel base.
- C. Compressors: Provide reciprocating or scroll type compressors.

1. Provide reversible positive displacement oil pump with factory set oil pressure regulating valve.
 2. Provide oil level sight glass, oil filter or strainer, and magnetic plug.
 3. Provide a suction gas cooled motor with high temperature motor protection, and suction pressure or electric actuated unloaders.
 4. Provide ten (10) year parts and labor warranty if reciprocating compressors are utilized.
- D. Condenser: Provide an air cooled condenser with seamless copper tube with aluminum fins.
1. Space fins for cleaning; maximum 200 per foot.
 2. Provide separate and independent refrigerant circuits for each compressor.
 3. Provide liquid accumulator and sub-cooling circuit.
 4. Design and test for 450 psig, factory dehydrate and charge.
 5. Provide propeller-type direct drive fans with aluminum or corrosion resistant steel blades, totally enclosed, permanently lubricated squirrel-cage motors, NEMA Code Letter C.
 6. Provide fan contactors, with overloads in weatherproof housing.
- E. Accessories:
1. Provide low ambient controls to allow operation at ambient temperatures scheduled.
 2. Refrigeration system shall be provided with hot gas bypass.
- F. Controls: Provide operating controls in a factory-installed weatherproof enclosure. Provide, as a minimum, fan fuses and terminal blocks, fan contactors one per fan, control power circuit transformer and power connection terminal block.
1. Provide molded case circuit breakers or motor circuit thermal protectors with thermal overload trips for each compressor.
 2. Provide compressor contactors.
 3. Provide recycling pump down relay and manual pump down switch.
 4. Provide high and low pressure cutout relays for each compressor.
 5. Provide oil pressure cutout switch for each compressor.
 6. Provide sequencing relay for multiple compressor units.

7. Provide a five (5) minute compressor restart timer to prevent short-cycling on power failure.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Support: Conform to manufacturer's clearance, support and installation requirements.
- B. Entrance Dimensions: Verify equipment building entrance requirements.

3.2 INSTALLATION OF CONDENSING UNITS

- A. General: Install condensing units in accordance with manufacturer's installation instructions.
- B. Refrigerant Piping: Refer to Division-23 Section, "Refrigerant Piping". Provide piping in strict accordance with manufacturer's requirements.
- C. Electric Wiring: Provide control and interlock wiring as specified, conforming to manufacturer's requirements. Coordinate field-installed automatic temperature control wiring with Division-23 Section, "Automatic Control Systems."
- D. Start-Up: Start-up under direction of a factory-authorized representative and test all controls, safeties and wiring before start-up.
- E. Field Test: Field tests during condensing unit installation and start-up tests shall not be considered as fulfilling requirements of commissioning tests.

3.3 COMMISSIONING TESTS

- A. Preparation for Tests: Before the scheduled commissioning tests, the Contractor and/or the manufacturer's representative shall have prepared the condensing units in accordance with the recommendations of the manufacturer for start-up and operations.
- B. Operational Control Test:
 1. Demonstrate proper functioning of the operational controls of the condensing units. Confirm proper operation for the following.
 - a. Crankcase heater
 - b. Oil pumping system
 - c. Compressor unloaders
 - d. Pump down operation
 - e. High and low pressure cutouts for each compressor

- f. Oil pressure cutout for each compressor
 - g. Sequencing relay for multiple compressor units
 - h. Time cycling relay
 - i. Low ambient controls
2. Demonstrate condensing unit capacity control by varying the space or unit load. The capacity range to be tested shall be from no load to full load and back to no load. The condensing unit must demonstrate stable operation without excess vibration and noise. Each step of the multi-step control (cylinder unloading and/or compressor staging) must be verified.
 3. Demonstrate that manual resetting is required to restart compressors for all safety cutouts.
 4. All safety control tests must be verified by electric signals at the compressor motor starters or actual stopping of the compressors.
 5. Demonstrate proper functioning of all indicating lights.

3.4 TRAINING OF PERSONNEL

- A. Training: Provide the services of a manufacturer's technical representative for one (1) four-hour day. Give instructions in operation, start-up, shut-down and maintenance.
 1. Schedule training, in writing, seven (7) days in advance.
 2. Obtain concurrence for training schedule.

END OF SECTION 23 62 00

SECTION 23 73 13 - AIR HANDLING UNITS

PART 1 - GENERAL

1.1 SUMMARY

- A. Scope: Extent of air handling unit work required by this Section is indicated on the drawings, by requirements of this Section, and all other Division-23 Sections.
- B. Refer to requirements of Division-26.

1.2 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Provide air handling units that are the standard product of an equipment manufacturer regularly engaged in the production of such units who issues complete catalog information on such products. Units shall not be fabricated by the Contractor.
- B. Certifications: Provide certified ratings of units based on tests performed in accordance with ARI 430.
- C. Codes and Standards: Provide air handling units conforming to the following:
 - 1. Air Movement and Control Association, Inc. (AMCA): Comply with applicable AMCA including:
 - a. 210 Laboratory Methods of Testing Fans for Rating Purposes
 - b. 500 Test Method for Louvers, Dampers, and Shutters
 - 2. Air-Conditioning and Refrigeration Institute (ARI): Comply with applicable ARI including the following:
 - a. 410 Forced-Circulation Air-Cooling and Air-Heating Coils
 - b. 430 Central-Station Air-Handling Units
 - 3. American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE): Construct and install refrigerant coils in accordance with ASHRAE 15, "Safety Code for Mechanical Refrigeration."
 - 4. National Electrical Manufacturers Association (NEMA): Except for motors, provide electrical components required as part of air handling units, which comply with NEMA Standards.
 - 5. National Fire Protection Association (NFPA): Provide air handling unit internal insulation having flame spread rating not over 25 and smoke developed rating no higher than 50; and complying with NFPA 90A, "Standard for the Installation of Air Conditioning and Ventilating Systems." Comply with NFPA 70, "National Electrical

Code," as applicable for installation and electrical connections of ancillary electrical components of air handling units.

6. Sheet Metal and Air Conditioning Contractors' National Association, Inc. (SMACNA): Comply with applicable SMACNA standards including "HVAC Duct Construction Standards - Metal and Flexible."
7. Underwriters Laboratories, Inc. (UL): Except for motors, provide electrical components required as part of air handling units, which have been listed and labeled by UL.

1.3 SUBMITTALS

- A. Product Data: Submit manufacturer's technical product data for air handling units showing dimensions, weights, capacities, ratings, fan performance with operating point clearly indicated, motor electrical characteristics, and finishes of materials, and installation instructions.
- B. Shop Drawings: Submit shop drawings showing unit dimensions, weight loadings, required clearances, field connection details and methods of support. Draw to a scale of one half inch to one foot (13 mm to 300 mm), using same sheet size as Contract Drawings. Include field fabricated mixing boxes, dampers and duct connections.
- C. Maintenance Data: Submit maintenance instructions, including instructions for lubrication, filter replacement, motor and drive replacement, and spare parts lists. Include this data, product data, shop drawings, and wiring diagrams in operating and maintenance manuals.

1.4 DELIVERY, STORAGE AND HANDLING

- A. Delivery: Deliver air handling units with factory-installed shipping skids and lifting lugs; pack small components in factory-fabricated protective containers.
- B. Handling: Handle air handling units carefully to avoid damage to components, enclosures, and finish. Do not install damaged components; replace and return damaged components to air handling unit manufacturer.
- C. Storage: Store air handling units in clean dry place and protect from weather and construction traffic.
- D. Unloading: Comply with manufacturer's rigging and installation instructions for unloading air handling units, and moving them to final locations.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products which may be incorporated in the work, shall be limited to the following:

1. Trane
2. Daikin
3. JCI
4. Carrier

2.2 INDOOR AIR HANDLING UNIT

- A. Unit layout and configuration shall be as defined in project plans and schedule.
- B. Manufacturer to provide a full perimeter integral base frame for either ceiling suspension of units or to support and raise all sections of the unit for proper trapping. Base frame will either be bolted construction or welded construction. Refer to schedule for base height and construction type. Contractor will be responsible for providing a housekeeping pad when unit base frame is not of sufficient height to properly trap unit. Unit base frames not constructed of galvanized steel shall be chemically cleaned and coated with both a rust-inhibiting primer and finished coat of rust-inhibiting enamel. Unit base height to be included in total height required for proper trap height.
- C. UNIT CASING
 1. Unit manufacturer shall ship unit in segments as specified by the contractor for ease of installation in tight spaces. The entire air handler shall be constructed of galvanized steel. Casing finished to meet ASTM B117 125-hour salt-spray test. The removal of access panels or access doors shall not affect the structural integrity of the unit. All removable panels shall be gasketed. All doors shall have gasketing around full perimeter to prevent air leakage. Contractor shall be responsible to provide connection flanges and all other framework that is needed to properly support the unit.
 2. Casing performance - Casing air leakage shall not exceed leak class 6 (CL = 6) per ASHRAE 111 at specified casing pressure, where maximum casing leakage (cfm/100 ft² of casing surface area) = CL X P^{0.65}.
 3. Air leakage shall be determined at 1.00 times maximum casing static pressure up to 8 inches w.g. Specified air leakage shall be accomplished without the use of caulk. Total estimated air leakage shall be reported for each unit in CFM, as a percentage of supply air, and as an ASHRAE 111 Leakage Class.
 4. Under 55F supply air temperature and design conditions on the exterior of the unit of 81F dry bulb and 73F wet bulb, condensation shall not form on the casing exterior. The AHU manufacturer shall provide tested casing thermal performance for the scheduled supply air temperature plotted on a psychrometric chart. The design condition on the exterior of the unit shall also be plotted on the chart. If tested casing thermal data is not available, AHU manufacturer shall provide, in writing to the Engineer and Owner, a guarantee against condensation forming on the unit exterior at the stated design conditions above. The guarantee shall note that the AHU manufacturer will cover all expenses associated with modifying units in the field should external condensate form on them. In lieu of AHU manufacturer providing a written guarantee, the installing contractor must provide additional external insulation on AHU to prevent condensation.

5. Unit casing (wall/floor/roof panels and doors) shall be able to withstand up to 1.5 times design static pressure, or 8-inch w.g., whichever is less, and shall not exceed 0.0042 per inch of panel span (L/240).
6. Floor panels shall be double-wall construction and designed to support a 300-lb load during maintenance activities and shall deflect no more than 0.0042 per inch of panel span.
7. Unit casing panels shall be 2-inch double-wall construction, with solid galvanized exterior and solid galvanized interior, to facilitate cleaning of unit interior.
8. Unit casing panels (roof, walls, floor) and doors shall be provided with a minimum thermal resistance (R-value) of 13 Hr*Ft²*°F/BTU.
9. Unit casing panels (roof, walls, floor) and external structural frame members shall be completely insulated filling the entire panel cavity in all directions so that no voids exist. Panel insulation shall comply with NFPA 90A.
10. Casing panel inner liners must not extend to the exterior of the unit or contact the exterior frame. A mid-span, no-through-metal, internal thermal break shall be provided for all unit casing panels.
11. Access panels and/or access doors shall be provided in all sections to allow easy access to drain pan, coil(s), motor, drive components and bearings for cleaning, inspection, and maintenance.
12. Access panels and doors shall be fully removable without the use of specialized tools to allow complete access of interior surfaces.

D. ACCESS DOORS

1. Access doors shall be 2-inch double-wall construction. Interior and exterior shall be of the same construction as the interior and exterior wall panels.
2. All doors shall be provided with a thermal break construction of door panel and door frame.
3. Gasketing shall be provided around the full perimeter of the doors to prevent air leakage.
4. Door hardware shall be surface-mounted to prevent through-cabinet penetrations that could likely weaken the casing leakage and thermal performance.
5. Handle hardware shall be designed to prevent unintended closure.
6. Access doors shall be hinged and removable without the use of specialized tools.
7. Hinges shall be interchangeable with the door handle hardware to allow for alternating door swing in the field to minimize access interference due to unforeseen job site obstructions.
8. Door handle hardware shall be adjustable and visually indicate locking position of door latch external to the section.

9. All doors shall be a 60-inch high when sufficient unit height is available, or the maximum height allowed by the unit height.
10. Multiple door handles shall be provided for each latching point of the door necessary to maintain the specified air leakage integrity of the unit.
11. Provide a shatterproof thermal dual pane window in all access doors. Window shall be capable of withstanding unit operating pressures and shall be safe for viewing UV-C lamps.

E. PRIMARY DRAIN PANS

1. All cooling coil sections shall be provided with an insulated, double-wall, galvanized drain pan.
2. The drain pan shall be designed in accordance with ASHRAE 62.1 being of sufficient size to collect all condensation produced from the coil and sloped in two planes, pitched toward drain connections, promoting positive drainage to eliminate stagnant water conditions when unit is installed level and trapped per manufacturer's requirements.
3. The outlet shall be located at the lowest point of the pan and shall be sufficient diameter to preclude drain pan overflow under any normally expected operating condition.
4. All drain pan threaded connections shall be visible external to the unit. Threaded connections under the unit floor shall not be accepted.
5. Drain connections shall be of the same material as the primary drain pan and shall extend a minimum 2-1/2-inch beyond the base to ensure adequate room for field piping of condensate traps.
6. The installing contractor is responsible to ensure the unit is installed level, trapped in accordance with the manufacturer's requirements, and visually inspected to ensure proper drainage of condensate.
7. Coil support members inside the drain pan shall be of the same material as the drain pan and coil casing.
8. If drain pans are required for heating coils, access sections, or mixing sections they will be indicated in the plans.

F. FANS

1. Fan sections shall have a minimum of one hinged and latched access door located on the drive side of the unit to allow inspection and maintenance of the fan, motor, and drive components.
2. Provide fans of type and class as specified on the schedule. All fans shall be statically and dynamically tested by the manufacturer for vibration and alignment as an assembly at the operating RPM to meet design specifications. Fans that are selected with inverter balancing shall first be dynamically balanced at design RPM. The fans then will be checked in the factory from 25% to 100% of design RPM to insure they are operating within vibration tolerance specifications, and that there

are no resonant frequency issues throughout this operating range. Inverter balancing that requires lockout frequencies inputted into a variable frequency drive to in order to bypass resonant frequencies shall not be acceptable. If supplied in this manner by the unit manufacturer, the contractor will be responsible for rebalancing in the field after unit installation. Fans selected with inverter balancing shall have a maintenance free grounding assembly installed on the fan motor to discharge both static and induced shaft currents to ground.

3. Direct drive plenum fans with integral frame motors, shall be mounted on isolation bases. Fan shall be dynamically balanced throughout the operating range to a BV-3 (0.20 in/s) per AMCA 204 test standard. Fan and motor shall be internally isolated with spring isolators. A flexible connection shall be installed between fan and unit casing to ensure complete isolation. Flexible connection shall comply with NFPA 90A and UL 181 requirements. If fans and motors are not internally isolated, then the entire unit shall be externally isolated from the building, including supply and return duct work, piping, and electrical connections. External isolation shall be furnished by the installing contractor in order to avoid transmission of noise and vibration through the ductwork and building structure.

G. MOTORS AND DRIVES

1. Motors shall meet or exceed all NEMA Standards Publication MG 1 - 2006 requirements and comply with NEMA Premium efficiency levels when applicable. Motors shall comply with applicable requirements of NEC and shall be UL Listed.
2. Fan Motors shall be heavy duty, open drip-proof operable at scheduled voltage. If applicable, motor efficiency shall meet or exceed NEMA Premium efficiencies.
3. Direct driven fans utilizing integral frame motors shall use 2-pole (3600 rpm), 4-pole (1800 rpm) or 6-pole (1200 rpm) motors, NEMA Design B, with Class B insulation capable to operate continuously at 104 deg F (40 deg C) without tripping overloads.
4. Motors shall have a +/- 10 percent voltage utilization range to protect against voltage variation.

H. COILS

1. Coils section header end panel shall be removable to allow for removal and replacement of coils without impacting the structural integrity of the unit.
2. Install coils such that headers and return bends are enclosed by unit casing to ensure that if condensate forms on the header or return bends, it is captured by the drain pan under the coil.
3. Coils shall be manufactured with plate fins to minimize water carryover and maximize airside thermal efficiency. Fin tube holes shall have drawn and belled collars to maintain consistent fin spacing to ensure performance and air pressure drop across the coil as scheduled. Tubes shall be mechanically expanded and bonded to fin collars for maximum thermal conductivity. Use of soldering or tinning during the fin-to-tube bonding process is not acceptable due to the inherent thermal stress and possible loss of bonding at that joint.

4. Construct coil casings of galvanized steel. End supports and tube sheets shall have belled tube holes to minimize wear of the tube wall during thermal expansion and contraction of the tube.
5. All coils shall be completely cleaned prior to installation into the air handling unit. Complete fin bundle in direction of airflow shall be degreased and steam cleaned to remove any lubricants used in the manufacturing of the fins, or dirt that may have accumulated, in order to minimize the chance for water carryover.
6. REFRIGERANT COOLING COILS
 - a. Coils shall be proof tested to 450 psig and leak tested to 300 psig air pressure under water. After testing, insides of tubes shall be air dried, charged with dry nitrogen or dry air, and sealed to prevent contamination.
 - b. Refrigerant suction and liquid headers shall be constructed of copper tubing. Suction and liquid connections shall penetrate unit casings to allow for sweat connections to refrigerant lines.
 - c. Tubes shall be 3/8-inch .012 copper, with aluminum fins.
 - d. Coils shall have equalizing type vertical distributors sized in conjunction with capacities of coils.
7. ELECTRIC HEATING COILS
 - a. A UL-recognized electric heater shall be factory installed. Electric heat to be open-wire resistance heating, installed in the reheat position. Heater to have primary and secondary protection circuits. The contactors for energizing the electric heater shall be magnetic. Electric heaters rated above 48 amps shall be circuited so that no circuit exceeds 48 amps as required by UL and NEC.
 - b. The electric heater shall be factory-wired to accommodate SSR-Full Modulating control if the Heater is 96 amps or lower. The SSR control can receive a 0-10 VDC signal from a standalone thermostat or building automation system providing full modulating control of the heater. If the Heater is above 96 amps, then SSR-Vernier control is used. The SSR control can receive a 0-10 VDC signal from a standalone thermostat or building automation system providing full modulating control of the first increment of heat. The staged increments are turned on and off by a step controller. As each stage is required to fulfill the demand for heat, the SSR increment is used as fully modulating between stages.
- I. FILTERS
 1. Provide factory-fabricated filter section of the same construction and finish as unit casings. Filter section shall have side access filter guides and access door(s) extending the full height of the casing to facilitate filter removal. Construct doors in accordance with Section 2.04. Provide fixed filter blockoffs as required to prevent air bypass around filters. Blockoffs shall not need to be removed during filter replacement. Filters to be of size, and quantity needed to maximize filter face area of each particular unit size.

2. Filter type, MERV rating, and arrangement shall be provided as defined in project plans and schedule.

J. DAMPERS

1. All dampers, with the exception of external bypass and multizones (if scheduled), shall be internally mounted. Dampers shall be premium ultra low leak and located as indicated on the schedule and plans. Blade arrangement (parallel or opposed) shall be provided as indicated on the schedule and drawings. Dampers shall be Ruskin CD60 double-skin airfoil design or equivalent for minimal air leakage and pressure drop. Leakage rate shall not exceed 3 CFM/square foot at one inch water gauge complying with ASHRAE 90.1 maximum damper leakage and shall be AMCA licensed for Class 1A. All leakage testing and pressure ratings shall be based on AMCA Standard 500-D. Manufacturer shall submit brand and model of damper(s) being furnished, if not Ruskin CD60.

K. ACCESS SECTIONS

1. Access sections shall be provided where indicated in the schedule and plans to allow additional access for inspection, cleaning, and maintenance of unit components. The unit shall be installed for proper access. Procedure for proper access, inspection and cleaning of the unit shall be provided in the AHU manufacturer's maintenance manual.

L. TOTAL ENERGY RECOVERY WHEEL SECTION

1. Total energy recovery wheels shall be provided as indicated on the schedule and drawings. Wheels shall be integral parts of the AHUs and shall be sized per the ventilation requirement of the units. Additional outside air units, or other field assembled and ducted energy recovery devices, are not acceptable. Mixed air units with economizing shall be constructed with internal bypass dampers such that the pressure drop across the wheel does not increase during economizing. External bypass and multiple duct connections are not acceptable.
2. The air handling unit shall be certified by AHRI to contain a rotary energy recovery wheel certified to ANSI/AHRI Standard 1060 and bears the AHRI 1060 label. Performance characteristics of the energy wheel shall be provided as defined by AHRI 1060 definitions. The energy wheel shall be a total energy wheel, with the sensible and latent effectiveness reported and within 5% of each other. The calculated total net effectiveness of the recovery wheel shall not be less than 70% when the specified ventilation flow rate equals the exhaust flow rate. The energy wheel EATR shall be less than the value indicated in the schedule and drawings. Wheel face velocity and pressure drop shall not exceed performance as defined on schedule. The energy recovery cassette shall be an Underwriters Laboratories (UL) Recognized Component certified for mechanical, electrical, and fire safety in accordance with UL Standard 1812.
3. The energy recovery component shall incorporate a rotary wheel in an insulated cassette frame complete with seals, drive motor and drive belts. The total energy recovery wheel shall incorporate a desiccant without the use of binders or adhesives, which may plug the desiccant aperture. The adsorbent shall not be applied as a glued on surface coating and not susceptible to erosion, abrasion, or delamination. Coated segments shall be washable using standard detergent or alkaline-based coil cleaners. The adsorbent shall be selected for its high affinity

for water vapor and shall not dissolve or deliquesce in the presence of water or high humidity. The rim shall be continuous rolled stainless steel to form an even concentric circle to prevent leakage around the rim and to minimize wear of components. All diameter and perimeter seals shall be provided as part of the cassette assembly. Perimeter seals shall be self-adjusting; diameter seals shall be adjustable.

4. Wheel drive motor shall be provided mounted in the cassette frame. Wheel drive motor shall be thermally protected and UL Component Recognized. Drive belts shall not require belt tensioner. On units that require drive belt tensioner for the wheel belt/motor assembly, the unit manufacturer shall provide at no additional charge to the customer a visual inspection every four months, and adjustment if necessary, of the recommended belt tension during the unit warranty period. Wheel motors shall be of the voltage, phase, frequency, and Hp indicated on the schedule and drawings.
 5. Wheel bearings shall be permanently sealed and lubricated and have a minimum L-10 life of 400,000 hours.
 6. Access doors shall be provided for the removal of wheel segments. Doors shall be located to allow access to the entire upstream and downstream face of each wheel. Adequate space and access shall be provided for energy wheel motor, bearing and belt removal.
 7. Energy recovery wheels shall be designed with variable effectiveness control, to vary the wheel recovery capacity. Variable effective control shall be done by an internal bypass damper provided by the AHU Manufacturer. The wheel variable effectiveness control shall have the ability to modulate the total energy recovery ability down to at least 40% of the initial recovery capacity. Variable frequency speed control is not an acceptable method for controlling variable effectiveness.
 8. Frost prevention shall be achieved by outside air bypass, return air preheat, or outside air preheat, depending upon design conditions. Frost set point temperatures based on the scheduled design air conditions shall be provided by the AHU Manufacturer. Variable frequency speed control is not an acceptable method of frost control. Winter design supply and exhaust air conditions leaving the energy wheel shall be provided by the AHU Manufacturer and shall include any de-rate in performance due to frost prevention measures.
 9. Control of energy wheels shall be incorporated and an integral part of the AHU control systems and shall be as described under the AHU control specifications. Secondary independent wheel controllers are not acceptable.
 10. Access doors shall be provided on all air entering and air leaving sides of wheel to allow for wheel maintenance, belt or motor removal. Access doors shall be constructed per Section 2.04.
- M. **FACTORY WIRING OF LIGHTS, VFDS, MOTORIZED IMPELLER CONTROL PANELS, AND COMBINATION STARTERS/DISCONNECTS**
1. All power wiring for voltages greater than 24V and traveling through multiple unit sections shall be contained in an enclosed, metal, power-wiring raceway or EMT. Sections less than 6-inch in length may be contained in FMC.

2. For fan motors not supplied with a factory mounted and wired starter, MICP or VFD, the unit manufacturer shall supply a 4 X 4 NEMA 4 junction box on the exterior of the fan section(s) with wiring, prewired to the fan motor, to allow for ease of field installation of a starter or VFD.

2.3 MOTORS (TYPICAL FOR ALL AIR HANDLING UNITS)

- A. See Division-23 Section, "Electrical Provisions for HVAC Equipment" for minimum motor efficiencies and other requirements.

2.4 ELECTRICAL

- A. The electrical components shall have an overall short circuit withstand rating of at least 65,000 Ampere Interrupting Capacity and be UL listed as such.

PART 3 - EXECUTION

3.1 INSTALLATION OF AIR HANDLING UNITS

- A. General: Install air handling units where indicated on the drawings, in accordance with equipment manufacturer's published installation instructions.
- B. Access: Provide access space around air handling units for service as indicated on the drawings, but in no case less than that recommended by the manufacturer.
- C. Mounting: Mount air handling units with internal factory furnished isolators in accordance with manufacturer's instructions.
- D. Electrical Wiring: Install electrical devices furnished by manufacturer but not specified to be factory-mounted.
 1. Verify that electrical wiring installation is in accordance with manufacturer's submittal and installation requirements of Division-26 sections.
- E. Piping Connections: Provide piping, valves, accessories, gauges, supports, and flexible connections as indicated on the drawings. Locate freezestats and trap air handling unit drain-pan connections according to manufacturer's recommendations.
- F. Duct Connections: Provide ductwork, accessories, and flexible connections as required.
- G. Extend condensate drain to nearest drain. Provide trap at drain pan at least 1" (25 mm) deeper than total supply fan pressure in inches of water column. For indoor units, provide a concrete pad of adequate height to allow for proper installation of condensate drain trap above floor.
- H. Provide MERV 13 filter media at all return air inlet locations throughout the duration of construction. Filter media shall not be removed until final filters are installed in the air handling units.

3.2 AIR HANDLING UNIT DISASSEMBLY AND REASSEMBLY

- A. Where required, the air handling units shall be disassembled by the mechanical contractor, transported with rigging as required to the assigned mechanical rooms located at the building interior, and reassembled in their permanent location. The air handling unit panels, doors, coils, fan base, superstructure, etc, shall be 100% bolted construction to facilitate the disassembly and reassembly procedure. Welded construction shall not be permitted. The manufacturer shall include costs for factory authorized representative(s) to supervise the complete disassembly and reassembly of the air handling units.
- B. Upon reassembly of the units, the unit manufacturer representative(s) shall inspect the installation and certify that the unit meets the manufacturer's standards. The inspection/certification shall include, but not be limited to, the following:
 - 1. Pulley alignment and adjustment.
 - 2. Superstructure inspection verifying all panels and unit frame are installed to manufacturer's standards.
 - 3. Spring isolator adjustment and certification.
 - 4. Motor operated damper adjustment and operation verification.
 - 5. Fan motor amperage reading with the fan operating at 60Hz.
 - 6. Belt tension reading and adjustment.
 - 7. Drain pan inspection.
 - 8. Access door operation and adjustment.
 - 9. Filter inspection.
 - 10. Pressure test(s) of the entire unit shall be performed and the maximum allowable leakage shall be one percent (1%) at 125% times the unit operating pressure, but not less than six inches (6") w.c.
- C. The owner shall be invited to be present during all testing and inspections and shall be given a minimum of one week notice (5 business days) prior to testing and certification.
- D. Upon completion of the inspection and testing, the manufacturer shall provide the installing contractor and the owner a type written report indicating deficiencies found. The deficiencies shall then be corrected to the satisfaction of the manufacturer and the owner.
- E. Upon completion of the inspection, testing, certification and start-up, the manufacturer shall provide the owner with a signed letter indicating that all warranties, either implied or expressed, shall remain in effect for a period of two years from the date of final approval by the manufacturer and the owner. The letter shall include the unit serial number, model number, as well as the location and address of the installed units.

3.3 FUNCTIONAL PERFORMANCE TESTING AND VERIFICATION

- A. General: In addition to the tests required during and after installation of all mechanical systems, as well as any other formal commissioning requirements, the unit manufacturer shall perform functional performance tests to verify that all systems are designed, installed, calibrated and adjusted to perform as required in the Contract.
- B. Comply with all applicable specification sections including, but not be limited to, "Basic HVAC Requirements", "Testing, Adjusting and Balancing", "Automatic Temperature Controls" and "Commissioning", where applicable.
- C. Prior to functional performance testing, all indicating, recording and control devices shall be calibrated. A verification calibration report shall be provided with the final test report.
- D. Provide functional performance testing to verify proper operation of each control sequence associated with the unit indicated throughout the contract documents.
- E. Failure of Tests: Should any test, verification, or demonstration fail to meet the specification requirements, the component of the system causing the failure shall be repaired, replaced or readjusted. The failed test, verification, or demonstration shall then be repeated.
- F. A "Functional Performance Test Verification Form" is included at the end of Section 230900. This form (electronic version is available upon request) shall be completed for each air handling unit provided under this contract.
- G. Test Report: Upon satisfactory verification of calibration and functional performance tests, a copy of the final test results shall be bound in the operations and maintenance manual. The final report shall also include a full compliance statement, on company letterhead, indicating that all units are installed and functioning per the contract requirements including drawings, specifications, control sequences and accepted submittals.
- H. The air handling unit installation shall not be considered complete until all functional performance verification forms, calibration reports and compliance statement have been submitted and reviewed. Submit in accordance with the submittal requirements indicated elsewhere in these specifications.

3.4 EXTRA STOCK

- A. Filters: Furnish one (1) extra set of filters for each air handling unit to the owner. In addition, install new filters at completion of air handling system work, and prior to testing, adjusting, and balancing work. Do not operate fans unless filters are in place.
- B. Belts: Contractor shall furnish one (1) spare set of belts for each belt-driven air handling unit. Deliver to the Owner's representative and mark with the air handling unit's number.

END OF SECTION 23 73 13

SECTION 23 81 19 - ENVIRONMENTAL CONTROL AIR CONDITIONING UNITS

PART 1 - GENERAL

1.1 SUMMARY

- A. Scope: Extent of environmental control air conditioning unit work required by this Section is indicated on drawings and schedules, by requirements of this Section, and all other Division-23 Sections.
- B. Refer to requirements of Division-26.

1.2 QUALITY ASSURANCE

- A. Manufacturer: Provide environmental control air conditioning units that are the standard product of an equipment manufacturer regularly engaged in the production of such units who issues complete catalog information on such products. Units shall not be field fabricated.
- B. Certifications: Submit certified technical and test data indicating compliance with the capacities specified.
- C. Codes and Standards: Provide environmental control air conditioning units conforming to the following:
 - 1. Air-Conditioning and Refrigeration Institution (ARI): Comply with ARI 240.
 - 2. American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE): Construct and install refrigerant coils in accordance with ASHRAE 15, "Safety Code for Mechanical Refrigeration."
 - 3. National Electrical Manufacturers Association (NEMA): Provide electrical components required as part of environmental control air conditioning units, which comply with NEMA Standards.
 - 4. National Fire Protection Association (NFPA): Comply with NFPA 70, "National Electrical Code" as applicable to installation and electrical connections of ancillary electrical components of environmental control air conditioning units.
 - 5. Underwriters Laboratories, Inc. (UL): Provide electrical components required as part of environmental control air conditioning units, which have been listed and labeled by UL.
- D. Certifications: Submit certified technical and test data indicating compliance with the capacities specified.

1.3 SUBMITTALS

- A. Product Data: Submit manufacturer's product data for air conditioning units showing dimensions, weights, capacities, ratings, fan performance with operating point clearly indicated, motor electrical characteristics, finishes of materials, and installation instructions.
- B. Maintenance Data: Submit maintenance instructions, including instructions for lubrication, filter replacement, motor and drive replacement, and spare parts list. Include this data, product data, shop drawings, and wiring diagrams in maintenance manuals in accordance with requirements of Division-01.

1.4 DELIVERY, STORAGE AND HANDLING

- A. Delivery: Deliver environmental control air conditioning unit with factory-installed shipping skids and lifting lugs; pack components in factory-fabricated protective containers.
- B. Handling: Handle environmental control air conditioning units carefully to avoid damage to components, enclosures, and finish. Do not install damaged components. Replace damaged units with new units.
- C. Storage: Store environmental control air conditioning units in a clean, dry place and protect from weather and construction traffic.
- D. Unloading: Comply with manufacturer's rigging instructions for unloading air conditioning units and condensing units, and moving them to final location.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products which may be incorporated in the work will be limited to:
 - 1. Mitsubishi
 - 2. Daikin
 - 3. Panasonic

2.2 ENVIRONMENTAL CONTROL AIR CONDITIONING UNITS

- A. General: Provide factory assembled air conditioning system complete with split system compact wall mounted packaged evaporator section and matching outdoor unit. The units shall be listed by Electrical Laboratories (ETL) and bear the ETL label. All wiring shall be in accordance with the National Electrical Code (NEC). The units shall be rated in accordance with ARI Standard 240 and bear the ARI label. A full charge of R-410A for 100 feet of refrigerant tubing shall be provided in the condensing unit. A dry nitrogen

holding charge shall be provided in the evaporator. System SEER shall meet or exceed 1992 Federal Standards.

- B. Capacities: Provide environmental control air conditioning units of capacity and type as indicated on the drawings and schedules.
- C. Warranty: The units shall have a manufacturer's warranty for a period of one (1) year from date of installation. The compressor shall have a warranty of six (6) years from date of installation. If, during this period, any part should fail to function properly due to defects in workmanship or material, it shall be replaced at the contractor's expense. Manufacturer shall have ten (10) years' experience in the U.S. market.
- D. Components: Provide environmental control air conditioning units that draw air through filter and coils, and that include fans, compressors, cooling coils, reheat coils, filters, remote air cooled condensing units, motors, starters, controls, and all other components necessary for proper operation.
 - 1. Units shall be furnished complete with remote air cooled condensing unit factory assembled and tested by manufacturers of environmental control air conditioning units.
 - 2. For units installed above ceiling, provide a secondary drain pan with leak detection. Leak detection shall alarm at the building automation system (BAS) and shall de-energize the unit.
- E. Indoor Evaporator Unit: The indoor evaporator unit shall be factory assembled and wired. The casing shall have a white finish. The evaporator fan shall be an assembly with line flow fans direct driven by a single motor. The fan shall be statically and dynamically balanced and run on permanently lubricated bearings. An adjustable guide vane shall be provided with the ability to change the air flow from horizontal to vertical. A motorized air sweep flow louver shall provide an automatic change in air flow by directing the air from side to side for uniform air distribution. Return air shall be filtered by means of an easily removable washable filter. The evaporator coil shall be of non-ferrous construction with smooth plate fins bonded to copper tubing. The tubing shall have inner grooves for high efficiency heat exchange. All tube joints shall be brazed with phosphor or silver alloy. The coils shall be pressure tested at the factory. A condensate pan and drain shall be provided under the coil. The unit electrical power shall be 208 volts, 1 phase, 60 hertz. The system shall be capable of satisfactory operation within voltage limits of 198 volts to 253 volts.
- F. Control System: The control system shall consist of two (2) microprocessors interconnected by a single non polar two wire cable as supplied. Wiring shall run from indoor unit to controller direct. NO SPLICES. When running longer lengths or more than one (1) set of remote controller wires together, a double insulated, two wire cable equivalent to that provided e.g. Belden 9407 cable, is mandatory or use shielded two-wire cable. One (1) microprocessor shall be factory wired and located within the indoor unit. It shall have the capability of sensing return air temperature and indoor coil temperature; receive and process commands from the remote controller; provide emergency operation; and control the outdoor unit. The microprocessor within the wall mounted remote controller shall provide automatic cooling; display setpoint and room temperature; a 24 hour on/off timer so that automatic operation can be set on the timer at one (1) hour intervals from one to twenty-four hours; have self-diagnostic function display; check mode for memory of most recent problem; control system shall have control continued operation of the air sweep louvers; and provide on-off and system/mode

function switching. Normal operation of the remote controller provides individual system control in which one (1) remote controller and one (1) indoor unit are installed in the same room. The remote controller shall have the capability of controlling up to a maximum of fifty (50) systems at a maximum developed control cable distance of 1,650 feet. The control voltage between the remote controller and the indoor unit shall be 12 volts D.C. The control voltage between the indoor unit and the outdoor unit shall be 12 volts D.C. Both 12VDC shall be generated from the indoor unit microprocessor board. The system shall be capable of automatic restart when power is restored after power interruption. System shall include twenty (20) function self-diagnostics including total hours of compressor run time.

- G. Outdoor Unit: The outdoor unit shall be completely factory assembled, piped and wired. The casing shall be fabricated of galvanized steel, bonderized and finished with baked enamel. The unit shall be furnished with one (1) direct drive, propeller type fan arranged for horizontal discharge. The motors shall have inherent protection, be of the permanently lubricated type and resiliently mounted for quiet operation. The fans shall be provided with a raised guard to prevent contact with moving parts. The compressor shall be of the high performance rotary type with crankcase heater, accumulator and internal thermal overloads. The compressor shall be mounted so as to avoid the transmission of vibration. The refrigeration system shall be equipped with high pressure switch and have the capability to operate with a maximum height difference of 100 feet and overall refrigerant tubing length of 100 feet between indoor and outdoor sections without the need for line size changes, traps or additional oil. Refrigerant flow from the condenser to be controlled by means of a capillary tube. The condenser coil shall be of non-ferrous construction with smooth plate fins bonded to copper tubing. The coil shall be protected with smooth plate fins bonded to copper tubing. The coil shall be protected with an integral metal guard. The unit shall be controlled by the microprocessor located in the indoor matching unit. A built-in, low ambient controller will allow cooling to 0 degrees F outdoor temperature. The unit electrical power shall be 208/230 volts, 1 phase, 60 hertz. The system shall be capable of satisfactory operation within voltage limits of 198 volts to 253 volts.
- H. Wind Baffle: To allow cooling operation in temperature down to zero degrees Fahrenheit, a wind baffle must be installed onto the condensing unit.
- I. Electrical Wiring: Provide all electrical circuits in conformance with NFPA 70 and color coded for ease in field tracing.
- J. Provide five (5) year parts and labor warranty for A/C condensing units.

PART 3 - EXECUTION

3.1 ENVIRONMENTAL CONTROL AIR CONDITIONING UNIT INSTALLATION

- A. General: Install environmental control air conditioning units where indicated on the drawings in accordance with equipment manufacturer's published installation instructions.
- B. Access: Provide access space around environmental control air conditioning units for service as indicated on the drawings, but in no case less than that recommended by the manufacturer.

- C. Electrical Wiring: Install electrical devices furnished by manufacturer but specified to be factory-mounted. Verify that electrical wiring installation is in accordance with manufacturer's submittal and installation requirements of Division-26 sections.
- D. Refrigerant Piping: Provide field installed refrigerant piping in accordance with Division-23 section, "Refrigerant Piping."
 - 1. Field installed refrigerant piping shall be refrigerant grade, Type L seamless copper tubing.
 - 2. All connections and joints shall be silver soldered or brazed.
 - 3. Pipe sizing and installation details shown on drawings shall be verified by the manufacturer. Piping shall be installed in strict accordance with manufacturer's recommendations regarding sizing and installation details.
- E. Piping Connections: Provide piping, valves, accessories, gauges, supports, and flexible connections as indicated on the drawings.

3.2 START-UP

- A. General: Start and adjust all units installed under this specification under the supervision of an authorized factory trained representative of the manufacturer of each unit. Perform operational checks to make certain that controls and safety devices and systems are operating properly. If defects or improper adjustments are found, they shall be corrected and tests repeated.
 - 1. An operational check shall be made to demonstrate compliance with contract requirements, including but not limited to, capacity and control accuracy.
 - 2. A report signed by each factory representative shall be submitted showing test conditions and results.

END OF SECTION 23 81 19

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SECTION 23 81 20 - VARIABLE REFRIGERANT VOLUME SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. Scope: Extent of variable refrigerant volume system work required by this Section is indicated on drawings and schedules, by requirements of this Section, and all other Division-23 Sections.
- B. Refer to the requirements of Division-26.

1.2 QUALITY ASSURANCE

- A. Manufacturer: Provide system components that are the standard product of an equipment manufacturer regularly engaged in the production of such units who issues complete catalog information on such products. Units shall not be field fabricated.
- B. Contractor to provide a complete working Variable Refrigerant Volume (VRV) system including all system components and electrical and plumbing systems required for a fully functioning system that will provide space conditions according to the requirements as indicated by ASHRAE for standard indoor conditions. Only three (3) system manufacturers are listed as acceptable for use in this building. Contractor and manufacturer shall determine the specific equipment requirements of each manufacturer in order to satisfy the space conditions as determined by ASHRAE.
- C. Certifications: Submit certified technical and test data indicating compliance with the capacities specified.
- D. Codes and Standards: Provide system components conforming to the following:
 - 1. Air-Conditioning and Refrigeration Institution (ARI): Comply with ARI 410, "Forced-Circulation Air-Cooling and Air-Heating Coils."
 - 2. Air Movement and Control Association, Inc. (AMCA): Comply with AMCA 210, "Laboratory Methods of Testing Fans for Rating Purposes."
 - 3. American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE): Construct and install refrigerant coils in accordance with ASHRAE 15, "Safety Code for Mechanical Refrigeration."
 - 4. National Electrical Manufacturers Association (NEMA): Provide electrical components required as part of computer room air conditioning units, which comply with NEMA Standards.
 - 5. National Fire Protection Association (NFPA): Comply with NFPA 70, "National Electrical Code" as applicable to installation and electrical connections of ancillary electrical components of computer room air conditioning units.

6. Underwriters Laboratories, Inc. (UL): Provide electrical components which have been listed and labeled by UL.

1.3 SUBMITTALS

- A. Conform to the requirements of Division-01 Section, "Submittals," where applicable.
- B. Product Data: Submit manufacturer's product data for air conditioning units showing dimensions, weights, capacities, ratings, fan performance with operating point clearly indicated, motor electrical characteristics, finishes of materials, and installation instructions.
- C. Maintenance Data: Submit maintenance instructions, including instructions for lubrication, filter replacement, motor and drive replacement, and spare parts list. Include this data, product data, shop drawings, and wiring diagrams in maintenance manuals in accordance with requirements of Division-01.

1.4 DELIVERY, STORAGE AND HANDLING

- A. Delivery: Deliver system components with factory-installed shipping skids and lifting lugs; pack components in factory-fabricated protective containers.
- B. Handling: Handle system components carefully to avoid damage to components, enclosures, and finish. Do not install damaged components. Replace damaged units with new units.
- C. Storage: Store system components in a clean, dry place and protect from weather and construction traffic.
- D. Unloading: Comply with manufacturer's rigging instructions for unloading system components, and moving them to final location.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Subject to compliance with requirements, manufacturers offering products which may be incorporated in the work shall be limited to the following:
 1. Mitsubishi
 2. Daikin
 3. Sanyo

2.2 CONDENSING UNIT

- A. General: Provide condensing unit factory assembled with pre-wired electronic and refrigerant controls, specifically designed for variable refrigerant volume (VRV) applications. Provide all components required for a complete and operational system.
- B. Capacities: Provide condensing units of capacity and type as indicated on the drawings and schedules.
- C. Components: The refrigeration circuit of the condensing unit shall consist of a rotary compressor, motors, fans, condenser coil, electronic expansion valve, solenoid valves, 4-way valve, distribution headers, capillaries, filters, shut-off valves, oil separators, service ports, liquid receivers and accumulators.
- D. Sound: The sound pressure dB(A) at rated conditions shall be a value of 55-62 decibels at 3 feet from the front of a single condensing unit. The condensing unit shall be capable of operating at further 52-59 dB(A) in "quiet mode."
- E. Restart: The condensing unit shall automatically restart operation after a power failure and shall not lose any settings during outage.
- F. Layout: The condensing unit shall be modular in design and should allow for side-by-side installation with minimal spacing.
- G. Safety Devices: Provide high pressure switch, control circuit fuses, crankcase heaters, fusible plug, high pressure switch, overload relay, inverter overload protector, thermal protectors for compressor and fan motors, overcurrent protection for the inverter and anti-recycling timers. Provide sub-cooling feature. Oil recovery shall be automatic, occurring 1 hour after system start-up and after every 6 hours of operation after that, or as required to maintain oil levels at the condensing unit.
- H. Condensing unit shall operate in heating mode to -4 degrees F dry bulb ambient without additional ambient controls.
- I. Coils: Air-cooled heat exchange coils shall be copper tubing with aluminum fins. The coils will be set in a vertical formation with air being drawn in through three sides of the unit and discharged out the top of the unit.
- J. Compressors: Condensing unit will have one inverter controlled compressor and up to four high efficiency scroll compressors depending on type. Each compressor shall be equipped with a crankcase heater, high pressure safety switch and internal thermal overload protector.
- K. Cabinet: Unit cabinet shall be completely weather proof and corrosion resistant.
- L. Fan: Unit shall consist of two propeller type, direct drive fans that have multiple speed operation via a DC inverter. Fans shall have internal protection and permanently lubricated bearings.
- M. Vibration: Unit shall have internal spring isolators or compressors shall be mounted on vibration damping rubber grommets.

2.3 SOLENOID VALVE KIT (SVK)

- A. The SVK box shall be constructed from galvanized steel plate, internally insulated with polyurethane foam.
- B. The SVK box shall be connected to each indoor unit or group of indoor units via a dedicated connection which shall provide power and control signals to the solenoid valves within the box.

2.4 BRANCH SELECTOR BOX (BSB)

- A. The BS box shall be constructed from galvanized steel plate, internally insulated with polyurethane foam.
- B. Provide individual power to each BS box.
- C. Provide control wiring between indoor units and BS boxes to the electronic expansion valves (EEVs).

2.5 INDOOR UNITS

- A. Indoor Unit Types:
 - 1. Ceiling mounted
 - 2. Wall mounted
 - 3. Floor Mounted Concealed
 - 4. Floor Mounted Console
- B. Construction: Unit shall be completely factory assembled and tested. The unit shall consist of factory wiring, piping, electronic proportional expansion valve, control circuit board, fan motor thermal protector, flare connections, condensate drain pan, self-diagnostics, auto-restart function, 3-minute fused time delay and test run switch. Unit shall have auto-swing louver which ensures efficient air distribution, and closes automatically when the unit stops.
- C. Fan: Unit fan shall be a direct drive cross-flow fan with statically and dynamically balanced impeller. Fan shall be capable of operating at high, medium and low speeds.
- D. Filter: Unit shall be complete with washable, long life filter with mildew proof resin.
- E. Coils: Shall be direct expansion type constructed from copper tubes with aluminum fins. The coil shall be a two row cross fin copper evaporator coil with 14 fins per inch design.
- F. For units installed above ceiling, provide a secondary drain pan with leak detection. Leak detection shall alarm at the building automation system (BAS) and shall de-energize the unit.

2.6 CONTROLLER

A. Simple-Wired Room Controller

1. Basic System Controller
2. Provide central control system that will allow global changes and monitoring of all system components from a central location.

2.7 UTILITY REBATE

- A. Utility Rebate Application: The mechanical contractor shall provide and submit a utility rebate application to the local utility (BGE Smart Energy Program, or other local utility serving this project area) for the major HVAC equipment (such as chillers, packaged A/C units, variable refrigerant flow systems, etc.). The rebate application shall include all information required by the utility company program administrator (ICF International, or other rebate administrator) including, but not limited to, the application, supporting calculations, analysis, comparison of the proposed equipment to baseline equipment or system., etc.; all as defined and/or required by the program administrator. The Owner shall be indicated on the application as the recipient for the full rebate.

PART 3 - EXECUTION

3.1 VARIABLE REFRIGERANT VOLUME SYSTEM INSTALLATION

- A. General: Install system components where indicated on the drawings in accordance with equipment manufacturer's published installation Instructions.
- B. Access: Provide access space around system components for service as indicated on the drawings, but in no case less than that recommended by the manufacturer.
- C. Electrical Wiring: Install electrical devices furnished by manufacturer but specified to be factory-mounted. Verify that electrical wiring installation is in accordance with manufacturer's submittal and installation requirements of Division-26 sections.
- D. Refrigerant Piping: Provide field installed refrigerant piping in accordance with Division-23 section, "Refrigerant Piping."
- E. Piping Connections: Provide piping, valves, accessories, gauges, supports, and flexible connections as indicated on the drawings. Provide ball valves at each indoor unit for ease of system isolation.

3.2 START-UP

- A. General: Start and adjust all units installed under this specification under the supervision of an authorized factory trained representative of the manufacturer of each unit. Perform operational checks to make certain that controls and safety devices and systems are operating properly. If defects or improper adjustments are found, they shall be corrected and tests repeated.

1. An operational check shall be made to demonstrate compliance with contract requirements, including but not limited to, capacity and control accuracy.
2. A report, signed by each factory representative, shall be submitted showing test conditions and results.

END OF SECTION 23 81 20

SECTION 23 82 00 - HEATING AND COOLING TERMINAL UNITS

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

- A. Extent of terminal unit work is indicated by drawings and schedules, and by requirements of this section and all other Division-23 sections.
- B. Types of terminal units required for project include the following:
 - 1. Unit heaters
 - 2. Cabinet heaters
- C. Refer to requirements of Division-26.

1.2 QUALITY ASSURANCE

- A. Codes and Standards:
 - 1. I=B=R Compliance: Test and rate finned tube radiation in accordance with I=B=R, provide published ratings bearing emblem of I=B=R.
 - 2. ARI Compliance: Provide coil ratings in accordance with ARI Standard 410 "Forced Circulation Air-Cooling and Air-Heating Coils".
 - 3. ASHRAE Compliance: Test coils in accordance with ASHRAE Standard 33 "Methods of Testing Forced Circulation Air Cooling and Heating Coils".
 - 4. ARI Compliance: Test and rate fan coil units in accordance with ARI Standard 440 "Room Fan Coil Air-Conditioners".
 - 5. UL Compliance: Construct and install fan coil units in compliance with UL 883 "Safety Standards for Fan Coil Units and Room Fan Heater Units".
 - 6. ARI Compliance: Test and rate unit ventilators in accordance with ARI Standard 330 "Unit Ventilators".
 - 7. UL Compliance: Provide electrical components for terminal units which have been listed and labeled by UL.

1.3 SUBMITTALS

- A. Product Data: Submit manufacturer's specifications for terminal units showing dimensions, capacities, ratings, performance characteristics, gages and finishes of materials, and installation instructions.

- B. Shop Drawings: Submit assembly-type shop drawings showing unit dimensions, construction details, and field connection details.
- C. Wiring Diagrams: Submit manufacturer's electrical requirements for power supply wiring to terminal units. Submit manufacturer's ladder-type wiring diagrams for interlock and control wiring. Clearly differentiate between portions of wiring that are factory installed and portions to be field-installed.
- D. Maintenance Data: Submit maintenance instructions, including lubrication instructions, filter replacement, motor and drive replacement, and spare parts lists. Include this data, product data, and shop drawings in maintenance manuals.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Handle terminal units and components carefully to prevent damage, breaking, denting and scoring. Do not install damaged terminal units or components; replace with new.
- B. Store terminal units and components in clean dry place. Protect from weather, dirt, fumes, water, construction debris, and physical damage.
- C. Comply with Manufacturer's rigging and installation instructions for unloading terminal units, and moving them to final location.

PART 2 - PRODUCTS

1.

2.2 ELECTRIC CABINET HEATERS

- A. General: Provide cabinet heaters where indicated, of sizes and capacities as scheduled. All units shall be UL listed.
- B. Cabinets: Basic unit shall be blow-through design with motor and fans in the air stream below electric heating bank. Fan discharge shall be baffled to insure even air flow through entire area of heating bank for even outlet temperatures.
 - 1. All solid panels of the front, top and bottom panels shall be internally insulated to provide quiet operation and low surface temperatures. Complete unit assembly shall be listed and approved by Underwriters' Laboratory, Inc.
 - 2. Casing shall be given a 5-stage phosphatizing treatment prior to application of high gloss baked enamel finish. Casing top and front shall be 16 gauge (1.6 mm) with 18 gauge (1.3 mm) front accent panel. Discharge grille shall be a continuous stamped louver. Front access panel fasteners shall be Phillips head.
 - 3. All recessed units shall have wall-guard type recess flanges which protect the wall from direct contact and damage when access panels are removed or replaced for normal maintenance.

- C. Elements: The electric heating bank shall consist of metal sheath heating elements. The elements shall have a copper clad steel sheath for strength and corrosion resistance and aluminum fins. Fin tubes shall be installed or removed individually, and shall be center anchored to insure noiseless expansion and contraction.

- D. Motors and Fans: Motor and fan assembly shall be direct drive on all unit sizes, using extended motor shaft on one fan unit, double extended motor shafts on two fan units and coupling with hollow steel shafts and end bearing on three, four and five fan units. Two-speed permanent split capacitor type motors with built-in automatic reset motor overload protection shall be standard.
 - 1. Fans shall be forwardly curved double inlet centrifugal type, aluminum construction and shall be modular in design.
 - 2. Motor and fans shall be mounted on an extra heavy 14 gauge (2.0 mm) galvanized mounting plate, forming an easily removable assembly. Motor leads shall be plug-in type for easy removal of the motor and fan assembly. Combination two-speed, two-heat tamperproof switch shall be located with access through discharge air grille, using Allen key for adjustment.

- E. Filters: Provide permanent, reusable polyurethane type filters. All models shall have filter access through removable front access panel.

- F. Controls: Automatic reset snap-action type thermal protection shall be furnished through holding coil circuit of the control system relay(s) for protection in the event of overheating due to air blockage from any cause. Thermal protector shall be linear type to sense temperatures the entire length of heating elements, to detect localized overheating from partial air blockages.
 - 1. Integral thermostat control shall be standard on floor and wall mounted units, and shall consist of factory built-in thermostat of sensitive bulb and capillary type, fully enclosed and snap-acting to prevent radio or TV interference, The thermostat shall have a temperature adjustment range between 45°F (7°C) and 95°F (35°C).
 - 2. Ceiling mounted units shall be provided with remote wall mounted thermostats.
 - 3. Thermostat operates the single-phase holding coil circuit of the integrally mounted power control relay(s). This single phase relay holding coil circuit shall be powered from the cabinet unit heater main power supply.
 - 4. An integral fan delay switch shall be standard to prevent discharge of cold air, by delaying start-up of the fan motor until heating elements have warmed up. This same fan delay switch shall maintain motor operation after heating elements have been de-energized to dissipate any residual heat.
 - 5. Units shall be equipped as standard with a two speed/two heat selector switch which permits simultaneous tamper-resistant "high-low" adjustment of fan speed and heat output by means of an Allen key through discharge grille.
 - 6. Units shall be provided with built-in circuit breakers. Ceiling mounted units shall be complete with a low voltage control transformer for remote wall mounted thermostat.

2.3 ELECTRIC UNIT HEATERS

- A. General: Provide unit heaters where indicated, of sizes and capacities as scheduled. All units shall be UL listed.
- B. Cabinets: The cabinet shall be constructed from 18 gauge (1.3 mm) die formed, furniture grade steel.
 - 1. Individually adjustable louvers with 30 degree downward stops shall be furnished.
 - 2. All metal surfaces of the casing shall be phosphate coated to resist corrosion and finished with baked enamel.
 - 3. Provide mounting brackets as required.
- C. Elements: The electric heating bank shall consist of metal sheath heating elements. The elements shall have a copper clad steel sheath and aluminum fins.
- D. Motors and Fans: Motors shall be totally enclosed, continuous heavy duty all-angle operation, equipped with built-in thermal overload protection. Fans shall be aluminum, directly connected to fan motor, designed specifically for unit heater application.
- E. Controls: Automatic reset thermal overload protector shall be of the linear capillary type, wired for instantaneous de-energizing in case of thermal overload.
 - 1. Fans shall be complete with delay feature to eliminate cold draft. Element shall heat-up before fan energizes, then fan continues to distribute heat after element shuts off.
 - 2. Provide a low voltage control transformer for remote wall mounted thermostat and summer fan switch.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Examine areas and conditions under which terminal units are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF UNIT HEATERS

- A. General: Install unit heaters as indicated, and in accordance with manufacturer's installation instructions.
- B. Uncrate units and inspect for damage. Verify that nameplate data corresponds with unit designation.
- C. Hang units from building substrate, not from piping. Mount as high as possible to maintain greatest headroom possible unless otherwise indicated.

- D. Support units with rod-type hangers anchored to building substrate.
- E. Install piping as indicated.
- F. Protect units with protective covers during balance of construction.

3.3 INSTALLATION OF CABINET HEATERS

- A. General: Install cabinet heaters as indicated, and in accordance with manufacturer's installation instructions.
- B. Locate cabinet heaters as indicated, coordinate with other trades to assure correct recess size for recessed units.
- C. Install piping as indicated.
- D. Protect units with protective covers during balance of construction.

3.4 ELECTRICAL WIRING

- A. General: Install electrical devices furnished by manufacturer but not specified to be factory-mounted. Furnish copy of manufacturer's wiring diagram submittal to Electrical Installer.
 - 1. Verify that electrical wiring installation is in accordance with manufacturer's submittal and installation requirements of Division-26 sections. Do not proceed with equipment start-up until wiring installation is acceptable to equipment installer.

3.5 ADJUSTING AND CLEANING

- A. General: After construction is completed, including painting, clean unit exposed surfaces, vacuum clean terminal coils and inside of cabinets.
- B. Retouch any marred or scratched surfaces of factory-finished cabinets, using finish materials furnished by manufacturer.

3.6 EXTRA STOCK

- A. Filters: Furnish one (1) extra set of filters for each terminal unit to the owner. In addition, install new filters at completion of terminal unit work, and prior to testing, adjusting, and balancing work. Do not operate fans unless filters are in place.
- B. Belts: Contractor shall furnish one (1) spare set of belts for distinct terminal unit size. Deliver to the Owner's representative and mark with the terminal unit size.

END OF SECTION 23 82 00

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SECTION 260010 - ELECTRICAL GENERAL PROVISIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1, 26, 27, and 28 Specification Sections, apply to this Section.

1.2 GENERAL REQUIREMENTS

- A. The requirements indicated in this specification section shall apply to all electrical work.
- B. Equipment: All electrical equipment, including but not limited to, wiring devices, wiring materials and electrical construction materials shall be new and of the highest quality and latest improved design.
- C. Workmanship: Workmanship shall be of the highest grade and all installation work shall be performed by thoroughly qualified mechanics of the appropriate trade. All equipment shall be installed and connected in accordance with the best engineering practice. Manufacturer's instructions and recommendations shall be followed and all electric connections shall be provided.
- D. Completeness: The Contractor shall furnish and install all labor, materials, tools, equipment, programming, software, startup, licenses, and services as required to make all equipment complete and fully operational. Provide all required mounting hangers, supports, hardware and accessories to install all equipment and devices. Make all equipment and devices complete and fully operational.
- E. Drawings: The drawings showing the layout of the electrical system indicate approximate locations of outlets, apparatus and equipment. The runs of feeders and branches as shown, the drawings are schematic only and are not intended to show the exact routing and location of conduits and conduit terminations. The final determination as to routing, location and termination shall be governed by structural conditions, obstructions and job conditions. This shall not be construed to mean that the design of the system may be changed without the written approval of the Engineer; it merely refers to the exact run of raceways and the exact placement of outlets, etc. It shall be the Contractor's responsibility to obtain all shop drawings affecting conduit terminations to the equipment specified in this or other sections or furnished by others, and to verify conduit locations before installation. The Contractor shall consult all contract drawings and specifications which may affect the location of any outlet, equipment or conduit run, to avoid improper locations of such items and to avoid interference with other trades.
- F. Accessibility: Electrical equipment such as junction and pull boxes, panelboards, switches, controls, and other apparatus that may require maintenance or operation from time to time, shall be made easily accessible. Although the equipment may be shown on the drawings in certain locations, in the course of building construction, it may develop that such locations do not afford proper accessibility, in which case the Contractor shall direct the Engineer's attention to the condition before advancing the construction.

- G. Site examinations: All bidders, prior to submitting a bid, shall thoroughly acquaint themselves with the conditions under which the work will be performed. No allowance shall be made subsequently in connection with this, for any error or negligence on the contractor's part.
- H. Unless noted as "EXISTING", "BY OTHERS" or "NIC", all work, devices and equipment are new and shall be furnished and installed by the contractor.
- I. The contractor shall comply with all the requirements indicated in the contract documents. The contractor shall provide all the items indicated in the contract documents, without any additional cost or time extension, regardless of whether or not the item is a special order, the item is in short supply, the item has a minimum quantity order requirement, the item has a long lead time, and/or the item has additional/non-standard costs associated with it. The contractor shall coordinate with the manufacturer and supplier of the item prior to submitting a bid.
- J. Where there is a conflict in the Contract Documents, contact the owner and the engineer immediately. The owner and the engineer will provide further direction. For pricing and bidding purposes, the more stringent or higher quality requirement shall be used. All work shall comply with all applicable codes, and shall be inspected and approved by the Authority Having Jurisdiction.
- K. Furnish and install devices and equipment in accordance with the NEC, the manufacturer's recommendations, and the contract documents.
- L. All devices and equipment shall be suitable for its intended use, environment, and location in accordance with the NEC, UL, the manufacturer's recommendations and the contract documents.
- M. All work shall be coordinated with the electrical contractor.
- N. Wire lugs, connectors and splices shall be UL Listed and shall be compatible with the wire size/material/type. Coordinate equipment and wiring to ensure that they are compatible with each other.
- O. The following applies to circuits rated 600V or less:
 - 1. For circuits rated 100 amperes or less, or marked for 14 AWG through 1 AWG conductors, the equipment shall be listed and identified for use with 75 degrees C conductors, unless otherwise noted.
- P. The ABBREVIATIONS indicated in the electrical drawings shall also apply to the abbreviations used in the electrical specifications, unless otherwise noted.
- Q. Exact location of electrical receptacles/floor boxes and/or electrical connections to equipment shall be coordinated with the exact location of items in the field (including, but not limited to, the following: exact location of cabinets/backsplashes/countertops/electrified systems furniture associated with the receptacles/floor boxes, exact locations of equipment, etc.); and, shall be coordinated with the exact location of wire terminals at the equipment (which shall be based on the wiring diagrams of the equipment, the installation manuals of the equipment, and/or coordination with the manufacturer). Coordination shall take place prior to starting any work.
- R. Wet Locations:
 - 1. The following areas shall be considered Wet Locations and shall be provided with equipment/materials that are suitable for Wet Locations in accordance with the NEC and the contract documents:
 - a. All outdoor or exterior locations

2. Hangers, supports, raceways, boxes, and other equipment/materials shall be suitable for use in Wet Locations in accordance with the NEC and the contract documents.
- S. Where there are space heating equipment located adjacent to electrical equipment (including but not limited to, infrared unit heaters, electric/gas fired unit heaters, etc), the contractor shall coordinate with the manufacturer of the space heating equipment, get the installation manuals for the space heating equipment, and determine the clearance requirements around the space heating equipment. The contractor shall comply with the clearance requirements of the manufacturer, and shall not install any electrical equipment/wiring/conduit within the clearance area. Additionally, all electrical equipment/wiring/conduit shall be provided with appropriate clearance from space heating equipment, so that their maximum operating temperature, and/or temperature rating, is not exceeded.
- T. Service equipment shall be UL labeled for use as service equipment. Provide grounding and bonding of service equipment in accordance with NEC requirements.
- U. Inside the sally port, storage room, trash room, garage, and rooms which can be entered by vehicles, keep the space directly in front of the exterior door (overhead door, rollup door, swing door, etc.) clear of all electrical items. The volume of the clear space shall not be less than the following:
 1. Volume of clear space = width of the exterior door opening x height of the exterior door opening x distance from the exterior door to the opposite wall
- V. Where the contract documents specifies a product name, model, or manufacturer, and this product has been discontinued or is no longer in production, the contractor shall provide a product from the same manufacturer, that meets the requirements indicated in the contract documents, at no additional cost to the owner. The product provided by the contractor shall be an approved equal of the specified product. Also, the contractor shall provide a written statement from the specified manufacturer, indicating that the specified product has been discontinued or is no longer in production. All products shall be submitted for review and approval by the design team.

1.3 QUALITY ASSURANCE

- A. Requirements of Regulatory Agencies: Comply with electrical construction code requirements of State, City and such other local political subdivision specifications as may exceed the requirements of national codes, standards and approving bodies.
- B. All electrical equipment installed under this contract shall bear UL label. Equipment shall be installed in accordance with the requirements of UL and the manufacturer.
- C. Comply with the National Electrical Code.
- D. Certificates and Permits: Upon completion of work, and prior to final payment, furnish to the Engineer formal certification of final inspections from authorities having jurisdiction and secure required permits or certificates (if any) from such authorities. Additionally, prepare detailed diagrams and drawings which may be required by those authorities having jurisdiction. All the cost for obtaining certificates and permits will be paid by the Contractor.

1.4 REFERENCES AND DEFINITIONS

A. Basic References: The following codes, standards, and approvals as referenced throughout the drawings and specifications, shall serve as the minimum standards and quality requirements directly appropriate to the work and workmanship. References to catalogs, standards, codes, specifications and recommendations, etc., means latest edition of such publications in effect at the date of invitation to submit bid.

1. American National Standards Institute (ANSI): ANSI C2; National Electrical Safety Code
2. National Electric Manufacturer's Association (NEMA) Standards as apply to specified Products.
3. National Fire Protection Association (NFPA): NFPA 70 (National Electrical Code), NFPA 72 (National Fire Alarm Code), NFPA 70E (Standard for Electrical Safety Requirements for Employee Workplaces), and other applicable NFPA codes
4. Underwriters' Laboratories, Inc. (UL) Listings, Labels, and Approvals shall govern the quality and performance of specified Products.
5. Americans with Disabilities Act (ADA)
6. Institute of Electrical and Electronics Engineers, Inc (IEEE)
7. National Electrical Contractor's Association (NECA)
8. International Electrical Testing Association (NETA)
9. Occupational Safety and Health Administration (OSHA)
10. Code of Maryland Regulations (COMAR)

B. Definitions:

1. "Provide" - means "furnish and install"
2. "Indicated" - means "indicated in contract documents"
3. "Concealed" - means items referred to are hidden from normal sight, this includes items partly excavated or crawl spaces and in service tunnels used solely for repairs and maintenance
4. "Exposed" - means items are not "concealed"
5. "Feeder" - means "All circuit conductors between the service equipment, the source of a separately derived system, or other power supply source and the final branch-circuit overcurrent device"
6. "Feeder circuit breakers" - means circuit breakers protecting feeders.
7. NETA ATS - International Electrical Testing Association Acceptance Testing Specifications, Latest Edition
8. "Building" – A structure that stands alone or that is cut off from adjoining structures by fire walls with all openings therein protected by approved fire doors
9. "degrees C" – means "degrees Celsius"
10. "degrees F" – means "degrees Fahrenheit"
11. "homerun" – This word shall refer to that portion of the electrical circuit wiring and conduit between the circuit breaker or fuse protecting the electrical circuit, and the first equipment or load on the electric circuit. There is no other equipment or load on the electrical circuit between the first equipment or load, and the circuit breaker or fuse. For example, a 120V, 20A circuit breaker feeds #12 AWG wiring which connects to 3 – NEMA 5-20R receptacles. The wiring and conduit that runs from the circuit breaker to the 1st receptacle is considered the homerun wiring and conduit. There is no other receptacle on the electrical circuit between the 1st receptacle and the circuit breaker.
12. "duct" – This word shall mean conduit that are installed underground
13. "Branch circuit" – means "The circuit conductors between the final overcurrent device protecting the circuit and the outlets(s)."
14. "Suspended ceiling" – Suspended ceiling (sometimes referred to as dropped ceiling or false ceiling) is a secondary ceiling suspended or supported from the building structure

above, creating a void between the underside of the building structure and the top of the suspended ceiling. Suspended ceilings include, but are not limited to, grid type ceilings, gypsum board ceilings, drywall type ceilings, and other ceilings which are located below the building structure. Suspended ceilings are either accessible ceilings (including, but not limited to, grid type ceilings with removable ceiling panels or tiles) or non-accessible ceilings (including, but not limited to, gypsum board ceilings and drywall type ceilings).

1.5 SUBMITTALS

- A. Product Data: Submit Product Data applicable to items listed under Submittals in each Section of Division 26, 27, and 28; and such items as may be indicated on the Drawings.
- B. Coordination Drawings:
 - 1. Where the contractor has any question or request-for-information that relates to locations of equipment, or coordination of equipment locations, the contractor shall provide a coordination drawing together with the question or request-for-information. The coordination drawing shall have reflected ceiling plans, structural plans, floor plans and other relevant drawings, drawn to scale on one drawing, on which the following items are shown and coordinated with each other, based on actual dimensions of the items, input from actual installer of the items involved, and existing conditions (the contractor shall field measure all existing conditions):
 - a. Routing of underground ducts or ductbanks.
 - b. Routing of conduit encased in concrete slab.
 - c. Routing of electrical wiring/conduit
 - d. Structural beams, trusses and columns.
 - e. Motors and all other mechanical equipment.
 - f. Mechanical pipes and ducts
 - g. Junction/pull boxes and electrical enclosures
 - h. Electrical Distribution Equipment (switchgear, transformers, motor control centers, panelboards, switchboards, etc.)
 - i. All equipment/devices which are relevant to the question or request-for-information
- C. Shop Drawings
 - 1. General: The Contractor shall submit to the Engineer for approval, before fabrication, detailed shop drawings for all electrical equipment and materials.
 - 2. Shop drawings shall clearly indicate, using arrows and/or highlighting on all copies, which items are being submitted and that each item being submitted is in compliance with all requirements on the drawings and in these specifications. All pertinent specification and drawing requirements shall be indicated on the manufacturer's drawings. Complete model number of equipment shall be indicated.
 - 3. Shop drawing shall include a cover sheet that indicates the project name, the name of the contractor, and the name of the supplier/distributor.
 - 4. Shop drawing shall have a summary page that indicates the following: quantities of all equipment, manufacturer/model number for all equipment, and lead time for all equipment.
 - 5. Shop drawings of related equipment shall be submitted together.
- D. "As-Built" Drawings:
 - 1. The contractor shall provide "as-built" drawings, in both electronic and hardcopy formats. The contractor shall provide accurate project record drawings, showing in red color on

the working drawings and electrical drawings, all changes, modifications, and alterations from the original drawings, made during installation of the work. Upon completion of the work, the contractor shall provide the Owner with a USB drive that has an electronic copy of the project record drawings, and a full size hardcopy of the project record drawings.

E. Operating and Maintenance Manuals

1. **General:** Upon completion of the work, the Contractor shall furnish Operating and Maintenance Manuals for use by the Owner. The manuals shall include operating and maintenance information on all systems and items of equipment. The data shall consist of catalogs, brochures, bulletins, charts, schedules and drawings describing location, operation, maintenance, lubrication, operating weight and other information necessary for the Owner to establish an effective operating and maintenance program.
2. **Shop Drawings:** Copies of appropriate shop drawings shall be included in the Operating and Maintenance Manuals. The requirements for manuals is a separate contractual item and in no way supersedes the requirements for shop drawings and vice-versa.
3. **Approval:** Completed manuals shall be submitted to the Engineer for review and approval. Incomplete or inadequate manuals will be returned to the Contractor for correction and resubmission.
4. Provide an electronic copy (PDF format) on 3 USB drives, and 3 hardcopies in 3-ring binders, of all operating and maintenance manuals, unless a greater quantity is specified elsewhere in the contract documents, in which case the greater quantity shall apply. Each drive and each hardcopy shall have all the operating and maintenance manuals for all the equipment.
5. Equipment keys and passwords shall be provided to the Owner's authorized representative or representatives. A document shall be provided indicating who received the keys and what are the passwords. Document shall be neat and typewritten.
6. Provide a separate section in the O&M Manuals for maintenance testing schedules of all equipment. A factory authorized representative of the equipment manufacturer shall certify the maintenance program. Include calendar schedule in table format to indicate all maintenance actions included during the warranty period with spaces for future testing.
7. All factory and field test reports by the contractor, manufacturer, and/or independent testing company shall be included in the O&M Manuals.
8. Wiring diagrams for all factory and field wiring shall be included in the O&M Manuals.

F. Spare Parts and Accessories List

1. A complete list of spare parts and accessories for equipment shall be provided.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials and equipment to the Project site in a clean condition with openings plugged or capped (or otherwise sealed by packaging) both during shipping and during temporary storage.
- B. Delivered electrical equipment crating and/or packaging shall clearly identify pick-points or lift-points. In the absence of crating or packaging, pick-points or lift-points must be identified on the equipment.
- C. When unloading materials and equipment provide special lifting harness or apparatus as may be required by manufacturers. Handle materials and equipment in accordance with the manufacturer's written instructions.

- D. The Contractor shall determine the required equipment needed for unloading operations and have such equipment on site to perform unloading work on the date of equipment delivery.
- E. Store materials and equipment, both on and off site, in accordance with manufacturer's written instructions. Keep equipment in a dry location.
 - 1. Temporary Heating: Apply temporary heat to materials and equipment, according to manufacturer's written instructions, throughout periods when environment is not controlled for temperature and humidity within manufacturer's stipulated service conditions.

1.7 WARRANTY

- A. The Contractor shall guarantee that all work performed, and all materials/equipment installed by him, are free from defects. The Contractor shall repair or replace any defective equipment, materials or workmanship, free of cost to the Owner, for a period of two (2) years from the date of final acceptance of the Contractor's work. The date of final acceptance is determined by the Owner. Where individual specification sections indicate a Warranty period longer than two (2) years, the longer warranty period shall apply.
- B. During this warranty period the Contractor shall:
 - 1. Correct and make good all electrical defects. Faulty equipment and materials shall be repaired or replaced as required to produce satisfactory results as directed by the engineer and without additional cost to the Owner. Contractor shall provide service within 24 hours after the call has been made by the Owner.

1.8 DAMAGE TO OTHER WORK

- A. Damage: Cutting or damage to existing structures, surfaces or installations shall be repaired at the expense of the Contractor. All such repairs or patching shall be neatly done by mechanics of the appropriate trade, and shall be done in such a fashion as to leave no readily apparent joint or change in appearance, and to leave no structural or other weakness.

1.9 TEMPORARY POWER

- A. Contractor shall be entirely responsible for temporary power. All applications, fees, temporary connections, etc. shall be made by the contractor.

1.10 COORDINATION

- A. General: The Contractor shall coordinate the work performed and equipment furnished by the Electrical Contractor with work performed and equipment furnished by other trades to ensure a complete and satisfactory installation.
- B. For all site work, comply with all the requirements of the state or local jurisdiction which apply to locating existing utilities. The requirements in Maryland include, but are not limited to, contacting "Miss Utility" prior to starting any site work.

1.11 INTERRUPTION OF ELECTRIC SERVICE

- A. Do not interrupt electric, data, telephone, and/or cable tv services to facilities occupied by the owner or others, unless permitted under the following conditions, and then only after arranging to provide temporary electric, data, telephone and/or cable tv services, according to requirements indicated:
 - 1. Notify the owner no fewer than 14 days in advance of proposed interruption of electric, data, telephone, and/or cable tv services.
 - 2. Do not proceed with interruption of electric, data, telephone, and/or cable tv services without the owner's written permission.

1.12 CONTRACTOR'S CERTIFICATION

- A. The Contractor shall submit a signed and dated letter to the owner and the engineer certifying the following:
 - 1. He shall certify that all work has been performed in accordance with the contract documents (including, but not limited to: any amendments, addendums, and contract modifications) ;
 - 2. He shall certify that all work has been inspected and approved by the Authorities Having Jurisdiction; AND,
 - 3. He shall certify that all work has been performed in accordance with the National Electrical Code and all applicable codes.

1.13 ELECTRICAL WORK FOR MECHANICAL AND PLUMBING EQUIPMENT

- A. Additional HVAC (Heating, Ventilation, and Air Conditioning) and Plumbing circuits/wiring are indicated in the mechanical/plumbing drawings and specifications. The electrical contractor shall coordinate with the mechanical/plumbing contractor to make sure that all the circuits/wiring required in order to make the HVAC/Plumbing system complete and fully operational are included in the bid price. All HVAC/Plumbing circuits/wiring shall be provided in accordance with the NEC and the Contract Documents. Wiring shown in the mechanical/plumbing drawings and specifications include, but are not limited to: wiring for dampers, thermostats, and other HVAC/Plumbing power/controls.
- B. Prior to submitting a bid or a price proposal, coordinate with the mechanical/plumbing contractor. Get wiring diagrams, cut sheets, installation/operation manuals, and other information regarding the equipment.
- C. Coordinate exact location and quantities of equipment with the mechanical/plumbing contractor.
- D. Provide wiring, conduit, mounting supports, hardware, and accessories (including, but not limited to: control switches, push buttons, safety devices, disconnects, starters, audio/visual indicators, interlocks, limit switches, remote stations, detector devices, etc.) as required for a complete, fully operational, and code compliant system.
- E. All work shall comply with the manufacturer's recommendations and NEC requirements.

1.14 ELECTRICAL WORK FOR MISCELLANEOUS EQUIPMENT

- A. For all equipment that require electrical connections, provide wiring, conduit, and equipment accessories (including, but not limited to: control switches, push buttons, safety devices, disconnects, starters, audio/visual indicators, interlocks, limit switches, remote stations, detector devices, sensors, controls, speakers, audio/visual devices, level/pressure instruments, power supplies, etc.) as required for a complete and fully operational, and code compliant system. The equipment accessories are specified in the contract documents (including, but not limited to, drawings and specifications) associated with each equipment. For example, the accessories associated with the overhead door are indicated in the overhead door specifications
- B. Prior to submitting a bid or a price proposal, coordinate with the contractor that is furnishing the miscellaneous equipment. Get wiring diagrams, cut sheets, installation/operation manuals, and other information regarding the equipment.
- C. Coordinate exact location and quantities of miscellaneous equipment with the contractor that is furnishing the miscellaneous equipment.
- D. All work shall comply with the manufacturer's recommendations and NEC requirements.

1.15 VIDEO RECORDING OF DEMONSTRATION AND TRAINING

- A. A professional camera firm shall provide a video recording of all demonstration and training. The demonstration and training video shall be saved onto portable external hard drives. 3 sets of portable external hard drives shall be provided to the owner.

1.16 TRACER WIRE

- A. Provide tracer wire for underground civil and/or plumbing utilities in accordance with State, Local Jurisdiction, and/or Utility requirements. All work shall comply with the NEC, and State/Local Jurisdiction/Utility requirements. Coordinate with Civil and/or Plumbing drawings/specifications/contractors.

1.17 TRAINING

- A. Provide training for all equipment. Schedule training with at least 21 days advance notice, to the owner and engineer, by submitting a draft training schedule. Indicate all proposed training dates with specific equipment descriptions. The Contractor shall then confirm these dates with the owner and engineer. After receiving approval of these dates, the Contractor shall submit a final training schedule at least 14 days prior to the agreed upon dates.
- B. Provide a minimum of 4 hours of training for each equipment. Where individual specification sections indicate a training period longer than 4 hours, the longer training period shall apply.

END OF SECTION 260010

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SECTION 260200 - ELECTRICAL TESTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1, 26, 27, and 28 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes general requirements for electrical field testing and inspecting. Detailed requirements are specified in each Section containing components that require testing. General requirements include the following:
 - 1. Qualifications of testing agencies and their personnel.
 - 2. Suitability of test equipment.
 - 3. Calibration of test instruments.
 - 4. Coordination requirements for testing and inspecting.
 - 5. Reporting requirements for testing and inspecting.

1.3 QUALITY ASSURANCE

- A. Testing Agency Qualifications: As specified in each Section containing electrical testing requirements and in subparagraph and associated subparagraph below.
 - 1. Independent Testing Agencies: Independent of manufacturers, suppliers, and installers of components to be tested or inspected.
 - a. Testing Agency's Field Supervisor for Power Component Testing: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Division 26 Specification Sections.
- B. Test Equipment Suitability: Comply with NETA ATS
- C. Test Equipment Calibration: Comply with NETA ATS

1.4 SUBMITTALS:

- A. Provide qualification data for testing agency. Qualification data shall include: corporate history and corporate resume, key personnel and project supervisor resumes, 10 similar projects with scope descriptions, 5 similar testing project reference names and contact information, copy of all certifications, samples of all test report sheets, and corporate safety procedures manual.

PART 2 - NOT USED

PART 3 - EXECUTION

3.1 TESTS AND INSPECTIONS

- A. See individual Specification Sections for Tests and Inspections required on Electrical Systems.
- B. In addition to the requirements indicated in each individual Specification Section, comply with all of the following:
 - 1. Provide a Test Report for each test that indicates the following:
 - a. Test procedures used.
 - b. Test results that comply with requirements.
 - c. Test results that do not comply with requirements and corrective actions taken to achieve compliance with requirements.
 - 2. At the beginning of each test report, provide an executive summary that indicates whether each equipment has PASSED all the specified tests or FAILED one or more tests. Where the equipment has failed, the summary shall indicate each test that FAILED. Where the equipment has failed, the summary shall provide a recommendation for corrective action.
 - 3. Remove and replace malfunctioning equipment and test new equipment at no additional cost to the owner. Submit test reports.
 - 4. Where a Test Report uses a specific name/label/designation for a particular equipment, that name/label/designation shall be consistent with the name/label/designation indicated in the Contract Documents and in the field.

END OF SECTION - 260200

SECTION 260500 - COMMON WORK RESULTS FOR ELECTRICAL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1, 26, 27, and 28 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Electrical equipment coordination and installation.
 - 2. Sleeves for raceways and cables.
 - 3. Sleeve seals.
 - 4. Grout.
 - 5. Touch up paint
 - 6. Common electrical installation requirements.

1.3 DEFINITIONS

- A. EPDM: Ethylene-propylene-diene terpolymer rubber.
- B. NBR: Acrylonitrile-butadiene rubber.
- C. NECA: National Electrical Contractors Association

1.4 SUBMITTALS

- A. Product Data: Provide product data for all items indicated in this specification section.

1.5 COORDINATION

- A. Coordinate arrangement, mounting, and support of electrical equipment:
 - 1. To allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.
 - 2. To provide for ease of disconnecting the equipment with minimum interference to other installations.
 - 3. To allow right of way for piping and conduit installed at required slope.
 - 4. Connecting raceways, cables, wireways, cable trays, and busways shall be clear of obstructions and of the working and access space of other equipment.
- B. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.

- C. Coordinate location of access panels and doors for electrical items that are behind finished surfaces or otherwise concealed.
- D. Coordinate sleeve selection and application with selection and application of firestopping.

PART 2 - PRODUCTS

2.1 SLEEVES FOR RACEWAYS AND CABLES

- A. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.
- B. Sleeves for Rectangular Openings: Galvanized sheet steel.
 - 1. Minimum Metal Thickness:
 - a. For sleeve cross-section rectangle perimeter less than 50 inches and no side more than 16 inches, thickness shall be 0.052 inch.
 - b. For sleeve cross-section rectangle perimeter equal to, or more than, 50 inches and 1 or more sides equal to, or more than, 16 inches, thickness shall be 0.138 inch.

2.2 SLEEVE SEALS

- A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Advance Products & Systems, Inc.
 - b. Calpico, Inc.
 - c. Metraflex Co.
 - d. Pipeline Seal and Insulator, Inc.
 - 2. Sealing Elements: EPDM interlocking links shaped to fit surface of cable or conduit. Include type and number required for material and size of raceway or cable.
 - 3. Pressure Plates: Carbon steel. Include two for each sealing element.
 - 4. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.3 GROUT

- A. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, nonmetallic aggregate grout, noncorrosive, nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

2.4 ACCESS DOORS

- A. Door and frame shall be constructed of steel, 16 gauge minimum. Access door shall have a continuous piano hinge. Door shall have a flush mounted lock. Finish shall be prime coat of rust inhibitive electrostatic powder, baked enamel. Access door shall be field painted to match the surrounding wall or ceiling.
- B. Provide fire rated access doors to maintain the fire rating of wall and ceiling assemblies, to restore original fire-resistance rating of assembly.

2.5 DUCT-SEALING COMPOUND

- A. Duct-sealing compound shall be Polywater FST Foam Sealant or approved equal. Duct-sealing compound shall be a 2-part, 98% closed-cell urethane foam. It shall react and set in 5-10 minutes at 70 degrees F. It shall be capable of sealing 3/4" to 10" conduits with multiple cable configurations. Duct-sealing compound shall be re-enterable. It shall be capable of withstanding temperatures from -20 degrees F to 200 degrees F continuous, and be chemically resistant to gasoline, oils, dilute acids, and bases. Duct-sealing compound shall not affect the physical or electrical properties of wires and cables.
- B. Duct-sealing compound shall have good adhesion to duct and cable jacket surfaces with good structural strength. It shall have 120 lb. compressive strength (ASTM D1621). Duct-sealing compound shall be capable of holding 22 feet water head pressure continuous, or 90 feet water head pressure short-term. It shall block up to 5 psi gas or vapor continuous. It shall meet NEC codes for Raceway Seals, meet UL 94 fire rating HBF, and be UL recognized.
- C. Duct-sealing compound shall be compatible with the wires/cables used in the project. The cured foam is an inert solid that does not affect wire/cable components. It does not change the physical or electrical properties of wires/cables, based on tensile – elongation and volume resistivity testing.
- D. Duct-sealing compound shall have excellent adhesion to PVC, rigid steel, EMT, IMC, fiberglass, and polyethylene conduits.

2.6 TOUCH UP PAINT

- A. Provide touch up paint from the manufacturer of the electrical equipment. Paint shall match the finish of the equipment. At a minimum, provide touch up paint all power distribution equipment.

PART 3 - EXECUTION

3.1 COMMON REQUIREMENTS FOR ELECTRICAL INSTALLATION

- A. Comply with NECA 1.
- B. Comply with NFPA 70, National Electrical Code.
- C. Mounting heights indicated in the contract documents are measured from the finished floor or finished grade to the bottom of the equipment, unless otherwise noted.

- D. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide maximum possible headroom consistent with these requirements.
- E. Equipment: Install to facilitate service, maintenance, and repair or replacement of components of both electrical equipment and other nearby installations. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.
- F. Right of Way: Give to piping systems installed at a required slope.
- G. Where underground ducts or conduit enter the building, the inside of the ducts or conduit shall be sealed with Duct-Sealing Compound.
- H. Provide touch up paint as required on equipment finishes that have been scratched, and provide touch up paint as directed by the engineer. Touch-up paint shall be provided in accordance with the manufacturer's recommendations. Do not allow paint to come in contact with conductors, insulation or any live parts. All nameplates and labels shall remain visible and legible.
- I. Overcurrent devices shall be readily accessible and shall be installed so that the center of the grip of the operating handle of the switch or circuit breaker, when in its highest position, is not more than 6 feet 7 inches above the floor or working platform.
- J. All exterior wall penetrations shall be made watertight. Seal inside and around conduit as required. The inside of the conduit shall be sealed with Duct-Sealing Compound.
- K. Provide access doors where required to keep concealed electrical devices and equipment accessible in accordance with the National Electrical Code.
- L. Unless otherwise noted, access doors shall be painted to match surrounding wall or ceiling.
- M. Enclosures, troughs, wireways, boxes and raceways which contain unmetrated wiring, shall be provided with a suitable means to accommodate the seals of the electric utility. Coordinate with electric utility and comply with their requirements.
- N. Provide boards, channels, blocking, wall anchors, screws, hardware, and other supports for mounting electrical equipment on walls. Where the electrical equipment are mounted in finished spaces (including, but not limited to, offices, etc.), the supports shall be concealed. Where the electrical equipment are mounted in wet locations, the supports shall be suitable for wet locations.
- O. Where electrical equipment are mounted above suspended ceilings, provide coordinate exact location of the equipment such that it does not block or prevent the removal/operation of ceiling tiles and access doors.
- P. Where underground conduit enters buildings, and terminate at electrical equipment (including, but not limited to, panelboards, enclosed circuit breakers, lighting relay panels, etc.), the conduit shall terminate at the bottom of the electrical equipment, unless otherwise noted.

3.2 SLEEVE INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Electrical penetrations occur when raceways, cables, wireways, cable trays, or busways penetrate concrete slabs, concrete or masonry walls, or fire-rated floor and wall assemblies.
- B. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.
- C. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
- D. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.
- E. Cut sleeves to length for mounting flush with both surfaces of walls.
- F. Extend sleeves installed in floors 2 inches above finished floor level.
- G. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and raceway or cable, unless indicated otherwise.
- H. Seal space outside of sleeves with grout for penetrations of concrete and masonry
 - 1. Promptly pack grout solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect grout while curing.
- I. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint.
- J. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at raceway and cable penetrations. Install sleeves and seal raceway and cable penetration sleeves with firestop materials.
- K. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.
- L. Aboveground, Exterior-Wall Penetrations: Seal penetrations using cast-iron pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
- M. Underground, Exterior-Wall Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch annular clear space between raceway or cable and sleeve for installing mechanical sleeve seals.

3.3 SLEEVE-SEAL INSTALLATION

- A. Install to seal exterior wall penetrations.
- B. Use type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.4 FIRESTOPPING

- A. Apply firestopping to penetrations of fire-rated ceiling, floor and wall assemblies for electrical installations to restore original fire-resistance rating of assembly.
- B. Install UL Listed Firestopping Material in accordance with the manufacturer's recommendations, and UL's requirements.

END OF SECTION 260500

SECTION 260519 - CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1, 26, 27, and 28 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Building wires and cables rated 600 V and less.
 - 2. Connectors, splices, and terminations rated 600 V and less.
 - 3. Sleeves and sleeve seals for cables.

1.3 DEFINITIONS

- A. AWG: American Wire Gauge
- B. KCMIL: Thousand Circular Mil

1.4 SUBMITTALS

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

1.5 QUALITY ASSURANCE

- A. 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.
- B. Comply with NFPA 70.

1.6 COORDINATION

- A. Set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.

PART 2 - PRODUCTS

2.1 CONDUCTORS AND CABLES

- 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. American Insulated Wire Corp.; a Leviton Company.
 - 2. General Cable Corporation.
 - 3. Senator Wire & Cable Company.
 - 4. Southwire Company.

- B. Copper Conductors: Comply with NEMA WC 70.

- C. Conductor Insulation:
 - 1. THHN/THWN-2 Wire:
 - a. Complies with NEMA WC 70
 - b. Listed to UL 83
 - c. Suitable for operation at 600 volts or less in wet or dry locations.
 - d. 90 degree C rated in wet or dry locations.
 - 2. XHHW-2 Wire:
 - a. Complies with NEMA WC 70
 - b. Listed to UL 44
 - c. Suitable for operation at 600 volts or less in wet or dry locations
 - d. 90 degree C rated in wet or dry locations.
 - e. Insulation is an abrasion, moisture, and heat resistant cross-linked polyethylene (XLP)

- D. Branch Circuit Type Metal Clad Cable:
 - 1. Conductor Insulation: THHN 90 degree C
 - 2. Copper conductor.
 - 3. Neutral wire shall be insulated and shall be the same size as the phase conductors.
 - 4. Voltage Rating: 600V
 - 5. Conductor covering: Polypropylene assembly tape overall
 - 6. Armor: Interlocked galvanized steel
 - 7. Fire Wall Rated for 1, 2 and 3 hour rated penetrations
 - 8. Grounding Means: One insulated copper grounding conductor, unless otherwise noted.
 - 9. Suitable for use in environmental air handling spaces
 - 10. UL 1569 Listed

2.2 CONNECTORS AND SPLICES

- 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. AFC Cable Systems, Inc.
 - 2. Hubbell Power Systems, Inc.
 - 3. O-Z/Gedney; EGS Electrical Group LLC.
 - 4. 3M; Electrical Products Division.
 - 5. Tyco Electronics Corp.

- B. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.
- C. 600V Vinyl Insulating Tape: The tape is based on polyvinyl chloride (PVC) and/or its copolymers and has a rubber based, pressure-sensitive adhesive. The tape shall be 7 mils thick, and UL Listed and marked per UL Standard 510 as "Flame Retardant, Cold and Weather Resistant."
- D. Screw-on Pressure Cable Connector: Connector shall be UL Listed. Voltage rating shall be 600 volts for building wire and 1000 volts for signs and fixtures.
- E. Mechanical Connector: Connector shall be UL Listed. Connector shall be wrapped with electrical insulating tape in accordance with the NEC and the manufacturer's requirements. Connectors shall be dual rated (suitable for use with copper or aluminum conductors), unless otherwise noted.
- F. Compression Connector: Connector shall be UL Listed. Connector shall be wrapped with electrical insulating tape in accordance with the NEC and the manufacturer's requirements. Use compression tool recommended by manufacturer. Connectors shall be dual rated (suitable for use with copper or aluminum conductors), unless otherwise noted.

PART 3 - EXECUTION

3.1 CONDUCTOR MATERIAL APPLICATIONS

- A. Service: Copper. Stranded.
- B. Feeders: Copper. Stranded.
- C. Branch Circuits: Copper.
 - 1. Solid for No. 10 AWG and smaller, unless otherwise noted and except as follows:
 - a. Where the conductors connect to vibrating equipment (including, but not limited to, transformers, motors, and generators), the conductors shall be stranded.
 - b. Where the equipment manufacturer recommends stranded conductors, the associated conductors shall be stranded.
 - 2. Stranded for No. 8 AWG and larger.
- D. Class 1 and Class 2 Control Wiring: Copper. Stranded.

3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

- A. Aboveground Service Entrance: Type THHN/THWN-2, single conductors in raceway, unless otherwise noted.
- B. Aboveground Exposed Feeders: Type THHN/THWN-2, single conductors in raceway, unless otherwise noted.

- C. Aboveground Feeders Concealed in Ceilings, Walls, and Partitions: Type THHN/THWN-2, single conductors in raceway, unless otherwise noted.
- D. Aboveground Exposed Branch Circuits: Type THHN/THWN-2, single conductors in raceway, unless otherwise noted.
- E. Aboveground Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type THHN/THWN-2, single conductors in raceway, unless otherwise noted and except as follows:
 - 1. Branch Circuit Type Metal Clad Cable may be used in lieu of THHN/THWN-2, single conductors in raceway where ALL of the following conditions are met:
 - a. Metal Clad Cable is fed from circuit breakers or fuses rated at 100 amperes or less.
 - b. Metal Clad Cable is only used for branch circuit conductors.
 - c. Metal Clad Cable is used only in dry locations.
 - d. Metal Clad Cable is used only in aboveground applications.
 - e. Metal Clad Cable is not subject to physical damage.
 - f. Metal Clad Cable is used only in concealed ceilings, walls, and partitions.
 - g. Metal Clad Cable is only used for final connections to the associated equipment.
 - h. Metal Clad Cable does not exceed 6' in length.
 - i. Metal Clad Cable is installed only where allowed by the National Electrical Code, NFPA Codes, and Federal/State/Local Codes.
- F. Aboveground Class 1 and Class 2 Control Wiring: Type THHN/THWN-2, single conductors in raceway unless otherwise noted.
- G. Underground Service, Feeders and Branch Circuits: XHHW-2 single conductors in raceway, unless otherwise noted. The wiring shall be type XHHW-2 from end-to-end, regardless of whether or not the wiring starts or ends aboveground or underground. For example, a branch circuit for an underground lighting circuit shall be XHHW-2 from where the branch circuit starts (at the aboveground panelboard), up to where it ends (at the aboveground light pole).
- H. Underground Class 1 and Class 2 Control Wiring: XHHW-2 single conductors in raceway, unless otherwise noted. The wiring shall be type XHHW-2 from end-to-end, regardless of whether or not the wiring starts or ends aboveground or underground. For example, a branch circuit for an underground lighting circuit shall be XHHW-2 from where the branch circuit starts (at the aboveground panelboard), up to where it ends (at the aboveground light pole).

3.3 INSTALLATION OF CONDUCTORS AND CABLES

- A. Comply with the NEC.
- B. Comply with the manufacturer's recommendations and requirements.
- C. Conceal cables in finished walls, ceilings, and floors, unless otherwise indicated.
- D. 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.
- E. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.

- F. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.
- G. Identify and color-code conductors and cables according to Specification Section "Electrical Identification."
- H. Do not splice feeders and underground branch circuits unless specifically indicated in the drawings. Cables shall be unspliced between termination points.
- I. Provide insulated bushings at the end of each Metal Clad Cable.
- J. Use insulating bushings to protect ALL conductors, including conductors smaller than No. 4 AWG. Provide insulated grounding bushings where required by NFPA 70 or the Contract Documents.
- K. Cables associated with roof mounted equipment or outdoor wall mounted equipment shall run concealed inside the building.
- L. Spare wires shall be disconnected at both ends and shall be insulated at both ends with wire nuts held in place by electrical insulating tape. For large wire sizes, the spare wires shall be disconnected at both ends and shall be insulated at both ends with double wrapped electrical insulating tape.
- M. Provide dedicated neutral wires for all branch circuits.
- N. Do not combine separate feeder circuits in the same raceway, unless otherwise noted.
- O. Do not combine separate branch circuits in the same raceway, unless otherwise noted and except as follows:
 - 1. Branch circuits may be combined in the same raceway where ALL of the following conditions are met:
 - a. The branch circuits being combined in the same raceway serve the same area or adjacent areas.
 - b. The branch circuits being combined in the same raceway homerun to the same panelboard.
 - c. The number of branch circuits being combined in the same raceway does not exceed 3.
 - d. The number of current carrying conductors installed in the same raceway does not exceed 6.
 - e. The branch circuits are installed in a manner that does not subject them to any ampacity derating, except for the ampacity derating caused by having 4 to 6 current carrying conductors in the same raceway.
 - f. The branch circuits that are being combined in the same raceway are all fed from 1-pole circuit breakers that have a trip rating of either 15 amperes or 20 amperes.
 - g. The branch circuits that are being combined in the same raceway are not fed from circuit breakers that have a trip rating greater than 20 amperes.
 - h. The branch circuits that are being combined in the same raceway are limited to 1-phase circuits that have a voltage of either 120V or 277V.
 - i. The smallest wire size, in the branch circuits which are being combined in the same raceway, is not smaller than #12 AWG.
 - j. The wires that are combined in the same raceway do not exceed the NEC wire fill capacity of the raceway. The raceway size is increased as required to comply with NEC requirements.
 - k. The branch circuits which are being combined in the same raceway are limited to lighting and receptacle branch circuits.

- I. Dedicated neutral wires are provided for all branch circuits.
 - m. Ground wires are provided in accordance with NEC requirements. Grounding and bonding are provided in accordance with NEC requirements.
 - n. Where the NEC does not allow branch circuits to be combined in the same raceway, the branch circuits are not combined in the same raceway.
 - o. All work complies with the NEC, the manufacturer's recommendations, and the contract documents.
- P. All metal clad cable shall be concealed, unless otherwise noted.
- Q. Underground splices of service, feeder, and branch circuits shall not be permitted, unless otherwise noted.
- R. Where wires larger than #10 AWG are installed on 15A or 20A branch circuits, splice #10AWG "pigtails" for connections to circuit breakers, devices and equipment. "Pigtails" in this paragraph shall mean short leads used to connect a circuit breaker, device or equipment to branch circuit wires. Comply with all of the following:
 - 1. Length of the wires of the "pigtails" shall be less than 48", unless otherwise noted and except as follows:
 - a. At light poles, the length of the "pigtails" shall be increased to match the height of the light pole such that the "pigtail" splice is located in the handhole at the base of the pole. The length of the "pigtail" shall not exceed 125% of the overall height of the light pole.
 - 2. Where the "pigtails" are run inside raceways, the length of the raceways shall be less than 23", and the raceways shall be sized per NEC requirements.
 - 3. Provide junction boxes as required for splicing wires.
 - 4. The wire size of the phase, neutral, and ground wires of the "pigtails" shall not be less than #10AWG, except as follows:
 - a. The wire size of the phase, neutral and ground wires of the "pigtails" shall be #12AWG where the wire terminals at the circuit breaker, device, or equipment are not suitable for wires larger than #12AWG.
 - 5. All work shall comply with NEC, the manufacturer's recommendations, and the contract documents.

3.4 CONNECTIONS

- A. 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.
- B. Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.
- C. Wiring at Outlets: Install conductor at each outlet, with at least 6 inches of slack.

3.5 FIELD QUALITY CONTROL

- A. Tests and Inspections:
 - 1. Engage a qualified testing agency and perform the following tests and inspections, and prepare test reports:
 - a. Perform each visual and mechanical inspection and electrical test stated in the NETA Acceptance Testing Specification. Certify compliance with test parameters.

- 1) Electrical tests (this includes, but is not limited to: insulation resistance testing) are required on all wiring that is #2 AWG and larger, and all sizes of underground wiring. Visual and mechanical inspections are required on all wiring.
2. The testing agency shall coordinate with the manufacturer of the item being tested, and shall obtain copies of the installation/testing manuals. The testing agency shall not exceed the test voltage/current/duration limits indicated by the manufacturer.
3. Remove and replace items which do not pass the tests. Test the replacement items.

END OF SECTION 260519

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SECTION 260526 - GROUNDING AND BONDING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1, 26, 27, and 28 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes methods and materials for grounding systems and equipment.

1.3 SUBMITTALS

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

1.4 QUALITY ASSURANCE

- A. 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.
- B. Comply with UL 467 for grounding and bonding materials and equipment.

PART 2 - PRODUCTS

2.1 CONDUCTORS

- A. Insulated Conductors: Copper wire or cable insulated for 600 V unless otherwise noted.
- B. Bare Copper Conductors:
 - 1. Solid Conductors: ASTM B 3.
 - 2. Stranded Conductors: ASTM B 8.
 - 3. Tinned Conductors: ASTM B 33.

2.2 CONNECTORS

- A. Listed and labeled by a nationally recognized testing laboratory acceptable to authorities having jurisdiction for applications in which used, and for specific types, sizes, and combinations of conductors and other items connected.
- B. Bolted Connectors for Conductors and Pipes: Copper or copper alloy, bolted pressure-type, with at least two bolts.

1. Pipe Connectors: Clamp type, sized for pipe.
- C. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

2.3 GROUNDING ELECTRODES

- A. Ground Rods: Copper-clad steel; 3/4 inch diameter by 10 foot long.

PART 3 - EXECUTION

3.1 APPLICATIONS

- A. Conductors: Install solid conductor for No. 8 AWG and smaller (exception: conductors for vibrating equipment, such as transformers, motors and generators, shall use stranded conductors; or, where stranded conductors are recommended by the manufacturer of the equipment, use stranded conductors), and stranded conductors for No. 6 AWG and larger, unless otherwise indicated.
- B. Conductor Terminations and Connections:
 1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
 2. Underground Connections: Welded connectors.
 3. Connections to Structural Steel: Welded connectors.

3.2 EQUIPMENT GROUNDING

- A. Install insulated equipment grounding conductors with all feeders and branch circuits. This includes, but is not limited to, low and medium voltage feeders and branch circuits.
- B. Unless otherwise noted, all equipment grounding conductors shall be insulated.

3.3 INSTALLATION

- A. Grounding Conductors: Route along shortest and straightest paths possible, unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.
- B. Common Ground Bonding with Lightning Protection System: Comply with NFPA 70, NFPA 780 and UL 96 when interconnecting with lightning protection system.
- C. Grounding and Bonding for Piping:
 1. Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes, using a bolted clamp connector or by bolting a lug-type connector to a pipe flange, using one of the lug bolts of the flange. Where a dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.

2. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.
 3. Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.
- D. Ufer Ground (Concrete-Encased Grounding Electrode): Fabricate according to NFPA 70, using a minimum of 20 feet of bare copper conductor not smaller than No. 4 AWG.
1. Bond grounding conductor to reinforcing steel in at least four locations and to anchor bolts.
- E. Ground cable shielding, metallic conduits, wireways, cable boxes, luminaires, light poles, electrical equipment housings, and all noncurrent carrying metallic parts.
- F. All metal conduit stub-ups shall be grounded, and where multiple stub-ups are made within an equipment enclosure, they shall be equipped with grounding bushings, bonded together, bonded to the enclosure, and bonded to the enclosure ground bus/terminal.

END OF SECTION 260526

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SECTION 260529 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1, 26, 27, and 28 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Hangers and supports for electrical equipment and systems.
 - 2. Construction requirements for concrete bases.

1.3 DEFINITIONS

- A. RMC: Rigid metal conduit.
- B. MFMA: Metal Framing Manufacturer's Association
- C. MSS: Manufacturers Standardization Society of The Valve and Fittings Industry Inc.

1.4 PERFORMANCE REQUIREMENTS

- A. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.
- B. Design equipment 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 for this Project, with a minimum structural safety factor of five times the applied force.

1.5 SUBMITTALS

- A. Product Data: For the following:
 - 1. Steel slotted support systems.

1.6 QUALITY ASSURANCE

- A. Comply with NFPA 70.

1.7 COORDINATION

- A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases.
- B. Coordinate installation of roof curbs, equipment supports, and roof penetrations.

PART 2 - PRODUCTS

2.1 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

- A. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.
 - 1. 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:
 - a. Allied Tube & Conduit.
 - b. Cooper B-Line, Inc.; a division of Cooper Industries.
 - c. ERICO International Corporation.
 - d. Thomas & Betts Corporation.
 - e. Unistrut; Tyco International, Ltd.
 - f. Hilti
 - 2. Comply with the following for Outdoor Locations, unless otherwise noted:
 - a. Steel Channel Metallic Coatings: Hot-dip galvanized after fabrication in accordance with ASTM A123 and applied according to MFMA-4.
 - b. Fittings and Accessories:
 - 1) Conduit hangers, conduit clamps, beam clamps, and wall brackets shall be steel, hot-dip galvanized after fabrication in accordance with ASTM A123.
 - 2) Threaded hardware such as mechanical expansion anchors, nuts, bolts, and threaded rods shall be steel, hot-dip galvanized after fabrication in accordance with ASTM A123. Threaded hardware not available as hot-dip galvanized after fabrication shall be stainless steel type 304.
 - 3. Comply with the following for Indoor Locations, unless otherwise noted:
 - a. Steel Channel metallic Coatings: Pre-Galvanized Steel with mill galvanized coating designation G90.
 - b. Fittings and Accessories:
 - 1) Conduit hangers, conduit clamps, beam clamps, and wall brackets shall be pre-galvanized (designation G90) or electroplated zinc (ASTM B633).
 - 2) Threaded hardware shall be electroplated zinc (ASTM B633).
 - 4. 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: Hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.
- D. 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.

- E. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:
 - 1. Mechanical-Expansion Anchors: Insert-wedge-type, 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. 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) Cooper B-Line, Inc.; a division of Cooper Industries.
 - 2) Empire Tool and Manufacturing Co., Inc.
 - 3) Hilti Inc.
 - 4) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
 - 5) MKT Fastening, LLC.
 - 2. Concrete Inserts: Steel slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.
 - 3. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.
 - 4. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
 - 5. Toggle Bolts: All-steel springhead type.
 - 6. Hanger Rods: Threaded steel.

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 and RMC as required by NFPA 70. Minimum rod size shall be 1/4 inch in diameter.
- C. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.
 - 1. Secure raceways and cables to these supports with single-bolt conduit clamps using spring friction action for retention in support channel.

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.

- 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 indicated by code:
1. To Wood: Fasten with lag screws or through bolts.
 2. To New Concrete: Bolt to concrete inserts.
 3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
 4. To Existing Concrete: Expansion anchor fasteners.
 5. To Steel: Beam clamps (MSS Type 19, 21, 23, 25, or 27) complying with MSS SP-69.
 6. To Light Steel: Sheet metal screws.
 7. 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.
- E. The use of powder-actuated tools is not allowed.
- F. Do not fasten supports to pipes, ducts, mechanical equipment, and conduit.
- G. Do not use spring steel clips and clamps.
- H. In wet or damp locations, use steel channel supports to standoff non-recessed, wall mounted cabinets and panelboards, at least one inch from the mounting surface.
- I. Where electrical equipment (including, but not limited to, lighting fixtures, wiring, conduit, etc.), or the items to which the electrical equipment are attached to or supported from (including, but not limited to, metal channels, junction boxes, etc.), are suspended, and the vertical length of the supports (including, but not limited to, threaded rods) for these equipment/items are longer than 48 inches, provide bracing supports to prevent swinging of the equipment/items.
- J. Suspended electrical equipment (including, but not limited to, lighting fixtures, wiring, conduit, etc.) shall be supported from the building structure. Where suspended electrical equipment are not located directly under roof trusses, roof supports, or other structural elements, or where other equipment (mechanical, plumbing, etc.) are located above the electrical equipment, provide metal channels and other supports to span, or attach to, the roof trusses, roof supports, or other structural elements. The electrical equipment shall be installed at the locations indicated in the Contract Documents, and metal channels and other supports shall be provided as required in order to support the electrical equipment.
- K. Provide supports for conductors in vertical conduit in accordance with the manufacturer's recommendations and NEC requirements.
- L. Where racks or cabinets are wall mounted, provide metal channels or fire-retardant plywood boards that are capable of supporting the equipment mounted on it, to span and attach to the wall studs, wall columns, or other wall elements. Where the wall elements cannot support the racks or cabinets, provide independent freestanding supports for the racks or cabinets. The metal channels, boards, and supports shall be painted to match adjacent wall surfaces where installed in finished spaces (including, but not limited to, offices, conference rooms, etc.)

3.3 CONCRETE BASES

- A. Construct concrete bases of dimensions indicated but not less than 4 inches larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.
- B. Use 3500-psi, 28-day compressive-strength concrete, unless otherwise indicated.
- C. Anchor equipment to concrete base.
 - 1. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 2. Install anchor bolts to elevations required for proper attachment to supported equipment.
 - 3. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
- D. Concrete Pad Protection and Curing:
 - 1. Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.
 - 2. Cure concrete for at least 28 days

3.4 PAINTING

- A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
 - 1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.
- B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION 260529

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SECTION 260533 - RACEWAYS AND BOXES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1, 26, 27, and 28 Specification Sections, apply to this Section.

1.2 DEFINITIONS

- A. FMC: Flexible metal conduit.
- B. LFMC: Liquidtight flexible metal conduit.
- C. RNC: Rigid nonmetallic conduit.
- D. EMT: Electrical metallic tubing.
- E. Where RGS (Rigid Galvanized Steel) Conduit, GRS (Galvanized Rigid Steel) Conduit, or RMC (Rigid Metal Conduit) are indicated in the contract documents, this shall mean Rigid Steel Conduit.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Source quality-control test reports.

1.4 QUALITY ASSURANCE

- A. 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.
- B. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 METAL CONDUIT AND TUBING

- 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. AFC Cable Systems, Inc.
 - 2. Allied Tube & Conduit; a Tyco International Ltd. Co.
 - 3. Anamet Electrical, Inc.; Anaconda Metal Hose.

4. O-Z Gedney; a unit of General Signal.
 5. Wheatland Tube Company.
 6. Robroy Industries Electrical Products Division
- B. Rigid Steel Conduit:
1. Manufactured in accordance with ANSI C80.1.
 2. UL 6 Listed
- C. FMC:
1. UL 1 Listed. UL Type RW (Reduced Wall)
 2. Zinc-coated steel construction
- D. EMT:
1. Manufactured in accordance with ANSI C80.3
 2. UL 797 listed
 3. Fittings: Set-screw or Compression type.
- E. LFMC:
1. UL 360 Listed
 2. Flexible steel conduit with PVC jacket.
 3. PVC jacket shall be moisture, oil and sunlight resistant.
- F. Fittings for Conduit (Including all Types and Flexible and Liquidtight), and Cable: NEMA FB 1; UL listed for type and size raceway with which used, and for application and environment in which installed.
1. Insulating Bushings: Plastic, 105 degree C minimum temperature rating.
 2. Insulated Grounding Bushings: Malleable Iron with plastic liner, 105 degree C minimum temperature rating.

2.2 NONMETALLIC CONDUIT AND TUBING

- 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. AFC Cable Systems, Inc.
 2. Anamet Electrical, Inc.; Anaconda Metal Hose.
 3. CANTEX Inc.
 4. Condux International, Inc.
 5. Electri-Flex Co.
 6. Lamson & Sessions; Carlon Electrical Products.
 7. RACO; a Hubbell Company.
 8. Thomas & Betts Corporation.
- B. RNC: NEMA TC 2, Type EPC-40-PVC (PVC Schedule 40) and Type EPC-80-PVC (PVC Schedule 80), UL 651, with matching fittings by same manufacturer as the conduit, complying with NEMA TC 3 and UL 514B. RNC shall be sunlight resistant and rated for use with 90 degree C conductors.

2.3 METAL TROUGHS

- 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. Cooper B-Line, Inc.
2. Hoffman.
3. Square D; Schneider Electric.

- B. Description: Sheet metal sized and shaped as indicated, NEMA 250, Type 1, unless otherwise indicated.
- C. Covers: Screw-cover type, unless otherwise noted
- D. Finish: ANSI 61 gray polyester powder paint finish inside and out over phosphatized surfaces.

2.4 METAL WIREWAYS

- 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. Cooper B-Line, Inc.
 2. Hoffman.
 3. Square D; Schneider Electric.
- B. Description: Sheet metal sized and shaped as indicated, NEMA 250, Type 1, unless otherwise indicated.
- C. Fittings and Accessories: Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.
- D. Wireway Covers: Screw-cover type, unless otherwise noted
- E. Finish: ANSI 61 gray polyester powder paint finish inside and out over phosphatized surfaces.

2.5 ROOFTOP SUPPORTS FOR CONDUIT

- A. Where conduit is mounted on top of flat rooftops, provide B-LINE DURA-BLOK rooftop supports to support the conduit. The rooftop supports shall have the following features:
1. Overall height of the support shall not be less than 5".
 - a. The clearance from the bottom of the conduit to the top of the roof shall not be less than 5".
 2. Built-in metal channel
 3. Load capacity shall be selected to provide a minimum of 5 times safety factor
 4. Made from 100% recycled rubber
 5. Reflective strip on both sides allow for easy product visibility
 6. Channel is through bolted on all sides for added strength
 7. Product composition is not sharp or abrasive
 8. UV resistant
 9. Suitable for any type of roofing material or other flat surface.

2.6 FLOOR BOXES

- A. Three-Compartment Floor Box shall include, but not be limited to the following components indicated below (provide additional hardware, accessories, and devices for a complete and fully operational floor box system):

1. Cast-iron Floor Box: Provide Wiremold 880CM3-1 three-gang shallow cast iron floor box, fully adjustable, or approved equal with the following features:
 - a. A divider shall be provided to separate the three compartments.
 - b. Dimension 5 3/16" x 12 1/2" x 2 7/16".
 - c. Conduit Openings: (8) 1"
 2. Cover Plate Flange: Provide Wiremold 837B three-gang, brass combination carpet and tile flange or approved equal with the following features:
 - a. Suitable for receptacle and telephone/data outlets
 - b. Suitable for carpet, tile or concrete floor applications
 3. The floor box shall have the following features:
 - a. Floor box shall have TopGuard protection (an integral design which keeps out water, dirt, and debris from the power and communication compartments).
 - b. Fully adjustable box. Before and after concrete pour adjustability.
 - c. Concrete tight cast-iron constructions. Meets requirements for on grade or below grade application.
 - d. Suitable for use in carpets, tiles or concrete floors.
 - e. Complies with UL Scrub Water Standards.
 - f. Water shall not enter power outlets during routine wet mopping and carpet shampooing.
 - g. Suitable for installation in concrete floors.
 4. Comply with the following for compartments with duplex receptacles:
 - a. Coverplate shall be Wiremold 828R brass duplex cover plate or approved equal. Provide faceplate, modules, adapters, and other accessories as required for the installation of the receptacle.
 5. Comply with the following for compartments with telephone/data/audio visual outlets:
 - a. Coverplate shall be Wiremold 828GFITC brass cover plate or approved equal. Provide faceplate, modules, adapters, inserts, and other accessories as required for installation of the telephone/data/coax/HDMI jacks.
 6. Provide all associated mounting hardware and accessories.
- B. Two-Compartment Floor Box shall include, but not be limited to the following components indicated below (provide additional hardware, accessories, and devices for a complete and fully operational floor box system):
1. Cast-iron Floor Box: Provide Wiremold 880CM2-1 two-gang shallow cast iron floor box, fully adjustable, or approved equal with the following features:
 - a. A divider shall be provided to separate the two compartments.
 - b. Dimension 5 3/16" x 8 1/2" x 2 7/16".
 - c. Conduit Openings: (6) 1"
 2. Cover Plate Flange: Provide Wiremold 827B two-gang, brass combination carpet and tile flange or approved equal with the following features:
 - a. Suitable for receptacle and telephone/data outlets
 - b. Suitable for carpet, tile or concrete floor applications
 3. The floor box shall have the following features:
 - a. Floor box shall have TopGuard protection (an integral design which keeps out water, dirt, and debris from the power and communication compartments).
 - b. Fully adjustable box. Before and after concrete pour adjustability.
 - c. Concrete tight cast-iron constructions. Meets requirements for on grade or below grade application.
 - d. Suitable for use in carpets, tiles or concrete floors.
 - e. Complies with UL Scrub Water Standards.
 - f. Water shall not enter power outlets during routine wet mopping and carpet shampooing.
 - g. Suitable for installation in concrete floors.
 4. Comply with the following for compartments with duplex receptacles:

- a. Coverplate shall be Wiremold 828R brass duplex cover plate or approved equal. Provide faceplate, modules, adapters, and other accessories as required for the installation of the receptacle.
5. Comply with the following for compartments with telephone/data/audio visual outlets:
 - a. Coverplate shall be Wiremold 828GFITC brass cover plate or approved equal. Provide faceplate, modules, adapters, inserts, and other accessories as required for installation of the telephone/data/coax/HDMI jacks.
6. Provide all associated mounting hardware and accessories.

2.7 BOXES

- 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. Cooper Crouse-Hinds; Div. of Cooper Industries, Inc.
 2. EGS/Appleton Electric.
 3. Hoffman.
 4. Hubbell Incorporated; Killark Electric Manufacturing Co. Division.
 5. O-Z/Gedney; a unit of General Signal.
 6. RACO; a Hubbell Company.
 7. Robroy Industries, Inc.; Enclosure Division.
 8. Spring City Electrical Manufacturing Company.
 9. Thomas & Betts Corporation.
 10. Walker Systems, Inc.; Wiremold Company (The).
- B. Sheet Metal Outlet and Device Boxes: NEMA OS 1.
- C. Cast-Metal Outlet and Device Boxes: NEMA FB 1, aluminum, Type FD, with gasketed cover.
- D. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.
- E. Cast-Metal Access, Pull, and Junction Boxes: NEMA FB 1, cast aluminum with gasketed cover.

2.8 ENCLOSURES AND CABINETS

- 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. Hoffman.
- B. Hinged-Cover Enclosures: NEMA 250, Type 1, with continuous-hinge cover with flush latch, unless otherwise indicated.
- C. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.

2.9 CORROSION PROTECTION TAPE

- A. Corrosion protection tape shall be 3M Scotchrap Tape 51 or approved equal with the following features:

1. Tape is a tough, polyvinyl chloride based tape with special high tack adhesives formulated to resist corrosion of metal piping systems above and below ground, fittings, and joints on all mill-coated pipe and electrical conduit systems.
 2. Tape is resistant to corrosive salt water, soil acids, alkalies and salts, common chemicals, chemical vapors, and exposure to outdoor weathering and sunlight.
 3. Tape is resistant to impact, abrasions, punctures and tears.
 4. Tape is 20 mil thick.
 5. Tape is suitable for -55 to 175 degree F service temperatures
 6. Tape shall be compatible with the conduit.
- B. Where the tape manufacturer recommends that a primer be used with the tape, provide a primer that is recommended by the manufacturer. The primer shall be manufactured by the same manufacturer as the tape. For the 3M Scotchrap Tape 51, use 3M Scotchrap Pipe Primer, unless the manufacturer recommends a different primer for the application. The primer shall be compatible with the tape and the conduit.
- C. Where the tape manufacturer recommends that putty be used with the tape, provide putty that is recommended by the manufacturer. The putty shall be manufactured by the same manufacturer as the tape. For the 3M Scotchrap Tape 51, use 3M Scotchfil Electrical Insulation Putty, unless the manufacturer recommends a different putty for the application. The putty shall be compatible with the tape and the conduit.

PART 3 - EXECUTION

3.1 RACEWAY AND BOXES APPLICATION

- A. Indoor locations:
1. Raceway shall be EMT, unless otherwise noted and except as follows:
 - a. Where raceway is used for supporting lighting fixtures, lighting control devices, occupancy sensors, photo sensors, wiring devices, receptacles, and other electrical equipment, the raceway shall be Rigid Steel Conduit, unless otherwise noted.
 - b. Use Rigid Steel Conduit in damp or wet locations, unless otherwise noted.
 - c. Conduit Larger than 4-inch trade size shall be Rigid Steel Conduit.
 - d. Where raceway is subject to physical damage, use Rigid Steel Conduit, unless otherwise noted.
 - e. For raceway embedded within a concrete/masonry wall or floor slab, use Rigid Steel Conduit, unless otherwise noted.
 - f. Use FMC for connection to vibrating equipment (including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment), and for connection to equipment where the manufacturer recommends a flexible raceway, unless otherwise noted and except as follows:
 - 1) Use LFMC for damp or wet locations.
 - 2) Use LFMC where LFMC is recommended by the manufacturer of the equipment.
 2. Boxes and enclosures shall be NEMA 1, galvanized steel, unless otherwise noted, and except as follows:

- a. Boxes and enclosures in damp or wet locations shall be NEMA 3R, die cast aluminum, gasketed covers, unless otherwise noted and except as follows:
 - 1) Boxes and enclosures in shower rooms shall be NEMA 4X stainless steel type 304, unless otherwise noted.
- B. Outdoor locations: Apply raceway and boxes products as specified below, unless otherwise noted:
 1. Raceway shall be Rigid Steel Conduit, unless otherwise noted and except as follows:
 - a. For underground raceway (including, but not limited to, raceway below the bottom of the lowest floor slab of the building/structure), use PVC Schedule 40 conduit, unless otherwise noted.
 - b. Use LFMC for connection to vibrating equipment (including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment), and for connection to equipment where the manufacturer recommends a flexible raceway, unless otherwise noted.
 2. Boxes and enclosures shall be NEMA 3R, die cast aluminum, gasketed covers, unless otherwise noted.
- C. Wireways and Troughs: All Wireways and Troughs shall be metal, with ANSI 61 gray polyester powder paint finish inside and out over phosphatized surfaces, unless otherwise noted.
- D. Minimum Raceway Size: 3/4-inch trade size, unless otherwise noted.
- E. Raceway Fittings: Compatible with raceways and suitable for use and location.
 1. Rigid Steel Conduit: Use threaded rigid steel conduit fittings, unless otherwise noted.

3.2 INSTALLATION

- A. Transitions from PVC conduit that is located underground (including, but not limited to, conduit below the bottom of the lowest floor slab of the building/structure), to aboveground metal conduit:
 1. Where the conduit is coming through the floor, an equipment pad, or finished grade, comply with the following:
 - a. Change from PVC conduit to Rigid Steel Conduit 12" below the top of the floor/pad/grade, and continue with Rigid Steel Conduit up to 24" above the finished floor or grade, or up to the equipment which the conduit connects to, whichever is lower, unless otherwise noted. Above 24" or above the equipment, use the raceway specified in the RACEWAY AND BOXES APPLICATION paragraph of this Specification Section, unless otherwise noted. Metal conduit shall be grounded and bonded in accordance with the NEC.
 - b. Exceptions:
 - 1) Where the PVC conduit turns up under freestanding, floor or concrete pad mounted, electrical equipment that completely enclosed and conceal the conduit, such as pad mounted switchboards/switchgear, the conduit shall be PVC conduit from underground up to where the conduit stops aboveground.
 - 2) The conduit shall be PVC conduit from below floor or grade up to where the conduit stops at the following locations:
 - a) Outdoors, where PVC conduit turns up at the utility transformer.
 - b) Outdoors, where PVC conduit turns up at the utility poles
 - c) Indoors, where PVC conduit from the utility poles or utility manholes, containing telephone, cable tv and fiber internet service cables, turns up at the telephone terminal board in the electrical/telecom room.

- B. Comply with NECA 1 for installation requirements applicable to products specified in Part 2 except where requirements on Drawings or in this Article are stricter.
- C. Keep raceways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.
- D. Complete raceway installation before starting conductor installation.
- E. Arrange stub-ups so curved portions of bends are not visible above the finished slab.
- F. Raceway Terminations: Use insulating bushings to protect ALL conductors, including conductors smaller than No. 4 AWG. Provide insulated grounding bushings where required by NFPA 70 or the Contract Documents.
- G. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull wire.
- H. Install raceway sealing fittings at suitable, approved, and accessible locations and fill them with 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:
 - 1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
 - 2. Where otherwise required by NFPA 70.
- I. Flexible Conduit Connections: Use maximum of 72 inches of flexible conduit for equipment subject to vibration, noise transmission, or movement; and for transformers and motors. Comply with the following:
 - 1. Use LFMC where required by the Contract Documents.
- J. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall.
- K. Raceway shall run parallel or perpendicular to wall and ceiling structures (columns, joists, support beams, etc.) for a neat appearance.
- L. All metallic raceways, boxes and enclosures shall be grounded.
- M. Provide watertight hubs for all junction boxes and enclosures installed outdoors or in wet locations. Hubs used with NEMA 3R junction boxes and enclosures shall be NEMA 3R or NEMA 4X rated. Hubs used with NEMA 4 or 4X junction boxes and enclosures shall be NEMA 4X rated.
- N. Underground raceway shall be made watertight.
- O. Provide reducers as required to match the conduit size with the hub or conduit entry on the junction box or equipment. Install reducers in accordance with the manufacturer's recommendations and NEC requirements.
 - 1. Where there are no available reducers in the sizes required, provide an interposing junction box between the larger conduit and the smaller hub or conduit entry, then provide a smaller conduit from the junction box to the hub or conduit entry. The size of the smaller conduit shall be the largest that can fit at the hub or conduit entry. Length of smaller conduit shall be less than 24". Do not exceed the conduit fill requirements

indicated in the NEC. All work shall comply with the manufacturer's recommendations and NEC requirements.

- P. Bending radius of conduit shall be selected to minimize wire or cable pulling tensions. Do not exceed the maximum pulling tension of the wire or cable manufacturer. Coordinate with wire or cable manufacturer.
- Q. Raceway associated with roof or canopy mounted equipment shall run concealed under the roof or canopy.
- R. Raceway associated with indoor or outdoor wall mounted equipment shall be concealed.
- S. Where raceway is installed above the roof, the distance from the roof to the bottom of the raceway shall not be less than 4 inches. Provide mounting and supporting devices as required.
- T. Floor Box Installation
 1. Furnish and install floor box in accordance with the manufacturer's recommendation and NEC requirements.
 2. Provide accessories as required for a complete installation.
 3. Close unused raceway openings using the manufacturer's recommended accessories.
 4. Coordinate floor box installation with the construction of the floor. Coordinate exact location of floor box with the owner/architect/engineer prior to installation.
- U. Where the voltage between adjacent switches, receptacles or similar devices, in the same junction box or enclosure is 300V or greater, provide an internal securely installed barrier between the adjacent switches. Comply with NEC requirements.
- V. All raceway shall be concealed, unless otherwise noted and except as follows:
 1. Raceway may be exposed in electrical and mechanical rooms.
- W. For surface mounted panelboards which are not located within electrical and mechanical rooms, the raceway from the finished floor to the bottom of the panelboard, and from the top of the panelboard to the ceilings space, shall be enclosed in a 3-sided trough that is 12 gauge steel minimum, and is painted to match the adjacent wall. The width and depth of the trough shall match the dimensions of the panelboards. The trough shall not prevent access/removal of the panelboard covers/doors.
- X. Raceways/boxes and associated electrical equipment shall not block or impede the movement/operation of equipment that move (including, but not limited to, overhead doors, sliding doors, etc.).
- Y. Provide corrosion protection tape on all metal conduit (including, but not limited to, empty/spare conduit, conduit that have wiring within, conduit used as support posts, etc.) that is in contact with earth, soil, or concrete. Provide corrosion protection tape on all metal conduit that is located underground. Provide primer and putty in accordance with the recommendations of the tape manufacturer. Tape, primer, and putty shall be installed in a manner which does not reduce the electrical continuity of the electrical conduit system. All work shall comply with the requirements of the manufacturer, the NEC, and the AHJ.

3.3 PROTECTION

- A. Provide final protection and maintain conditions that ensure coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion.

1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
2. Repair damage to paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION 260533

SECTION 260540 - UNDERGROUND DUCTS AND UTILITY STRUCTURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1, 26, 27, and 28 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Conduit, ducts, and duct accessories for direct-buried and concrete-encased duct banks, and in single duct runs.

1.3 DEFINITION

- A. RNC: Rigid nonmetallic conduit.
- B. OSHA: Occupational Safety and Health Administration
- C. Duct: Conduit that are suitable for use underground
- D. Ductbank: Two or more ducts
- E. Direct buried duct: Duct that is buried in the ground, without any concrete encasement
- F. Direct buried ductbank: Ductbank that is buried in the ground, without any concrete encasement

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Field quality-control test reports.

1.5 QUALITY ASSURANCE

- A. Comply with ANSI C2.
- B. Comply with NFPA 70.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver ducts to Project site with ends capped. Store nonmetallic ducts with supports to prevent bending, warping, and deforming.

1.7 COORDINATION

- A. Coordinate elevation, layout and installation of ducts with final arrangement of other utilities, site grading, and surface features as determined in the field.

PART 2 - PRODUCTS

2.1 CONDUIT

- A. RNC: NEMA TC 2, Type EPC-40-PVC (PVC Schedule 40) and Type EPC-80-PVC (PVC Schedule 80), UL 651, with matching fittings by same manufacturer as the conduit, complying with NEMA TC 3 and UL 514B. RNC shall be sunlight resistant and rated for use with 90 degree C conductors.

2.2 DUCT ACCESSORIES

- 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. Cantex, Inc.
 - 2. Condux International, Inc.
 - 3. Lamson & Sessions; Carlon Electrical Products.
 - 4. Manhattan/CDT; a division of Cable Design Technologies.
 - 5. Spiraduct/AFC Cable Systems, Inc.
- B. Duct Accessories:
 - 1. Duct Separators: Factory-fabricated rigid PVC interlocking spacers, sized for type and sizes of ducts with which used, and selected to provide minimum duct spacings indicated while supporting ducts during concreting or backfilling.
 - 2. Warning Tape: Underground-line warning tape specified in Specification Section "Electrical Identification."

2.3 HANDHOLES AND BOXES OTHER THAN PRECAST CONCRETE

- A. Polymer Concrete Handhole:
 - 1. Enclosures, boxes, and covers shall conform to all test provisions of the most current ANSI/SCTE 77 "Specification For Underground Enclosure Integrity" for Tier 22 applications. All covers are required to have the Tier level rating embossed on the surface. In no assembly can the cover design load exceed the design load of the box.
 - 2. Handhole shall be tested by UL to meet the requirements of ANSI/SCTE 77. Handhole shall be UL Listed.
 - 3. Handhole shall have an open bottom, unless otherwise noted.
 - 4. Handhole design load (including box and cover) shall be 22,500 pounds.
 - 5. Handhole cover shall be secured to the box with stainless steel bolts.
 - 6. Handhole shall be manufactured by Quazite or approved equal. See drawings for dimensions of handhole.

PART 3 - EXECUTION

3.1 DUCT APPLICATION

- A. Direct-buried ducts: Duct shall be NEMA TC 2, Type EPC-40-PVC (PVC Schedule 40), unless otherwise noted on the drawings.
- B. Concrete encased ducts: Duct shall be NEMA TC 2, Type EPC-40-PVC (PVC Schedule 40), unless otherwise noted on the drawings.

3.2 EARTHWORK

- A. Excavation and Backfill: Do not use heavy-duty, hydraulic-operated, compaction equipment.
- B. Restore surface features at areas disturbed by excavation and reestablish original grades, unless otherwise indicated. Replace removed sod immediately after backfilling is completed.
- C. Restore areas disturbed by trenching, storing of dirt, cable laying, and other work. Restore vegetation and include necessary topsoiling, fertilizing, liming, seeding, sodding, sprigging, and mulching.
- D. Cut and patch existing streets, roads, driveways, parking lots, and paved areas in the path of underground ducts and utility structures. Repair existing streets, roads, driveways, parking lots, and paved areas after underground ducts and utility structures have been constructed/installed. The repaired streets, roads, driveways, parking lots, and paved areas shall match the adjacent streets, roads, driveways, parking lots, and paved areas.
- E. Remove, re-install and repair as required, existing fences, sign posts, walls or structures that are in the path of underground ducts and utility structures.

3.3 DUCT INSTALLATION

- A. Burial Depth:
 - 1. Direct buried duct or ductbanks: All direct buried duct or ductbanks shall have a minimum of 36" of cover from the top of the duct or ductbank to finished grade, unless otherwise noted on the drawings.
 - 2. Concrete encased ducts or ductbanks: All concrete encased duct or ductbanks shall have a minimum of 36" of cover from the top of the duct or ductbank to finished grade, unless otherwise noted on the drawings.
- B. Slope: Pitch ducts a minimum slope of 1:300 down toward manholes and handholes and away from buildings and equipment. Slope ducts from a high point in runs between two manholes or handholes to drain in both directions.
- C. Where new ducts/ductbanks cross existing underground utilities, comply with the minimum cover requirements and minimum separation requirements indicated in the contract documents. Provide supports under the new ducts/ductbanks and existing underground utilities as required. The new duct/ductbanks shall be installed below the existing underground utilities, unless otherwise noted and except as follows:
 - 1. The new duct/ductbanks may be installed above the existing underground utilities where ALL of the following conditions are met:

- a. Where it is installed, the new duct/ductbanks comply with the minimum cover requirements and minimum separation requirements indicated in the contract documents.
 - b. Adequate supports are provided for the new duct/ductbanks such that it does not add weight onto the existing underground utilities.
 - c. There will be no damage to the existing underground utilities.
- D. Where new ducts/ductbanks cross other new ducts/ductbanks, comply with the minimum cover requirements and minimum separation requirements in the contract documents. The new ducts/ductbanks shall be installed above and below each other as required to comply with the minimum cover requirements and minimum separation requirements indicated in the contract documents. Provide supports under the new ducts/ductbanks as required.
- E. Do not damage existing underground utilities and structures. Any damage caused by the contractor to existing underground utilities and structures shall be repaired by the contractor at no cost to the owner.
- F. Curves and Bends: Use 5-degree angle couplings for small changes in direction. Use manufactured long sweep bends, both horizontally and vertically, at other locations, unless otherwise noted.
- G. Joints: Use solvent-cemented joints in ducts and fittings and make watertight according to manufacturer's written instructions. Stagger couplings so those of adjacent ducts do not lie in same plane.
- H. Provide duct sealing compound where underground ducts and ductbanks stub up at utility poles/transformers and where underground ducts and ductbanks enter buildings. Duct sealing compound shall provide a watertight seal inside the ducts and ductbanks. Where duct sealing compound is in contact with wiring that is furnished and/or installed by the utility company, product data of the duct sealing compound shall be submitted to the utility company for their review/approval prior to its use.
- I. Sealing: Provide temporary closure at terminations of ducts that have cables pulled. Seal spare ducts at terminations. Use sealing compound and plugs to withstand at least 15-psig (1.03-MPa) hydrostatic pressure.
- J. Pulling Cord: Install 100-lbf- (445-N-) test nylon cord in ducts, including spares.
1. Provide pulling cord in all unused or spare ducts.
- K. Duct Entrances to Manholes and Handholes: Use end bells, spaced approximately 10 inches o.c. for 5-inch ducts, and vary proportionately for other duct sizes.
1. Begin change from regular spacing to end-bell spacing 10 feet from the end bell without reducing duct line slope and without forming a trap in the line.
 2. Grout end bells into structure walls from both sides to provide watertight entrances.
- L. Building Wall Penetrations: Install conduit penetrations of building walls as specified in Specification Section "Common Work Results for Electrical."
- M. Concrete-Encased Ducts:
1. Support ducts on duct separators coordinated with duct size, duct spacing, and outdoor temperature. Where there are multiple sizes of conduit in a ductbank, provide spacers and spacer accessories to accommodate the conduit.
 2. Separator Installation: Space separators close enough to prevent sagging and deforming of ducts, with not less than 5 spacers per 20 feet of duct. Secure separators to earth and

- to ducts to prevent floating during concreting. Stagger separators approximately 6 inches between tiers. Tie entire assembly together using fabric straps; do not use tie wires or reinforcing steel that may form conductive or magnetic loops around ducts or duct groups.
3. Excavate trench bottom to provide firm and uniform support for ducts.
 4. Place and compact bedding course on trench bottoms. Use satisfactory soil, free of particles larger than 1 inch in any direction, as the compact bedding course. Depth of bedding course shall be not less than 6".
 5. Concreting Sequence: Pour each run of envelope between manholes, handholes or other terminations in one continuous operation.
 - a. Start at one end and finish at the other, allowing for expansion and contraction of ducts as their temperature changes during and after the pour. Use expansion fittings installed according to manufacturer's written recommendations, or use other specific measures to prevent expansion-contraction damage.
 - b. If more than one pour is necessary, terminate each pour in a vertical plane and install 3/4-inch reinforcing rod dowels extending 18 inches into concrete on both sides of joint near corners of envelope.
 6. Pouring Concrete: Spade concrete carefully during pours to prevent voids under and between conduits and at exterior surface of envelope. Do not allow a heavy mass of concrete to fall directly onto ducts. Use a plank to direct concrete down sides of bank assembly to trench bottom. Allow concrete to flow to center of bank and rise up in middle, uniformly filling all open spaces. Do not use power-driven agitating equipment unless specifically designed for duct-bank application.
 7. Forms: Use walls of trench to form side walls of duct bank where soil is self-supporting and concrete envelope can be poured without soil inclusions; otherwise, use forms.
 8. Comply with all of the following separation requirements, unless otherwise noted:
 - a. Provide a minimum of 12" separation between 600V power or communications ducts and foreign structures (including, but not limited to, gas, water, sanitary and oil pipes).
 - b. Provide a minimum of 12" separation between 600V power or communications ducts and medium voltage (>600V) duct/wiring.
 - c. Provide a minimum of 6" separation between 600V power ducts and communications (including, but not limited to, telephone and cable tv) ducts.
 - d. Provide a minimum of 3" separation between 600V power ducts and other 600V power ducts.
 - e. Provide a minimum of 3" separation between communication ducts and other communication ducts.
 - f. Comply with the minimum separation requirements of the Utility Companies. Coordinate with the Utility Companies as required.
 9. Stub-Ups: Use manufactured duct elbows for stub-ups at poles and equipment and at building entrances through the floor, unless otherwise indicated. Extend concrete encasement throughout the length of the elbow.
 10. Warning Tape: Bury warning tape above all concrete-encased ducts. Align tape parallel to and within 3 inches of the centerline of duct bank. Provide an additional warning tape for each 12-inch increment of duct-bank width over a nominal 36 inches. Space additional tapes 12 inches apart, horizontally. Depth of warning tape shall be 12" below finished grade.

N. Direct-Buried Ducts:

1. Support ducts on duct separators coordinated with duct size, duct spacing, and outdoor temperature. Where there are multiple sizes of conduit in a ductbank, provide spacers and spacer accessories to accommodate the conduit.

2. Space separators close enough to prevent sagging and deforming of ducts, with not less than 5 spacers per 20 feet of duct. Secure separators to earth and to ducts to prevent displacement during backfill and yet permit linear duct movement due to expansion and contraction as temperature changes. Stagger spacers approximately 6 inches between tiers.
 3. Excavate trench bottom to provide firm and uniform support for ducts.
 4. Place and compact bedding course on trench bottoms. Use satisfactory soil, free of particles larger than 1 inch in any direction, as the compact bedding course. Depth of bedding course shall be not less than 6".
 5. After installing first tier of ducts, backfill and compact. Start at tie-in point and work toward end of duct run, leaving ducts at end of run free to move with expansion and contraction as temperature changes during this process. Repeat procedure after placing each tier. After placing last tier, hand-place backfill to 4 inches over ducts and hand tamp. Firmly tamp backfill around ducts to provide maximum supporting strength. Use hand tamper only. After placing controlled backfill over final tier, make final duct connections at end of run and complete backfilling with normal compaction.
 6. Comply with all of the following separation requirements, unless otherwise noted:
 - a. Provide a minimum of 12" separation between 600V power or communications ducts and foreign structures (including, but not limited to, gas, water, sanitary and oil pipes).
 - b. Provide a minimum of 12" separation between 600V power or communications ducts and medium voltage (>600V) duct/wiring.
 - c. Provide a minimum of 12" separation between 600V power ducts and communications (including, but not limited to, telephone and cable tv) ducts.
 - d. Provide a minimum of 3" separation between 600V power ducts and other 600V power ducts.
 - e. Provide a minimum of 3" separation between communication ducts and other communication ducts.
 - f. Comply with the minimum separation requirements of the Utility Companies. Coordinate with the Utility Companies as required.
 7. Install manufactured duct elbows for stub-ups at poles and equipment and at building entrances through the floor, unless otherwise indicated.
 8. Warning Tape: Bury warning tape above all direct buried ducts. Align tape parallel to and within 3 inches of the centerline of duct bank. Provide an additional warning tape for each 12-inch increment of duct-bank width over a nominal 36 inches. Space additional tapes 12 inches apart, horizontally. Depth of warning tape shall be 12" below finished grade.
 9. Concrete encasement at bends and 90 degree elbows: All bends and 90 degree elbows shall be concrete encased with a minimum of 3" thick of 3000 psi concrete at 28 days.
- O. Provide underground-line warning tape above all direct buried and concrete encased ducts.
- P. Excavation for Utility Trenches:
1. Trench Bottoms: Excavate and shape trench bottoms to provide uniform bearing and support of ducts and ductbanks.
- Q. Utility Trench Backfill:
1. Place backfill on subgrades free of mud, frost, snow, or ice.
 2. Backfill material shall be free of particles larger than 1 inch in any dimension.
 3. Carefully compact initial backfill under conduit haunches and compact evenly up on both sides and along the full length of conduit to avoid damage or displacement of conduit.
 4. Backfill voids while installing and removing shoring and bracing.
 5. Backfill in layers not more than 4 inches for material compacted by hand operated tampers.

6. Compact soil material to not less than the following percentage of maximum dry unit weight according to ASTM D698:
 - a. For utility trenches, compact each layer of initial and final backfill soil material at 85 percent.

- R. Ducts and ductbanks shall be made watertight.

- S. Bending radius of ducts shall be selected to minimize wire or cable pulling tensions. Do not exceed the maximum pulling tension of the wire or cable manufacturer. Coordinate with wire or cable manufacturer.

- T. Provide pull wires in all empty ducts.

- U. Underground conduit, ducts, or ductbanks shall not be installed under concrete footings, piers, or other load bearing structures of the building. Additionally, these items shall not be located within a 45 degree zone that extends downwards and outwards from the bottom outer edge of the load bearing structures.

- V. Where ducts run under bollards or the outside perimeter of the building, comply with the following:
 1. Increase the depth of the ducts to provide a minimum of 12" clearance between the top of the ducts and the bottom of the bollard or the outside perimeter of the building.
 2. For Direct-Buried Ducts: Provide concrete encasement. Concrete encasement shall be a minimum of 3" thick on the sides, and 12" thick at the top and bottom, of the ducts. Concrete encasement shall extend a minimum of 3' before and after the bollard or the outside perimeter of building. Concrete shall be 3000 PSI at 28 days.
 3. For Concrete-Encased Ducts: Increase the thickness of the concrete encasement to a minimum of 12" thick at the top and bottom. Concrete encasement shall extend a minimum of 3' before and after the bollard or the outside perimeter of building. Concrete shall be 3000 PSI at 28 days.

- W. Where the burial depth of a duct is indicated in the Contract Documents, the indicated depth is the shortest distance measured between a point on the top surface of the duct, and the top surface of finished grade, concrete, or similar cover.

- X. Where an underground duct penetrates an exterior wall below grade, and enters a room that is located below grade, the wall penetration shall not be located above any electrical equipment, unless otherwise noted.

3.4 INSTALLATION OF HANDHOLES AND BOXES OTHER THAN PRECAST CONCRETE

- A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting ducts to minimize bends and deflections required for proper entrances. Use box extension if required to match depths of ducts, and seal joint between box and extension as recommended by the manufacturer.

- B. Unless otherwise indicated, support handhole/box on a level bed of crushed stone or gravel, 6" deep minimum, graded from 1/2-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth. Where the handhole/box manufacturer requires a different type of stone/gravel, or requires a greater depth of stone/gravel, comply with the manufacturer's recommendations.

- C. Elevation: Cover surface will be flush with finished floor or finished grade.

- D. Field-cut openings for ducts and conduits according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.
- E. For solid bottom handholes, provide a 1" diameter hole at the bottom of the handhole, to allow water to drain through.
- F. Install handholes and boxes in accordance with the manufacturer's recommendations, so that the installed handholes and boxes comply with the load ratings required by the contract documents.

3.5 TEST PIT EXCAVATION

- A. Provide test pits where the new underground ducts will cross with the location of the existing underground utilities and structures. Coordinate location of underground ducts, utilities and structures with the plans, the drawings provided by the utility locator contractor, and field conditions.
- B. The test pits shall be used to determine the depth of existing underground utilities and structures where these utilities and structures are located within the depth of the test pits.
- C. Depth of test pit shall be as required to determine there is no conflict between the new and existing underground ducts, utilities and structures. Minimum depth and separation requirements for the new underground ducts are indicated in the contract documents.
- D. Upon completion, the test pit shall be backfilled, compacted, repaired, and the site returned to the original condition.
- E. Perform test pit excavation prior to installing underground conduit, manholes/handholes or other underground structures.
- F. Any damage to existing underground utilities and structures due to the test pit excavation shall be repaired by the contractor at no cost to the owner.
- G. Coordinate depth and routing of ductbank with the results of the field investigation.

3.6 LOCATING EXISTING UNDERGROUND UTILITIES

- A. The drawings do not show all the existing underground utilities. Also, the existing underground utilities shown on the drawings are shown in their approximate locations only. The contractor is responsible for determining the existing underground utilities and their exact location for the areas where he will be working.
- B. Before starting any work, hire the services of a Utility Locator contractor to determine the locations of existing underground utilities in the following areas:
 - 1. Where underground ducts are being installed
 - 2. Where concrete foundations are being installed for various equipment
 - 3. Where any underground equipment or structures are being installed
 - 4. Where light poles and light bollards are being installed
 - 5. Where handholes and manholes are being installed
 - 6. Where the existing grade is being lowered
- C. Location of existing underground utilities shall be marked up on the drawings.

- D. The location of existing underground utilities shall be marked on the ground in the field.
- E. Coordinate depth and routing of ductbank with the results of the field investigation.

3.7 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections and prepare test reports:
 - 1. Demonstrate capability and compliance with requirements on completion of installation of underground ducts.
 - 2. Pull aluminum or wood test mandrel through duct to prove joint integrity and test for out-of-round duct. Provide mandrel equal to 80 percent fill of duct. If obstructions are indicated, remove obstructions and retest.
- B. Correct deficiencies and retest as specified above to demonstrate compliance.

3.8 CLEANING

- A. Pull leather-washer-type duct cleaner, with graduated washer sizes, through full length of ducts. Follow with rubber duct swab for final cleaning and to assist in spreading lubricant throughout ducts.
- B. Clean internal surfaces of manholes and handholes, including sump. Remove foreign material.
- C. Do not damage the ducts during cleaning.

END OF SECTION 260540

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SECTION 260553 - ELECTRICAL IDENTIFICATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1, 26, 27, and 28 Specification Sections, apply to this Section.

1.2 SUBMITTALS

- A. Product Data: For each electrical identification product indicated.

1.3 QUALITY ASSURANCE

- A. Comply with NFPA 70.
- B. Comply with 29 CFR 1910.145.

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 Operation and Maintenance Manual, and with those required by codes, standards, and 29 CFR 1910.145. Use consistent designations throughout Project.
- B. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- C. Coordinate installation of identifying devices with location of access panels and doors.
- D. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.1 RACEWAY AND METAL-CLAD CABLE IDENTIFICATION MATERIALS

- A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway and cable size.
- B. Color for Printed Legend:
 - 1. Power Circuits: Black letters on an orange field.
 - 2. Instrumentation and Control Circuits: Black letters on a yellow field.
 - 3. Legend: Indicate system or service and voltage, if applicable.

- C. Self-Adhesive Vinyl Tape: Colored, heavy duty, waterproof, fade resistant; 2 inches wide; compounded for outdoor use.

2.2 CONDUCTOR AND COMMUNICATION- AND CONTROL-CABLE IDENTIFICATION MATERIALS

- A. Color-Coding Conductor Tape: Colored, self-adhesive vinyl tape not less than 3 mils thick by 1 to 2 inches wide.
- B. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.
- C. Write-On Tags: Polyester tag, 0.010 inch thick, with corrosion-resistant grommet and polyester or nylon tie for attachment to conductor or cable.
 - 1. Marker for Tags: Permanent, waterproof, black ink marker recommended by tag manufacturer.

2.3 UNDERGROUND-LINE WARNING TAPE

- A. Description: Permanent, bright-colored, continuous-printed, polyethylene tape.
 - 1. Not less than 6 inches wide by 4 mils thick.
 - 2. Compounded for permanent direct-burial service.
 - 3. Embedded continuous metallic strip or core.
 - 4. Printed legend shall indicate type of underground line.

2.4 WARNING LABELS AND SIGNS

- A. Comply with NFPA 70 and 29 CFR 1910.145.
- B. Self-Adhesive Warning Labels: Factory printed, multicolor, pressure-sensitive adhesive labels, configured for display on front cover, door, or other access to equipment, unless otherwise indicated.

2.5 INSTRUCTION SIGNS

- A. Self-Adhesive Instruction Signs: Factory printed, multicolor, pressure-sensitive adhesive labels, configured for display on front cover, door, or other access to equipment, unless otherwise indicated.

2.6 EQUIPMENT IDENTIFICATION LABELS

- A. Self-Adhesive, Engraved, Laminated Acrylic or Phenolic Label: Adhesive backed, with white letters on a dark-gray background. Minimum letter height shall be 3/8 inch.

2.7 MISCELLANEOUS IDENTIFICATION PRODUCTS

- A. Cable Ties: Fungus-inert, self-extinguishing, 1-piece, self-locking, Type 6/6 nylon cable ties.

1. Minimum Width: 3/16 inch.
2. Tensile Strength: 50 lb, minimum.
3. Temperature Range: Minus 40 to plus 185 deg F.
4. Color: Black, except where used for color-coding.

PART 3 - EXECUTION

3.1 APPLICATION

- A. Power-Circuit Conductor Identification: For conductors No. 4/0 AWG and larger in vaults, pull and junction boxes, manholes, and handholes use write-on tags. Identify source and circuit number of each set of conductors. For single conductor cables, identify phase in addition to the above.
- B. Branch-Circuit Conductor Identification: Where there are conductors for more than three branch circuits in same junction or pull box, use marker tape. Identify each ungrounded conductor according to source and circuit number.
- C. Locations of Underground Lines: Provide underground-line warning tape for direct buried and concrete encased ducts or ductbanks.
- D. All receptacles, starters, disconnects, and drop cords (receptacles and lights) shall be labeled with its associated circuit number.
- E. All panelboards shall be labeled with the circuit number associated with the feeder breaker that supplies power to it.
- F. All equipment with integral disconnects shall be labeled with its associated circuit number.
- G. All fire alarm control panels and fire alarm remote booster power supplies shall be labeled with its associated circuit number.
- H. Warning Labels for Cabinets, Boxes, and Enclosures for Power and Lighting: Comply with 29 CFR 1910.145 and apply self-adhesive warning labels. Identify system voltage with black letters on an orange background. Apply to exterior of door, cover, or other access.
 1. Equipment Requiring Workspace Clearance According to NFPA 70: Unless otherwise indicated, apply to door or cover of equipment but not on flush panelboards and similar equipment in finished spaces.
 2. Provide a sign/label on panelboards, receptacles, controller and other equipment that are fed from the generator as follows: "FED FROM GENERATOR THRU ATS-xxx", where xxx is the label of the transfer switch.
 3. Provide a "BUILDING FEEDER DISCONNECT" label for each building feeder disconnect at the building. Source of feeder shall also be indicated.
 4. Where the removal of a grounding or bonding connection in normal power source equipment interrupts the grounding electrode conductor connection to the alternate power source(s) grounded conductor, a warning sign shall be installed at the normal power source equipment stating: SHOCK HAZARD EXISTS IF GROUNDING ELECTRODE CONDUCTOR OR BONDING JUMPER CONNECTION IN THIS EQUIPMENT IS REMOVED WHILE ALTERNATE SOURCES(S) IS ENERGIZED.
- I. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and Operation and Maintenance Manual.

Apply labels to disconnect switches and protection equipment, central or master units, control panels, control stations, terminal cabinets, and racks of each system. Systems include power, lighting, control, communication, signal, monitoring, and alarm systems unless equipment is provided with its own identification.

1. Labeling Instructions:
 - a. Indoor Equipment: Adhesive film label. Unless otherwise indicated, provide a single line of text with 1/2-inch- high letters on 1-1/2-inch- high label; where 2 lines of text are required, use labels 2 inches high.
 - b. Outdoor Equipment: Adhesive film label with clear protective overlay
2. Equipment to be labeled includes, but is not limited to, the following:
 - a. All power distribution equipment (including, but not limited to, panelboards, disconnects, breakers, transformers, electrical cabinets/enclosures, etc.)

3.2 INSTALLATION

- A. Verify the identity of each item before installing identification products.
- B. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.
- C. Apply identification devices to surfaces that require finish after completing finish work.
- D. Self-Adhesive Identification Products: Clean surfaces before application, using materials and methods recommended by manufacturer of identification device.
- E. Color-Coding for Phase and Voltage Level Identification, 600 V and Less: Use the colors listed below for ungrounded service, feeder, and branch-circuit conductors.
 1. Color shall be factory applied or, for sizes larger than No. 10 AWG if authorities having jurisdiction permit, field applied.
 2. Colors for 208/120-V and 240/120V Circuits:
 - a. Phase A: Black.
 - b. Phase B: Red.
 - c. Phase C: Blue.
 - d. Neutral: White
 3. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches from terminal points and in boxes where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding. Locate bands to avoid obscuring factory cable markings.
- F. Underground-Line Warning Tape: During backfilling of trenches install continuous underground-line warning tape directly above line at 12 inches below finished grade. Use multiple tapes where width of multiple lines installed in a common trench or concrete envelope exceeds 36 inches overall.

END OF SECTION 260553

SECTION 260573 - POWER SYSTEMS ANALYSIS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1, 26, 27, and 28 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes computer-based, fault-current and overcurrent protective device coordination studies. Protective devices shall be set based on results of the protective device coordination study.

1.3 SUBMITTALS

- A. Product Data: For computer software program to be used for studies.
- B. Product Certificates: For coordination-study and fault-current-study computer software programs, certifying compliance with IEEE 399.
- C. Qualification Data: For coordination-study specialist.
- D. Other Action Submittals: The following submittals shall be made after the approval process for system protective devices has been completed.
 - 1. Coordination-study input data, including completed computer program input data sheets.
 - 2. Study and Equipment Evaluation Reports.
 - 3. Coordination-Study Report.
 - 4. Arc-Flash Hazard Analysis
- E. Coordination study shall be submitted at the same time as the submittals for the power distribution equipment.
- F. Coordination study shall be sealed and signed by a Professional Electrical Engineer that is licensed in the State of Maryland.

1.4 QUALITY ASSURANCE

- A. Studies shall use computer programs that are distributed nationally and are in wide use. Software algorithms shall comply with requirements of standards and guides specified in this Section. Manual calculations are not acceptable.
- B. Coordination-Study Specialist Qualifications: An entity experienced in the application of computer software used for studies, having performed successful studies of similar magnitude on electrical distribution systems using similar devices.
- C. Comply with IEEE 242 for short-circuit currents and coordination time intervals.

- D. Comply with IEEE 399 for general study procedures.

PART 2 - PRODUCTS

2.1 COMPUTER SOFTWARE DEVELOPERS

- A. Available Computer Software Developers: Subject to compliance with requirements, companies offering computer software programs that may be used in the Work include, but are not limited to, the following:
 - 1. CGI CYME.
 - 2. EDSA Micro Corporation.
 - 3. ESA Inc.
 - 4. Operation Technology, Inc.
 - 5. SKM Systems Analysis, Inc.

2.2 COMPUTER SOFTWARE PROGRAM REQUIREMENTS

- A. Comply with IEEE 399.
- B. Analytical features of fault-current-study computer software program shall include "mandatory," "very desirable," and "desirable" features as listed in IEEE 399.
- C. Computer software program shall be capable of plotting and diagramming time-current-characteristic curves as part of its output. Computer software program shall report device settings and ratings of all overcurrent protective devices and shall demonstrate selective coordination by computer-generated, time-current coordination plots.

PART 3 - EXECUTION

3.1 APPLICATION

- A. Provide Fault-Current Study, Coordination Study, Overcurrent Protective Device Setting, and Arc Flash Hazard Analysis for the following:
 - 1. All new power distribution equipment
- B. Provide Arc-flash labels on all new power distribution equipment included in the Arc Flash Hazard Analysis.
- C. The contractor shall obtain the latest fault current information from the Electric Utility. The fault current information shall be used in the studies.

3.2 EXAMINATION

- A. Examine Project overcurrent protective device submittals for compliance with electrical distribution system coordination requirements and other conditions affecting performance. Devices to be coordinated are indicated on Drawings.

- B. Proceed with coordination study only after relevant equipment submittals have been assembled. Overcurrent protective devices not submitted for approval with coordination study may not be used in study.

3.3 FAULT-CURRENT STUDY

- A. Contractor shall coordinate with the electric utility and get the available fault current from the electric utility. Use the actual available fault current from the utility.
- B. Study electrical distribution system from normal and alternate power sources throughout electrical distribution system for Project and use approved computer software program to calculate values. Include studies of system-switching configurations and alternate operations that could result in maximum fault conditions.
- C. Calculate momentary and interrupting duties on the basis of maximum available fault current.
- D. Calculations to verify interrupting ratings of overcurrent protective devices shall comply with the following:
 - 1. Low-Voltage Circuit Breakers: IEEE 1015 and IEEE C37.50.
 - 2. Low-Voltage Fuses: IEEE C37.46.
 - 3. Circuit Breakers: IEEE C37.13.
- E. Study Report: Enter calculated X/R ratios and interrupting (5-cycle) fault currents on electrical distribution system diagram of the report. List other output values from computer analysis, including momentary (1/2-cycle), interrupting (5-cycle), and 30-cycle fault-current values for 3-phase, 2-phase, and phase-to-ground faults.
- F. Equipment Evaluation Report: Prepare a report on the adequacy of overcurrent protective devices and conductors by comparing fault-current ratings of these devices with calculated fault-current momentary and interrupting duties.

3.4 COORDINATION STUDY

- A. Gather and tabulate the following input data to support coordination study:
 - 1. Product Data for overcurrent protective devices specified in other Division 26 Sections and involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.
 - 2. Impedance of utility service entrance.
 - 3. Electrical distribution system diagram showing the following:
 - a. Load current that is the basis for sizing continuous ratings of circuits for cables and equipment.
 - b. Circuit-breaker and fuse-current ratings and types.
 - c. Relays and associated power and current transformer ratings and ratios.
 - d. Transformer kilovolt amperes, primary and secondary voltages, connection type, impedance, and X/R ratios.
 - e. Generator kilovolt amperes, size, voltage, and source impedance.
 - f. Cables. Indicate conduit material, sizes of conductors, conductor insulation, and length.

- g. Busway ampacity and impedance.
 - h. Motor horsepower and code letter designation according to NEMA MG 1.
- 4. Data sheets to supplement electrical distribution system diagram, cross-referenced with tag numbers on diagram:
 - a. Special load considerations, including starting inrush currents and frequent starting and stopping.
 - b. Magnetic inrush current overload capabilities of transformers.
 - c. Motor full-load current, locked rotor current, service factor, starting time, type of start, and thermal-damage curve.
 - d. Ratings, types, and settings of utility company's overcurrent protective devices.
 - e. Special overcurrent protective device settings or types stipulated by utility company.
 - f. Time-current-characteristic curves of devices indicated to be coordinated.
 - g. Manufacturer, frame size, interrupting rating in amperes rms symmetrical, ampere or current sensor rating, long-time adjustment range, short-time adjustment range, and instantaneous adjustment range for circuit breakers.
 - h. Manufacturer and type, ampere-tap adjustment range, time-delay adjustment range, instantaneous attachment adjustment range, and current transformer ratio for overcurrent relays.
 - i. Panelboards, switchboards, motor-control center ampacity, and interrupting rating in amperes rms symmetrical.
- B. Perform coordination study and prepare a written report using the results of fault-current study and approved computer software program. Comply with IEEE 399.
- C. Comply with NFPA 70 for overcurrent protection of circuit elements and devices.
- D. Comply with IEEE 242 recommendations for fault currents and time intervals.
- E. Conductor Protection: Protect cables against damage from fault currents according to ICEA P-32-382, ICEA P-45-482, and conductor melting curves in IEEE 242. Verify adequacy of phase conductors at maximum three-phase bolted fault currents, equipment grounding conductors, and grounding electrode conductors at maximum ground-fault currents.
- F. Coordination-Study Report: Prepare a written report indicating the following results of coordination study:
 - 1. Tabular Format of Settings Selected for Overcurrent Protective Devices:
 - a. Device tag.
 - b. Relay-current transformer ratios; and tap, time-dial, and instantaneous-pickup values.
 - c. Circuit-breaker sensor rating; and long-time, short-time, and instantaneous settings.
 - d. Fuse-current rating and type.
 - e. Ground-fault relay-pickup and time-delay settings.
 - 2. Coordination Curves: Prepared to determine settings of overcurrent protective devices to achieve selective coordination. Graphically illustrate that adequate time separation exists between series devices, including power utility company's upstream devices. Show the following specific information:
 - a. Device tag.

- b. Voltage and current ratio for curves.
 - c. Three-phase and single-phase damage points for each transformer.
 - d. No damage, melting, and clearing curves for fuses.
 - e. Cable damage curves.
 - f. Transformer inrush points.
 - g. Maximum fault-current cutoff point.
3. Completed data sheets for setting of overcurrent protective devices.

3.5 OVERCURRENT PROTECTIVE DEVICE SETTING

- A. Manufacturer's Field Service: Engage a factory-authorized service representative, of electrical distribution equipment being set and adjusted, to assist in setting of overcurrent protective devices within equipment.
- B. Perform the following device setting and prepare reports:
 - 1. Adjust devices according to recommendations in NETA ATS.

3.6 ARC-FLASH HAZARD ANALYSIS

- A. The Arc-Flash Hazard Analysis shall be performed with the aid of computer software intended for this purpose in order to calculate Arc-Flash Incident Energy (AFIE) levels and flash protection boundary distances.
- B. The Arc-Flash Hazard Analysis shall be performed in conjunction with a short-circuit analysis and a time-current coordination analysis.
- C. Results of the Analysis shall be submitted in tabular form, and shall include device or bus name, bolted fault and arcing fault current levels, flash protection boundary distances, personal-protective equipment classes and AFIE levels.
- D. The analysis shall be performed under worst-case Arc-Flash conditions, and the final report shall describe, when applicable, how these conditions differ from worst-case bolted fault conditions.
- E. The Arc-Flash Hazard Analysis shall be performed in compliance with IEEE Standard 1584, the IEEE "Guide for Performing Arc-Flash Calculations".
- F. Labeling on equipment shall be in compliance with the National Electrical Code and ANSI Z535.4 to identify AFIE and appropriate Personal Protective Equipment classes.
- G. Furnish and install the arc flash labels on all equipment included in the arc flash hazard analysis.

END OF SECTION 260573

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SECTION 260943 - LIGHTING CONTROL SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1, 26, 27, and 28 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes a networked lighting control system which includes, but is not limited to, the following components:
 - 1. System Software Interfaces
 - a. Management and Visual Interface
 - b. Historical Database and Analytics Interface
 - 2. System Backbone and Integration Equipment
 - a. System Controller
 - 3. Lighting Control Devices

1.3 SUBMITTALS

- A. Submittals shall include the following items:
 - 1. Bill of Materials for all components of the Lighting Control System
 - 2. Product Specification Sheets indicating general device descriptions, dimensions, electrical specifications, wiring details, and nomenclature.
 - 3. Plan drawings showing locations of all lighting control devices and all cables connecting the devices to each other and other devices.
 - 4. Information Technology (IT) connection information pertaining to interconnection with facility IT networking equipment and third-party systems.
 - 5. Other Diagrams and Operational Descriptions as needed to indicate system operation or interaction with other system(s).
 - 6. Contractor Startup/Commissioning Worksheet which shall be completed by the contractor prior to factory start-up
 - 7. Service Specification Sheets indicating general service descriptions, including startup, training, post-startup support, and service contract terms.
 - 8. Hardware and Software Operation Manuals.
 - 9. Color selection chart for devices/equipment
 - 10. Screenshots of the following:
 - a. Web-based visualization interface that displays a graphical floorplan (use the actual floorplan for the building in this project, generic floorplans are not acceptable). System data, to include status of occupancy sensors, daylight sensors and light output shall be overlaid to the floorplan to provide a graphical status page.
- B. Submittal drawings, details, and diagrams
 - 1. Prior to installation of lighting control devices/equipment and lighting fixture/luminaires, provide a 1/8" = 1'-0" scaled plan drawings, details, and wiring diagrams; which show locations of all devices/equipment/fixtures/luminaires, with all device addresses, wired network control zones, symbols, power/control wiring, mounting details, and other

information indicated. All equipment that require line voltage power (120V or 277V) shall be indicated on the plan drawings. At the completion of the construction, this drawing shall be updated with as-built information (including, but not limited to, exact location of all devices/equipment/fixtures/luminaires).

- C. Prior to the demonstration and training, provide copies of the training materials (power point slide presentations, etc.)
- D. Provide the following closeout submittals:
 - 1. Project Record Documents: Accurately record the actual locations of Products.
 - 2. Operating and maintenance manuals.
 - 3. Operating Instructions: Document training by furnishing a sign-in sheet with a description on the training provided, instructors name and organization and those who received training.
 - 4. Submit software database file with desired device labels and notes completed.
 - 5. As-built drawings, details, and wiring diagrams
- E. Provide field quality control test reports.

1.4 QUALITY ASSURANCE

- A. Product Qualifications
 - 1. System electrical components shall be listed or recognized by a nationally recognized testing laboratory (e.g., UL, ETL, or CSA) and shall be labeled accordingly; and, shall be suitable for the intended use and location.
 - 2. System shall be listed as qualified under DesignLights Consortium Networked Lighting Control System Specification V2.0.
 - 3. System luminaires and controls are certified by manufacturer to have been designed, manufactured and tested for interoperability.
 - 4. All components shall be subjected to 100% end of line testing prior to shipment to the project site to ensure proper device operation.
 - 5. All components and the manufacturing facility where product was manufactured must be RoHS compliant.
- B. Installation and Startup Qualifications
 - 1. System startup shall be performed by qualified personnel approved or certified by the manufacturer.

1.5 WARRANTY

- A. Provide the following warranties in addition to any warranties specified elsewhere in the contract documents:
 - 1. The manufacturer shall provide a minimum five-year warranty on all devices and equipment. Warranty coverage shall begin on the date of shipment. The warranty shall cover repair or replacement any defective products within the warranty period.

1.6 COORDINATION

- A. Coordinate the lighting control system to all other devices, equipment and systems to which it connects to. All input/output/communications interfaces/modules shall be compatible and suitable for use with each other.

- B. Coordinate the names/identification/labels used by the lighting control system software/cables, with the actual room/area identification tags provided in the field.
- C. Coordinate programming of the lighting control system (including, but not limited to, time delay settings, min/max light level settings, time schedules, etc.) with the owner prior to programming.
- D. Coordination with the IT (Information Technology) Network Infrastructure
 - 1. Coordinate with the IT Network System Integrator and secure all required network connections to the IT network infrastructure.
 - 2. Provide all network infrastructure requirements of the lighting control system to the IT Network System Integrator.
- E. Coordinate line voltage power (120V through 277V) requirements prior to starting any work to ensure that power is provided to all equipment. The contractor shall provide line voltage power to all equipment that require it, in accordance with the manufacturer's recommendations and NEC requirements.

PART 2 - PRODUCTS

2.1 MANUFACTURER

- A. The Acuity Controls nLight Lighting Control System is the basis-of-design. Provide Acuity Controls nLight Lighting Control System or approved equal.

2.2 GENERAL

- A. The contractor shall provide all labor, software, programming, materials, equipment, hardware, mounting, wiring, conduit, junction boxes, power supplies, transformers, batteries, equipment enclosures (all equipment shall have enclosures), and accessories as required for a complete and fully operational system. The contractor shall provide all startup and testing as required, in order to confirm that the system operates in accordance with the contract documents. The system shall comply with all applicable codes, the manufacturer's recommendations, and the requirements of the authorities having jurisdiction.
- B. Where licenses are required to install, operate, and maintain the system, provide a minimum of 2 licenses, except where more licenses are required elsewhere in the contract documents, in which case, the larger quantity shall apply. Each license shall be capable of being used locally (at the building), or remotely (in remote facility through the internet).
- C. Wires shall be sized and selected such that proper operation of the system is achieved. Excessive voltage drop that can adversely affect proper operation of any component in the system shall be avoided.

2.3 SYSTEM PERFORMANCE REQUIREMENTS

- A. System Architecture
 - 1. System shall have an architecture that is based upon three main concepts: (a) networkable intelligent lighting control devices, (b) standalone lighting control zones using distributed intelligence, (c) system backbone for remote, time based and global operation between control zones.

2. The system shall be capable of providing individually addressable switching and dimming control of the following: networked luminaires, control zones to include multiple switch legs or circuits, and relay and dimming outputs from centralized panels to provide design flexibility appropriate with sequence of operations required in each project area or typical space type.
3. Lighting control zones shall be capable of being networked with a higher-level system backbone to provide time based control, remote control from inputs and/or systems external to the control zone, and remote configuration and monitoring through a software.
4. All system devices shall support remote firmware update, such that physical access to each device is not necessary, for purposes of upgrading functionality at a later date.
5. System shall be capable of “out of box” sequence of operation for each control zone. Standard sequence is:
 - a. All switches control all fixtures in a zone
 - b. All occupancy sensors automatically control all fixtures in the control zone with a default timeout.

B. Wired Networked Control Zone Characteristics

1. Following proper installation and provision of power, all networked devices connected together with low voltage network cable shall automatically form a functional lighting control zone without requiring any type of programming, regardless of the programming mechanism (e.g., software application, handheld remote, pushbutton). The “out of box” default sequence of operation is intended to provide typical sequence of operation so as to minimize the system startup and programming requirements and to also have functional lighting control operation prior to system startup and programming.
 - a. System shall be able to automatically discover all connected devices without requiring any provisioning of system or zone addresses.

C. System Integration Capabilities

1. The system shall have the hardware (interface/converter/connector module/card/feature) and software that provides it with the capability of interfacing with third party building management systems (BMS) to support two-way communication using the industry standard BACnet/IP or BACnet/MSTP protocols.

- D. The lighting control system shall be capable of being remotely controlled by the Lighting Control System software, either through the local area network, or remotely through the internet. Software shall be password protected.**

2.4 SYSTEM SOFTWARE INTERFACES

A. General:

1. Provide Lighting Control System software that shall allow for remote control/monitoring of the lighting control system. The software shall be password protected.

B. Management Interface

1. System shall provide a web-based management interface that provides remote system control, live status monitoring, and configuration capabilities of lighting control settings and schedules.
2. Management interface must be compatible with industry-standard web browser clients, including, but not limited to, Microsoft Internet Explorer®, Apple Safari®, Google Chrome®, Mozilla Firefox®.
3. All system software updates must be available for automatic download and installation via the internet.

C. Historical Database and Analytics Interface

1. System shall provide a browser-based trending and monitoring interface that stores historical data for all occupancy/daylight sensors and lighting loads. Additionally, the system shall upload that data to a cloud-based server.
- D. Visualization Interfaces
 1. System shall provide a web-based visualization interface that displays a graphical floorplan. System data, to include status of occupancy sensors, daylight sensors and light output shall be overlaid to the floorplan to provide a graphical status page.
- E. All lighting control devices can be programmed and controlled over the internet. Password protection shall be provided to prevent unauthorized access.

2.5 SYTEM BACKBONE AND INTEGRATION EQUIPMENT

- A. System Controller
 1. System Controller shall be a multi-tasking, real-time digital control processor consisting of modular hardware with plug-in enclosed processors, communication controllers, and power supplies.
 2. System Controller shall perform the following functions:
 - a. Facilitation of global network communication between different areas and control zones.
 - b. Time-based control of downstream wired and wireless network devices.
 - c. Linking into an Ethernet network.
 - d. Connection to various software interfaces, including management interface, historical database and analytics interface, visualization interface, and personal control applications.
 3. System Controller shall not require a dedicated PC or a dedicated cloud connection.
 4. Device shall automatically detect all networked devices connected to it, including those connected to wired and wireless communication bridges.
 5. Device shall have a standard and astronomical internal time clock.
 6. Shall be capable of connecting to the customers Local Area Network (LAN) via IEEE 802.11.x Wireless and IEEE 802.3 Wired connection.
 7. System Controller shall support BACnet/IP and BACnet/MSTP protocols to directly interface with BMS without the need for additional protocol translation gateways.
 - a. BACnet/MSTP shall support a minimum of 50 additional BACnet MS/TP controllers in addition to the Expansion I/O modules.
 - b. BACnet/MSTP shall support 9600 to 115200 baud.
 - c. System Controller shall be BACnet Testing Laboratory (BTL listed) using Device Profile BACnet Building Controller (B-BC) with outlined enhanced features.
 - d. System controller must support BACnet/IP Broadcast Management Device (BBMD) and Foreign Device Registration (FDR).

2.6 LIGHTNG CONTROL DEVICES

- A. Occupancy sensors, switches and other lighting controls shall be provided in accordance with the drawings.

PART 3 - EXECUTION

3.1 APPLICATIONS

- A. Provide junction boxes as required, in accordance with the NEC and the manufacturer's recommendations.

- B. Wiring Methods for Control Wiring
 - 1. Control wiring that is exposed, concealed inside walls/floor, or concealed above inaccessible ceilings: All control wiring shall be installed in raceway.
 - 2. Control wiring that is concealed above accessible ceilings: All control wiring shall be installed in raceway, unless otherwise noted and except as follows:
 - a. Raceway may be omitted for control wiring if ALL of the following conditions are met:
 - 1) Wiring is used for Class 2 circuits
 - 2) Wiring is used only in dry locations;
 - 3) Wiring is used only in above ground applications;
 - 4) Wiring is not subject to physical damage;
 - 5) Wiring is supported and secured where such support does not exceed 3 foot intervals;
 - 6) Wiring is supported by hangers and supports from the building structure;
 - 7) Wiring is not laid on ceiling tiles
 - 8) Wiring shall not be fastened in a manner that puts tension on the cable;
 - 9) Wiring is for control wiring;
 - 10) Wiring shall be plenum rated (UL Type CMP);
 - 11) All wiring that is not enclosed by raceway shall be supported via UL Listed Metal J-Hooks (with rounded edges and integral cable retainer metal clip) and secured together with plenum rated nylon straps or clamps (the use of staples is prohibited);
 - 12) Wiring is concealed above accessible suspended ceilings (this includes, ceiling spaces above grid type ceilings with removable ceiling tiles); AND
 - 13) Raceway is omitted only where it is allowed to be omitted by the National Electrical Code, NFPA Codes, applicable codes, and the contract documents.

- C. Provide CAT6 data cable from the lighting control system to the network switches, to allow the lighting control system to be monitored and controlled through the local area network by a computer with the lighting control software (software provided by the contractor). Coordinate exact location of the network switches in the field. All work shall comply with the manufacturer's recommendations, the NEC, and the contract documents.

- D. All junction box covers shall be painted CYAN.

- E. Provide the following label on the network switch port used to communicate with the Access Control System: "LIGHTING CONTROL SYSTEM".

- F. Adjust exact location of photocells, photocontrols, and photosensors in the field so that the best possible view of the sunlight is provided, and the manufacturer's installation recommendations are followed.

- G. Adjust exact location of occupancy sensors so that any motion within the room or space is detected by the occupancy sensors, and the manufacturer's installation recommendations are followed.

- H. All switches and pushbuttons shall be labeled as to which lights are being controlled. Unused switches and pushbuttons shall be labeled as "spare".
- I. Adjust exact location of sensors so that their sensor coverage is not blocked by raceways, boxes, and other equipment.
- J. Coordinate electrical power supply connection type with the equipment. Where the equipment requires a receptacle connection, provide a receptacle. Where the equipment requires a hardwired connection, provide a hardwired connection. Coordinate all work with the manufacturer and the installation manuals. All work shall comply with the NEC, the manufacturer's recommendations, and the contract documents.

3.2 INSTALLATION

- A. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.
- B. Cables shall have a minimum separation of 12 inches from 120V or higher power wiring. Cables shall have a minimum separation of 12 inches from light fixtures.
- C. All wall and floor penetrations shall be sleeved. All conduit and sleeve ends must have bushings to prevent chafing. Where a conduit or other through-penetration device is installed through a fire rated assembly, the opening around the sleeve and the hole through the sleeve shall be sealed with an Underwriters Laboratory approved fire rated sealant material after the cables have been installed.
- D. Install cables without damaging conductors or jacket.
- E. Do not bend cables, in handling or in installing, to smaller radii than minimums recommended by manufacturer.
- F. Pull cables without exceeding cable manufacturer's recommended pulling tensions.
 - 1. Pull cables simultaneously if more than one is being installed in same raceway.
 - 2. Use pulling compound or lubricant if necessary. Use compounds that will not damage conductor or insulation.
 - 3. Use pulling means, including fish tape, cable, rope, and basket-weave wire or cable grips, that will not damage media or raceway.
 - 4. Monitor cable pulling tensions.
- G. Install cables parallel and perpendicular to surfaces or structural members and follow surface contours where possible.
- H. Wiring within Wiring Closets and Enclosures: Provide conductors of adequate length. Train conductors to terminal points with no excess. Use lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommended by manufacturer.
- I. Separation of Wires: Comply with TIA/EIA-569-A rules for separating unshielded copper telephone and data communication cabling from potential EMI sources, including electrical power lines and equipment.
- J. Make splices, taps, and terminations only at indicated outlets, terminals, and cross-connect panels.

- K. Use splice and tap connectors compatible with media types.
- L. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
- M. In the communications equipment room, install a 5-foot- long service loop on each end of cable.
- N. Cable support inside wiring closets, telecommunications closets, data closets:
 - 1. Support horizontal and backbone cabling from the fire retardant plywood board in each closet.
 - 2. Provide cable ties and cable tie mounts to support the horizontal and backbone cabling from the plywood board. Provide cable ties every 3”.
 - 3. Cable tie mount shall be manufactured by Panduit or approved equal and shall use galvanized steel screws as the mounting method. Cable tie mount shall be UL Recognized. Cable tie mount size shall be suitable for the cables being supported.
- O. Install all devices and equipment in accordance with the manufacturer’s requirements.

3.3 IDENTIFICATION

- A. Identify system devices, equipment, components, wiring, cabling, and terminals. Comply with the requirements for identification specified in Specification Section "Electrical Identification". Comply with the identification requirements of the applicable codes.

3.4 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
- B. Tests and Inspections:
 - 1. Walkthrough each room/area and confirm that each lighting control device (switch, occupancy sensor, etc.) can turn on the lights within the room/area.
 - 2. Confirm that each dimming control device can dim the lights from its minimum to maximum dimming level.
 - 3. Confirm that each photosensor used for dimming or on/off switching is capable of dimming the associated lights, and/or turning the associated lights on/off.
 - 4. Confirm that each time schedule used to turn the lights on/off controls the lights at the appropriate day/time.
 - 5. Test all the low voltage, data, and/or communications cables, using a cable to tester, and confirm with the lighting control system manufacturer that the cables meet all the criteria that are needed for a complete and fully operational lighting control system.
- C. Prepare test and inspection reports.
- D. Remove and replace items which failed the tests/inspections, and then re-test/re-inspect.
- E. Prepare re-test and re-inspection reports.

3.5 SYSTEM STARTUP

- A. Installation Procedures and Verification
 1. The contractor shall review all required installation and pre-startup procedures with the manufacturer's representative through pre-construction meetings.
 2. The contractor shall install and connect the networked lighting control system components according to the manufacturer's installation instructions, wiring diagrams, the project submittals and plans specifications.
 3. The contractor shall be responsible for testing of all low voltage network cable included in the bid. The contractor is responsible for verification of the following minimum parameters:
 - a. Wire Map (continuity, pin termination, shorts and open connections, etc.)
 - b. Length
 - c. Insertion Loss
- B. Upon completion of installation by the installer, including completion of all required verification and documentation required by the manufacturer, the system shall be started up and programmed by an authorized representative of the manufacturer.
 1. Low voltage network cable testing shall be performed prior to system startup at the discretion of the manufacturer.
- C. System start-up and programming shall include:
 1. Verifying operational communication to all system devices.
 2. Programming the network devices into functional control zones to meet the required sequence of operation.
 3. Programming and verifying all sequence of operations.
 4. Customization of owner's software interfaces and applications.
- D. Initial start-up and programming shall occur on-site. Additional programming shall also occur on-site, unless otherwise noted and except as follows:
 1. Additional programming may be done over the Internet, where all of the following conditions are met:
 - a. The additional programming does not require physical access to the equipment and can be made through the internet.
 - b. The contractor provides all the hardware, software, and other equipment as required to be able to access the internet.

3.6 SOFTWARE SERVICE AGREEMENT

- A. Technical Support: Beginning at Substantial Completion, service agreement shall include software support for five (5) years. Technical support shall include the following:
 1. Toll free technical support via phone
 2. Technical support via the internet
- B. Upgrade Service: At Substantial Completion, update software to latest version. Install and program software upgrades that become available within five (5) years from date of Substantial Completion. Upgrading software shall include operating system and new or revised licenses for using software.
 1. Upgrade Notice: At least 30 days to allow Owner to schedule access to system and to upgrade computer equipment if necessary.

3.7 DEMONSTRATION AND TRAINING

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain the lighting control system.
- B. The System Supplier shall schedule and present a minimum of 8 hours of documented formalized instruction for the building owner, detailing the proper operation and maintenance of the installed System.
- C. The instruction shall be presented in an organized and professional manner by a person factory trained in the operation and maintenance of the equipment and who is also thoroughly familiar with the installation.

END OF SECTION 260943

SECTION 262416 - PANELBOARDS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1, 26, 27, and 28 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Distribution panelboards.
 - 2. Branch-circuit panelboards.

1.3 DEFINITIONS

- A. SVR: Suppressed voltage rating.
- B. MCB: Main Circuit Breaker
- C. KAIC: Thousand Ampere Interrupting Capacity
- D. Branch Breaker: A circuit breaker at a panelboard, that is located on the loadside of the Main Circuit Breaker or Main Lugs of that panelboard.
- E. NEC: National Electrical Code

1.4 SUBMITTALS

- A. Product Data: For each type of panelboard, switching and overcurrent protective device, transient voltage suppression device, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes. Provide size/quantity for all wire lugs/terminals at the equipment.
- B. Shop Drawings: For each panelboard and related equipment.
 - 1. Include dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings.
 - 2. Detail enclosure types and details for types other than NEMA 250, Type 1.
 - 3. Detail bus configuration, current, and voltage ratings.
 - 4. Short-circuit current rating of panelboards and overcurrent protective devices.
 - 5. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
 - 6. Include wiring diagrams for power, signal, and control wiring.
 - 7. Include time-current coordination curves for each type and rating of overcurrent protective device included in panelboards.

- C. Panelboard Schedules: For installation in panelboards. Submit final versions after load balancing.
- D. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 1 Section "Operation and Maintenance Data," include the following:
 - 1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
 - 2. Time-current curves, including selectable ranges for each type of overcurrent protective device that allows adjustments.

1.5 QUALITY ASSURANCE

- A. Source Limitations: Obtain panelboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Comply with NEMA PB 1.
- D. Comply with NFPA 70.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Remove loose packing and flammable materials from inside panelboards; install temporary electric heating (250 W per panelboard) to prevent condensation.
- B. Handle and prepare panelboards for installation according to NEMA PB 1.

1.7 PROJECT CONDITIONS

- A. Environmental Limitations:
 - 1. Do not deliver or install panelboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above panelboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
- B. Service Conditions: NEMA PB 1, usual service conditions.

1.8 COORDINATION

- A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
- B. Coordinate wire terminals/lugs at the equipment with the wires that are connected to it. Wire terminals/lugs shall be suitable for use with the wires that are connected to.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR PANELBOARDS

- A. Enclosures: Flush- or surface-mounted cabinets, as indicated on the drawings.
 - 1. Rated for environmental conditions at installed location. See drawings for NEMA 250 enclosure type.
 - 2. Finishes: Steel (unless otherwise noted), factory finished immediately after cleaning and pretreating with manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.
 - 3. Directory Card: Inside panelboard door, mounted in metal frame with transparent protective cover.
- B. Phase and Neutral, Buses:
 - 1. Material: Copper, unless otherwise noted
- C. Ground Buses:
 - 1. Equipment Ground Bus: Copper. Adequate for feeder and branch-circuit equipment grounding conductors; bonded to box.
- D. Conductor Connectors: Suitable for use with conductor material and sizes.
 - 1. Main and Neutral Lugs: Mechanical type.
 - 2. Ground Lugs and Bus-Configured Terminators: Mechanical type.
- E. Future Devices: Mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.
- F. Multi-Section Panelboards:
 - 1. Multi-Section Panelboards shall have equal-height boxes and common trim.
- G. Panelboard Short-Circuit Current Rating:
 - 1. Fully rated to interrupt symmetrical short-circuit current available at terminals, unless otherwise noted.
- H. Where the Panel Schedules (the Panel Schedules are shown on the drawings) indicate that a 200% neutral is required; this shall mean that the panel shall have a neutral bus that is rated at 200% of the phase bus, and is UL listed as suitable for non-linear loads. Neutral wire terminals/connectors shall be suitable for use with the wiring indicated in the drawings.
- I. All service equipment shall have barriers in place, such that no uninsulated ungrounded service busbar or service terminal is exposed to inadvertent contact by persons or maintenance equipment while servicing load terminations.

2.2 DISTRIBUTION PANELBOARD

- A. Manufacturers: Square D is the basis-of-design manufacturer. Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work also include, but are not limited to, the following:
 - 1. General Electric Company.
 - 2. Siemens Energy & Automation, Inc.

- 3. Eaton
- B. Panelboards: Comply with NEMA PB 1
- C. Doors: Secured with vault-type latch with tumbler lock; keyed alike. All panelboards shall have doors, and all doors shall have locks (provide a minimum of 3 keys per lock). All panelboards shall be keyed alike.
 - 1. For doors more than 36 inches high, provide two latches, keyed alike.
- D. All panelboards with service disconnects shall be UL listed as suitable for use as service equipment.
- E. Dimensions of Panelboards shall not exceed the following:
 - 1. Box Width: 44"
 - 2. Box Depth: 9.5"
 - 3. Enclosure Height: Varies based on the quantity of circuit breakers and spaces.
- F. Basis-of-Design Distribution Panelboards:
 - 1. Square-D Type I-LINE

2.3 BRANCH CIRCUIT PANELBOARD

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 - 2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
 - 3. Siemens Energy & Automation, Inc.
 - 4. Square D; a brand of Schneider Electric.
- B. Panelboards: Comply with NEMA PB 1
- C. All panelboards with service disconnects shall be UL listed as suitable for use as service equipment.
- D. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.
- E. Doors: Provide single door construction, made of cold-rolled steel. Door shall have concealed hinges, flush catch, and lock. Secure top and bottom of door to cabinet by slotted steel bolts. Release shall be by one-half turn with a screwdriver. All panelboards shall have doors, and all doors shall have locks (provide a minimum of 3 keys per lock). All panelboards shall be keyed alike.
 - 1. Panelboards shall be equipped with "door within door" type trim. The entire front trim shall be hinged to the box, and a standard door shall be within the hinged trim cover.
- F. Dimensions of 120/208V Panelboards shall not exceed the following:
 - 1. Box Width: 20"
 - 2. Box Depth: 5.75"
 - 3. Enclosure Height: Varies based on the quantity of circuit breakers and spaces.
- G. Basis of Design Branch Circuit Panelboards:
 - 1. 120/208V Panels: Square-D Type NQ

2.4 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
 3. Siemens Energy & Automation, Inc.
 4. Square D; a brand of Schneider Electric.
- B. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with interrupting capacity to meet available fault currents.
1. 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.
 2. GFCI Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (5-mA trip).
 3. Molded-Case Circuit-Breaker (MCCB) Features and Accessories:
 - a. Standard frame sizes, trip ratings, and number of poles.
 - b. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor materials.
 - c. Application Listing: Type SWD for switching fluorescent lighting loads; Type HACR for heating, air-conditioning, and refrigerating equipment;
 - d. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
 - e. Multipole units enclosed in a single housing or factory assembled to operate as a single unit.
 - f. Handle Padlocking Device: Fixed attachment, for locking circuit-breaker handle in off position.
 - g. Handle Clamp: The handle clamp shall prevent the circuit breaker handle from being manually switched to the OFF position. Handle clamp shall not prevent the circuit breaker from tripping. Authorized personnel shall have the capability to remove the handle clamp.
 - h. Trip-free mechanism: allows breaker to trip even with the handle locked or held in the ON position.
 - i. Circuit breakers shall be suitable for reverse feed.
- C. Where the Panel Schedules (the Panel Schedules are shown on the drawings) indicate that the main circuit breaker or any circuit breaker shall have adjustable LSI trip settings, this shall mean that the circuit breaker shall have an electronic trip unit, and that the following trip settings shall be field adjustable:
1. Long Time Pickup
 2. Short Time Pickup
 3. Instantaneous Pickup
 4. Long Time Delay
 5. Short Time Delay
- D. Where the Panel Schedules (the Panel Schedules are shown on the drawings) indicate that the main circuit breaker or any circuit breaker shall have adjustable LSIG trip settings, this shall mean that the circuit breaker shall have an electronic trip unit, and that the following trip settings shall be field adjustable:
1. Long Time Pickup
 2. Short Time Pickup
 3. Instantaneous Pickup

4. Ground Fault Pickup
 5. Long Time Delay
 6. Short Time Delay
 7. Ground Fault Time Delay
- E. Where the Panel Schedules (the Panel Schedules are shown on the drawings) indicate that the main circuit breaker or any circuit breaker shall be 100% rated, this shall mean that the circuit breaker is UL listed as suitable for carrying 100% of rated current continuously.
- F. Circuit breakers which incorporate ground fault protection shall have the following features:
1. Ground fault push-to-trip button
 2. Ground fault trip indicator light
- G. For circuit breakers rated 800A and less, comply with the following:
1. Where the circuit breaker has an electronic trip unit with an adjustable long time trip setting, the sensor plug, which sets the maximum trip the circuit breaker can be adjusted to, shall not be greater than 800A.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Receive, inspect, handle, and store panelboards according to NEMA PB 1.1.
- B. Examine panelboards before installation. Reject panelboards that are damaged or rusted or have been subjected to water saturation.
- C. Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install panelboards and accessories according to NEMA PB 1.1.
- B. Mount panelboard at one of the following mounting heights, unless otherwise indicated on the drawings:
 1. Wherever the overall height of the panelboard is 5' or less, mount the panelboard such that the top of the panelboard enclosure is located at 6' above the finished floor.
 2. Wherever the overall height of the panelboard is greater than 5', mount the panelboard such that the center of the grip of the operating handle of the top-most circuit breaker, when in the highest position, is not more than 6'-6" above the finished floor. Where the topmost circuit breaker position is a space for a future circuit breaker, assume that there is a circuit breaker mounted in the space for determining the mounting height of the panelboard.
- C. Mount panelboard cabinet plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.
- D. Install overcurrent protective devices and controllers not already factory installed.

1. Set field-adjustable, circuit-breaker trip ranges.
- E. Install filler plates in unused spaces.
- F. Arrange conductors in gutters into groups and bundle and wrap with wire ties after completing load balancing.
- G. Comply with NECA 1.
- H. Provide all necessary blocking, channels and other hardware for securing panelboards to wall, column, or other parts of building structure.
- I. Spare circuit breakers and spaces for future circuit breakers shall be located towards the top of the panelboards.

3.3 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with Specification Section "Electrical Identification."
- B. Create a directory to indicate installed circuit loads after balancing panelboard loads; incorporate Owner's final room designations. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are not acceptable.
- C. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Specification Section "Electrical Identification."
- D. Service Equipment Label: Service equipment shall be NRTL labeled for use as service equipment.

3.4 ADJUSTING

- A. Adjust moving parts and operable component to function smoothly, and lubricate as recommended by manufacturer.
- B. Set field-adjustable circuit-breaker trip ranges.
- C. Load Balancing: After Substantial Completion, but not more than 60 days after Final Acceptance, measure load balancing and make circuit changes.
 1. Measure as directed during period of normal system loading.
 2. Perform load-balancing circuit changes outside normal occupancy/working schedule of the facility and at time directed. Avoid disrupting critical 24-hour services such as fax machines and on-line data processing, computing, transmitting, and receiving equipment.
 3. After circuit changes, recheck loads during normal load period. Record all load readings before and after changes and submit test records.
 4. Tolerance: Difference exceeding 20 percent between phase loads, within a panelboard, is not acceptable. Rebalance and recheck as necessary to meet this minimum requirement.

3.5 FIELD QUALITY CONTROL

- A. Tests and Inspections:

1. Engage a qualified testing agency and perform the following tests and inspections, and prepare test reports:
 - a. Perform each visual and mechanical inspection and electrical test stated in the NETA Acceptance Testing Specification. Certify compliance with test parameters.
 - 1) Electrical tests are required for all panelboards. Visual and mechanical inspections are required on all panelboards.
2. The testing agency shall coordinate with the manufacturer of the item being tested, and shall obtain copies of the installation/testing manuals. The testing agency shall not exceed the test voltage/current/duration limits indicated by the manufacturer.
3. Remove and replace items which do not pass the tests. Test the replacement items.

3.6 DEMONSTRATION AND TRAINING

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to maintain panelboards. Provide a minimum of 4 hours of training.

END OF SECTION 262416

SECTION 262713 – ELECTRIC UTILITY METERING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1, 26, 27, and 28 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes equipment for utility company's electricity metering.

1.3 SUBMITTALS

- A. Product Data: Include construction details, material descriptions, dimensions of individual components and profiles, and finishes. Describe electrical characteristics, features, and operating sequences, both automatic and manual. Include the following:
 - 1. Electricity-metering equipment.
- B. Shop Drawings for Electricity-Metering Equipment:
 - 1. Dimensioned plans and sections or elevation layouts.
 - 2. Wiring Diagrams: Power, signal, and control wiring specific to this Project. Identify terminals and wiring designations and color codes to facilitate installation, operation, and maintenance. Indicate recommended types, wire sizes, and circuiting arrangements for field-installed wiring, and show circuit protection features.
- C. Field quality-control test reports.
- D. Operation and Maintenance Data: For electricity-metering equipment to include in emergency, operation, and maintenance manuals.
- E. Submit product data and shop drawings to the electric utility for review and approval.

1.4 QUALITY ASSURANCE

- A. 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.
- B. Comply with NFPA 70.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Receive, store, and handle modular meter stack as specified in NECA 400.

1.6 COORDINATION

- A. Electrical Service Connections: Coordinate with utility companies and components they furnish as follows:
 - 1. Comply with requirements of utilities providing electrical power and communication services.
 - 2. Coordinate installation and connection of utilities and services, including provision for electricity-metering components.

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.

2.2 EQUIPMENT FOR ELECTRICITY METERING BY UTILITY COMPANY

- A. Current-Transformer Cabinets for Utility Company Metering: Comply with requirements of electrical power utility company.
- B. Meter Sockets for Utility Company Metering: Comply with requirements of electrical power utility company.

2.3 IDENTIFICATION

- A. Service Equipment Label: Service equipment shall be UL labeled for use as service equipment.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Comply with equipment installation requirements in NECA 1.
- B. Furnish and install equipment for utility company metering. Furnish and install associated raceways, troughs, wireways, enclosures, cabinets, and other equipment according to the utility company's requirements.

END OF SECTION 262713

SECTION 262714 - ELECTRIC SUBMETERING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1, 26, 27, and 28 Specification Sections, apply to this Section.

1.2 SUBMITTALS

- A. Submittals shall include the following items:
 - 1. Bill of Materials for all components of the electric submetering system
 - 2. Product Specification Sheets indicating general device descriptions, dimensions, electrical specifications, wiring details, and nomenclature.
 - 3. Plan drawings showing locations of all electric submetering equipment and all cables connecting the equipment to each other and other equipment
 - 4. Information Technology (IT) connection information pertaining to interconnection with facility IT networking equipment and third-party systems.
 - 5. Other Diagrams and Operational Descriptions as needed to indicate system operation or interaction with other system(s).
 - 6. Contractor Startup Worksheet which shall be completed by the contractor prior to factory start-up
 - 7. Service Specification Sheets indicating general service descriptions, including startup, training, post-startup support, and service contract terms.
 - 8. Hardware and Software Operation Manuals.
 - 9. Screenshots of the following:
 - a. Displays on the laptop with the energy software, to indicate how the submetering data will be shown.
- B. Submittal drawings, details, and diagrams
 - 1. Prior to installation of electric submetering equipment, provide a 1/8" = 1'-0" scaled plan drawings, details, and wiring diagrams; which show locations of all equipment, with all equipment addresses, symbols, power/control wiring, mounting details, and other information indicated. All equipment that require line voltage power shall be indicated on the plan drawings. At the completion of the construction, this drawing shall be updated with as-built information.
- C. Prior to the demonstration and training, provide copies of the training materials (power point slide presentations, etc.)
- D. Provide the following closeout submittals:
 - 1. Project Record Documents: Accurately record the actual locations of Products.
 - 2. Operating and Maintenance manuals. In addition to items specified elsewhere in the contract documents, include the following:
 - a. Application and operating software documentation.
 - b. Software licenses: The license to use the software shall not expire.
 - c. Software service agreement.
 - d. Hard copies of manufacturer's operating specifications, design user's guides for software and hardware, and PDF file copies of the hard-copy Submittal on USB drives.

3. Operating Instructions: Document training by furnishing a sign-in sheet with a description on the training provided, instructors name and organization and those who received training.
 4. Submit software database file with desired device labels and notes completed.
 5. As-built drawings, details, and wiring diagrams
- E. Provide field quality control test reports.

1.3 QUALITY ASSURANCE

- A. 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.
- B. Comply with NFPA 70.
- C. Comply with NECA 1.

1.4 COORDINATION

- A. Coordinate the equipment indicated in this specification section with all other equipment and systems it connects to. All input/output/communications interfaces/modules shall be compatible and suitable for use with each other.
- B. Coordinate programming of system with the preferences of the owner. Comply with the owner's requirements, except where it conflicts with the applicable codes or the requirements of the authorities having jurisdiction.
- C. Where equipment are connected to the data network system, coordinate all network settings/configurations with the owner's IT (Information Technology) department.
- D. Coordinate line voltage power requirements prior to starting any work to ensure that power is provided to all equipment. The contractor shall provide line voltage power to all equipment that require it, in accordance with the manufacturer's recommendations and NEC requirements.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Basis-of-Design Product: Where the contract documents specifies a product name, model, or manufacturer, this product shall be considered as the basis-of-design product. The contractor shall provide the basis-of-design product or approved equal. All products shall be submitted for review and approval by the design team.

2.2 GENERAL

- A. The contractor shall provide all labor, software, programming, materials, equipment, hardware, mounting, wiring, conduit, junction boxes, power supplies, transformers, batteries, equipment enclosures (all equipment shall have enclosures), and accessories as required for a complete and fully operational system. The contractor shall provide all startup and testing as required, in

order to confirm that the system operates in accordance with the contract documents. The system shall comply with all applicable codes, the manufacturer's recommendations, and the requirements of the authorities having jurisdiction.

- B. Where licenses are required to install, operate, and maintain the system, provide a minimum of 2 licenses, except where more licenses are required elsewhere in the contract documents, in which case, the larger quantity shall apply. Each license shall be capable of being used locally (at the building), or remotely (in remote facility through the internet).
- C. Wires shall be sized and selected such that proper operation of the system is achieved. Excessive voltage drop that can adversely affect proper operation of any component in the system shall be avoided.
- D. Provide the following spare parts:
 - 1. Provide a 10% spare fuses for each type of fuse. Fuse shall be provided in a box that is labeled to indicate which types of equipment will use the fuse.

2.3 ELECTRIC SUBMETER

- A. Provide Honeywell E-Mon Class 5000 Green Net Smart Meter with the following features:
 - 1. Advanced 4-line display showing
 - a. kWh delivered, received and Net kWh
 - b. kW demand (with peak date and time)
 - c. Power factor per phase
 - d. Amps per phase
 - e. Volts per phase
 - f. On-board set-up option for:
 - 1) IP address
 - 2) Meter date/time
 - 3) ID codes for EZ7, Modbus and BACnet
 - 2. 0-2 volt output current sensors allow for enhanced safety and accurate remote mounting of sensors up to 500 feet from meter without power interruption.
 - 3. Onboard installation diagnostics and verification system
 - 4. Phase loss alarm (normally open contact)
 - 5. Built-in RS-485 communication capability supports the following connection configurations (or combinations not to exceed 52 devices per channel):
 - a. Each channel can accommodate up to 4,000 feet of cabling, with up to 52 submeters daisy chained together.
 - 6. Records kWh and kVARh delivered, kWh and kVARh received in first four channels. Data stored in 15 minute intervals for up to 72 days or 5 minute intervals for up to 24 days. Data is maintained in a first-in, first-out format.
 - 7. Suitable for 3 phase, 3 wire; 3 phase, 4 wire; or, 1 phase, 3 wire, applications. Provide additional equipment that are needed to make the meter compatible with the voltage configuration of the associated circuit/equipment.
 - 8. Outdoor NEMA 4X polycarbonate enclosure with padlocking hasp and mounting flanges for indoor/outdoor installation.
 - 9. UL Listed. Meets or exceeds ANSI C12.20 national accuracy standards (+/-0.2% from 1% to 100% of rated load)
 - 10. Meets or exceed MID (Measuring Instruments Directive) accuracy standards
 - 11. Meter shall be field programable for meter date/time, IP address and ID code for communication purposes.
 - 12. The communications protocol of the electric submeter shall be coordinated with all other systems/equipment connected the electric submetering system
 - 13. Voltage rating/configuration of the electric submeter shall be compatible with the voltage rating/configuration of the circuit/equipment being submetered.

14. The electric submeter shall be capable of accurately measuring all currents from zero amperes, up to the continuous current ampere rating of the associated current sensor.
15. Dimensions of the electric submeter shall not exceed 6" high x 6" wide x 4.25" deep.

B. The submeter data shall be accessible over the local and wide area networks.

2.4 ENERGY SOFTWARE

A. Energy software shall be Honeywell E-Mon Energy Software with the following features:

1. Software is an energy-monitoring system that allows users to read and monitor energy consumption easily and effectively via on-site or off-site non-dedicated computers. The software allows the user to generate graphs and profiles of energy data for demand analysis and usage reduction. The software shall also generate electrical bills for usage verification.
2. Graphic profiling provides analytical charts and graphs with demand profiling for 5, 15, 30 or 60 minute sampling rates.
3. Generate and print itemized electric bills (using coincidental peak demand date and time). Software shall generate bills from user-specific time periods via profile data (you need not be present to generate meter readings).
4. Reads up to 8 time periods, 4 seasons and multiple holidays for time-of-use (TOU) monitoring.
5. Reads the electric submeters, either on-site or off-site, via ethernet
6. Exports data to spreadsheets for analysis (*.csv files)
7. Exports data to MV-90 system (*.hhf files)

B. The contractor shall provide a dedicated laptop that is capable of using the Energy Software, and accessing the submeter data over the local and wide area networks. The Energy Software shall be installed on the laptop. The laptop shall become the property of the owner.

PART 3 - EXECUTION

3.1 APPLICATION

A. Program the energy software with the actual billing rates of the electric utility for the facility, such that the owner can see the amount (in dollars) he is using in electricity.

3.2 INSTALLATION

- A. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.
- B. Cables shall have a minimum separation of 12 inches from 120V or higher power wiring. Cables shall have a minimum separation of 12 inches from light fixtures.
- C. All wall and floor penetrations shall be sleeved. All conduit and sleeve ends must have bushings to prevent chafing. Where a conduit or other through-penetration device is installed through a fire rated assembly, the opening around the sleeve and the hole through the sleeve shall be sealed with an Underwriters Laboratory approved fire rated sealant material after the cables have been installed.
- D. Install cables without damaging conductors or jacket.

- E. Do not bend cables, in handling or in installing, to smaller radii than minimums recommended by manufacturer.
- F. Pull cables without exceeding cable manufacturer's recommended pulling tensions.
 - 1. Pull cables simultaneously if more than one is being installed in same raceway.
 - 2. Use pulling compound or lubricant if necessary. Use compounds that will not damage conductor or insulation.
 - 3. Use pulling means, including fish tape, cable, rope, and basket-weave wire or cable grips, that will not damage media or raceway.
 - 4. Monitor cable pulling tensions.
- G. Install cables parallel and perpendicular to surfaces or structural members and follow surface contours where possible.
- H. Wiring within Wiring Closets and Enclosures: Provide conductors of adequate length. Train conductors to terminal points with no excess. Use lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommended by manufacturer.
- I. Separation of Wires: Comply with TIA/EIA-569-A rules for separating unshielded copper telephone and data communication cabling from potential EMI sources, including electrical power lines and equipment.
- J. Make splices, taps, and terminations only at indicated outlets, terminals, and cross-connect panels.
- K. Use splice and tap connectors compatible with media types.
- L. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
- M. In the communications equipment room, install a 5-foot- long service loop on each end of cable.
- N. Cable support inside wiring closets, telecommunications closets, data closets:
 - 1. Support horizontal and backbone cabling from the fire retardant plywood board in each closet.
 - 2. Provide cable ties and cable tie mounts to support the horizontal and backbone cabling from the plywood board. Provide cable ties every 3".
 - 3. Cable tie mount shall be manufactured by Panduit or approved equal and shall use galvanized steel screws as the mounting method. Cable tie mount shall be UL Recognized. Cable tie mount size shall be suitable for the cables being supported.
- O. Install all devices and equipment in accordance with the manufacturer's requirements.
- P. Prior to installing devices and equipment, the contractor shall coordinate the exact locations where the devices and equipment are being installed with the plan drawings and existing conditions, and shall notify the engineer immediately if there are any issues or conflicts. The coordinated locations shall be indicated in the shop drawing submittals. Where conflicts are found during or after the shop drawing submittal process, but before installation of the devices and equipment, the contractor shall notify the engineer of the conflict, and shall adjust the locations of the devices and equipment, where directed by the engineer to do so. The contractor's bid price shall include adjusting the locations of devices and equipment up to 12 feet from the locations on the plan drawings, unless otherwise noted.

- Q. All programmable and adjustable settings and sequence of operations shall be coordinated with the owner, and set in accordance with the owner's recommendations. Where the owner has no preference, provide a recommendation for the owner's review. Provide eight (8) hours of on-site meetings with the owner, to discuss and make decisions related to the programmable/adjustable settings/sequence of operations. Prior to meeting with the owner on-site, submit a list of items to be discussed, so that the owner is prepared for the on-site discussions.
- R. All equipment shall be installed plumb and level.
- S. Clean all equipment in accordance with the manufacturer's recommendations.

3.3 FIELD QUALITY CONTROL

- A. **Manufacturer's Field Service:** Engage a factory-authorized service representative to inspect field-assembled components and equipment installation and supervise pretesting, testing, and adjusting of video surveillance equipment.
- B. **Inspection:** Verify that units and controls are properly installed, connected, and labeled, and that interconnecting wires and terminals are identified.
- C. **Pretesting:** Align and adjust system and pretest components, wiring, and functions to verify that they comply with specified requirements. Conduct tests at varying lighting levels, including day and night scenes as applicable. Prepare electric submetering equipment for acceptance and operational testing as follows:
 - 1. Connect a resistive load on all phases of the load side of each electric submeter, and confirm that the correct ampere reading is displayed on the submeter display, and the laptop with the energy software.
- D. **Test Schedule:** Schedule tests after pretesting has been successfully completed and system has been in normal functional operation for at least 14 days. Provide a minimum of 10 days' notice of test schedule.
- E. **Operational Tests:** Perform operational system tests to verify that system complies with Specifications. Include all modes of system operation. Test equipment for proper operation in all functional modes.
- F. Remove and replace malfunctioning items and retest as specified above.
- G. Record test results for each piece of equipment.
- H. **Retest:** Correct deficiencies identified by tests and observations and retest until specified requirements are met.

3.4 IDENTIFICATION

- A. In addition to requirements in this Article, comply with applicable requirements in Division 16 Section "Electrical Identification".
- B. Each equipment shall be labeled with an address/identification name/number which matches information provided in the submittals or indicated in the drawings. Identify each cable segment between equipment with a unique number corresponding to the address/identification

name/number of the associated equipment. Provide a cable schedule which identifies each cable segment and the associated equipment.

3.5 SOFTWARE SERVICE AGREEMENT

- A. Provide software technical support as follows:
 - 1. Beginning at Substantial Completion, service agreement shall include software support for two (2) years.
 - 2. Technical support shall include the following:
 - a. Toll free technical support via phone
 - b. Technical support via the internet
- B. Provide software upgrade service as follows:
 - 1. At Substantial Completion, update software to latest version. Install and program software upgrades that become available within two (2) years from date of Substantial Completion. Upgrading software shall include operating system and new or revised licenses for using software.
 - 2. Upgrade Notice: At least 30 days to allow Owner to schedule access to system and to upgrade computer equipment if necessary.

3.6 DEMONSTRATION AND TRAINING

- A. The contractor shall provide to the owner, complete manuals of the completed system. The manuals shall include operating and maintenance instruction, catalog cuts of all equipment and components, as-built wiring diagrams, and a manufacturer's suggested spare parts list.
- B. In addition to the above manuals, the contractor shall provide the services of the manufacturer's trained representative for a period of eight (8) hours to instruct the owners' designated personnel on the operation and maintenance of the entire system.
- C. During the training, the instructor shall provide a laptop that is loaded with the system software, which allows the trainees to monitor and control the system through the network. At the end of the training, this laptop and all software installed on it, shall become the property of the owner, at no additional cost.
- D. Training shall be on-site, and hands-on, using the actual equipment installed at the project site.
- E. Provide training on how to operate and maintain the system. Also, provide the following additional training:
 - 1. How to view and analyze the submetering data

END OF SECTION 262714

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SECTION 262726 - WIRING DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1, 26, 27, and 28 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Single and duplex receptacles, ground-fault circuit interrupters.
 - 2. Single- and double-pole snap switches.
 - 3. Device wall plates.

1.3 DEFINITIONS

- A. EMI: Electromagnetic interference.
- B. GFCI: Ground-fault circuit interrupter.
- C. PVC: Polyvinyl chloride.
- D. Heavy Duty Grade: Industrial Grade

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Field quality-control test reports.

1.5 QUALITY ASSURANCE

- A. Source Limitations: Obtain each type of wiring device 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 intended use.
- C. Comply with NFPA 70.

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. Wiring Devices:
 - a. Hubbell Incorporated; Wiring Device-Kellems.
 - b. Leviton Mfg. Company Inc.
 - c. Pass & Seymour/Legrand; Wiring Devices Div.

2.2 RECEPTACLES

- A. Straight-Blade-Type Receptacles: Comply with NEMA WD 1, NEMA WD 6, DSCC W-C-596G, and UL 498.
- B. Straight-Blade and Locking Receptacles: Heavy-Duty grade.
- C. GFCI Receptacles: Straight blade, feed-through type; heavy-duty grade, with ground fault protection, test and reset pushbuttons; NEMA WD 6, duplex receptacle; Complies with UL 498 and UL 943. Design units for installation in a 2-3/4 inch deep outlet box without an adapter.
- D. All 15 and 20 ampere receptacles in wet locations shall be UL listed as weather-resistant.

2.3 CORD AND PLUG SETS

- A. Description: Match voltage and current ratings and number of conductors to requirements of equipment being connected.
 - 1. Cord: Rubber-insulated, stranded-copper conductors, with Type SOW-A jacket; with green-insulated grounding conductor and equipment-rating ampacity plus a minimum of 30 percent.
 - 2. Plug: Nylon body and integral cable-clamping jaws. Match cord and receptacle type for connection.

2.4 SWITCHES

- A. Single- and Double-Pole Switches: Comply with DSCC W-C-896F and UL 20.
- B. Snap Switches: Heavy-Duty grade, quiet type.

2.5 WALL PLATES

- A. Single and combination types to match corresponding wiring devices.
 - 1. Plate-Securing Screws: Stainless steel screws.
 - 2. Material for Switches and Receptacles in Dry Locations: 0.035-inch-thick, satin-finished stainless steel, unless otherwise noted

3. Material for Receptacles in Wet Locations and Outdoors, or where the drawings indicate that the receptacle cover shall be weatherproof:
 - a. Cast aluminum construction.
 - b. Mounting screws and gaskets included for fast, easy installation onto surface mounted outdoor type boxes or flush-mounted wall boxes.
 - c. Weatherproof while-in-unattended use with cover closed and plug inserted.
 - d. Cover shall have provisions for padlocks.
 - e. Depth of cover shall not exceed 3.5".
4. Material for Switches in Wet Locations and Outdoors, or where the drawings indicate that the switch cover shall be weatherproof:
 - a. Cast aluminum construction
 - b. Mounting screws and gaskets included for fast, easy installation onto surface-mounted outdoor type boxes or flush-mounted wall boxes.
 - c. Cover shall have provisions for padlocks.
 - d. Suitable for use in wet locations.
 - e. Switch cover shall be O-Z/Gedney FS-1-WSCA for single gang boxes and FS-2-WSCA for two gang boxes, or approved equal.

2.6 FINISHES

A. Color:

1. Wiring Devices Connected to Normal Power System: White, unless otherwise indicated or required by NFPA 70.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install devices and assemblies level, plumb, and square with building lines.
- B. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical, and with grounding terminal of receptacles on top. Group adjacent switches under single, multigang wall plates.
- C. Coordination with Other Trades:
 1. Take steps to insure that devices and their boxes are protected. Do not place wall finish materials over device boxes and do not cut holes for boxes with routers that are guided by riding against outside of the boxes.
 2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
 3. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
 4. Remove wall plates and protect devices and assemblies during painting.
- D. Conductors:
 1. Do not strip insulation from conductors until just before they are spliced or terminated on devices.
 2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.

- E. Device Installation:
 - 1. Replace all devices that have been in temporary use during construction or that show signs that they were installed before building finishing operations were complete.
 - 2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
 - 3. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.
 - 4. Use a torque screwdriver when a torque is recommended or required by the manufacturer.
 - 5. Tighten unused terminal screws on the device.
 - 6. When mounting into metal boxes, remove the fiber or plastic washers used to hold device mounting screws in yokes, allowing metal-to-metal contact.

- F. Device Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.

3.2 CONNECTIONS

- A. Ground equipment according to Specification Section "Grounding and Bonding."
- B. Connect wiring according to Specification Section "Conductors and Cables."
- C. 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.

3.3 FIELD QUALITY CONTROL

- A. Perform the following field tests and inspections and prepare test reports:
 - 1. After installing wiring devices and after electrical circuitry has been energized, test for proper polarity, ground continuity, and compliance with requirements.
 - 2. Test GFCI operation with both local and remote fault simulations according to manufacturer's written instructions.

- B. Remove malfunctioning units, replace with new units, and retest as specified above.

END OF SECTION 262726

SECTION 262746- ELECTRIC VEHICLE CHARGING STATIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 DEFINITIONS

- A. EV: Electric vehicle.
- B. EV Charger or EV Charging Station: See "EVCS."
- C. EVCS: Electric-Vehicle Charging Station. It includes the EV charging equipment and conductors, including the ungrounded, grounded, and equipment grounding conductors and EV cables, attachment plugs, and all other fittings, devices, power outlets, or apparatus installed specifically for transferring energy between the premises wiring and the EV.

1.3 SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for EV charging equipment.
 - 2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
 - 3. Provide size/quantity for all wire lugs/terminals at the equipment.
 - 4. Detailed information regarding the commercial service plan, cellular data/phone plan, and any contracts that need to be signed which apply to the EVCS.
- B. Shop Drawings: For EVCS.
 - 1. Include plans, elevations, sections, and mounting details.
 - 2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 3. Detail fabrication and assembly of mounting assemblies for EV charging equipment.
 - 4. Include diagrams for power, signal, and control wiring.
 - 5. Include verification of wireless communications service at each location of EV charging equipment.
- C. Coordination Drawings: Area plans and details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 - 1. Structural members to which equipment will be attached.
 - 2. Electrical service.
 - 3. Communications service, including wireless communications equipment
 - 4. Items penetrating finished floor

- D. Provide screenshots of the software used for managing the EVCS, as part of the commercial service plan.
- E. Samples of reports and analytics that are generated by the commercial service plan.
- F. Qualification Data: For Installer
- G. Field quality-control reports.
- H. Warranty: For manufacturer's warranty.
- I. Operation and Maintenance Data: For EVCS to include in operation and maintenance manuals.
- J. Software and Firmware Operational Documentation:
 - 1. Software operating manuals.
 - 2. Program Software Backup: On USB, CD, Cloud, or approved media, complete with configuration files.
 - 3. Device address and password list.
 - 4. Printout of software application and graphic screens.

1.4 QUALITY ASSURANCE

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

1.5 FIELD CONDITIONS

- A. Wireless Survey: Complete wireless survey to determine if wireless provider signals meet or exceed manufacturer's recommended minimum values.
- B. Rate equipment for continuous operation under the following conditions unless otherwise indicated:
 - 1. Ambient Temperature: Not exceeding minus 22 to plus 122 deg F (minus 30 to plus 50 deg C).
 - 2. Altitude: Not exceeding 6600 feet (2000 m).

1.6 COORDINATION

- A. Coordinate wire terminals/lugs at the equipment with the wires that are connected to it. Wire terminals/lugs shall be suitable for use with the wires that are connected to.

PART 2 - PRODUCTS

2.1 GENERAL

- A. The contractor shall provide all labor, software, programming, materials, equipment, hardware, mounting, wiring, conduit, junction boxes, power supplies, transformers, batteries, equipment enclosures (all equipment shall have enclosures), and accessories as required for a complete

and fully operational system. The contractor shall provide all startup and testing as required, in order to confirm that the system operates in accordance with the contract documents. The system shall comply with all applicable codes, the manufacturer's recommendations, and the requirements of the authorities having jurisdiction.

- B. Where licenses are required to install, operate, and maintain the system, provide a minimum of 2 licenses, except where more licenses are required elsewhere in the contract documents, in which case, the larger quantity shall apply. Each license shall be capable of being used locally (at the building), or remotely (in remote facility through the internet).

2.2 ELECTRIC VEHICLE CHARGING STATION

- A. The Electrical Vehicle Charging Station shall be ChargePoint CT4025-GW1 (dual port, bollard mount) with CT4001-CCM (mounting kit), CPCLD-COMMERCIAL-5 (5 year commercial service plan), CT-4000-ASSURE-2 (2 year maintenance plan), CPSSUPPORT-ACTIVE (station activation and configuration), CT4000-INSTALLVALID (installation and validation); or approved equal with the following features:

1. Dual Port Bollard Mounted type charging station
 - a. Electrical Input
 - 1) Standard
 - a) Voltage: 208/240VAC
 - b) Input Current: 30A x 2
 - c) Input Power Connection: Two independent 40A branch circuits
 - d) Require Service Panel Breaker: 40A dual pole (non-GFCI type) x 2
 - 2) Wiring
 - a) 5-wire (L1, L1, L2, L2, Earth)
 - 3) Station Power
 - a) 8W typical (standby), 15W maximum (operation)
 - b. Electrical Output
 - 1) 7.2 kW (240VAC @ 30A) x 2 (note: EVCS shall be suitable for both 208VAC and 240VAC)
 - c. Functional Interfaces
 - 1) SAE J1772 x 2
 - 2) Cable Length – 8 feet
 - 3) Overhead Cable Management System (Yes)
 - 4) LCD display: 5.7" full color, 640 x 480, 30 fps full motion video, active matrix, UV protected
 - 5) Card Reader: ISO 15693, ISO 14443, NFC
 - 6) Locking Holster: Yes x 2
 - d. Safety and Connectivity Features
 - 1) Ground Fault Detection: 20 mA CCID with auto retry
 - 2) Open Safety Ground Detection: Continuously monitors presence of safety (green wire) ground connection
 - 3) Plug-Out Detection: Power terminated per SAE J1772 specifications
 - 4) Power Measurement Accuracy: +/-2 % from 2% to full scale (30A)
 - 5) Power Report /Store Interval: 15 minute, aligned to hour
 - 6) Local Area Network: 2.4 GHz WiFi (802.11 b/g/n)
 - 7) Wide Area Network: LTE Category 4
 - e. Safety and Operational Ratings
 - 1) Enclosure Rating: Type 3R per UL 50E
 - 2) Safety Compliance: UL Listed; complies with UL 2594, UL 2231-1, UL 2231-2, and NEC Article 625
 - 3) Surge Protection: 6kV @ 3,000A.
 - 4) EM Compliance: FCC Part 15 Class A
 - 5) Operating Temperature: -40 degrees F to 122 degrees F

- 6) Storage Temperature: -40 degrees F to 140 degrees F
 - 7) Non-Operating Temperature: -40 degrees F to 140 degrees F
 - 8) Operating Humidity: Up to 85% @ 122 degrees F, non-condensing
 - 9) Non-Operating Humidity: Up to 95% @ 122 degrees F, non-condensing
 - 10) Terminal Block Temperature Rating: 105 degrees C
 - 11) Network: All stations shall include integral LTE model and shall be automatically configured to operate as gateway or non-gateway as needed.
2. Internet Gateway Modem
 - a. Cellular data/phone plan for 5 years shall be included, to allow the EVCS to communicate and have payment transactions.
 3. 5 Year ChargePoint Commercial Service Plan
 - a. The service plan includes a cloud-based commercial plan which provide everything needed to manage the EVCS, including but not limited to, the following:
 - 1) Flexible management tools
 - 2) Rich data analysis
 - 3) Payment processing
 - 4) 24x7x365 driver support
 - b. The EVCS are connected over a secure, cellular data network allowing station owners to manage all their charging operations from a single dashboard.
 - c. The cloud-based plan simply station management and administration, allowing the owner to build a relationship with drivers who frequent the station.
 - d. Adjustable Pricing
 - 1) Set charging fees by time, session, kWh, or any combination thereof. Fees can be set for different drivers or groups of drivers, or different times of the day.
 - e. Automated payment services
 - 1) ChargePoint handles all payment processing for the owner with a PCI-compliant solution known as Flex Billing. The owner sets the price; while ChargePoint handles the money on the behalf of the owner, and sends a check every month.
 - f. Connect with drivers
 - 1) ChargePoint Connections creates relationship between drivers and organizations. Connections gives the owner control and helps the owner manage who can charge on the stations and how much they pay. Drivers request to connect with the owner's organization and the owner decides who can join.
 - g. Grant rights to other ChargePoint organizations
 - 1) Through Rights Granting, the owner can easily approve an organization to view and manage the stations, allowing the owner to outsource all of the EV charging-related operations such as provisioning and trouble shooting stations.
 - h. 24/7 driver support from ChargePoint
 - 1) Every ChargePoint networked station displays a ChargePoint customer support phone number for fast, 24/7 station-side driver support by ChargePoint experts. ChargePoint takes care of the EV drivers using the owner's stations.
 - i. Station Mapping
 - 1) Station owners have the option of making their stations visible to all drivers or specific groups of drivers such as employees or customers. Drivers with access will see the real-time availability and status of the stations, and the price that has been set, on the ChargePoint website, mobile apps, and in the navigation systems of top-selling electric vehicles.
 - j. Get detailed reports
 - 1) ChargePoint Analytics provides a wide range of automated reports showing everything from energy usage and greenhouse gases avoided, to station usage by time-of-day, peak occupancy, number of drivers, session duration,

- and much more. The owner can access logs and reports for all stations via a single login and dashboard.
- k. Allow reservations
 - 1) The owner can decide whether to make the station reservable. With reservations, drivers can make, cancel and change reservation
 4. Customization and branding
 - a. EVCS shall incorporate custom signage. Coordinate custom signage with the owner.
 - b. With customized signage and tailored videos, the owner can use the station to communicate timely and targeted messaging to drivers.
 5. 2 Year ChargePoint Assure Plan
 - a. Proactive Monitoring
 - 1) ChargePoint finds out problems before drivers do with remote monitoring
 - b. One business day response time
 - 1) Respond to all issues within one business day
 - 2) Technicians will be onsite to repair the station within one business day of receiving required parts
 - c. Parts and Labor Warranty
 - 1) Comprehensive warranty of parts and on-site labor
 - 2) Covers vandalism, auto accidents, and excessive wear and tear
 - d. Expert Advice and Unlimited Changes
 - 1) Provides advise for station configuration and management
 - 2) Unlimited station configuration and policy changes
 - e. Reporting
 - 1) Monthly summaries provide on station usage
 6. Provide EVCS activation, configuration, installation, and validation.
 7. Dimensions of EVCS shall not exceed 96" high x 14" wide x 19" deep.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for EVCS electrical conduit to verify actual locations of conduit connections before equipment installation.
- C. Examine pavement for suitable conditions where EVCS will be installed.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Comply with NECA 1 and NECA 413.
- B. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.
- C. Secure covers to enclosure.

- D. Provide bollard and associated bolts for mounting the EVCS.

3.3 CONNECTIONS

- A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.
- B. Verify that all electrical connections have been made according to the manufacturer's instructions. Remove all burrs, shavings, and detritus from inside the enclosure.
- C. After confirming all connections, install covers and tighten fasteners to according to manufacturer's instructions.

3.4 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals.

3.5 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- B. Tests and Inspections:
 - 1. For each unit of EV charging equipment, perform the following tests and inspections:
 - a. Unit self-test.
 - b. Operation test with load bank.
 - c. Operation test with EV.
 - d. Network communications test.
- C. EVCS will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

3.6 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service.
 - 1. Complete installation and startup checks according to manufacturer's written instructions.

3.7 SOFTWARE SERVICE AGREEMENT

- A. Upgrade Service: At Substantial Completion, update software to latest version. Install and program software upgrades that become available within five (5) years from date of Substantial Completion. Upgrading software shall include operating system and new or revised licenses for using software.

1. Upgrade Notice: At least 30 days to allow Owner to schedule access to system and to upgrade computer equipment if necessary.

3.8 DEMONSTRATION AND TRAINING

- A. The contractor shall provide to the owner, complete manuals of the completed system. The manuals shall include operating and maintenance instruction, catalog cuts of all equipment and components, as-built wiring diagrams, and a manufacturer's suggested spare parts list.
- B. In addition to the above manuals, the contractor shall provide the services of the manufacturer's trained representative for a period of eight (8) hours to instruct the owners' designated personnel on the operation and maintenance of the entire system.
- C. During the training, the instructor shall provide a laptop that is loaded with the system software, which allows the trainees to monitor and control the system through the network. At the end of the training, this laptop and all software installed on it, shall become the property of the owner, at no additional cost.
- D. Training shall be on-site, and hands-on, using the actual equipment installed at the project site.

END OF SECTION - 262746

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SECTION 262813 - FUSES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1, 26, 27, and 28 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Cartridge fuses rated 600 V and less for use in switches, controllers and motor-control centers.

1.3 SUBMITTALS

- A. Product Data: Include the following for each fuse type indicated:
 - 1. Dimensions and manufacturer's technical data on features, performance, electrical characteristics, and ratings.
 - 2. Let-through current curves for fuses with current-limiting characteristics.
 - 3. Time-current curves, coordination charts and tables, and related data.
 - 4. Fuse size for elevator feeders and elevator disconnect switches.
- B. Operation and Maintenance Data: For fuses to include in emergency, operation, and maintenance manuals.
 - 1. In addition to items specified in Division 1 Section "Operation and Maintenance Data," include the following:
 - a. Let-through current curves for fuses with current-limiting characteristics.
 - b. Time-current curves, coordination charts and tables, and related data.
 - c. Ambient temperature adjustment information.

1.4 QUALITY ASSURANCE

- A. Source Limitations: Obtain fuses 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 intended use.
- C. Comply with NEMA FU 1.
- D. Comply with NFPA 70.

1.5 COORDINATION

- A. Coordinate fuse ratings with utilization equipment nameplate limitations of maximum fuse size.

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. Cooper Bussman, Inc.
 - 2. Eagle Electric Mfg. Co., Inc.; Cooper Industries, Inc.
 - 3. Ferraz Shawmut, Inc.

2.2 CARTRIDGE FUSES

- A. Characteristics: NEMA FU 1, nonrenewable cartridge fuse; class and current rating indicated; voltage rating consistent with circuit voltage.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine utilization equipment nameplates and installation instructions. Install fuses of sizes and with characteristics appropriate for each piece of equipment.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 FUSE APPLICATIONS

- A. Feeders: Class RK1, time delay, except as follows:
 - 1. Class J Fuses shall be used where indicated on the drawings. Class J fuses shall be time delay type unless otherwise noted.
 - 2. Class L Fuses shall be used where indicated on the drawings. Class L fuses shall be time delay type unless otherwise noted.
- B. Motor Branch Circuits: Class RK1, time delay.
- C. Other Branch Circuits: Class RK1, time delay, except as follows:
 - 1. Class J Fuses shall be used where indicated on the drawings. Class J fuses shall be time delay type unless otherwise noted.
 - 2. Class L Fuses shall be used where indicated on the drawings. Class L fuses shall be time delay type unless otherwise noted.

3.3 INSTALLATION

- A. Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse.

3.4 IDENTIFICATION

- A. Install labels indicating fuse replacement information on inside door of each fused switch.

END OF SECTION 262813

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SECTION 262816 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1, 26, 27, and 28 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following individually mounted, enclosed switches and circuit breakers:
 - 1. Fusible switches.
 - 2. Nonfusible switches.
 - 3. Enclosed molded-case circuit breakers.
 - 4. Enclosures.

1.3 DEFINITIONS

- A. GFCI: Ground-fault circuit interrupter.
- B. HD: Heavy duty.
- C. RMS: Root mean square.
- D. SPDT: Single pole, double throw.

1.4 SUBMITTALS

- A. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.
 - 1. Enclosure types and details for types other than NEMA 250, Type 1.
 - 2. Current and voltage ratings.
 - 3. Short-circuit current rating.
 - 4. Features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
 - 5. Provide size/quantity for all wire lugs/terminals at the equipment.
- B. Shop Drawings: Diagram power, signal, and control wiring.
- C. Operation and Maintenance Data: For enclosed switches and circuit breakers to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 1 Section "Operation and Maintenance Data," include the following:

1. Manufacturer's written instructions for testing and adjusting enclosed switches and circuit breakers.
2. Time-current curves, including selectable ranges for each type of circuit breaker.

1.5 QUALITY ASSURANCE

- A. 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.
- B. Comply with NFPA 70.

1.6 PROJECT CONDITIONS

- A. Environmental Limitations: Rate equipment for continuous operation under the following conditions, unless otherwise indicated:
 1. Ambient Temperature: Not less than minus 22 deg F and not exceeding 104 deg F.
 2. Altitude: Not exceeding 6600 feet.

1.7 COORDINATION

- A. Coordinate layout and installation of switches, circuit breakers, and components with other construction, including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
- B. Coordinate wire terminals/lugs at the equipment with the wires that are connected to it. Wire terminals/lugs shall be suitable for use with the wires that are connected to.

1.8 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 1. Spares: For the following:
 - a. Fuses for Fusible Switches:
 - 1) Provide 3 spare fuses for each fused switch rated 100A and higher.
 - 2) Provide 10% spare fuses for fuses rated less than 100A.

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.

2.2 FUSIBLE AND NONFUSIBLE SWITCHES

- A. Available Manufacturers:
 - 1. Eaton Corporation; Cutler-Hammer Products.
 - 2. General Electric Co.; Electrical Distribution & Control Division.
 - 3. Siemens Energy & Automation, Inc.
 - 4. Square D/Group Schneider.
- B. Type HD, Heavy Duty Switch: NEMA KS 1, Type HD, lockable handle with capability to accept two padlocks, and interlocked with cover in closed position.
- C. Provisions for padlocks: Fusible and non-fusible switches shall include provisions for being padlocked in the open or closed position.
- D. Fusible switches shall be suitable for use with Class R fuses unless otherwise noted and except as follows:
 - 1. Provide fusible switches with Class J fuses where indicated on the drawings.
 - 2. Provide fusible switches with Class L fuses where indicated on the drawings.
- E. Fusible switches shall have clips or bolt pads to accommodate specified fuses.
- F. Short circuit rating of Type HD Fusible Switches when used with Class R, Class J, or Class L fuses shall not be less than 200,000A.
- G. Conductor Connectors: Suitable for use with conductor material and sizes.
- H. Voltage Rating:
 - 1. Fusible switches: Switches shall be rated for 240V or 600V as indicated on the drawings.
 - 2. Non-fusible switches: Switches shall be rated for 600V.
 - a. Where 208V is indicated in the drawings, this is intended to show that the supplied voltage for the circuit is 208V. However, switch shall still be rated for 600V.
 - b. Where 240V is indicated in the drawings, this is intended to show that the supplied voltage for the circuit is either 208V or 240V. However, switch shall still be rated for 600V.
- I. Accessories:
 - 1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
 - 2. Neutral Kit: Internally mounted; insulated, capable of being grounded, and bonded; and labeled for copper and aluminum neutral conductors.
 - 3. Auxiliary Contact Kit: Auxiliary set of contacts arranged to open before switch blades open.
- J. All service equipment shall have barriers in place, such that no uninsulated ungrounded service busbar or service terminal is exposed to inadvertent contact by persons or maintenance equipment while servicing load terminations.

2.3 ENCLOSED MOLDED-CASE CIRCUIT BREAKERS

- A. Available Manufacturers:
 - 1. Eaton Corporation; Cutler-Hammer Products.

2. General Electric Co.; Electrical Distribution & Control Division.
 3. Siemens Energy & Automation, Inc.
 4. Square D/Group Schneider.
- B. Molded-Case Circuit Breaker: NEMA AB 1, with interrupting capacity to meet available fault currents.
1. 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.
- C. Provisions for padlocks: Molded-Case Circuit-Breakers shall include provisions for being padlocked in the open or closed position.
1. When the breaker is padlocked in the closed position, the padlock shall not prevent the breaker from tripping due to overcurrent conditions.
 2. Enclosed circuit breakers with NEMA 1 Enclosures that are required to be lockable shall have Handle Padlock Attachments.
- D. Molded-Case Circuit-Breaker Features and Accessories:
1. Standard frame sizes, trip ratings, and number of poles.
 2. Lugs: Mechanical style suitable for number, size, trip ratings, and conductor material.
 3. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
 4. Application Listing: Type HACR for heating, air-conditioning, and refrigerating equipment;
 5. Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at 55 percent of rated voltage.
 6. Auxiliary Switch: One SPDT switch with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts.
- E. Circuit Breaker Short-Circuit Current Rating:
1. Fully rated to interrupt symmetrical short-circuit current available at terminals.
- F. Circuit breakers which incorporate ground fault protection shall have the following features:
1. Ground fault push-to-trip button
 2. Ground fault trip indicator light
- G. Enclosed circuit breaker dimensions shall not exceed the following:
1. Enclosed Circuit Breakers rated 600A and higher: 53" high x 21" wide x 10" deep
 2. Enclosed Circuit Breakers rated 100A and less: 19" high x 9" wide x 5" deep
- H. For circuit breakers rated 800A and less, comply with the following:
1. Where the circuit breaker has an electronic trip unit with an adjustable long time trip setting, the sensor plug, which sets the maximum trip the circuit breaker can be adjusted to, shall not be greater than 800A.
- I. All service equipment shall have barriers in place, such that no uninsulated ungrounded service busbar or service terminal is exposed to inadvertent contact by persons or maintenance equipment while servicing load terminations.

2.4 ENCLOSURES

- A. NEMA AB 1 and NEMA KS 1 to meet environmental conditions of installed location. See drawings for NEMA 250 enclosure type.

2.5 IDENTIFICATION

- A. Service Equipment Label: Service equipment shall be UL labeled for use as service equipment.

PART 3 - EXECUTION

3.1 APPLICATIONS

- A. All disconnects for elevators shall have an auxiliary contact to indicate switch position.
- B. All Fusible and Nonfusible Switches shall be Type HD, Heavy Duty Switches.

3.2 EXAMINATION

- A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.3 INSTALLATION

- A. Comply with applicable portions of NECA 1, NEMA PB 1.1, and NEMA PB 2.1 for installation of enclosed switches and circuit breakers.
- B. Mount individual wall-mounting switches and circuit breakers with tops at uniform height, unless otherwise indicated. Anchor floor-mounting switches to concrete base.
- C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.
- D. Provide UL Listed fuse reducers as required

3.4 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in Specification Section "Electrical Identification."
- B. Enclosure Nameplates: Label each enclosure as specified in Specification Section "Electrical Identification."

3.5 ADJUSTING

- A. Set field-adjustable circuit-breaker trip ranges.

3.6 CLEANING

- A. On completion of installation, vacuum dirt and debris from interiors; do not use compressed air to assist in cleaning.
- B. Inspect exposed surfaces and repair damaged finishes.

3.7 FIELD QUALITY CONTROL

- A. Tests and Inspections:
 - 1. Engage a qualified testing agency and perform the following tests and inspections, and prepare test reports:
 - a. Perform each visual and mechanical inspection and electrical test stated in the NETA Acceptance Testing Specification. Certify compliance with test parameters.
 - 1) Electrical tests are required for switches and enclosed circuit breakers that are rated 100A and higher. Visual and mechanical inspections are required on all switches and enclosed circuit breakers.
 - 2. The testing agency shall coordinate with the manufacturer of the item being tested, and shall obtain copies of the installation/testing manuals. The testing agency shall not exceed the test voltage/current/duration limits indicated by the manufacturer.
 - 3. Remove and replace items which do not pass the tests. Test the replacement items.

END OF SECTION 262816

SECTION 263213 - PACKAGED ENGINE GENERATOR

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1, 26, 27, and 28 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes packaged engine-generator sets for emergency power supply with the following features:
 - 1. Diesel engine.
 - 2. Unit-mounted cooling system.
 - 3. Unit-mounted control and monitoring.
- B. Related Sections include the following:
 - 1. Specification Section "Transfer Switches" for transfer switches, including sensors and relays to initiate automatic-starting and -stopping signals for engine-generator sets.
- C. The generator system shall be capable of being remotely monitored and controlled by the Generator Monitoring and Control Software, either through the local area network, or remotely through the internet. Software shall be password protected.
- D. The contractor shall provide all labor, programming, materials, equipment, hardware, mounting, wiring, conduit, junction boxes, power supplies, and accessories as required for a complete and fully operational generator and transfer switch power system. The contractor shall provide all startup and testing as required, in order to confirm that the generators and transfer switches operate in accordance with the contract documents. The generators and transfer switches shall comply with all applicable codes, the manufacturer's recommendations, and the requirements of the authorities having jurisdiction.

1.3 DEFINITIONS

- A. Operational Bandwidth: The total variation from the lowest to highest value of a parameter over the range of conditions indicated, expressed as a percentage of the nominal value of the parameter.

1.4 SUBMITTALS

- A. Product Data: For each type of packaged engine generator indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. In addition, include the following:
 - 1. Thermal damage curve for generator.
 - 2. Time-current characteristic curves for generator protective device.

3. Locked Rotor Motor Starting Curve for generator
 4. Three Phase Efficiency Curve for generator
 5. Short Circuit Decrement Curve for generator
 6. Maximum available short circuit current produced by the generator
 7. Provide size/quantity for all wire lugs/terminals at the equipment.
- B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
1. Dimensioned outline plan and elevation drawings of engine-generator set and other components specified.
 2. Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.
 3. Vibration Isolation Base Details: Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include base weights.
 4. Wiring Diagrams: Power, signal, and control wiring.
- C. Qualification Data: For installer and manufacturer
- D. Source quality-control test reports.
1. Certified summary of prototype-unit test report.
 2. Certified Test Reports: For components and accessories that are equivalent, but not identical, to those tested on prototype unit.
 3. Report of factory test on units to be shipped for this Project, showing evidence of compliance with specified requirements.
 4. Report of sound generation.
 5. Report of exhaust emissions showing compliance with applicable regulations.
 6. Certified Torsional Vibration Compatibility: Comply with NFPA 110.
- E. Factory Test Reports.
- F. Field quality-control test reports.
- G. Operation and Maintenance Data: For packaged engine generators to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 1 Section "Operation and Maintenance Data," include the following:
1. List of tools and replacement items recommended to be stored at Project for ready access. Include part and drawing numbers, current unit prices, and source of supply.
- H. Warranty: Special warranty specified in this Section.
- I. Screenshots of the following:
1. The Generator Monitoring and Control Software.
- J. Provide a copy of any applications made to the Maryland Public Service Commission and/or the Maryland Department of the Environment. Provide evidence that the applications have been submitted and approved prior to purchase and installation of the generator.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.
 - 1. Maintenance Proximity: Not more than 4 hours' normal travel time from Installer's place of business to Project site.
- B. Manufacturer Qualifications: A qualified manufacturer. Maintain, within 200 miles of Project site, a service center capable of providing training, parts, and emergency maintenance repairs.
- C. Source Limitations: Obtain packaged generator sets and auxiliary components through one source from a single manufacturer.
- D. 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.
- E. Comply with ASME B15.1.
- F. Comply with NFPA 37.
- G. Comply with NFPA 30.
- H. Comply with NFPA 70.
- I. Comply with NFPA 110 requirements for Level 1 emergency power supply system.
- J. Comply with UL 2200.
- K. Engine Exhaust Emissions: Comply with applicable federal, state and local government requirements, whichever is the most stringent.
- L. Generator engine shall be EPA (Environmental Protection Agency) certified to the latest EPA requirements.
- M. The generator shall pass all the requirements of the Maryland Department of the Environment.

1.6 PROJECT CONDITIONS

- A. Environmental Conditions: Engine-generator system shall withstand the following environmental conditions without mechanical or electrical damage or degradation of performance capability:
 - 1. Ambient Temperature: Minus 15 to plus 40 deg C.
 - 2. Relative Humidity: 0 to 95 percent.
 - 3. Altitude: Sea level to 1000 feet.

1.7 COORDINATION

- A. Coordinate size and location of concrete bases for package engine generators. Cast anchor-bolt inserts into bases.

- B. Coordinate wire terminals/lugs at the equipment with the wires that are connected to it. Wire terminals/lugs shall be suitable for use with the wires that are connected to.

1.8 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of packaged engine generators and associated auxiliary components that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: 5 years from date of Substantial Completion.

1.9 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Fuses: One for every 10 of each type and rating, but no fewer than one of each.
 - 2. Indicator Lamps: Two for every six of each type used, but no fewer than two of each.
 - 3. Filters: One set each of lubricating oil, fuel, and combustion-air filters.
 - 4. Lubricating oil: Provide enough for one complete oil change.
 - 5. Coolant: Provide equivalent to the capacity of the radiator.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide a generator set manufactured by Kohler Power Systems, or a comparable product by one of the following:
 - 1. Onan/Cummins Power Generation; Industrial Business Group.
 - 2. Katolight.
 - 3. Caterpillar; Engine Div.

2.2 ENGINE-GENERATOR SET

- A. Factory-assembled and -tested, engine-generator set.
- B. Mounting Frame: Maintain alignment of mounted components without depending on concrete foundation; and have lifting attachments.
 - 1. Rigging Diagram: Inscribed on metal plate permanently attached to mounting frame to indicate location and lifting capacity of each lifting attachment and generator-set center of gravity.
- C. Capacities and Characteristics:
 - 1. Power Output Ratings: Nominal ratings as indicated on the drawings.
 - 2. Output Connections: Three-phase, four wire.
 - 3. Nameplates: For each major system component to identify manufacturer's name and address, and model and serial number of component.

- D. Generator-Set Performance:
1. Steady-State Voltage Operational Bandwidth: 3 percent of rated output voltage from no load to full load.
 2. Transient Voltage Performance: Not more than 20 percent variation for 50 percent step-load increase or decrease. Voltage shall recover and remain within the steady-state operating band within three seconds.
 3. Steady-State Frequency Operational Bandwidth: 0.5 percent of rated frequency from no load to full load.
 4. Steady-State Frequency Stability: When system is operating at any constant load within the rated load, there shall be no random speed variations outside the steady-state operational band and no hunting or surging of speed.
 5. Transient Frequency Performance: Less than 5 percent variation for 50 percent step-load increase or decrease. Frequency shall recover and remain within the steady-state operating band within five seconds.
 6. Output Waveform: At no load, harmonic content measured line to line or line to neutral shall not exceed 5 percent total and 3 percent for single harmonics. Telephone influence factor, determined according to NEMA MG 1, shall not exceed 50 percent.
 7. Sustained Short-Circuit Current: For a 3-phase, bolted short circuit at system output terminals, system shall supply a minimum of 300 percent of rated full-load current for not less than 10 seconds and then clear the fault automatically, without damage to generator system components.
 8. Start Time: Comply with NFPA 110, Type 10, system requirements.

2.3 ENGINE

- A. Fuel: Fuel oil, Grade DF-2.
- B. Rated Engine Speed: 1800 rpm.
- C. Maximum Piston Speed for Four-Cycle Engines: 2250 fpm (11.4 m/s).
- D. Lubrication System: The following items are mounted on engine or skid:
1. Filter and Strainer: Rated to remove 90 percent of particles 5 micrometers and smaller while passing full flow.
 2. Thermostatic Control Valve: Control flow in system to maintain optimum oil temperature. Unit shall be capable of full flow and is designed to be fail-safe.
 3. Crankcase Drain: Arranged for complete gravity drainage to an easily removable container with no disassembly and without use of pumps, siphons, special tools, or appliances.
- E. Engine Fuel System:
1. Main Fuel Pump: Mounted on engine. Pump ensures adequate primary fuel flow under starting and load conditions.
 2. Relief-Bypass Valve: Automatically regulates pressure in fuel line and returns excess fuel to source.
- F. Coolant Jacket Heater: Electric-immersion type, factory installed in coolant jacket system. Comply with NFPA 110 requirements for Level 1 equipment for heater capacity.
- G. Governor: Adjustable isochronous, with speed sensing.

- H. Cooling System: Closed loop, liquid cooled, with radiator factory mounted on engine-generator-set mounting frame and integral engine-driven coolant pump.
1. Coolant: Solution of 50 percent ethylene-glycol-based antifreeze and 50 percent water, with anticorrosion additives as recommended by engine manufacturer.
 2. Size of Radiator: Adequate to contain expansion of total system coolant from cold start to 110 percent load condition.
 3. Temperature Control: Self-contained, thermostatic-control valve modulates coolant flow automatically to maintain optimum constant coolant temperature as recommended by engine manufacturer.
 4. Coolant Hose: Flexible assembly with inside surface of nonporous rubber and outer covering of aging-, ultraviolet-, and abrasion-resistant fabric.
 - a. Rating: 50-psig (345-kPa) maximum working pressure with coolant at 180 deg F (82 deg C), and noncollapsible under vacuum.
 - b. End Fittings: Flanges or steel pipe nipples with clamps to suit piping and equipment connections.
- I. Muffler/Silencer: Critical type, sized as recommended by engine manufacturer and selected with exhaust piping system to not exceed engine manufacturer's engine backpressure requirements.
1. Minimum sound attenuation of 25 dB at 500 Hz.
- J. Air-Intake Filter: Heavy-duty, engine-mounted air cleaner with replaceable dry-filter element and "blocked filter" indicator.
- K. Starting System: 24-V electric, with negative ground.
1. Components: Sized so they will not be damaged during a full engine-cranking cycle with ambient temperature at maximum specified in Part 1 "Project Conditions" Article.
 2. Cranking Motor: Heavy-duty unit that automatically engages and releases from engine flywheel without binding.
 3. Cranking Cycle: As required by NFPA 110 for system level specified.
 4. Battery: Adequate capacity within ambient temperature range specified in Part 1 "Project Conditions" Article to provide specified cranking cycle at least three times without recharging.
 5. Battery Cable: Size as recommended by engine manufacturer for cable length indicated. Include required interconnecting conductors and connection accessories.
 6. Battery Compartment: Factory fabricated of metal with acid-resistant finish and thermal insulation. Provide a battery heater. The Thermostatically controlled heater shall be arranged to maintain battery above 10 deg C regardless of external ambient temperature within range specified in Part 1 "Project Conditions" Article. Include accessories required to support and fasten batteries in place.
 7. Battery-Charging Alternator: Factory mounted on engine with solid-state voltage regulation and 35-A minimum continuous rating.
 8. Battery Charger: Current-limiting, automatic-equalizing and float-charging type. Unit shall comply with UL 1236 and include the following features:
 - a. Operation: Equalizing-charging rate of 10 A shall be initiated automatically after battery has lost charge until an adjustable equalizing voltage is achieved at battery terminals. Unit shall then be automatically switched to a lower float-charging mode and shall continue to operate in that mode until battery is discharged again.
 - b. Automatic Temperature Compensation: Adjust float and equalize voltages for variations in ambient temperature from minus 40 deg C to plus 60 deg C to prevent overcharging at high temperatures and undercharging at low temperatures.

- c. Automatic Voltage Regulation: Maintain constant output voltage regardless of input voltage variations up to plus or minus 10 percent.
- d. Ammeter and Voltmeter: Flush mounted in door. Meters shall indicate charging rates.
- e. Safety Functions: Sense abnormally low battery voltage and close contacts providing low battery voltage indication on control and monitoring panel. Sense high battery voltage and loss of ac input or dc output of battery charger. Either condition shall close contacts that provide a battery-charger malfunction indication at system control and monitoring panel.
- f. Enclosure and Mounting: NEMA 250, Type 1, wall-mounted cabinet.

2.4 FUEL OIL STORAGE

- A. Comply with NFPA 30.
- B. Base-Mounted Fuel Oil Tank: Factory installed and piped, complying with UL 142 fuel oil tank. Features include the following:
 - 1. Tank level indicator.
 - 2. Fuel Capacity: As indicated in the drawings.
 - 3. Vandal-resistant fill cap.
 - 4. Low-Low-Level Alarm Sensor: Liquid-level device operates alarm contacts at 25 percent of normal fuel level.
 - 5. Provide normal and emergency vents with vent caps.
 - 6. Containment: Integral rupture basin with a capacity of 150 percent of nominal capacity of day tank.
 - a. Leak Detector: Locate in rupture basin and connect to provide audible and visual alarm in the event of fuel tank leak.
- C. Height of fuel tank shall be 30 inches or less.
- D. Tank Markings
 - 1. Provide tank number and safe fuel fill height
 - 2. Provide NFPA 704 identification

2.5 CONTROL AND MONITORING

- A. Automatic Starting System Sequence of Operation: When mode-selector switch on the control and monitoring panel is in the automatic position, remote-control contacts in one or more separate automatic transfer switches initiate starting and stopping of generator set. When mode-selector switch is switched to the on position, generator set starts. The off position of same switch initiates generator-set shutdown. When generator set is running, specified system or equipment failures or derangements automatically shut down generator set and initiate alarms. Operation of a remote emergency-stop switch also shuts down generator set.
- B. Configuration: Operating and safety indications, protective devices, basic system controls, and engine gages shall be grouped in a common control and monitoring panel mounted on the generator set. Mounting method shall isolate the control panel from generator-set vibration.
- C. Indicating and Protective Devices and Controls: As required by NFPA 110 for Level 1 system, and the following:

1. AC voltmeter.
 2. AC ammeter.
 3. AC frequency meter.
 4. DC voltmeter (alternator battery charging).
 5. Engine-coolant temperature gage.
 6. Engine lubricating-oil pressure gage.
 7. Running-time meter.
 8. Ammeter-voltmeter, phase-selector switch(es).
 9. Generator-voltage adjusting rheostat.
 10. Fuel tank derangement alarm.
 11. Fuel tank high-level shutdown of fuel supply alarm.
 12. Generator overload.
 13. Contacts for remote indication of Generator Running and Generator Fault on the Fire Alarm System
 14. Ground Fault Indication and Protection in accordance with NEC Requirements.
- D. Supporting Items: Include sensors, transducers, terminals, relays, and other devices and include wiring required to support specified items. Locate sensors and other supporting items on engine or generator, unless otherwise indicated.
- E. Remote Alarm Annunciator: Comply with NFPA 110 Level 1. An LED labeled with proper alarm conditions shall identify each alarm event and a common audible signal shall sound for each alarm condition. Silencing switch in face of panel shall silence signal without altering visual indication. Connect so that after an alarm is silenced, clearing of initiating condition will reactivate alarm until silencing switch is reset. Cabinet and faceplate are surface- or flush-mounting type to suit mounting conditions indicated. In addition to the alarms required by NFPA 110 Level 1, provide the following:
1. Indication of fuel rupture basin switch activation.
 2. Ground Fault Indication.
 3. Alarm condition at the UPS (Uninterruptible Power Supply)
 4. Alarm condition at the ATS (Automatic Transfer Switch)
 5. Indicate when the ATS is connected to the generator
- F. Remote Emergency-Stop Switch: Surface; wall mounted, unless otherwise indicated; and labeled. Push button shall be protected from accidental operation.
- G. The controller shall have an ethernet connection to allow for connection to the IT (Information Technology) network.

2.6 GENERAOTR MONITORING AND CONTROL SOFTWARE

- A. GENERAL
1. Provide Generator Monitoring and Control software which shall allow for remote control/monitoring of the generator system. The software shall be password protected.
- B. The software shall have the following features:
1. Monitor and control the generator and transfer switches through a Windows based graphical user interface.
 2. View the status of all devices on one site overview screen
 3. Password-protected data access: Guest, User, and Supervisor
 4. Monitor and control systems over the local area network, or remotely through the internet.
 5. Start or stop the generator set from a PC
 6. Read and adjust trip points, time delays, and system parameter settings

7. Assign inputs and outputs
8. View system run time history
9. View up to 100 recent events including engine starts, faults, shutdowns, and warnings.

2.7 GENERATOR OVERCURRENT AND FAULT PROTECTION

- A. Generator Circuit Breaker: Molded-case, electronic-trip type; complying with UL 489.
1. Trip Settings: Selected to coordinate with generator thermal damage curve.
 2. Mounting: Adjacent to or integrated with control and monitoring panel.
 3. Where there are multiple circuit breakers at the generator, provide separate enclosures for each circuit breaker to isolate the circuit breakers from each other, in order to comply with NEC requirements for separation of emergency systems. Where one of the circuit breaker is shipped loose, the contractor shall field install the circuit breaker in accordance with the manufacturer's recommendations and NEC requirements.
 4. Circuit breakers which incorporate ground fault protection shall have the following features:
 - a. Ground fault push-to-trip button
 - b. Ground fault trip indicator light
 5. For circuit breakers rated 800A and less, comply with the following:
 - a. Where the circuit breaker has an electronic trip unit with an adjustable long time trip setting, the sensor plug, which sets the maximum trip the circuit breaker can be adjusted to, shall not be greater than 800A.
 6. See drawings for additional circuit breaker requirements.
- B. Generator Protector: Microprocessor-based unit shall continuously monitor current level in each phase of generator output, integrate generator heating effect over time, and predict when thermal damage of alternator will occur. When signaled by generator protector or other generator-set protective devices, a shunt-trip device in the generator disconnect switch shall open the switch to disconnect the generator from load circuits. Protector shall perform the following functions:
1. Initiates a generator overload alarm when generator has operated at an overload equivalent to 110 percent of full-rated load for 60 seconds. Indication for this alarm is integrated with other generator-set malfunction alarms.
 2. Under single or three-phase fault conditions, regulates generator to 300 percent of rated full-load current for up to 10 seconds.
 3. As overcurrent heating effect on the generator approaches the thermal damage point of the unit, protector switches the excitation system off, opens the generator disconnect device, and shuts down the generator set.
 4. Senses clearing of a fault by other overcurrent devices and controls recovery of rated voltage to avoid overshoot.
 5. Provide the following protections:
 - a. Alternator Protection
 - 1) AC sensing loss
 - 2) Critical overvoltage
 - 3) Generator running
 - 4) Locked rotor
 - b. AC Protection (the following will shutdown the generator)
 - 1) Alternator protection (short circuit and overload)
 - 2) Overcurrent (through a combination of current transformers and overcurrent relay).
 - 3) Overfrequency
 - 4) Overpower
 - 5) Overvoltage
 - 6) Reverse power

- 7) Underfrequency
- 8) Undervoltage

- C. Lockable: Generator Circuit Breakers shall be provided with provisions for padlock attachments. Provide padlock and 3 keys to the owner for each breaker. Trip-free mechanism shall allow the breaker to trip even when the handle is locked or held in the ON position.

2.8 GENERATOR, EXCITER, AND VOLTAGE REGULATOR

- A. Comply with NEMA MG 1.
- B. Exciter Type: Permanent Magnet Generator (PMG)
- C. Drive: Generator shaft shall be directly connected to engine shaft. Exciter shall be rotated integrally with generator rotor.
- D. Electrical Insulation: Class H.
- E. Stator-Winding Leads: Brought out to terminal box to permit future reconnection for other voltages if required.
- F. Construction shall prevent mechanical, electrical, and thermal damage due to vibration, overspeed up to 125 percent of rating, and heat during operation at 110 percent of rated capacity.
- G. Enclosure: Drip-proof.
- H. Instrument Transformers: Mounted within generator enclosure.
- I. Voltage Regulator: Solid-state type, separate from exciter, providing performance as specified.
 - 1. Adjusting rheostat on control and monitoring panel shall provide plus or minus 5 percent adjustment of output-voltage operating band.
- J. Windings: Two-thirds pitch stator winding and fully linked amortisseur winding.
- K. The maximum available short circuit current produced by the generator shall not exceed the short circuit current rating of the generator circuit breaker.
- L. The ampacity of the conductors from the generator terminals to the first distribution device(s) containing overcurrent protection shall comply with NEC and UL Requirements.
- M. Provide thermostatically controlled generator strip heater.

2.9 OUTDOOR GENERATOR-SET ENCLOSURE

- A. Description: Sound attenuated, vandal-resistant, weatherproof steel housing, wind resistant up to 100 mph. Multiple panels shall be lockable and provide adequate access to components requiring maintenance. Panels shall be removable by one person without tools. Instruments and control shall be mounted within enclosure.
 - 1. Construction: Galvanized-steel, metal-clad, integral structural-steel-framed building erected on concrete foundation.

2. Structural Design and Anchorage: Comply with ASCE 7 for wind loads.
 3. Louvers: Equipped with bird screen and filter arranged to permit air circulation when engine is not running while excluding exterior dust, birds, and rodents.
 4. Hinged Doors: With padlocking provisions.
 5. Ventilation: Louvers equipped with bird screen and filter arranged to permit air circulation while excluding exterior dust, birds, and rodents.
 6. Muffler/Silencer Location: Internal to enclosure.
- B. The sound-attenuated enclosure shall provide an average of not more than 75 dbA (at full rated load of the generator-set) sound level at 23 feet. Acoustic insulation shall be provided that meets UL94 HF1 flammability classification.
- C. Air intakes shall be located at the generator end of the packaged engine generator. The air intake openings shall be located on the sides of the enclosure, at the generator end. The air discharge/muffler/silencer shall be located on the opposite end of the enclosure. The air discharge opening shall be on the top of the enclosure, and the muffler/silencer shall discharge exhaust air vertically upwards.
- D. Air discharge openings on the sides of the enclosure are not acceptable. Muffler/silencer which discharge exhaust air horizontally are not acceptable.
- E. Overall generator dimensions (with base mounted fuel oil tank) shall not exceed 16.5' long x 5.5' wide x 10' high.
- F. Overall generator weight (with maximum fuel) shall not exceed 21,000 lbs.

2.10 VIBRATION ISOLATION DEVICES

- A. Restrained Spring Isolators: Freestanding, steel, open-spring isolators with seismic restraint.
1. Housing: Steel with resilient vertical-limit stops to prevent spring extension due to wind loads or if weight is removed; factory-drilled baseplate bonded to 1/4-inch- (6-mm-) thick, elastomeric isolator pad attached to baseplate underside; and adjustable equipment mounting and leveling bolt that acts as blocking during installation.
 2. Outside Spring Diameter: Not less than 80 percent of compressed height of the spring at rated load.
 3. Minimum Additional Travel: 50 percent of required deflection at rated load.
 4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
 5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
- B. Non-spring type vibration isolators, such as rubber pads, are unacceptable.

2.11 FINISHES

- A. Indoor and Outdoor Enclosures and Components: Manufacturer's standard finish over corrosion-resistant pretreatment and compatible primer.

2.12 SOURCE QUALITY CONTROL

- A. Prototype Testing: Factory test engine-generator set using same engine model, constructed of identical or equivalent components and equipped with identical or equivalent accessories.

1. Tests: Comply with NFPA 110, Level 1 Energy Converters and with IEEE 115.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas, equipment bases, and conditions, with Installer present, for compliance with requirements for installation and other conditions affecting packaged engine-generator performance.
- B. Examine roughing-in of piping systems and electrical connections. Verify actual locations of connections before packaged engine-generator installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Comply with packaged engine-generator manufacturers' written installation and alignment instructions and with NFPA 110.
- B. Install packaged engine generator to provide access, without removing connections or accessories, for periodic maintenance.
- C. Electrical Wiring: Install electrical devices furnished by equipment manufacturers but not specified to be factory mounted.
- D. The contractor shall apply for, submit, and secure any required permits from the Maryland Public Service Commission and the Maryland Department of the Environment. The contractor shall pay for all required fees. The contractor shall fill-in and complete all forms that are required. Applications that need to be applied for, submitted, and secured; include but are not limited to, the following:
 1. Air Quality Permit to Construct & Registration Application for Emergency Generator, for the Maryland Department of the Environment. At a minimum, the following information are required in the application: facility information/address, owner information, installer information, specific generator information, vendor literature, and worker's compensation information.
- E. Clearances around the generator shall comply with the manufacturer's recommendations and the applicable codes.
- F. Provide network wiring in 1" minimum conduit (where the conduit runs underground, see the drawings for the conduit size), from the generator controller to the IT network to allow the generator to be controlled through the local area network, or remotely over the internet. Coordinate the exact location of the generator controller and IT network equipment connected by the network wiring in the field. All work shall comply with the manufacturer's recommendations, the NEC, and the contract documents.
- G. No part of the generator shall be less than 5' away from the nearest building.
- H. Provide a minimum of 36" clear space all around the generator.

3.3 CONNECTIONS

- A. Provide all required connections (including, but not limited to, fuel system, cooling system, and exhaust system) in accordance with the manufacturer's recommendations and applicable codes.
- B. Ground equipment according to Specification Section "Grounding and Bonding."
- C. Connect wiring according to Specification Section "Conductors and Cables."

3.4 IDENTIFICATION

- A. Identify system components according to Specification Section "Electrical Identification."

3.5 FIELD QUALITY CONTROL

- A. **Manufacturer's Field Service:** Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Report results in writing.
- B. **Tests and Inspections:**
 - 1. Perform tests recommended by manufacturer. Certify compliance with test parameters.
 - 2. **NFPA 110 Acceptance Tests:** Perform tests required by NFPA 110 that are additional to those specified here including, but not limited to, single-step full-load pickup test.
 - a. Contractor shall provide a portable load bank for the single-step full-load pickup test. The load bank shall have a capacity not less than the full load capacity of the generator.
 - b. Contractor shall provide all temporary electrical connections required for the load test.
 - 3. **Battery Tests:** Equalize charging of battery cells according to manufacturer's written instructions. Record individual cell voltages.
 - a. Measure charging voltage and voltages between available battery terminals for full-charging and float-charging conditions. Check electrolyte level and specific gravity under both conditions.
 - b. Test for contact integrity of all connectors. Perform an integrity load test and a capacity load test for the battery.
 - c. Verify acceptance of charge for each element of the battery after discharge.
 - d. Verify that measurements are within manufacturer's specifications.
 - 4. **Battery-Charger Tests:** Verify specified rates of charge for both equalizing and float-charging conditions.
 - 5. **System Integrity Tests:** Methodically verify proper installation, connection, and integrity of each element of engine-generator system before and during system operation. Check for air, exhaust, and fluid leaks.
 - 6. **Exhaust Emissions Test:** Comply with applicable government test criteria.
 - 7. Provide all the necessary fuel, engine oil, coolant and other liquids required for the generator set testing.
- C. Coordinate tests with tests for transfer switches and run them concurrently.

- D. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
- E. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
- F. Simulate a power failure by turning off the normal power service disconnect. Verify that the generator starts, the transfer switch transfers, and loads are energized. Simulate return of normal power, by turning the normal power service disconnect back on. Verify that the transfer switch transfers, the generator stops (after cooldown time delay), and the loads are energized.
- G. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- H. Remove and replace malfunctioning units and retest as specified above.
- I. Retest: Correct deficiencies identified by tests and observations and retest until specified requirements are met.
- J. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation resistances, time delays, and other values and observations. Attach a label or tag to each tested component indicating satisfactory completion of tests.

3.6 MAINTENANCE SERVICE

- A. Provide 2 years of maintenance service. Maintenance service shall include, but not be limited, to the following:
 - 1. Perform all maintenance items recommended by the manufacturer
 - 2. Perform all the maintenance items required by NFPA 110
 - 3. Check, replace and top off generator fluids (oil, etc.) during each service visit
 - 4. Check battery health/strength
 - 5. Check wire, hose, tubes, and associated connectors for damage
 - 6. Perform a load bank test on the generator at least once a year, or more frequently if recommended by the manufacturer. The amount of load to be placed on the generator, and the duration of the load bank test; shall not be less than what is recommended by the manufacturer or NFPA 110, whichever is higher.

3.7 SOFTWARE SERVICE AGREEMENT

- A. Upgrade Service: At Substantial Completion, update software to latest version. Install and program software upgrades that become available within five (5) years from date of Substantial Completion. Upgrading software shall include operating system and new or revised licenses for using software.
 - 1. Upgrade Notice: At least 30 days to allow Owner to schedule access to system and to upgrade computer equipment if necessary.

3.8 DEMONSTRATION AND TRAINING

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain the lighting control system.

- B. The System Supplier shall schedule and present a minimum of 8 hours of documented formalized instruction for the building owner, detailing the proper operation and maintenance of the installed System.
- C. The instruction shall be presented in an organized and professional manner by a person factory trained in the operation and maintenance of the equipment and who is also thoroughly familiar with the installation.
- D. During the training, the instructor shall provide a laptop that is loaded with the Generator Monitoring and Control Software software, that shall allow the trainees to control/monitor the generator via the internet. At the end of the training, this laptop and all software installed on it, shall become the property of the owner, at no additional cost.

END OF SECTION 263213

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SECTION 263600 - TRANSFER SWITCHES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1, 26, 27, and 28 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes transfer switches rated 600 V and less, including the following:
 - 1. Automatic transfer switches.
- B. Related Sections include the following:
 - 1. Specification Section “ Packaged Engine Generator” for generators, including the requirements for the Generator Monitoring and Control Software, which shall also monitor/control the Automatic Transfer Switch.
- C. The transfer switch shall be capable of being remotely monitored and controlled by the Generator Monitoring and Control Software, either through the local area network, or remotely through the internet. Software shall be password protected.
- D. The contractor shall provide all labor, programming, materials, equipment, hardware, mounting, wiring, conduit, junction boxes, power supplies, and accessories as required for a complete and fully operational generator and transfer switch power system. The contractor shall provide all startup and testing as required, in order to confirm that the generators and transfer switches operate in accordance with the contract documents. The generators and transfer switches shall comply with all applicable codes, the manufacturer’s recommendations, and the requirements of the authorities having jurisdiction.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated. Include rated capacities, weights, operating characteristics, furnished specialties, and accessories. Provide size/quantity for all wire lugs/terminals at the equipment.
- B. Shop Drawings: Dimensioned plans, elevations, sections, and details showing minimum clearances, conductor entry provisions, gutter space, installed features and devices, and material lists for each switch specified.
- C. Qualification Data: For installer and manufacturer
- D. Factory test reports
- E. Field quality-control test reports.

- F. Operation and Maintenance Data: For each type of product to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 1 Section "Operation and Maintenance Data," include the following:
 - 1. Features and operating sequences, both automatic and manual.
 - 2. List of all factory settings of relays; provide relay-setting and calibration instructions, including software, where applicable.
- G. Screenshots of the following:
 - 1. The Generator Monitoring and Control Software.
- H. Warranty: Special warranty specified in this Section.

1.4 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Maintain a service center capable of providing training, parts, and emergency maintenance repairs within a response period of less than eight hours from time of notification.
- B. Source Limitations: Obtain automatic transfer switches through one source from a single manufacturer.
- C. 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.
- D. Comply with NEMA ICS 1.
- E. Comply with NFPA 70.
- F. Comply with NFPA 110.
- G. Comply with UL 1008 unless requirements of these Specifications are stricter.

1.5 COORDINATION

- A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases.
- B. Coordinate wire terminals/lugs at the equipment with the wires that are connected to it. Wire terminals/lugs shall be suitable for use with the wires that are connected to.

1.6 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of packaged engine generators and associated auxiliary components that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: 5 years from date of Substantial Completion.

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. Contactor Transfer Switches:
 - a. Caterpillar; Engine Div.
 - b. Emerson; ASCO Power Technologies, LP.
 - c. Kohler Power Systems; Generator Division.
 - d. Onan/Cummins Power Generation; Industrial Business Group.
 - e. Spectrum Detroit Diesel.

2.2 GENERAL TRANSFER-SWITCH PRODUCT REQUIREMENTS

- A. Environmental Specifications:
 - 1. Operating Temperature: -4 degrees F to 158 degrees F
 - 2. Humidity: 5% to 95% noncondensing
- B. Indicated Current Ratings: Apply as defined in UL 1008 for continuous loading and total system transfer, including tungsten filament lamp loads not exceeding 30 percent of switch ampere rating, unless otherwise indicated.
- C. Tested Fault-Current Closing and Withstand Ratings: Adequate for duty imposed by protective devices at installation locations in Project under the fault conditions indicated, based on testing according to UL 1008.
 - 1. Transfer switches shall have a withstand and close-on rating of 50,000A, at the supply voltage, when protected by any circuit breaker.
- D. Solid-State Controls: Repetitive accuracy of all settings shall be plus or minus 2 percent or better over an operating temperature range of minus 20 to plus 70 deg C.
- E. Resistance to Damage by Voltage Transients: Components shall meet or exceed voltage-surge withstand capability requirements when tested according to IEEE C62.41. Components shall meet or exceed voltage-impulse withstand test of NEMA ICS 1.
- F. Electrical Operation: Accomplish by a nonfused, momentarily energized solenoid or electric-motor-operated mechanism, mechanically and electrically interlocked in both directions.
- G. Switch Characteristics: Designed for continuous-duty repetitive transfer of full-rated current between active power sources.
 - 1. Limitation: Switches using molded-case switches or circuit breakers or insulated-case circuit-breaker components are not acceptable.
 - 2. Switch Action: Double throw; mechanically held in both directions.
 - 3. Contacts: Silver composition or silver alloy for load-current switching. Conventional automatic transfer-switch units, rated 225 A and higher, shall have separate arcing contacts.
- H. Neutral Terminal: Solid and fully rated, unless otherwise indicated.

- I. Factory Wiring: Train and bundle factory wiring and label, consistent with Shop Drawings, either by color-code or by numbered or lettered wire and cable tape markers at terminations. Color-coding and wire and cable tape markers are specified in Specification Section "Electrical Identification."
 - 1. Designated Terminals: Pressure type, suitable for types and sizes of field wiring indicated.
 - 2. Power-Terminal Arrangement and Field-Wiring Space: Suitable for top, side, or bottom entrance of feeder conductors as indicated.
 - 3. Control Wiring: Equipped with lugs suitable for connection to terminal strips.
- J. Enclosures: NEMA 1 metal enclosure, unless otherwise noted.

2.3 AUTOMATIC TRANSFER SWITCH

- A. Automatic Transfer Switch shall have the following features:
 - 1. Complies with Level 1 equipment according to NFPA 110.
 - 2. UL 1008 Listed
 - 3. Electrically operated, mechanically held mechanism
 - 4. Fully rated for use as a manual 3-position transfer switch
 - 5. Heavy duty mechanical interlocks
 - 6. Design suitable for emergency and standby applications on all classes of load, 100% tungsten rated through 400 amperes
 - 7. Reliable, field proven solenoid mechanism
 - 8. Switching mechanisms lubricated for life
 - 9. Main shaft auxiliary contacts
- B. Automatic Transfer Switch shall be Programmed Transition Type with the following features:
 - 1. Programmed-transition operation provides a center OFF position that allows residual voltages in the load circuits to decay. The time spent in the OFF position shall be field programmable.
 - 2. Programmable OFF time
 - 3. Double-throw, mechanically interlocked design (break both sides)
 - 4. Solid neutral
- C. Automatic Transfer Switch Controller shall have the following features:
 - 1. LCD display, 4 lines x 20 characters, backlit
 - 2. Complete programming and viewing capability at the door using the keypad and LCD display
 - 3. LED indicators: Source available, transfer switch position, service required (fault), and "not in auto"
 - 4. Programmable voltage and frequency pickup and dropout settings
 - 5. Programmable time delays
 - 6. Programmable generator exerciser
 - 7. Time-based load control
 - 8. Ethernet connection. The ethernet port is a standard RJ-45 jack.
 - 9. Input/Output (I/O) Module with a minimum of 2 inputs and 6 outputs. The operation of the inputs/outputs shall be programmable.
 - 10. Provide Alarm Module with a minimum of 1 output.
 - 11. Provide 1 pre-transfer signal output contact. The contact shall activate before the transfer switch transfers from normal to generator power and vice versa.
 - 12. Provide 3 post-transfer (to generator) signal output contacts. The contacts shall activate when the transfer switch is connected to generator power.
 - 13. Provide 1 alarm output contact. The contact shall activate when there is an alarm condition at the transfer switch.

- D. Automatic Transfer Switch shall have a digital meter with the following features:
1. Display voltage, current, frequency and power for both sources
- E. Automatic Transfer-Switch shall include the following features:
1. Undervoltage Sensing for Each Phase of Normal Source: Sense low phase-to-ground voltage on each phase. Pickup voltage shall be adjustable from 85 to 100 percent of nominal, and dropout voltage is adjustable from 75 to 98 percent of pickup value. Factory set for pickup at 90 percent and dropout at 85 percent.
 2. Adjustable Time Delay for engine start: For override of normal-source voltage sensing to delay engine start signals. Adjustable from zero to six seconds, and factory set for one second.
 3. Voltage/Frequency Lockout Relay: Prevent premature transfer to generator. Pickup voltage shall be adjustable from 85 to 100 percent of nominal. Factory set for pickup at 90 percent. Pickup frequency shall be adjustable from 90 to 100 percent of nominal. Factory set for pickup at 95 percent.
 4. Time Delay for transfer to Emergency Source: Adjustable from 0 to 30 minutes, and factory set for 1 second.
 5. Time Delay for Retransfer to Normal Source: Adjustable from 0 to 30 minutes, and factory set for 10 minutes to automatically defeat delay on loss of voltage or sustained undervoltage of emergency source, provided normal supply has been restored.
 6. Test Switch: Simulate normal-source failure.
 7. Switch-Position Pilot Lights: Indicate source to which load is connected.
 8. Source-Available Indicating Lights: Supervise sources via transfer-switch normal- and emergency-source sensing circuits.
 - a. Normal Power Supervision: Green light with nameplate engraved "Normal Source Available."
 - b. Emergency Power Supervision: Red light with nameplate engraved "Emergency Source Available."
 9. Unassigned Auxiliary Contacts: Four normally open, single-pole, double-throw contacts for each switch position, rated 10 A at 240-V ac.
 10. Transfer Override Switch: Overrides automatic retransfer control so automatic transfer switch will remain connected to emergency power source regardless of condition of normal source. Pilot light indicates override status.
 11. Engine Starting Contacts: One isolated and normally closed, and one isolated and normally open; rated 10 A at 32-V dc minimum.
 12. Engine Shutdown Contacts: Time delay adjustable from zero to five minutes, and factory set for five minutes. Contacts shall initiate shutdown at remote engine-generator controls after retransfer of load to normal source.
 13. Engine-Generator Exerciser: Solid-state, programmable-time switch starts engine generator and transfers load to it from normal source for a preset time, then retransfers and shuts down engine after a preset cool-down period. Initiates exercise cycle at preset intervals adjustable from 7 to 30 days. Running periods are adjustable from 10 to 120 minutes. Factory settings are for 7-day exercise cycle, 20-minute running period, and 5-minute cool-down period. Exerciser features include the following:
 - a. Exerciser Transfer Selector Switch: Permits selection of exercise with and without load transfer.
 - b. Push-button programming control with digital display of settings.
 - c. Integral battery operation of time switch when normal control power is not available.
- F. All automatic transfer switch components shall be accessible from the front. Automatic transfer switches which require rear access are not acceptable.

- G. Dimensions of the automatic transfer switch shall not exceed 78" high x 34" wide x 24" deep.
- H. Weight of the automatic transfer switch shall not exceed 1100 lbs.

2.4 SOURCE QUALITY CONTROL

- A. Factory test and inspect components, assembled switches, and associated equipment. Ensure proper operation. Check transfer time and voltage, frequency, and time-delay settings for compliance with specified requirements. Perform dielectric strength test complying with NEMA ICS 1.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Identify components according to Specification Section "Electrical Identification."
- B. Set field-adjustable intervals and delays, relays, and engine exerciser clock.
- C. Provide network wiring in 1" minimum conduit, from the automatic transfer switch to the IT network, to allow the automatic transfer switch to be controlled through the local area network, or remotely over the internet. Coordinate the exact location of the generator controller and IT network equipment connected by the network wiring in the field. All work shall comply with the manufacturer's recommendations, the NEC, and the contract documents.
- D. Provide control wiring in 3/4" minimum conduit, from the automatic transfer switch pre-transfer signal and post-transfer (to generator) signal output contacts, to the elevator controller. These signals shall indicate to the elevator controller, when a transfer of power is about to take place, and when the transfer of power (to generator) has been completed. The elevator controller shall be programmed to recognize these signals, and act accordingly, in order to avoid a sudden loss of power to the elevator while it is in motion; and, to allow only one elevator to operate at any time (if there are 2 or more elevators fed from the transfer switch), when the transfer switch is connected to the generator.
- E. Provide control wiring in 3/4" minimum conduit, from the automatic transfer switch post-transfer (to generator) signal and alarm output contacts, to the generator remote annunciator panel to indicate that when the transfer switch is connected to the generator, and when there is an alarm condition at the transfer switch.

3.2 CONNECTIONS

- A. Ground equipment according to Specification Section "Grounding and Bonding."
- B. Connect wiring according to Specification Section "Conductors and Cables."

3.3 IDENTIFICATION

- A. Identify system components according to Specification Section "Electrical Identification."

3.4 FIELD QUALITY CONTROL

- A. **Manufacturer's Field Service:** Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Report results in writing.
- B. **Tests and Inspections:**
 - 1. Perform tests as recommended by the manufacturer.
 - 2. **NFPA 110 Acceptance Tests:** Perform tests required by NFPA 110
 - 3. After installing equipment and after electrical circuitry has been energized, test for compliance with requirements.
 - 4. After energizing circuits, demonstrate interlocking sequence and operational function for each switch at least three times.
 - a. Simulate power failures of normal source to automatic transfer switches and of emergency source with normal source available.
 - b. Simulate loss of phase-to-ground voltage for each phase of normal source.
 - c. Verify time-delay settings.
 - d. Verify pickup and dropout voltages by data readout or inspection of control settings.
 - e. Verify proper sequence and correct timing of automatic engine starting, transfer time delay, retransfer time delay on restoration of normal power, and engine cool-down and shutdown.
- C. For programmed transition transfer switches, set the time delay during transition times to allow sufficient time for residual voltages in the load circuits to decay. Do not set the time delay longer than what is needed to achieve this. In no case shall the time delay last longer than the rated backup time of the UPS (Uninterruptible Power Supply) at full load.
- D. Coordinate tests with tests of generator and run them concurrently.
- E. Report results of tests and inspections in writing. Record adjustable relay settings and time delays. Attach a label or tag to each tested component indicating satisfactory completion of tests.
- F. Remove and replace malfunctioning units and retest as specified above.

3.5 MAINTENANCE SERVICE

- A. Provide 2 years of maintenance service. Maintenance service shall include, but not be limited, to the following:
 - 1. Perform all maintenance items recommended by the manufacturer
 - 2. Perform all the maintenance items required by NFPA 110
 - 3. Check battery health/strength of integral batteries
 - 4. Check wire associated connectors for damage

3.6 SOFTWARE SERVICE AGREEMENT

- A. **Upgrade Service:** At Substantial Completion, update software to latest version. Install and program software upgrades that become available within five (5) years from date of Substantial

Completion. Upgrading software shall include operating system and new or revised licenses for using software.

1. Upgrade Notice: At least 30 days to allow Owner to schedule access to system and to upgrade computer equipment if necessary.

3.7 DEMONSTRATION AND TRAINING

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain the lighting control system.
- B. The System Supplier shall schedule and present a minimum of 8 hours of documented formalized instruction for the building owner, detailing the proper operation and maintenance of the installed System.
- C. The instruction shall be presented in an organized and professional manner by a person factory trained in the operation and maintenance of the equipment and who is also thoroughly familiar with the installation.
- D. During the training, the instructor shall provide a laptop that is loaded with the Generator Monitoring and Control Software, that shall allow the trainees to control/monitor the automatic transfer switch via the internet. At the end of the training, this laptop and all software installed on it, shall become the property of the owner, at no additional cost. The laptop specified in this specification section, and in Specification Section "Packaged Engine Generator", is the same laptop.

END OF SECTION 263600

SECTION 264113 - LIGHTNING PROTECTION SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1, 26, 27, and 28 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes lightning protection systems.

1.3 DEFINITIONS

- A. LPI: Lightning Protection Institute.
- B. NRTL: National recognized testing laboratory.
- C. NEC: National Electrical Code

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: Detail lightning protection system, including air-terminal locations, conductor routing and connections, and bonding and grounding provisions. Include indications for use of raceway, data on how concealment requirements will be met, and calculations required by NFPA 780 for bonding of grounded and isolated metal bodies.
- C. Qualification data for firms and persons specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include data on listing or certification by LPI.
- D. Certification, signed by Contractor, that roof adhesive for air terminals is approved by manufacturers of both the terminal assembly and the single-ply membrane roofing material.
- E. Field inspection reports indicating compliance with specified requirements.
- F. The Certified Designer shall provide a complete design for the Lightning Protection System. The design shall comply with all the requirements of NFPA 780 and UL. The design shall include, but not be limited to:
 - 1. Size and location of main size conductors.
 - 2. Size and location of bonding conductors.
 - 3. Size and location of air terminals.
 - 4. Size and location of supports.
 - 5. Size and location of connections.
 - 6. Size and location of intermediate-level interconnection loop conductors.
 - 7. Size and location of ground loop conductors.
 - 8. Size and location of ground rods.

9. And all other required hardware and accessories for a complete and fully functional, lightning protection system with a UL Master Label.
 - G. Provide plan drawings in 1/8" = 1'-0" scale showing size and location of lightning protection system components. The drawings shall be designed by a Lightning Protection Certified Master Designer and the drawings shall bear his seal. The seal shall be current at the time of submission and shall be signed by the Master Designer.
 - H. Provide UL Master Label Certificate.
 - I. Provide As-built drawings.
- 1.5 QUALITY ASSURANCE
- A. Installer Qualifications: Installer shall be certified by LPI as a Master Installer.
 - B. Designer Qualifications: Designer shall be certified by LPI as a Master Designer.
 - C. The lightning protection system shall conform to the requirements and standards for lightning protection systems of UL and NFPA.
 - D. Provide UL Master Label Certificate.
- 1.6 COORDINATION
- A. Coordinate installation of lightning protection with installation of other building systems and components, including electrical wiring, supporting structures and building materials, metal bodies requiring bonding to lightning protection components, and building finishes.
 - B. Coordinate installation of air terminals attached to roof systems with roofing manufacturer and Installer.
 - C. Installer shall study all the drawings and submittals to have a complete understanding of all the equipment and structure located on the roof, as well as the overall structure of the building. Installer shall also visit the site to ensure he has a complete understanding of what is required to perform his work.
 - D. Designer shall review the surge protection devices being provided for this project to ensure that the devices shall comply with UL requirements for obtaining a UL Master Label.
- 1.7 GENERAL REQUIREMENTS
- A. The Lightning Protection System shall be designed by a Lightning Protection Institute (LPI) Certified Master Designer.
 - B. The system design and installation shall comply with the NEC, NFPA 780, the Lightning Protection Institute (LPI), Underwriters' Laboratories Inc. (UL), and UL 96A (Installation Requirements for Lightning Protection Systems).
 - C. The contractor shall furnish all labor, materials, equipment and services to provide a complete lightning protection system. The system shall include strike termination devices, interconnecting

conductors, a proper grounding system, and interconnection with other building grounded systems.

- D. The manufacturer of the material components shall be a member of the Lightning Protection Institute, and all materials shall be listed and labeled in accordance with the requirements of UL 96.
- E. The system installer shall be certified by LPI as a Master Installer.
- F. Upon completion of the installation, the contractor shall deliver to the owner the Master Label of Underwriters' Laboratories, Inc. (UL) and the LPI certified system registration.
- G. Provide bi-metallic connectors to connect dissimilar metals.
- H. Provide bonding conductors to all equipment that require bonding per NFPA 780
- I. Provide lightning protection air terminals per NFPA 780.
- J. All underground connections shall be made with exothermic weld connections.
- K. All materials shall be UL Listed.

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. Automatic Lightning Protection.
 - 2. ERICO International Corporation.
 - 3. Harger Lightning Protection, Inc.
 - 4. Independent Protection Co.
 - 5. Thompson Lightning Protection, Inc.

2.2 LIGHTNING PROTECTION SYSTEM COMPONENTS

- A. Comply with UL 96.
- B. Comply with NFPA 780 for size, type and location of the following:
 - 1. Main size conductors
 - 2. Bonding conductors
 - 3. Air terminals. Air terminals shall be UL Listed Blunt Type.
 - 4. Supports
 - 5. Connections
 - 6. Intermediate-level interconnection loop conductors
- C. Ground rods shall be Copper-clad steel, ¾ inch diameter by 10 foot long.
- D. All underground connections shall use welded connectors. Welded connectors shall be exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

PART 3 - EXECUTION

3.1 APPLICATION

- A. A Lightning Protection System shall be provided for the building, and mechanical/electrical equipment which are located within 20' of the building (including, but not limited to, ground mounted Heating, Ventilation, and Air Conditioning Equipment; and, ground mounted Electric Generators).

3.2 INSTALLATION

- A. Change to Copper Conductors before entering the ground. Use only copper conductors underground. Use listed bimetallic connectors to connect aluminum and copper conductors. Make transition at 10' above finished grade.
- B. Install lightning protection components and systems according to UL 96A and NFPA 780.
- C. Install conductors with direct paths from air terminals to ground connections. Avoid sharp bends and narrow loops.
- D. Where Air Terminals are mounted on Single-Ply Membrane Roofing, comply with adhesive manufacturer's and roofing manufacturer's written instructions. Coordinate with roofing manufacturer and comply with their requirements.
- E. Conductors within normal view of exterior locations at grade within 200 feet of the building shall be concealed, unless otherwise noted, and except as follows:
- F. Cut and patch existing pavement in the path of the ground loop conductors. Repair existing pavement after conductors have been constructed/installed. The newly repaired pavement shall match the existing pavement.
- G. Where down conductors are located at new walls, the down conductors shall run in PVC Schedule 40 conduit (size per NEC), that is concealed within the new walls. Where down conductors are located at existing walls, the down conductors shall run in PVC Schedule 80 conduit (size per NEC), that is exposed on the exterior side of the exterior wall. Exposed conduit shall be painted in a color recommended by the owner/architect. Coordinate exact location of the down conductors with the owner/architect. The entire vertical run of the down conductors shall be installed in conduit.
- H. Common Ground Bonding with Lightning Protection System: Comply with the NEC, NFPA 780 and UL 96 when interconnecting with lightning protection system.
- I. Furnish and install all required hardware and accessories for a complete and fully functional lightning protection system with a UL Master Label. The required hardware and accessories, include, but are not limited to, the following:
 - 1. Main size conductors.
 - 2. Bonding conductors.
 - 3. Air terminals.
 - 4. Supports.
 - 5. Connections.
 - 6. Intermediate-level interconnection loop conductors.
 - 7. Ground loop conductors.
 - 8. Ground rods.

9. Surge Protective Devices.

- J. A certified roofing contractor shall inspect all roof work. Roof work shall be performed in a manner that does not void the roofing warranty. Roofing warranty shall be maintained. Provide a certificate indicating that all roof work has been properly performed and that the roofing warranty has been maintained.

3.3 CORROSION PROTECTION

- A. Do not combine materials that can form an electrolytic couple that will accelerate corrosion in the presence of moisture unless moisture is permanently excluded from junction of such materials.
- B. Use conductors with protective coatings where conditions would cause deterioration or corrosion of conductors.

3.4 FIELD QUALITY CONTROL

- A. UL Inspection: Provide inspections as required to obtain a UL Master Label for system.

END OF SECTION 264113

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SECTION 264313 - SURGE PROTECTIVE DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1, 26, 27, and 28 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This section describes the materials and installation requirements for Surge Protective Devices.

1.3 DEFINITIONS

- A. SPD: Surge Protective Device
- B. UL: Underwriter's Laboratories

1.4 SUBMITTALS

- A. Submit complete product data on all the features and ratings of the devices, including, but not limited to, the following:
 - 1. Short Circuit Current Rating
 - 2. Voltage Protection Ratings for all modes
 - 3. Maximum Continuous Operating Voltage
 - 4. I-nominal rating (In)
 - 5. UL File Number
 - 6. UL Category Code
 - 7. Provide size/quantity for all wire lugs/terminals at the equipment.
- B. Submittals shall include shop drawings including manufacturer installation instruction manual and line drawings detailing dimensions and weight of enclosure, internal wiring diagram illustrating all modes of protection in each type of SPD required, wiring diagram showing all field connections and manufacturer's recommended wire and breaker sizes.
- C. Field quality control test reports

1.5 COORDINATION

- A. Coordinate SPD with the manufacturer of the protected equipment prior to purchase and installation of the SPD to ensure that the surge protector is suitable for its application. Items to coordinate, include, but are not limited to: equipment voltage, maximum continuous operating voltage, frequency bandwidth, and wire connections.
- B. Coordinate wire terminals/lugs at the equipment with the wires that are connected to it. Wire terminals/lugs shall be suitable for use with the wires that are connected to.

- C. Coordinate SPD with the breaker/circuit it will be connected to. The SPD shall be compatible and suitable for use with the associated breaker/circuit.

1.6 WARRANTY

- A. Provide the following warranties in addition to any warranties specified elsewhere in the contract documents:
 - 1. The manufacturer shall provide a minimum ten-year warranty on all devices and equipment. Warranty coverage shall begin on the date of shipment. The warranty shall cover repair or replacement any defective products within the warranty period.

PART 2 - PRODUCTS

2.1 MAIN SURGE PROTECTIVE DEVICE

- A. Provide Square D EMA model series with the following features:
 - 1. Modular parallel device
 - 2. Multi-stage suppression circuits consisting of field-proven, fast-acting metal oxide varistors (MOVs)
 - 3. A surge suppression path is provided for each mode, line-to-neutral (L-N), line-to-line (L-L), line-to-ground, and neutral-to-ground.
 - 4. Each surge suppression mode is individually fused and uses Thermal Cut-Off (TCO) circuitry to isolate the PSD and ensure shutdown in the event of MOV damage during severe overvoltages, even when operated on high-fault current power systems.
 - 5. A filter provides EMI/RFI noise attenuation.
 - 6. On-line diagnostics continuously monitor the device status, and LEDs signal a loss of a suppression circuit. An audible alarm with an enable/disable feature and dry contacts are included in the diagnostic package.
 - 7. Push-to-test on-line diagnostic display
 - 8. Front panel alarm with enable/disable switch
 - 9. Duty cycle tested (ANSI C62.41 C_{high} , 10kA, 20kV) 20,000 impulses
 - 10. High-energy parallel design for ANSI/IEEE C62.41 and C62.45 category B and C applications
 - 11. Short Circuit Current Rating: 200kA
 - 12. EMI/RFI filtering up to -42dB (100kHz to 100MHz)
 - 13. Sine Wave Tracking
 - 14. UL 1449 Listed
 - 15. UL 1283 Listed
 - 16. NEMA 4X Enclosure
 - 17. Nominal Discharge Current Rating (In): 20kA
 - 18. Complies with UL96A and NFPA 780 requirements for surge protective devices used for lightning protection
 - 19. Surge Protective Device (SPD) Type 1. SPD Type 1 are defined by UL as follows:
 - a. Permanently connected SPDs intended for installation between the secondary of the service transformer and the line side of the service equipment overcurrent device, as well as the load side, including watt-hour meter socket enclosures and intended to be installed without an external overcurrent protective device.
- B. Surge Capacity: 240 kA/phase, 120 kA line-neutral, 120 kA line-ground, and 120 kA neutral-ground.
- C. Enclosure Dimensions shall not exceed 11.70" wide x 9.4" deep x 22.67" high. Weight shall not exceed 33 lbs.

- D. Wire terminals shall be suitable for use with #10 through #2 AWG size wiring.
- E. SPD shall be suitable for connection to a 30A circuit breaker.
- F. The full model number of the SPD shall be coordinated with the associated circuit/equipment. The SPD shall be compatible with the voltage of the circuit/equipment it is connected to.

PART 3 - EXECUTION

3.1 APPLICATION

- A. Provide a Main Surge Protective Device for the following locations:
 - 1. Where the drawings show a surge protective device on the load side of the service disconnect.
 - 2. Where the drawings show a surge protective device connected to the main distribution panelboard.

3.2 INSTALLATION

- A. Install surge protective devices in accordance with the manufacturer's recommendations, NEC/NFPA 780 requirements, UL's requirements, and applicable codes.

3.3 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory authorized service representative to inspect, test, and adjust, field assembled components and equipment installation, including connections. Report results in writing.
- B. Test unit in accordance with manufacturer's written instructions.

3.4 DEMONSTRATION AND TRAINING

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to maintain surge protective devices. Provide a minimum of 4 hours of training

END OF SECTION 264313

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SECTION 265119 - LIGHTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1, 26, 27, and 28 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Interior and exterior lighting fixtures, lamps, and ballasts. This includes exterior luminaires mounted on exterior surfaces of buildings.
 - 2. Emergency lighting units.
 - 3. Exit signs.
 - 4. Mini Lighting Inverters

1.3 DEFINITIONS

- A. BF: Ballast factor.
- B. CRI: Color-rendering index.
- C. CU: Coefficient of utilization.
- D. HID: High-intensity discharge.
- E. LER: Luminaire efficacy rating.
- F. Luminaire: Complete lighting fixture, including ballast housing if provided.
- G. RCR: Room cavity ratio.

1.4 SUBMITTALS

- A. Product Data: For each type of lighting fixture, arranged in order of fixture designation. Include data on features, accessories, finishes, and the following:
 - 1. Physical description of lighting fixture including dimensions.
 - 2. Emergency lighting units including battery and charger.
 - 3. Ballast.
 - 4. Energy-efficiency data.
 - 5. Life, output, and energy-efficiency data for lamps.
- B. Shop Drawings: Show details of nonstandard or custom lighting fixtures. Indicate dimensions, weights, methods of field assembly, components, features, and accessories.

1. Wiring Diagrams: Power and control wiring.
 - C. Field quality-control test reports.
 - D. Operation and Maintenance Data: For lighting equipment and fixtures to include in emergency, operation, and maintenance manuals.
 - E. IES Photometric files for each lighting fixture. Label for the files shall match the labeling of each lighting fixture indicated in the Lighting Fixture Schedule.
 - F. Color samples
- 1.5 QUALITY ASSURANCE
- A. 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.
 - B. Comply with NFPA 70.
- 1.6 COORDINATION
- A. Coordinate layout and installation of lighting fixtures and suspension system with other construction that penetrates ceilings or is supported by them, including HVAC equipment, fire-suppression system, and partition assemblies.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In Lighting Fixture Schedule where titles below are column or row headings that 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.

2.2 LIGHTING FIXTURES AND COMPONENTS, GENERAL REQUIREMENTS

- A. Metal Parts: Free of burrs and sharp corners and edges.
- B. Sheet Metal Components: Steel, unless otherwise indicated. Form and support to prevent warping and sagging.
- C. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.
- D. Reflecting surfaces shall have minimum reflectance as follows, unless otherwise indicated:

1. White Surfaces: 85 percent.
2. Specular Surfaces: 83 percent.
3. Diffusing Specular Surfaces: 75 percent.
4. Laminated Silver Metallized Film: 90 percent.

E. Plastic Diffusers, Covers, and Globes:

1. Acrylic Lighting Diffusers: 100 percent virgin acrylic plastic. High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
 - a. Lens Thickness: At least 0.125 inch minimum unless different thickness is indicated.
 - b. UV stabilized.
2. Glass: Annealed crystal glass, unless otherwise indicated.

2.3 EXIT SIGNS

- A. Description: Comply with UL 924; for sign colors, visibility, luminance, and lettering size, comply with authorities having jurisdiction.
- B. Internally Lighted Signs:
1. Lamps for AC Operation: LEDs, 70,000 hours minimum rated lamp life.
 2. Self-Powered Exit Signs (Battery Type): Integral automatic charger in a self-contained power pack.
 - a. Battery: Sealed, maintenance-free, nickel-cadmium type, unless otherwise noted on the drawings
 - b. Charger: Fully automatic, solid-state type with sealed transfer relay.
 - c. Operation: Relay automatically energizes lamp from battery when circuit voltage drops to 80 percent of nominal voltage or below. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
 - d. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
 - e. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.

2.4 EMERGENCY LIGHTING UNITS

- A. Description: Self-contained units complying with UL 924.
1. Battery: Sealed, maintenance-free, lead-acid type, unless otherwise noted.
 2. Charger: Fully automatic, solid-state type with sealed transfer relay.
 3. Operation: Relay automatically turns lamp on when power supply circuit voltage drops to 80 percent of nominal voltage or below. Lamp automatically disconnects from battery when voltage approaches deep-discharge level. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
 4. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
 5. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.

2.5 LIGHTING FIXTURES

- A. See "Lighting Fixture Schedule" on the Drawings, for the manufacturer and model number of each lighting fixture.
- B. Coordinate dimming control type of the lighting fixtures and the lighting controls so that they are compatible and suitable for use with each other.

2.6 LIGHTING FIXTURE SUPPORT COMPONENTS

- A. Comply with Specification Section "Hangers and Supports for Electrical Systems" for channel- and angle-iron supports and nonmetallic channel and angle supports.
- B. Single-Stem Hangers: 1/2-inch steel tubing with swivel ball fittings and ceiling canopy. Finish same as fixture.
- C. Twin-Stem Hangers: Two, 1/2-inch steel tubes with single canopy designed to mount a single fixture. Finish same as fixture.
- D. Wires: ASTM A 641/A 641M, Class 3, soft temper, zinc-coated steel, 12 gage.
- E. Rod Hangers: 3/16-inch minimum diameter, cadmium-plated, threaded steel rod.
- F. Hook Hangers: Integrated assembly matched to fixture and line voltage and equipped with threaded attachment, cord, and locking-type plug.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Lighting fixtures: Set level, plumb, and square with ceilings and walls. Install lamps in each fixture.
- B. Support for Lighting Fixtures in or on Grid-Type Suspended Ceilings: Support fixtures directly from building structure with wires, and provide support clips. For fixtures of sizes less than ceiling grid, support fixtures directly from building structure with wires, and provide metal channels spanning and secured to ceiling tees.
 - 1. Support Clips: Fasten to lighting fixtures and to ceiling grid members at or near each fixture corner with clips that are UL listed for the application.
 - 2. 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.
 - 3. Install at least four independent support wires from building structure to tabs on the lighting fixture. Locate not more than 6 inches from lighting fixture corners. Wire shall have breaking strength of the weight of fixture at a safety factor of 3. Wires shall be arranged to support the fixture directly from the building structure.
- C. Suspended Lighting Fixture Support:
 - 1. Pendants and Rods: Where longer than 48 inches, brace to limit swinging.
 - 2. Aircraft Cable: Where longer than 24 inches, brace to limit swinging.
 - 3. Stem-Mounted, Single-Unit Fixtures: Suspend with twin-stem hangers.

4. Continuous Rows: Use tubing or stem for wiring at one point and tubing or rod for suspension for each unit length of fixture chassis, including one at each end.
5. Support fixtures directly from the building structure.
6. Where suspended lighting fixtures are not located directly under roof trusses, roof supports, or other structural elements, provide metal channels to span, or attach to, the roof trusses, roof supports, or other structural elements. Furnish and install metal channels such that the lighting fixtures can be suspended from the metal channels, and installed at the locations required by the contract documents.

D. Lighting Fixtures surface mounted to hard ceilings which have concealed spaces above it:

1. Provide all necessary blocking, channels, and other hardware for securing lighting fixtures to the ceiling, and the building structure as required. The blocking/channels shall be concealed above the hard ceiling. Hard ceilings shall be reinforced as required so that it can handle the weight of the lighting fixtures.

E. Wall-Mounted Lighting Fixture Support:

1. Provide all necessary blocking, channels, and other hardware for securing lighting fixtures to the wall. The blocking/channels shall be concealed inside the hollow spaces of the wall where the wall is gypsum board or other similar wall type.

F. Air-Handling Lighting Fixtures: Install with dampers closed and ready for adjustment.

G. Adjust aimable lighting fixtures to provide required light intensities.

H. Connect wiring according to Specification Section "Conductors and Cables."

I. Where non-IC rated lighting fixtures are installed in insulated ceilings, provide clearance between the lighting fixture and the insulation in accordance with the manufacturer's recommendations and NEC requirements.

J. Where non-fire rated lighting fixtures are recessed into fire rated ceilings, build a fire rated enclosure around the lighting fixtures such that a fire in the lighting fixture shall have to pass through the fire rated enclosure and a fire in the ceiling shall have to pass through the fire rated enclosure. The fire rating of the enclosure shall match the fire rating of the ceiling.

3.2 FIELD QUALITY CONTROL

- A. Test for Emergency Lighting and Mini Lighting Inverters: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery and retransfer to normal.
- B. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

3.3 DEMONSTRATION AND TRAINING

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain the lighting fixtures.

- B. The System Supplier shall schedule and present a minimum of 4 hours of documented formalized instruction for the building owner, detailing the proper operation and maintenance of the installed lighting fixtures.
- C. The instruction shall be presented in an organized and professional manner by a person factory trained in the operation and maintenance of the equipment and who is also thoroughly familiar with the installation.

END OF SECTION 265119

SECTION 271513 – TELECOMMUNICATIONS SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1, 26, 27, and 28 Specification Sections, apply to this Section.

1.2 SUBMITTALS

- A. Product Data: Include data on features, ratings, and performance for each component specified.
- B. Shop Drawings. A complete set of shop drawings shall be supplied. The shop drawings shall be reviewed and stamped by a RCDD certified person. This package shall include but not be limited to:
 - 1. Control panel wiring and interconnection schematics. Contractor is responsible for verifying that all the voltages, inputs and outputs are compatible with each other.
 - 2. Complete point to point wiring diagrams.
 - 3. Riser diagrams.
 - 4. Complete floor plan drawing locating all devices and equipment in 1/8" = 1'-0" scale plan. Show the placement of each individual device/equipment as well as raceway size/routing, junction box size/location, and wire/cable size/type/quantity/color/routing. This includes, but is not limited to, the following:
 - a. Cable tray layout
 - b. Location of rack in the electrical/telecom room, showing clearances from walls and equipment.
 - 5. Show elevation drawing of all equipment. This includes, but is not limited to, the following:
 - a. Equipment rack elevation.
 - 6. Detailed system operational description.
 - 7. Complete system bill of material.
- C. Operation and Maintenance Data
- D. Field quality control test reports
- E. Equipment and cable identification/labelling schedule
- F. Qualifications of persons working on the project.

1.3 QUALITY ASSURANCE

- A. Installer Qualifications: Cabling installer shall have personnel certified by BICSI on staff
 - 1. Layout Responsibility: Preparation of Shop drawings by a person certified by BICSI as an RCDD
 - 2. Installation Supervision: Installation shall be made under the direct supervision of a person certified by BICSI as an RCDD

- B. Testing Agency Qualifications: Testing agency must have personnel certified by BICSI on staff
 - 1. Testing Agency's Field Supervisor: A person certified by BICSI as an RCDD
- C. 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.
- D. Comply with NFPA 70.
- E. Comply with NECA 1.

1.4 COORDINATION

- A. Coordinate the equipment indicated in this specification section with all other equipment and systems it connects to. All input/output/communications interfaces/modules shall be compatible and suitable for use with each other.
- B. Coordinate programming of system with the preferences of the owner. Comply with the owner's requirements, except where it conflicts with the applicable codes or the requirements of the authorities having jurisdiction.
- C. Where equipment are connected to the data network system, coordinate all network settings/configurations with the owner's IT (Information Technology) department.
- D. Coordinate line voltage power requirements prior to starting any work to ensure that power is provided to all equipment. The contractor shall provide line voltage power to all equipment that require it, in accordance with the manufacturer's recommendations and NEC requirements.

1.5 DEFINITIONS

- A. BICSI: Building Industry Consulting Services International
- B. RCDD: Register Communications Distribution Designer (Certified by BICSI)

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Basis-of-Design Product: Where the contract documents specifies a product name, model, or manufacturer, this product shall be considered as the basis-of-design product. The contractor shall provide the basis-of-design product or approved equal. All products shall be submitted for review and approval by the design team.

2.2 CATEGORY 6 CABLE

- A. Provide Category 6 Cable with the following features:
 - 1. ANSI/TIA Category: 6
 - 2. Cable Type: Unshielded
 - 3. Jacket Color: BLUE
 - 4. Cable shall be Plenum Rated (CMP Type)

5. Remote Powering: Fully complies with the recommendations set forth by IEEE 802.3bt (Type 4) for the safe delivery of power over LAN cable
6. UL Listed

2.3 CATEGORY 5E CABLE

- A. Provide Category 5E Cable with the following features:
 1. ANSI/TIA Category: 5E
 2. Cable Type: Unshielded
 3. Jacket Color: WHITE
 4. Cable shall be Plenum Rated (CMP Type)
 5. Remote Powering: Fully complies with the recommendations set forth by IEEE 802.3bt (Type 4) for the safe delivery of power over LAN cable
 6. UL Listed

2.4 TELEPHONE AND/OR DATA OUTLETS

- A. Provide Category 5e and 6 jacks in each telephone and/or data outlet.
- B. Category 5e jacks shall comply with the following:
 1. ANSI/TIA Category: 5e
 2. UL Listed
- C. Category 6 jacks shall comply with the following:
 1. ANSI/TIA Category: 6
 2. UL Listed
- D. Wall plates shall comply with the following:
 1. Non-metallic
 2. UL Listed

PART 3 - EXECUTION

3.1 APPLICATIONS

- A. Provide junction boxes as required, in accordance with the NEC and the manufacturer's recommendations.
- B. Wiring methods for low voltage (24V or less) power wiring, control wiring, and phone/data/video/audio wiring:
 1. Wiring that is exposed, concealed inside walls/floor, or concealed above inaccessible ceilings:
 - a. All wiring shall be installed in raceway.
 2. Wiring that is concealed above accessible ceilings:
 - a. All wiring shall be installed in raceway, unless otherwise noted and except as follows:
 - 1) Raceway may be omitted where all of the following conditions are met:
 - a) Wiring is used for Communications Circuits or Class 2 Circuits.
 - b) Wiring is used in dry locations.
 - c) Wiring is used in aboveground applications.
 - d) Wiring is not subject to physical damage.

- e) Wiring is supported and secured at intervals which do not exceed 3 feet.
 - f) Wiring is supported by hangers and supports from the building structure.
 - g) Wiring is not laid on ceiling tiles.
 - h) Wiring is not fastened in a manner that puts tension on the wiring.
 - i) Wiring is plenum rated (UL Type CMP).
 - j) Wiring is supported by UL Listed Metal J-Hooks (with rounded edges and integral cable retainer metal clip) and secured together with plenum rated nylon straps or clamps (the use of staples is prohibited).
 - k) Wiring is concealed above accessible suspended ceilings (this includes, but is not limited to, ceiling spaces above grid type ceilings with removable ceiling tiles).
 - l) Raceway is not required by the NEC.
- C. All junction box covers shall be painted ORANGE, and labeled "DATA"
- D. Coordinate electrical power supply connection type with the equipment. Where the equipment requires a receptacle connection, provide a receptacle. Where the equipment requires a hardwired connection, provide a hardwired connection. Coordinate all work with the manufacturer and the installation manuals. All work shall comply with the NEC, the manufacturer's recommendations, and the contract documents.
- E. Where low voltage (24V or less) power wiring, control wiring, and phone/data/video/audio wiring, enter or pass through boxes, enclosures, and furniture/fixtures/equipment, provide grommets and bushings in accordance with the manufacturer's recommendations and NEC requirements.

3.2 INSTALLATION

- A. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.
- B. Cables shall have a minimum separation of 12 inches from 120V or higher power wiring. Cables shall have a minimum separation of 12 inches from light fixtures.
- C. All wall and floor penetrations shall be sleeved. All conduit and sleeve ends must have bushings to prevent chafing. Where a conduit or other through-penetration device is installed through a fire rated assembly, the opening around the sleeve and the hole through the sleeve shall be sealed with an Underwriters Laboratory approved fire rated sealant material after the cables have been installed.
- D. Install cables without damaging conductors or jacket.
- E. Do not bend cables, in handling or in installing, to smaller radii than minimums recommended by manufacturer.
- F. Pull cables without exceeding cable manufacturer's recommended pulling tensions.
- 1. Pull cables simultaneously if more than one is being installed in same raceway.
 - 2. Use pulling compound or lubricant if necessary. Use compounds that will not damage conductor or insulation.
 - 3. Use pulling means, including fish tape, cable, rope, and basket-weave wire or cable grips, that will not damage media or raceway.
 - 4. Monitor cable pulling tensions.

- G. Install cables parallel and perpendicular to surfaces or structural members and follow surface contours where possible.
- H. Wiring within Wiring Closets and Enclosures: Provide conductors of adequate length. Train conductors to terminal points with no excess. Use lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommended by manufacturer.
- I. Separation of Wires: Comply with TIA/EIA-569-A rules for separating unshielded copper telephone and data communication cabling from potential EMI sources, including electrical power lines and equipment.
- J. Make splices, taps, and terminations only at indicated outlets, terminals, and cross-connect panels.
- K. Use splice and tap connectors compatible with media types.
- L. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
- M. In the communications equipment room, install a 5-foot- long service loop on each end of cable.
- N. Cable support inside wiring closets, telecommunications closets, data closets:
 - 1. Support horizontal and backbone cabling from the fire retardant plywood board in each closet.
 - 2. Provide cable ties and cable tie mounts to support the horizontal and backbone cabling from the plywood board. Provide cable ties every 3”.
 - 3. Cable tie mount shall be manufactured by Panduit or approved equal and shall use galvanized steel screws as the mounting method. Cable tie mount shall be UL Recognized. Cable tie mount size shall be suitable for the cables being supported.
- O. Install all devices and equipment in accordance with the manufacturer’s requirements.
- P. Prior to installing devices and equipment, the contractor shall coordinate the exact locations where the devices and equipment are being installed with the plan drawings and existing conditions, and shall notify the engineer immediately if there are any issues or conflicts. The coordinated locations shall be indicated in the shop drawing submittals. Where conflicts are found during or after the shop drawing submittal process, but before installation of the devices and equipment, the contractor shall notify the engineer of the conflict, and shall adjust the locations of the devices and equipment, where directed by the engineer to do so. The contractor’s bid price shall include adjusting the locations of devices and equipment up to 12 feet from the locations on the plan drawings, unless otherwise noted.
- Q. All equipment shall be installed plumb and level.
- R. Clean all equipment in accordance with the manufacturer’s recommendations.

3.3 FIELD QUALITY CONTROL

- A. Perform the following field tests and inspections and prepare test reports:
 - 1. Provide the following tests and inspections for all cables:
 - a. Visually inspect jacket materials for NRTL certification markings. Inspect cabling terminations in communications equipment rooms for compliance with color-coding

- for pin assignments, and inspect cabling connections for compliance with TIA-568-C.1.
 - b. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
 - 2. Provide the following tests and inspections for Category 5e cables, using test equipment that have been calibrated within the last 12 months prior to the testing (provide proof of calibration)
 - a. Wire Map
 - b. Length
 - c. Propagation Delay
 - d. Delay Skew
 - e. DC Loop Resistance
 - f. DC Resistance Unbalance
 - g. Insertion Loss
 - h. NEXT (Near-End Crosstalk)
 - i. PS NEXT (Power Sum Near-End Crosstalk)
 - j. ACR-N (Attenuation to Crosstalk Ratio Near-End)
 - k. PS ACR-N (Power Sum Attenuation to Crosstalk Ratio Near-End)
 - l. ACR-F (Attenuation to Crosstalk Ratio Far-End)
 - m. PS ACR-F (Power Sum Attenuation to Crosstalk Ratio Far-End)
 - n. Return Loss
 - o. TCL (Transverse Conversion Loss)
 - p. ELTCTL (Equal Level Transverse Conversion Transfer Loss)
 - 3. Provide the following tests and inspections for Category 6 cables, using test equipment that have been calibrated within the last 12 months prior to the testing (provide proof of calibration)
 - a. Wire Map
 - b. Length
 - c. Propagation Delay
 - d. Delay Skew
 - e. DC Loop Resistance – recorded for information only
 - f. DC Resistance Unbalance – recorded for information only
 - g. Insertion Loss
 - h. NEXT (Near-End Crosstalk)
 - i. PS NEXT (Power Sum Near-End Crosstalk)
 - j. ACR-N (Attenuation to Crosstalk Ratio Near-End) – recorded for information only
 - k. PS ACR-N (Power Sum Attenuation to Crosstalk Ratio Near-End) – recorded for information only
 - l. ACR-F (Attenuation to Crosstalk Ratio Far-End)
 - m. PS ACR-F (Power Sum Attenuation to Crosstalk Ratio Far-End)
 - n. Return Loss
 - o. TCL (Transverse Conversion Loss) – recorded for information only
 - p. ELTCTL (Equal Level Transverse Conversion Transfer Loss) – recorded for information only
 - B. Retesting: Correct deficiencies and retest. Prepare a written record of tests.
 - C. Inspection: Verify that units and controls are properly labeled and interconnecting wires and terminals are identified.
- 3.4 IDENTIFICATION
- A. Each equipment shall be labeled with an address/identification name/number which matches information provided in the submittals or indicated in the drawings. Identify each cable segment between equipment with a unique number corresponding to the address/identification

name/number of the associated equipment. Provide a cable schedule which identifies each cable segment and the associated equipment.

3.5 DOCUMENTATION AND TRAINING

- A. The contractor shall provide to the owner, complete manuals of the completed system. The manuals shall include operating and maintenance instruction, catalog cuts of all equipment and components, as-built wiring diagrams, and a manufacturer's suggested spare parts list.
- B. In addition to the above manuals, the contractor shall provide the services of the manufacturer's trained representative for a period of eight (8) hours to instruct the owners' designated personnel on the operation and maintenance of the entire system.
- C. Training shall be on-site, and hands-on, using the actual equipment installed at the project site.
- D. Provide training on how to operate and maintain the system.

END OF SECTION 271513

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SECTION 275123 - INTERCOM SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1, 26, 27, and 28 Specification Sections, apply to this Section.

1.2 SUBMITTALS

- A. Product Data: Include data on features, ratings, and performance for each component specified.
- B. Shop Drawings. A complete set of shop drawings shall be supplied. This package shall include but not be limited to:
 - 1. Control panel wiring and interconnection schematics. Contractor is responsible for verifying that all the voltages, inputs and outputs are compatible with each other.
 - 2. Complete point to point wiring diagrams.
 - 3. Riser diagrams.
 - 4. Complete floor plan drawing locating all devices and equipment in 1/8" = 1'-0" scale plan. Show the placement of each individual device/equipment as well as raceway size/routing, junction box size/location, and wire/cable size/type/quantity/color/routing.
 - 5. Show elevation drawing of all equipment.
 - 6. Detailed system operational description.
 - 7. Complete system bill of material.
- C. Operation and Maintenance Data
- D. System Operation: Provide a detailed description of the system operation, including but not limited to the following:
 - 1. Indicate when an alarm or supervisory signal is generated.
 - 2. Indicate what data is stored on the control panel.
- E. System Calculations
 - 1. Provide battery sizing calculations for the standby batteries.
- F. Voltage Drop Calculations
 - 1. Provide voltage drop calculations to show that adequate voltage is provided at each equipment, in order to maintain proper equipment operation.
- G. Field quality-control test reports
- H. Equipment and cable identification/labelling schedule
- I. Qualifications of persons working on the project.

1.3 QUALITY ASSURANCE

- A. A Systems Integrator shall integrate all the different components of the system, and shall make sure that the system is complete and fully operational in accordance with the contract documents, and the applicable codes.
- B. Systems Integrator Qualifications:
 - 1. An experienced equipment installer who has completed systems integration work for installations similar in material, design, and extent to that indicated for this Project, and whose work has resulted in construction with a record of successful in-service performance.
 - 2. Certified by the equipment manufacturer to perform the work required by the contract documents.
 - 3. Capable of sizing and selecting different components of the system (including, but not limited to, the wiring) to ensure that all equipment are compatible and suitable for use with each other.
 - 4. Capable of performing all the calculations required by the manufacturer, industry standards, and the contract documents.
- C. 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.
- D. Comply with NFPA 70.
- E. Comply with NECA 1.

1.4 COORDINATION

- A. Coordinate the equipment indicated in this specification section with all other equipment and systems it connects to. All input/output/communications interfaces/modules shall be compatible and suitable for use with each other.
- B. Coordinate programming of system with the preferences of the owner. Comply with the owner's requirements, except where it conflicts with the applicable codes or the requirements of the authorities having jurisdiction.
- C. Where equipment are connected to the data network system, coordinate all network settings/configurations with the owner's IT (Information Technology) department.
- D. Coordinate line voltage power requirements prior to starting any work to ensure that power is provided to all equipment. The contractor shall provide line voltage power to all equipment that require it, in accordance with the manufacturer's recommendations and NEC requirements.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Basis-of-Design Product: Where the contract documents specifies a product name, model, or manufacturer, this product shall be considered as the basis-of-design product. The contractor shall provide the basis-of-design product or approved equal. All products shall be submitted for review and approval by the design team.

2.2 GENERAL

- A. The contractor shall provide all labor, software, programming, materials, equipment, hardware, mounting, wiring, conduit, junction boxes, power supplies, transformers, batteries, equipment enclosures (all equipment shall have enclosures), and accessories as required for a complete and fully operational system. The contractor shall provide all startup and testing as required, in order to confirm that the system operates in accordance with the contract documents. The system shall comply with all applicable codes, the manufacturer's recommendations, and the requirements of the authorities having jurisdiction.
- B. Intercom System shall be Aiphone JF Series.

2.3 MASTER INTERCOM STATION

- A. Provide Aiphone JF-2MED with the following features:
 - 1. Video identification and monitoring with 3-1/2" screen
 - 2. Hands-free communication
 - 3. Door release
 - 4. All Call between inside stations
 - 5. Surface mounts to wall on 1-gang box or ring
 - 6. Internal Picture Memory
 - 7. Internal voice memo and outgoing message can be recorded for playback
 - 8. 5 display languages (English, French, German, Spanish, or Dutch)

2.4 DOOR INTERCOM STATION

- A. Provide Aiphone JF-DV with the following features:
 - 1. Fixed camera provides clear video
 - 2. LED illumination automatically turns on in low light conditions
 - 3. LED backlit nameplate

PART 3 - EXECUTION

- A. Provide junction boxes as required, in accordance with the NEC and the manufacturer's recommendations.
- B. Wiring methods for low voltage (24V or less) power wiring, control wiring, and phone/data/video/audio wiring:
 - 1. Wiring that is exposed, concealed inside walls/floor, or concealed above inaccessible ceilings:
 - a. All wiring shall be installed in raceway.
 - 2. Wiring that is concealed above accessible ceilings:
 - a. All wiring shall be installed in raceway, unless otherwise noted and except as follows:
 - 1) Raceway may be omitted where all of the following conditions are met:
 - a) Wiring is used for Communications Circuits or Class 2 Circuits.
 - b) Wiring is used in dry locations.
 - c) Wiring is used in aboveground applications.
 - d) Wiring is not subject to physical damage.
 - e) Wiring is supported and secured at intervals which do not exceed 3 feet.

- f) Wiring is supported by hangers and supports from the building structure.
 - g) Wiring is not laid on ceiling tiles.
 - h) Wiring is not fastened in a manner that puts tension on the wiring.
 - i) Wiring is plenum rated (UL Type CMP).
 - j) Wiring is supported by UL Listed Metal J-Hooks (with rounded edges and integral cable retainer metal clip) and secured together with plenum rated nylon straps or clamps (the use of stapes is prohibited).
 - k) Wiring is concealed above accessible suspended ceilings (this includes, but is not limited to, ceiling spaces above grid type ceilings with removable ceiling tiles).
 - l) Raceway is not required by the NEC.
- C. All junction box covers shall be painted YELLOW, and labeled "INT".
- D. Coordinate electrical power supply connection type with the equipment. Where the equipment requires a receptacle connection, provide a receptacle. Where the equipment requires a hardwired connection, provide a hardwired connection. Coordinate all work with the manufacturer and the installation manuals. All work shall comply with the NEC, the manufacturer's recommendations, and the contract documents.
- E. Where low voltage (24V or less) power wiring, control wiring, and phone/data/video/audio wiring, enter or pass through boxes, enclosures, and furniture/fixtures/equipment, provide grommets and bushings in accordance with the manufacturer's recommendations and NEC requirements.

3.2 INSTALLATION

- A. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.
- B. Cables shall have a minimum separation of 12 inches from 120V or higher power wiring. Cables shall have a minimum separation of 12 inches from light fixtures.
- C. All wall and floor penetrations shall be sleeved. All conduit and sleeve ends must have bushings to prevent chafing. Where a conduit or other through-penetration device is installed through a fire rated assembly, the opening around the sleeve and the hole through the sleeve shall be sealed with an Underwriters Laboratory approved fire rated sealant material after the cables have been installed.
- D. Install cables without damaging conductors or jacket.
- E. Do not bend cables, in handling or in installing, to smaller radii than minimums recommended by manufacturer.
- F. Pull cables without exceeding cable manufacturer's recommended pulling tensions.
- 1. Pull cables simultaneously if more than one is being installed in same raceway.
 - 2. Use pulling compound or lubricant if necessary. Use compounds that will not damage conductor or insulation.
 - 3. Use pulling means, including fish tape, cable, rope, and basket-weave wire or cable grips, that will not damage media or raceway.
 - 4. Monitor cable pulling tensions.

- G. Install cables parallel and perpendicular to surfaces or structural members and follow surface contours where possible.
- H. Wiring within Wiring Closets and Enclosures: Provide conductors of adequate length. Train conductors to terminal points with no excess. Use lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommended by manufacturer.
- I. Separation of Wires: Comply with TIA/EIA-569-A rules for separating unshielded copper telephone and data communication cabling from potential EMI sources, including electrical power lines and equipment.
- J. Make splices, taps, and terminations only at indicated outlets, terminals, and cross-connect panels.
- K. Use splice and tap connectors compatible with media types.
- L. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
- M. In the communications equipment room, install a 5-foot- long service loop on each end of cable.
- N. Cable support inside wiring closets, telecommunications closets, data closets:
 - 1. Support horizontal and backbone cabling from the fire retardant plywood board in each closet.
 - 2. Provide cable ties and cable tie mounts to support the horizontal and backbone cabling from the plywood board. Provide cable ties every 3".
 - 3. Cable tie mount shall be manufactured by Panduit or approved equal and shall use galvanized steel screws as the mounting method. Cable tie mount shall be UL Recognized. Cable tie mount size shall be suitable for the cables being supported.
- O. Install all devices and equipment in accordance with the manufacturer's requirements.
- P. Prior to installing devices and equipment, the contractor shall coordinate the exact locations where the devices and equipment are being installed with the plan drawings and existing conditions, and shall notify the engineer immediately if there are any issues or conflicts. The coordinated locations shall be indicated in the shop drawing submittals. Where conflicts are found during or after the shop drawing submittal process, but before installation of the devices and equipment, the contractor shall notify the engineer of the conflict, and shall adjust the locations of the devices and equipment, where directed by the engineer to do so. The contractor's bid price shall include adjusting the locations of devices and equipment up to 12 feet from the locations on the plan drawings, unless otherwise noted.
- Q. All programmable and adjustable settings and sequence of operations shall be coordinated with the owner, and set in accordance with the owner's recommendations. Where the owner has no preference, provide a recommendation for the owner's review. Provide eight (8) hours of on-site meetings with the owner, to discuss and make decisions related to the programmable/adjustable settings/sequence of operations. Prior to meeting with the owner on-site, submit a list of items to be discussed, so that the owner is prepared for the on-site discussions.
- R. All equipment shall be installed plumb and level.

- S. Clean all equipment in accordance with the manufacturer's recommendations.

3.3 FIELD QUALITY CONTROL

- A. **Manufacturer's Field Service:** Engage a factory authorized service representative to inspect, test, and adjust, field assembled components and equipment installation, including connections. Report results in writing.
- B. Perform the following field tests and inspections and prepare test reports:
 - 1. Schedule tests with at least seven days' advance notice of test performance.
 - 2. After installing equipment and after electrical circuitry has been energized, test for compliance with requirements.
 - 3. **Operational Test:** Test each system in accordance with the manufacturer's recommendations. Verify that the system is complete and fully operational.
- C. Provide the following additional tests and inspections:
 - 1. Verify that each control unit is in normal condition as detailed in manufacturer's operation and maintenance manual.
 - 2. Initiate a call at the door. Verify that the call is received at the master intercom and at a phone with the mobile app. Verify that voice/video is clear at the intercom and at the phones.
- D. **Retesting:** Correct deficiencies and retest. Prepare a written record of tests.
- E. **Inspection:** Verify that units and controls are properly labeled and interconnecting wires and terminals are identified.

3.4 IDENTIFICATION

- A. Each equipment shall be labeled with an address/identification name/number which matches information provided in the submittals or indicated in the drawings. Identify each cable segment between equipment with a unique number corresponding to the address/identification name/number of the associated equipment. Provide a cable schedule which identifies each cable segment and the associated equipment.

3.5 SOFTWARE SERVICE AGREEMENT

- A. Provide software technical support as follows:
 - 1. Beginning at Substantial Completion, service agreement shall include software support for two (2) years.
 - 2. Technical support shall include the following:
 - a. Toll free technical support via phone
 - b. Technical support via the internet
- B. Provide software upgrade service as follows:
 - 1. At Substantial Completion, update software to latest version. Install and program software upgrades that become available within two (2) years from date of Substantial Completion. Upgrading software shall include operating system and new or revised licenses for using software.
 - 2. **Upgrade Notice:** At least 30 days to allow Owner to schedule access to system and to upgrade computer equipment if necessary.

3.6 DEMONSTRATION AND TRAINING

- A. The contractor shall provide to the owner, complete manuals of the completed system. The manuals shall include operating and maintenance instruction, catalog cuts of all equipment and components, as-built wiring diagrams, and a manufacturer's suggested spare parts list.
- B. In addition to the above manuals, the contractor shall provide the services of the manufacturer's trained representative for a period of eight (8) hours to instruct the owners' designated personnel on the operation and maintenance of the entire system.
- C. Training shall be on-site, and hands-on, using the actual equipment installed at the project site.
- D. Provide training on how to operate and maintain the system.

END OF SECTION 275123

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SECTION 283111 - FIRE-ALARM SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1, 26, 27, and 28 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Fire-alarm control unit.
 - 2. Manual fire-alarm boxes.
 - 3. System smoke detectors.
 - 4. Heat detectors.
 - 5. Notification appliances.
 - 6. Magnetic door holders.
 - 7. Addressable interface device.
 - 8. Digital alarm communicator transmitter.
- B. The Contractor shall furnish all labor, services and materials necessary to furnish and install a complete, functional fire alarm system (System). The System shall comply in respects with all pertinent codes, rules, regulations and laws of the Authority, and local jurisdiction. The System shall comply in all respects with the requirements of the specifications, manufacturer's recommendations and Underwriters Laboratories Inc. (UL) listings.

1.3 DEFINITIONS

- A. LED: Light-emitting diode.
- B. NICET: National Institute for Certification in Engineering Technologies.
- C. UL: Underwriter's Laboratories
- D. LCD: Liquid Crystal Display
- E. ADA: Americans with Disabilities Act
- F. ADA Rooms: Rooms that are specifically reserved for people with disabilities
- G. EST: Edwards Systems Technology
- H. NAC: Notification Appliance Circuit
- I. MC: Metal Clad

1.4 REFERENCES

- A. All work and materials shall conform to all applicable Federal, State and local codes and regulations governing the installation. If there is a conflict between the referenced standards, federal, state or local codes, and this specification, it is the bidder's responsibility to immediately bring the conflict to the attention of the Engineer for resolution. National standards shall prevail unless local codes are more stringent. The bidder shall not attempt to resolve conflicts directly with the local authorities unless specifically authorized by the Engineer.

- B. System components proposed in this specification shall be UL listed to operate together as a system. The supplier shall provide evidence, with his submittal, of listings of all proposed equipment and combinations of equipment. The supplier shall be responsible for filing of all documents, paying all fees (including, but not limited to plan checking and permit) and securing all permits, inspections and approvals. Upon receipt of approved drawings from the authority having jurisdiction, the supplier shall immediately forward two sets of drawings to the Owner. These drawings shall either be stamped approved or a copy of the letter stating approval shall be included.

- C. The equipment and installation shall comply with the current provisions of the following codes and standards:
 - 1. NFPA 70 - 2002 National Electric Code®
 - 2. NFPA 72 - 1999 National Fire Alarm Code®
 - 3. NFPA 90A - 1999 Air Conditioning Systems
 - 4. NFPA 101- 2000 Life Safety Code®
 - 5. UL 864 - Control Units for Fire Protective Signaling Systems.
 - 6. UL 268 - Smoke Detectors for Fire Protective Signaling Systems.
 - 7. UL 268A - Smoke Detectors for Duct Applications.
 - 8. UL 521 - Heat Detectors for Fire Protective Signaling Systems.
 - 9. UL 228 - Door Closers-Holders, With or Without Integral Smoke Detectors.
 - 10. UL 464 - Audible Signaling Appliances.
 - 11. UL 38 - Manually Actuated Signaling Boxes for Use with Fire-Protective Signaling Systems.
 - 12. UL 346 - Waterflow Indicators for Fire Protective Signaling Systems.
 - 13. UL 1971 - Signaling Devices for the Hearing-Impaired.
 - 14. UL 1481 - Power Supplies for Fire Protective Signaling Systems.

1.5 SUBMITTALS

- A. General Submittal Requirements:
 - 1. Submittals shall be approved by authorities having jurisdiction prior to submitting them to Architect.
 - 2. Shop Drawings shall be prepared by persons with the following qualifications:
 - a. Trained and certified by manufacturer in fire-alarm system design.
 - b. NICET-certified fire-alarm technician, Level IV minimum.

- B. Product Data: For each type of product indicated.

- C. Shop Drawings: For fire-alarm system. Include plans, elevations, sections, details, and attachments to other work.

1. Comply with recommendations in the "Documentation" Section of the "Fundamentals of Fire Alarm Systems" Chapter in NFPA 72.
 2. Include voltage drop calculations for notification appliance circuits.
 3. Include battery-size calculations.
 4. Include performance parameters and installation details for each detector, verifying that each detector is listed for complete range of air velocity, temperature, and humidity possible when air-handling system is operating.
 5. Include plans, sections, and elevations of heating, ventilating, and air-conditioning ducts, drawn to scale and coordinating installation of duct smoke detectors and access to them. Show critical dimensions that relate to placement and support of sampling tubes, detector housing, and remote status and alarm indicators. Locate detectors according to manufacturer's written recommendations.
 6. Include complete floor plans to indicate equipment and device locations. The address of each addressable device shall be indicated on the floor plans. Show type, size and route of cable and conduits. Floor plans shall be drawn in 1/8" = 1'-0" scale.
 7. All drawings shall be reviewed, stamped and signed by an individual having a minimum of a NICET Level IV certification in fire protection engineering technology, subfield of fire alarm systems.
- D. Qualification Data: For qualified Installer.
- E. Field quality-control reports.
- F. Operation and Maintenance Data: For fire-alarm systems and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 1 Section "Operation and Maintenance Data," deliver copies to authorities having jurisdiction and include the following:
1. Comply with the "Records" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA 72.
 2. Provide "Record of Completion Documents" according to NFPA 72 article "Permanent Records" in the "Records" Section of the "Inspection, Testing and Maintenance" Chapter.
 3. Record copy of site-specific software.
 4. Provide "Maintenance, Inspection and Testing Records" according to NFPA 72 article of the same name and include the following:
 - a. Frequency of testing of installed components.
 - b. Frequency of inspection of installed components.
 - c. Requirements and recommendations related to results of maintenance.
 - d. Manufacturer's user training manuals.
 5. Manufacturer's required maintenance related to system warranty requirements.
 6. Complete information and drawings describing and depicting the entire system as installed, including all information necessary for maintaining, troubleshooting, and/or expanding the system at a future date.
 7. Complete documentation of system testing.
 8. Certification that the entire system has been inspected and tested, is installed entirely in accordance with the applicable codes, standards, manufacturer's recommendations and UL listings, and is in proper working order.
 9. As-Built drawings consisting of: a scaled plan of each building showing the placement of each individual item of the Fire Alarm System as well as raceway size and routing, junction boxes, and conductor size, quantity, and color in each raceway. All drawings must reflect point to point wiring, device address and

programmed characteristics as verified in the presence of the engineer and/or the end user unless device addressing is electronically generated, and automatically graphically documented by the system.

10. Provide all drawings in standard .DXF format. A bond paper plot of each sheet shall also be provided.
11. Project specific operating manuals covering the installed Life Safety System. A generic or typical owner's instruction and operation manual shall not be acceptable to fulfill this requirement.
12. The application program listing for the system as installed at the time of acceptance by the building owner and/or local AHJ (disk, hard copy printout, and all required passwords).
13. Provide the name, address and telephone of the authorized factory representative.

G. Software and Firmware Operational Documentation:

1. Software operating and upgrade manuals.
2. Program Software Backup: On magnetic media or compact disk, complete with data files.
3. Device address list.
4. Printout of software application and graphic screens.

H. A copy of the Fire Alarm System submittal shall be provided to the Permits Department and to the Fire Marshall. Resubmit as required to make clarifications or revisions to obtain approval.

I. Equipment and cable identification/labelling schedule

J. Qualifications of persons working on the project.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: Personnel shall be trained and certified by manufacturer for installation of units required for this Project.

B. Installer Qualifications: Installation shall be by personnel certified by NICET as fire-alarm Level II technician.

C. Source Limitations for Fire-Alarm System and Components: Obtain fire-alarm system from single source from single manufacturer.

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

E. The contractor shall coordinate with the AHJ and the Fire Marshal. The contractor shall provide all certifications, testing, and other requirements that are required by the AHJ and the Fire Marshal. All certifications, testing, and other requirements which are required by the AHJ and the Fire Marshal shall be included in the contractor's bid price.

1.7 COORDINATION

- A. Fire alarm system manufacturer shall coordinate wiring and conduit layout and requirements with the Electrical Contractor.
- B. Keys for the locks and switches shall be coordinated with the owner and the Fire Department.
- C. Comply with the requirements for the Fire Marshall, the Elevator Safety Inspector and the Authority Having Jurisdiction. Program the fire alarm control panel as required.

1.8 SOFTWARE SERVICE AGREEMENT

- A. Comply with UL 864.
- B. Technical Support: Beginning with Substantial Completion, provide software support for two years.
- C. Upgrade Service: Update software to latest version at Project completion. Install and program software upgrades that become available within two years from date of Substantial Completion. Upgrading software shall include operating system. Upgrade shall include new or revised licenses for use of software.
 - 1. Provide 30 days' notice to Owner to allow scheduling and access to system and to allow Owner to upgrade computer equipment if necessary.

1.9 EXTRA MATERIALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Smoke Detectors: Quantity equal to 10 percent of amount of each type installed, but no fewer than 1 unit of each type.
 - 2. Detector Bases: Quantity equal to 2 percent of amount of each type installed, but no fewer than 1 unit of each type.
 - 3. Keys and Tools: One extra set for access to locked and tamperproofed components.
 - 4. Audible and Visual Notification Appliances: One of each type installed.
 - 5. Fuses: Two of each type installed in the system.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. The manufacturer of the system equipment shall be regularly involved in the design, manufacture, and distribution of all products specified in this document. These processes shall be monitored under a quality assurance program that meets the ISO 9000 requirements.
- B. All System components shall be the cataloged products of a single supplier. All products shall be listed by the manufacturer for their intended purpose.

- C. Edwards Systems Technology, Inc. products constitute the minimum type and quality of equipment to be installed.
- D. All control panel assemblies and connected field appliances shall be both designed and manufactured by the same company, and shall be tested and cross-listed as to ensure that a fully functioning is designed and installed. The system supplied under this specification shall be a microprocessor-based, system. The system shall utilize independently addressed, microprocessor-based smoke detectors, heat detectors, and modules as described in this specification.
- E. Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Edwards Systems Technology (EST), (Contact Ark Systems Inc. at 410-995-1220)

2.2 SYSTEMS OPERATIONAL DESCRIPTION

- A. Fire-alarm signal initiation shall be by one or more of the following devices and systems:
 - 1. Manual stations.
 - 2. Heat detectors.
 - 3. Smoke detectors.
 - 4. Duct smoke detectors.
 - 5. Automatic sprinkler system water flow.
- B. Fire-alarm signal shall initiate the following actions:
 - 1. Continuously operate alarm notification appliances.
 - 2. Identify alarm at fire-alarm control unit and remote annunciators.
 - 3. Transmit an alarm signal to the remote alarm receiving station.
 - 4. Unlock electric door locks in designated egress paths.
 - 5. Release fire and smoke doors held open by magnetic door holders.
 - 6. Activate alarm system.
 - 7. Switch heating, ventilating, and air-conditioning equipment controls to fire-alarm mode.
 - 8. Close smoke dampers in air ducts of designated air-conditioning duct systems.
 - 9. Recall elevators to primary or alternate recall floors.
 - 10. Record events in the system memory.
- C. Supervisory signal initiation shall be by one or more of the following devices and actions:
 - 1. Valve supervisory switch.
 - 2. Elevator shunt-trip supervision.
 - 3. Carbon monoxide detection.
- D. System trouble signal initiation shall be by one or more of the following devices and actions:
 - 1. Open circuits, shorts, and grounds in designated circuits.
 - 2. Opening, tampering with, or removing alarm-initiating and supervisory signal-initiating devices.
 - 3. Ground or a single break in fire-alarm control unit internal circuits.

4. Abnormal ac voltage at fire-alarm control unit.
 5. Break in standby battery circuitry.
 6. Failure of battery charging.
 7. Abnormal position of any switch at fire-alarm control unit or annunciator.
- E. System Trouble and Supervisory Signal Actions: Annunciate at fire-alarm control unit and remote annunciators. Transmit trouble or supervisory signal to the remote alarm receiving station.

2.3 FIRE-ALARM CONTROL PANEL AND FUNCTIONS

- A. The control panel shall be a multi-processor-based system designed specifically for fire and releasing system applications. The control panel shall be listed and approved for the application standards as listed under the General section.
- B. The control panel shall include all required hardware, software and system programming to provide a complete and operational system. The control panel shall assure that life safety takes precedence among all panel activities.
- C. The control panel shall include the following capacities:
1. Support up to 380 analog/addressable points per panel (1,900 total with 5 networked panels).
 2. Support up to 576 chronological events in history.
 3. Support up to 5 fully supervised network remote annunciators.
 4. Support a DACT (dialer) for off premise notification
 5. The control panel shall include the following features:
 - a. Provide auto-programing and electronic addressing and mapping of analog/addressable devices.
 - b. Provide an operator interface display that shall include functions required for annunciation, command and control system functions.
 - c. Provide a discreet system control switch provided for reset, alarm silence, local silence, drill switch, up/down switches, status switch, program switch, enable and disable switches, activate and restore switches, reports switch and test switch.
 - d. Provide system reports that provide sensitivity and history details.
 - e. Provide an authorized operator with the ability to operate or modify system functions like system time, date, passwords; and autoprogram, enable mapping, restart the system and clear control panel event history file.
 - f. Provide an authorized operator to perform test functions within the installed system.
 6. Supervision of system components, wiring, initiating devices and software shall be provided by the control panel. Failure or fault of system component or wiring shall be indicated by type and location on the LCD display. Software and processor operation shall be independently monitored for failure.
- D. ANNUNCIATION
1. The system shall be designed and equipped to receive, monitor, and annunciate signals from devices and circuits installed throughout the building. Manufacturer's standard control switches shall be acceptable if they provide the required operation, including performance, supervision and position indication. If the manufacturers' standard switches do not comply with these requirements, fabrication of custom manual controls acceptable to the owner is required.
 2. Receipt of alarm, trouble, and supervisory signals shall activate integral audible devices at the control panel(s) and at each remote annunciation device.
 3. The annunciator shall contain the following system status indicators:

- a. 80 character Backlit Liquid Crystal Display.
 - b. System Power Indicator – green LED
 - c. System Common Alarm – red LED
 - d. System Common Trouble – yellow LED
 - e. System Common Supervisory – yellow LED
 - f. System Common Monitor – yellow LED
 - g. System Ground Fault – yellow LED
 - h. System CPU Fault – yellow LED.
 - i. System Disabled – yellow LED.
 - j. System Test Point(s) – yellow LED.
 - k. System Reset Switch with Integral yellow LED.
 - l. System Alarm Silence Switch with Integral yellow LED.
 - m. System Local Silence Switch with Integral yellow LED.
 - n. System Drill Switch with Integral yellow LED.
 - o. System Message Queue Scroll Switches.
 - p. Additional buttons as required to provide system control and operator functions.
- E. Alphanumeric Display and System Controls: Arranged for interface between human operator at fire-alarm control unit and addressable system components including annunciation and supervision. Display alarm, supervisory, and component status messages and the programming and control menu.
1. The display module shall be of membrane style construction with a 4 line by 20 character Liquid Crystal Display. The LCD shall use super-twist technology and backlighting for high contrast visual clarity. In the normal mode display the time, the total number of active events and the total number of disable points. In the alarm mode display the total number of events and the type of event on display. Reserve 40 characters of display space for user custom messages. The module shall have visual indicators for the following common control functions; AC Power, alarm, supervisory, monitor, trouble, disable, ground fault, CPU fail, and test. There shall be common control keys and visual indicators for; reset, alarm silence, trouble silence, drill, and one custom programmable key/indicator. Provide four pairs of display control keys for selection of event display by type (alarm, supervisory, monitor and trouble) and forward / backward scrolling through event listings. The operation of these keys shall be integrated with the related common control indicator that lights when an event of its type is active. Allow the first event of the highest priority to capture the LCD for display so that arriving fire fighters can view the first alarm event "hands free". Provide system function keys; status, reports, enable, disable, activate, restore, program, and test. The module shall have a numeric keypad, zero through nine with delete and enter keys.
 2. The display module shall be an EST model 2-LCD.
- F. Circuits:
1. Initiating Device Circuits:
 - a. The Initiating device circuits (IDC) used to monitor manual fire alarm stations, smoke and heat detectors, waterflow switches, valve supervisory switches, fire pump functions, and air pressure supervisory switches shall be Class B (Style "A" or "B").
 - b. The Initiating device circuits shall be EST Signature series modules.
 2. 24 VDC Notification Appliance Circuits:
 - a. 24 VDC Notification appliance circuits (NAC) shall be Class B (Style "Y"). All notification appliance circuits shall have a minimum circuit output rating

- of 2 amp @ 24 vdc. The notification circuits shall be power limited. Non-power limited circuits are not acceptable.
- b. The 24 VDC Notification appliance circuits shall be EST Signature series modules
3. Signaling Line Circuits:
 - a. The signaling line circuit shall communicate from a panel/node to analog/addressable detectors, input modules, output modules, isolation modules and notification appliance circuits.
 - b. Each signaling circuit connected to addressable/analog devices shall provide a minimum of 20 spare addresses. When a signaling line circuit covers more than one fire/smoke compartments, a wire-to-wire short shall not effect the operation of the circuit from the other fire/smoke compartments. The signaling line circuit (SLC) connecting panels and annunciators shall be Class B (style 4).
 - c. The signaling line circuit connecting to addressable/analog devices including, detectors, monitor modules, control modules, isolation modules, and notification circuit modules shall be Class B (style 4).
 4. Serial Interfaces: Two RS-232 ports for printers.
- G. Elevator Recall:
1. Smoke detectors at the following locations shall initiate automatic elevator recall. Alarm-initiating devices, except those listed, shall not start elevator recall.
 - a. Elevator lobby detectors except the lobby detector on the designated floor.
 - b. Smoke detector in elevator machine room.
 - c. Smoke detectors in elevator hoistway (top of elevator shaft and in the elevator pit)
 2. Elevator lobby detectors located on the designated recall floors shall be programmed to move the cars to the alternate recall floor.
 3. A heat detector alarm and/or a water-flow alarm connected to sprinkler in an elevator shaft (top of elevator shaft and in the elevator pit) and elevator machine room shall shut down elevators associated with the location without time delay.
- H. Door Controls: Door hold-open devices that are controlled by smoke detectors at doors in smoke barrier walls shall be connected to fire-alarm system.
- I. Remote Smoke-Detector Sensitivity Adjustment: Controls shall select specific addressable smoke detectors for adjustment, display their current status and sensitivity settings, and change those settings. Allow controls to be used to program repetitive, time-scheduled, and automated changes in sensitivity of specific detector groups. Record sensitivity adjustments and sensitivity-adjustment schedule changes in system memory, and print out the final adjusted values on system printer.
- J. Transmission to Remote Alarm Receiving Station: Automatically transmit alarm, supervisory, and trouble signals to a remote alarm station.
- K. Printout of Events: On receipt of signal, print alarm, supervisory, and trouble events. Identify zone, device, and function. Include type of signal (alarm, supervisory, or trouble) and date and time of occurrence. Differentiate alarm signals from all other printed indications. Also print system reset event, including same information for device, location, date, and time. Commands initiate the printing of a list of existing alarm, supervisory, and trouble conditions in the system and a historical log of events.

- L. Primary Power: 24-V dc obtained from 120-V ac service and a power-supply module. Initiating devices, notification appliances, signaling lines, trouble signals, supervisory and digital alarm communicator transmitters shall be powered by 24-V dc source.
 - 1. Alarm current draw of entire fire-alarm system shall not exceed 80 percent of the power-supply module rating.

- M. Secondary Power: 24-V dc supply system with batteries, automatic battery charger, and automatic transfer switch.
 - 1. Batteries shall be sealed and maintenance free.

- N. Instructions: Computer printout or typewritten instruction card mounted behind a plastic or glass cover in a stainless-steel or aluminum frame. Include interpretation and describe appropriate response for displays and signals. Briefly describe the functional operation of the system under normal, alarm, and trouble conditions.

- O. Digital Alarm Communicator and Transmitter:
 - 1. The panel shall have a dialer (alarm communicator transmitter (DACT)) module to transmit alarm, supervisory and trouble signals to a Central Monitoring Station (CMS). The DACT shall support dual telephone lines, 20 PPS 4/2 communications, and configured for dual tone multi-frequency (DTMF) or pulse modes. It shall be possible to delay AC power failure reports, auto test call, and site program using a touch tone phone and password.
 - 2. The dialer shall be an EST model DL2.

- P. Display
 - 1. System Message Processing and Display Operations:
 - a. The system shall allow message routing to be configured to any or all annunciators.
 - b. All system printer port shall be configurable to output any combination of alarm, supervisory, trouble, or monitor, event messages.
 - c. Each LCD display on each annunciator shall be configurable to display the status of any combination of alarm, supervisory, trouble, or monitor, event messages.
 - d. Clear distinction shall be provided between alarm, supervisory, trouble, and monitor status messages.
 - e. The system shall provide the ability to retrieve data from the analog/addressable detectors to a PC while the system is on-line and operational in the protected premises. The uploaded data may then be analyzed in a diagnostic program supplied by the system manufacturer.
 - f. A standby power supply shall automatically supply electrical energy to the system upon primary power supply failure.

- Q. Reports
 - 1. The system shall provide the operator with system reports that give detailed chronological description of the last 576 system events. The system shall provide a report that gives a listing of the sensitivity and environmental compensation usage of all of the detectors on the system, or specified analog/addressable circuit.
 - 2. The system report shall also include facility name, compiled date, compiler revision, project revision and report date. The system shall output these reports via the main LCD, and reports shall be capable of being printed on the system printer.

- R. Battery backup:

1. The entire fire alarm system shall have a battery backup system. Batteries shall be sized for 24 hours of standby followed by 15 minutes of alarm. Provide an additional 20% spare battery capacity on top of that.

2.4 BOOSTER POWER SUPPLIES

- A. The booster supply must incorporate four independent supervised Notification Appliance Circuits. It shall be possible to configure the NACs to follow the main panel's NAC or activate from intelligent Signature Series modules. The booster NACs must be configurable to operate independently at any one of the following rates: continuous; 120 SPM; or, 3-3-3 temporal. Fault conditions on the booster shall not impede alarm activation of host NAC circuits.
- B. Fault conditions detected by the power supply shall open the main fire alarm control panel's NAC. This initiates a trouble condition and eliminates the need to wire a separate trouble signal back to the control panel.
- C. Power supply shall have an enclosure.
- D. Battery backup shall be provided.
- E. Booster Power Supplies shall be EST BPS Series with enclosure and battery backup.

2.5 MANUAL FIRE-ALARM BOXES

- A. Provide analog/addressable single action, single stage fire alarm stations at the locations shown on the drawings. The fire alarm station shall be of metal construction and incorporate an internal toggle switch. The station shall be finished in red with silver "PULL IN CASE OF FIRE" lettering. The manual station shall be suitable for mounting on North American 2 ½ (64mm) deep 1-gang boxes and 1 ½ (38mm) deep 4 square boxes with 1-gang covers.
- B. The analog/addressable single action, single stage fire alarm stations shall be EST model SIGA-270.

2.6 SYSTEM SMOKE DETECTORS

- A. Analog Addressable Smoke General
 1. Each analog addressable smoke detector's sensitivity shall be capable of being programmed individually as: most sensitive, more sensitive, normal, less sensitive or least sensitive.
 2. An alternate alarm sensitivity level shall be provided for each detector, which can be set to any of the five (5) sensitivity settings manually or automatically using a time of day event.
 3. The detector's sensing element reference point shall automatically adjust, compensating for background environmental conditions such as dust, temperature, and pressure. Periodically, the sensing element real-time analog value shall be compared against its reference value. The detector shall provide a maintenance alert signal that 80% to 99% compensation has been used. The detector shall provide a dirty fault signal that 100% compensation has been used.
 4. The system shall allow for changing of detector types for service replacement purposes without the need to reprogram the system. The replacement detector

type shall automatically continue to operate with the same programmed sensitivity levels and functions as the detector it replaced. System shall display an off-normal condition until the proper detector type has been installed or change in the application program profile has been made.

- B. Smoke Detector – Photoelectric
 - 1. Smoke detector shall be analog/addressable photoelectric smoke detector type.
 - 2. The system shall have the ability to set the sensitivity and alarm verification of each of the individual detectors on the circuit. It shall be possible to automatically change the sensitivity of individual analog/addressable detectors for the day and night periods. Each smoke detector shall be capable of transmitting alarm signals as well as normal, trouble and need cleaning information. It shall be possible to program control panel activity to each level. Each smoke detector may be individually programmed to operate at any one of five (5) sensitivity settings. Each detector microprocessor shall contain an environmental compensation algorithm that identifies and sets ambient environmental thresholds approximately six times an hour. The microprocessor shall monitor the environmental compensation value and alert the system operator when the detector approaches 80% and 100% of the allowable environmental compensation value.
 - 3. The analog/addressable photoelectric smoke detector shall be an EST model SIGA-PS.

- C. Duct Detector Housing
 - 1. Provide smoke detector duct housing assemblies to mount an analog/addressable detector along with a standard, relay or isolator detector mounting base. The housing shall also protect the measuring chamber from damage and insects. The housing shall utilize an air exhaust tube and an air sampling inlet tube that extends into the duct air stream up to ten feet. Drilling templates and gaskets to facilitate locating and mounting the housing shall also be provided. The housing shall be finished in baked red enamel.
 - 2. A remote key-operated test station with built-in alarm LED indicator shall be provided for each duct smoke detector.
 - 3. The smoke detector duct housing shall be an EST model SIGA-DH.

2.7 SYSTEM HEAT DETECTORS

- A. Heat detector shall be analog/addressable combination fixed temperature / rate-of-rise detector type.
- B. The heat detector shall have a nominal fixed temperature alarm point rating of 135°F (57°C) and a rate of rise alarm point of 15°F(9°C) per minute. The heat detector shall be rated for ceiling installation at a minimum of 70 ft (21.3m) centers and be suitable for wall mount applications.
- C. The analog/addressable combination fixed temperature / rate-of-rise detector shall be EST model SIGA-HRS.

2.8 DETECTOR BASES

- A. Provide standard detector mounting bases suitable for mounting on either North American 1-gang, 3½ or 4 inch octagon box and 4 inch square box, or European BESA

or 1-gang box. The base shall, contain no electronics and support all series detector types.

- B. The standard detector base shall be an EST model SIGA-SB.

2.9 NOTIFICATION APPLIANCES

A. General (signals)

1. All appliances which are supplied for the requirements of this specification shall be UL Listed for Fire Protective Service, and shall be capable of providing the "equivalent facilitation" which is allowed under the Americans with Disabilities Act Accessabilities Guidelines (ADA(AG)), and shall be UL 1971 Listed.
2. All appliances shall be of the same manufacturer as the fire alarm control panel specified to insure absolute compatibility between the appliances and the control panels, and to insure that the application of the appliances are done in accordance with the single manufacturer's instructions.
3. Any appliances that do not meet the above requirements, and are submitted for use must show written proof of their compatibility for the purpose intended. Such proof shall be in the form of documentation from all manufacturers that clearly states that their equipment (as submitted) is 100% compatible with each other for the purpose intended. All strobes shall be provided with lens markings oriented for wall mounting.
4. All notification appliances shall be red unless noted otherwise on the drawings.
5. The word "FIRE" shall be engraved on the devices.
6. Provide weatherproof devices where indicated on the drawings.

B. Horns

1. The horn shall have a minimum of 2 field selectable settings for dBA levels. Horn shall be UL Listed under Standard 464.

C. Speaker

1. The speaker shall have a minimum of 4 field selectable settings for dBA levels. Speaker shall be UL Listed under Standard 1480.

D. Strobes

1. The strobe shall have switch selectable settings for light output. Output shall be rated per UL Standard 1971 for 15, 30, 75 and 110 candela. Strobes shall provide synchronized output.

E. Horn-Strobe

1. The combination device shall consists of a horn and a strobe.
 - a. The horn shall have a minimum of 2 field selectable settings for dBA levels. Horn shall be UL Listed under Standard 464.
 - b. The strobe shall have switch selectable settings for light output. Output shall be rated per UL Standard 1971 for 15, 30, 75 and 110 candela. Strobes shall provide synchronized output.

F. Speaker-Strobe

1. The combination device shall consist of a speaker and a strobe.
 - a. The speaker shall have a minimum of 4 field selectable settings for dBA levels. Speaker shall be UL Listed under Standard 1480.
 - b. The strobe shall have switch selectable settings for light output. Output shall be rated per UL Standard 1971 for 15, 30, 75 and 110 candela. Strobes shall provide synchronized output.

2.10 INITIATION AND CONTROL MODULES

- A. Intelligent Modules – General
 - 1. It shall be possible to address each intelligent module without the use of DIP or rotary switches. Devices using DIP switches for addressing shall not be acceptable. The personality of multifunction modules shall be programmable at site to suit conditions and may be changed at any time using a personality code downloaded from the Analog Loop Controller. Modules requiring EPROM, PROM, ROM changes or DIP switch and/or jumper changes shall not be acceptable. The modules shall have a minimum of 2 diagnostic LEDs mounted behind a finished cover plate. A green LED shall flash to confirm communication with the loop controller. A red LED shall flash to display alarm status. The module shall be capable of storing up to 24 diagnostic codes which can be retrieved for troubleshooting assistance. Input and output circuit wiring shall be supervised for open and ground faults. The module shall be suitable for operation in the following environment:
 - a. Temperature: 32°F to 120°F (0°C to 49°C)
 - b. Humidity: 0-93% RH, non-condensing
- B. Control Relay Module
 - 1. The Control Relay Module shall provide one form "C" dry relay contact rated at 2 amps @ 24 Vdc (0.5 amps at 120VAC) to control external appliances or equipment shutdown. The control relay shall be rated for pilot duty and releasing systems. The position of the relay contact shall be confirmed by the system firmware. The control relay module shall be suitable for mounting on North American 2 ½" (64mm) deep 1-gang boxes and 1 ½" (38mm) deep 4" square boxes with 1-gang covers.
 - 2. The addressable control relay circuit module shall be an EST model SIGA-CR.
- C. Dual Input Module
 - 1. The Dual Input Module shall provide two (2) supervised Class B input circuits each capable of a minimum of 4 personalities, each with a distinct operation. The module shall be suitable for mounting on North American 2 ½" (64mm) deep 1-gang boxes and 1 ½" (38mm) deep 4" square boxes with 1-gang covers. The dual input module shall support the following circuit types:
 - a. Normally-Open Alarm Latching (Manual Stations, Heat Detectors, etc.)
 - b. Normally-Open Alarm Delayed Latching (Waterflow Switches)
 - c. Normally-Open Active Non-Latching (Monitor, Fans, Dampers, Doors, etc.)
 - d. Normally-Open Active Latching (Supervisory, Tamper Switches)
 - 2. The intelligent dual input module shall be an EST model SIGA-CT2.
- D. Isolator Module
 - 1. The Isolator Module shall be capable of isolating and removing a fault from a class A data circuit while allowing the remaining data loop to continue operating. The module shall be suitable for mounting on North American 2 ½" (64mm) deep 2-gang boxes and 1 ½" (38mm) deep 4" square boxes with 2-gang covers, or European 100mm square boxes.
 - 2. The intelligent fault isolator module shall be an EST model SIGA-IM.
- E. Single Input Module
 - 1. The Single Input Module shall provide one (1) supervised Class B input circuit capable of a minimum of 4 personalities, each with a distinct operation. The module shall be suitable for mounting on North American 2 ½" (64mm) deep 1-gang boxes and 1 ½" (38mm) deep 4" square boxes with 1-gang covers. The single input module shall support the following circuit types:
 - a. Normally-Open Alarm Latching (Manual Stations, Heat Detectors, etc.)

- b. Normally-Open Alarm Delayed Latching (Waterflow Switches)
 - c. Normally-Open Active Non-Latching (Monitor, Fans, Dampers, Doors, etc.)
 - d. Normally-Open Active Latching (Supervisory, Tamper Switches)
 2. The intelligent single input module shall be an EST model SIGA-CT1.
 - F. Single Input Signal Module
 1. The Single Input (Single Riser Select) Signal Module shall provide one (1) supervised Class B output circuit capable of a minimum of 2 personalities, each with a distinct operation. When selected as a telephone power selector, the module shall be capable of generating its own "ring tone". The module shall be suitable for mounting on North American 2 ½" (64mm) deep 2-gang boxes and 1 ½" (38mm) deep 4" square boxes with 2-gang covers, or European 100mm square boxes. The single input signal module shall support the following operations:
 - a. Audible/Visible Signal Power Selector (Polarized 24 Vdc @ 2A, 25Vrms @50w or 70 Vrms @ 35 Watts of Audio)
 - b. Telephone Power Selector with Ring Tone (Fire Fighter's Telephone)
 2. The intelligent single input signal module shall be an EST model SIGA-CC1.
 - G. Dual Input Signal Module
 1. The Dual Input (Dual Riser Select) Signal Module shall provide two (2) supervised Class B output circuits capable of a minimum of 2 personalities, each with a distinct operation. When selected as a telephone power selector, the module shall be capable of generating its own "ring tone". The module shall be suitable for mounting on North American 2 ½" (64mm) deep 2-gang boxes and 1 ½" (38mm) deep 4" square boxes with 2-gang covers, or European 100mm square boxes. The dual input signal module shall support the following operations:
 - a. Audible/Visible Signal Power Selector (Polarized 24 Vdc @ 2A, 25Vrms @50w or 70 Vrms @ 35 Watts of Audio)
 - b. Telephone Power Selector with Ring Tone (Fire Fighter's Telephone)
 2. The intelligent single input signal module shall be an EST model SIGA-CC2.
 - H. Multi-Voltage Control Relay
 1. The relay is encapsulated multi-voltage device providing 10 amp form C contacts. The relay may be energized by one of three input voltages: 24VAC, 24VDC or 115VAC.
 2. The relay shall support the following operations:
 - a. To be provided as required to switch larger currents that cannot be handled by other devices.
 - b. To monitor 24VDC voltage.
 3. The relay shall be EST model PAM-1.
- 2.11 MAGNETIC DOOR HOLDERS
- A. Description: Units are equipped for wall or floor mounting as indicated and are complete with matching doorplate.
 1. Electromagnet: Requires no more than 3 W to develop 25-lbf holding force.
 2. Wall-Mounted Units: Flush mounted unless otherwise indicated.
 3. Rating: 24VDC. Provide power to the door holder from the fire alarm system 24VDC power supplies.
 4. Material and Finish: Match door hardware.

2.12 FIRE ALARM ANNUNCIATOR PANEL

- A. The annunciator panel shall include an LCD Display mounted inside the enclosure. LCD shall have 4 lines of 20 characters per line. Display shall be capable of supporting custom messages as well as system event annunciation. It must be possible to filter unwanted annunciation of trouble, alarm or supervisory functions.
- B. Provide fire alarm graphic annunciator panels where graphic panels are required by the drawings.

2.13 FIRE ALARM DOCUMENTS BOX

- A. Fire Alarm Documents Box shall Space Age Electronics, Inc Fire Alarm Storage Cabinet RED with the following features:
 - 1. The documents box shall be UL listed, constructed of 18 gauge cold rolled steel. It shall have a red powder coat epoxy finish. The cover shall be permanently screened with 1" high lettering "FIRE ALARM DOCUMENTS" with white indelible ink. The access door shall be locked with a 3/4" barrel lock and the hinge shall be a solid width 12" stainless steel piano hinge. The enclosure will supply 4 mounting holes. Inside the enclosure will accommodate standard 8 1/2" x 11" manuals and loose document records that will be protected within the enclosure. A legend sheet will be permanently attached to the door for system required documentation. Key contacts and system information. The documents box will have securely mounted inside a minimum of 4 Gigabyte digital flash memory drive with a standard USB B connector for uploading and downloading information. The drive shall not be accessible without tools to any person whom gains access to the records. The enclosure shall also provide 2 key ring holders with a location to mount standard business type cards for key contact personnel.
 - 2. The items that shall be stored in the documents box include, but are not limited to, the following: fire alarm software, business cards for fire alarm system installer, test records, inspection records, service records, systems records, manuals, and folded as-built drawings of the fire alarm system.

PART 3 - EXECUTION

3.1 EQUIPMENT INSTALLATION

- A. Where the project includes an elevator, provide the following modules:
 - 1. Provide 2 control modules per elevator, one to recall the elevator to the primary floor and one to recall the elevator to the alternate floor.
 - 2. Provide 1 control module to activate the firefighter's hat flash.
 - 3. Provide 1 monitor module to monitor the shunt trip voltage for the elevator.
 - 4. Provide 1 control module to shunt trip the power feeder for the elevator.
- B. Air Handling Unit Shutdown:
 - 1. Duct smoke detectors shall include housing, sampling tube, smoke detector, and remote key-operated test station (with built-in alarm LED indicator). Provide wiring as recommended by the manufacturer in 3/4" conduit from duct smoke detector to remote test station. Remote test station shall be located in an accessible location that can easily be seen.
 - 2. Provide a control module to interlock with the Air Handling Unit.

- C. Provide booster power supplies and audio power supplies as required or as indicated. Field install circuit breakers as required to provide power to the booster panels. Provide branch circuit wiring (2#12 & #12G in 1/2" conduit, minimum) to feed power to the power supply. Install power supplies in an accessible location. Do not install above the ceiling.
- D. Comply with NFPA 72 for installation of fire-alarm equipment.
- E. Install wall-mounted equipment, with tops of cabinets not more than 72 inches above the finished floor.
- F. Smoke- or Heat-Detector Spacing:
 - 1. Comply with NFPA 72, "Smoke-Sensing Fire Detectors" Section in the "Initiating Devices" Chapter, for smoke-detector spacing.
 - 2. Comply with NFPA 72, "Heat-Sensing Fire Detectors" Section in the "Initiating Devices" Chapter, for heat-detector spacing.
 - 3. HVAC: Locate detectors not closer than 3 feet from air-supply diffuser or return-air opening.
 - 4. Lighting Fixtures: Locate detectors not closer than 12 inches from any part of a lighting fixture.
- G. Duct Smoke Detectors: Comply with NFPA 72 and NFPA 90A. Install sampling tubes so they extend the full width of duct.
- H. Heat Detectors in Elevator Shafts: Coordinate temperature rating and location with sprinkler rating and location. Comply with NFPA 72.
- I. Remote Status and Alarm Indicators: Install near each smoke detector and each sprinkler water-flow switch and valve-tamper switch that is not readily visible from normal viewing position.
- J. Circuit disconnecting means (circuit breaker) for the Fire Alarm Control Panel shall have a red marking, and shall be identified as "FIRE ALARM CIRCUIT".
- K. Circuit disconnecting means (circuit breaker) for the Fire Alarm power supplies and other fire alarm system components that require 120VAC shall have a red marking, and shall be identified as "FIRE ALARM - XXX", where "XXX" is the description of the equipment.
- L. The location of the circuit disconnecting means (circuit breaker) feeding the Fire Alarm Control Panel shall be permanently identified at the Fire Alarm Control Panel.
- M. All strobes shall flash in synchronization. Provide synchronization modules as required.
- N. Provide fire alarm documents box adjacent to the fire alarm control panel.
- O. Prior to installing devices and equipment, the contractor shall coordinate the exact locations where the devices and equipment are being installed with the plan drawings and existing conditions, and shall notify the engineer immediately if there are any issues or conflicts. The coordinated locations shall be indicated in the shop drawing submittals. Where conflicts are found during or after the shop drawing submittal process, but before installation of the devices and equipment, the contractor shall notify the engineer of the conflict, and shall adjust the locations of the devices and equipment, where directed by the engineer to do so. The contractor's bid price shall include

adjusting the locations of devices and equipment up to 12 feet from the locations on the plan drawings, unless otherwise noted.

3.2 CONNECTIONS

- A. Install the interface device less than 3 feet from the device controlled. Make an addressable confirmation connection when such feedback is available at the device or system being controlled.

3.3 IDENTIFICATION

- A. Each equipment shall be labeled with an address/identification name/number which matches information provided in the submittals or indicated in the drawings. Identify each cable segment between equipment with a unique number corresponding to the address/identification name/number of the associated equipment. Provide a cable schedule which identifies each cable segment and the associated equipment.
- B. Install framed instructions in a location visible from fire-alarm control unit.
- C. Junction box covers shall be painted red.
- D. Fire alarms cables shall be red in color.

3.4 GROUNDING

- A. Ground fire-alarm control unit and associated circuits; comply with IEEE 1100. Install a ground wire from main service ground to fire-alarm control unit.

3.5 FIELD QUALITY CONTROL

- A. Field tests shall be witnessed by the authorities having jurisdiction.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
- C. Perform tests and inspections.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- D. Tests and Inspections:
 - 1. Visual Inspection: Conduct visual inspection prior to testing.
 - a. Inspection shall be based on completed Record Drawings and system documentation that is required by NFPA 72 in its "Completion Documents, Preparation" Table in the "Documentation" Section of the "Fundamentals of Fire Alarm Systems" Chapter.

- b. Comply with "Visual Inspection Frequencies" Table in the "Inspection" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA 72; retain the "Initial/Reacceptance" column and list only the installed components.
 - 2. System Testing: Comply with "Test Methods" Table in the "Testing" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA 72.
 - 3. Test audible appliances for the public operating mode according to manufacturer's written instructions. Perform the test using a portable sound-level meter complying with Type 2 requirements in ANSI S1.4.
 - 4. Test audible appliances for the private operating mode according to manufacturer's written instructions.
 - 5. Test visible appliances for the public operating mode according to manufacturer's written instructions.
 - 6. Factory-authorized service representative shall prepare the "Fire Alarm System Record of Completion" in the "Documentation" Section of the "Fundamentals of Fire Alarm Systems" Chapter in NFPA 72 and the "Inspection and Testing Form" in the "Records" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA 72.
 - 7. Using a portable sound-level meter complying with Type 2 requirements in ANSI S1.4, field verify that the measured sound level (during a fire alarm condition) in each room, space or area complies ADA and NFPA 72 requirements. Record the measured sound level in each room, space or area, and indicate if it complies with ADA and NFPA 72 requirements. If it does not comply, provide written recommendations in order to fix the deficiency.
- E. Fire-alarm system will be considered defective if it does not pass tests and inspections.
 - F. Prepare test and inspection reports.
 - G. Maintenance Test and Inspection: Perform tests and inspections listed for weekly, monthly, quarterly, and semiannual periods. Use forms developed for initial tests and inspections.
 - H. Annual Test and Inspection: One year after date of Substantial Completion, test fire-alarm system complying with visual and testing inspection requirements in NFPA 72. Use forms developed for initial tests and inspections.

3.6 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain fire-alarm system.
- B. The System Supplier shall schedule and present a minimum of 8 hours of documented formalized instruction for the building owner, detailing the proper operation of the installed System.
- C. The instruction shall be presented in an organized and professional manner by a person factory trained in the operation and maintenance of the equipment and who is also thoroughly familiar with the installation.
- D. The instruction shall cover the schedule of maintenance required by NFPA 72 and any additional maintenance recommended by the system manufacturer.

- E. Instruction shall be made available to the Local Municipal Fire Department if requested by the Local Authority Having Jurisdiction.

END OF SECTION 283111