PROJECT MANUAL – VOLUME 2 OF 2

Tomball High School #3

Tomball Independent School District

Tomball, Texas

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MORE THAN ARCHITECTS

PROJECT MANUAL

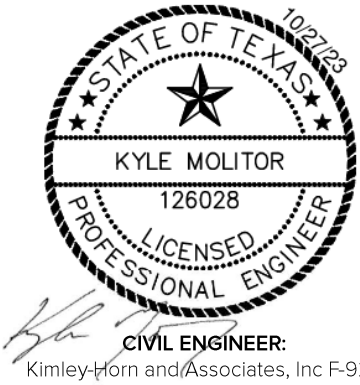
Project Name:	Tomball High School #3 – Volume 2 of 2		
Client Name:	Tomball Independent School District	Location:	Tomball, Texas
Project Number:	(1940-01-01)	Date:	November 2, 2023

All inquiries shall be forwarded to Caitlin Munch, Huckabee; caitlin.munch@huckabee-inc.com; 800.687.1229.

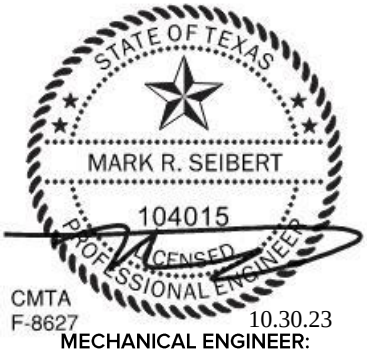
PROJECT TEAM

ARCHITECT:
Huckabee & Associates, Inc.
Brendon Hoffman, AIA 25988
800.687.1229

STRUCTURAL ENGINEER:
Huckabee & Associates, Inc., F-1252
R. Craig McKee, PE 111569
800.687.1229



CIVIL ENGINEER:
Kimley-Horn and Associates, Inc F-928
Kyle Molitor, P.E.
281.597.9300



MECHANICAL ENGINEER:
CMTA, Inc.
Mark R. Seibert
281.366.9068

ELECTRICAL ENGINEER:
CMTA Inc.
Gregory J. Gehrt
281.366.9068

Huckabee

10.30.23

TECHNOLOGY:
CMTA, Inc.
Ian Soule
281.366.9068

10.30.23

SPORTS DESIGN:
Sports Design Group, LLC
Richard McDonald, RLA
469.952.2060

THEATER DESIGN:
Wrightson, Johnson, Haddon, & Williams
F# 19548
Emily Piersol
972.934.3700

TABLE OF CONTENTS – VOLUME 2 OF 2

DIVISION 23 – HEATING, VENTILATING, AND AIR CONDITIONING

DIVISION 26 – ELECTRICAL

END OF SECTION

SECTION 13 1733
WHIRLPOOL TUBS

GENERAL

1.01 SUMMARY

A. Related Documents: General and Supplementary Conditions of the Contract, Division 01 General Requirements, and Drawings are applicable to this Section.

B. Section Includes, but is not limited to:
   1. Hydrotherapy bathtubs, fixtures and accessories

C. Related Sections:
   1. Division 22 – Plumbing
   2. Division 26 – Electrical

1.02 REFERENCES

A. American National Standards Institute (ANSI):
   1. Z124.1 - American National Standard for Plastic Bathtub Units

B. American Society for Testing and Materials (ASTM):
   1. E 84 - Standard Test Method for Surface Burning Characteristics of Building Materials
   2. F 446 - Standard Consumer Safety Specification for Grab Bars and Accessories Installed in the Bathing Area.

1.03 SUBMITTALS

A. Shop drawings, product data, and samples under provisions of Section 01 3300 – Submittal Procedures.

B. Product Data: Manufacturer's data sheets on each product to be used, including:
   1. Preparation instructions and recommendations.
   2. Storage and handling requirements and recommendations.
   3. Installation methods.

C. Shop Drawings:
   1. Dimensioned drawings of overall size, rough-in dimensions, reinforcing locations, molded features and accessory placement.

D. Samples:
   1. For each finish product specified, two complete sets of color chips representing manufacturer's full range of available colors and patterns.

E. Closeout Submittals:
   1. Submit under provisions of Section 01 7800 – Closeout Submittals.

1.04 QUALITY ASSURANCE

A. Regulatory Requirements:
   1. Conform to ANSI- I Z124.1 - bath tub.
   2. Fire resistance: Units shall be certified with backside flame spread of less than 30 complying with ASTM E 84.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Comply with requirements of Section 01 6600 – Product Storage and Handling Requirements.

B. Storage and Protection
   1. Store products in manufacturer's unopened packaging until ready for installation.

1.06 WARRANTY

A. Comply with requirements of Section 01 7800 – Closeout Submittals.

B. Submit a written warranty, executed by the Contractor, Installer, and Manufacturer, agreeing to repair or replace whirlpool tub that fails in materials or workmanship within the specified warranty period.
   1. Warranty Period: One (1) year commercial warranty after date of Substantial Completion on all components.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Subject to compliance with requirements indicated herein, provide products of one of the listed manufacturers.
   1. Whitehall Manufacturing: www.whitehallmfg.com.
   2. Morgan Spas: www.morganusa.com.
   3. Hot Spring: www.hotspring.com.
   4. Substitutions: Under provisions of Section 01 6000 – Product Requirements

2.02 HYDROTHERAPY BATHTUBS

A. Whirlpool Tub
   1. Configuration: Oval tank with stainless steel legs
   2. Tub Size: 46”L x 24”W x 25”D.
   3. Capacity: 90 gallons
   4. Tub Color: 304 Stainless Steel.
   5. Acceptable Product: Whitehall S-90-M.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Site Verification of Conditions:
   1. Do not begin installation until rough-ins and openings have been properly prepared.
   2. If rough-in preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

3.02 PREPARATION

A. Comply with provisions of Section 01 7200 – Preparation.

B. Prepare supporting surfaces using the methods recommended by the manufacturer for achieving the best result for the installation under the project conditions.

3.03 INSTALLATION

A. Comply with provisions of Section 01 7300 – Execution.

B. Install in accordance with manufacturer's instructions.

C. Bed and seal perimeter and flanges to make water tight and to receive adjacent finish details.

3.04 CLEANING AND POLISHING

A. Cleaning
   1. Comply with requirements of Section 01 7400 – Cleaning and Waste Management.

3.05 PROTECTION

A. Protect installed products until completion of project.

B. Touch-up, repair or replace damaged products until Substantial Completion.

END OF SECTION

SECTION 13 3416
GRANDSTANDS AND BLEACHERS

PART 1 – GENERAL

1.01 SECTION INCLUDES

A. Permanent Steel Grandstands

B. Elevated Angle Frame Bleachers

C. Non-Elevated Angle Frame Bleachers

1.02 RELATED REQUIREMENTS

A. Documents affecting work of this Section include, but are not necessarily limited to, General Conditions, Supplementary Conditions, and Sections in Division 01 of these Specifications.

B. Section 00 3132 – Geotechnical Data.

C. Section 01 4100 – Regulatory Requirements.

D. Section 03 3000 – Cast-In-Place Concrete.

1.03 REFERENCE STANDARDS

A. AAMA 2603 - Voluntary Specification, Performance Requirements and Test Procedures for Pigmented Organic Coatings on Aluminum Extrusions and Panels.

B. AISC Steel Construction Manual.

C. Aluminum Association (AA) Aluminum Design Manual.

D. ASTM A 36 / A 36M - Standard Specification for Carbon Structural Steel.

E. ASTM A 123 / A 123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.

F. ASTM A 307 - Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60?000 PSI Tensile Strength.

G. ASTM A 325 - Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength.

H. ASTM A 529 / A 529M - Standard Specification for High-Strength Carbon-Manganese Steel of Structural Quality.

I. ASTM A 992 / A 992M - Standard Specification for Structural Steel Shapes.

J. AWS D1.1 / D1.1M - Structural Welding Code - Steel.

1.04 QUALITY ASSURANCE

A. Use adequate numbers of skilled workmen who are thoroughly trained and experienced in the necessary crafts and who are completely familiar with the specified requirements and the methods needed for proper performance of the work of this Section.

B. Manufacturer Qualifications: Manufacturers must have ten years of experience in the manufacture of bleachers and grandstands; welders must be AWS certified.

C. Installer Qualifications: Experienced in the proper installation of grandstands.

D. Source Quality Control: Mill Test Certification.

1.05 SUBMITTALS

A. Comply with pertinent provisions of Section 01 3000 – Administrative Requirements.

B. Product data: Within 15 calendar days after the Contractor has received the Owner's Notice to Proceed, submit:

C. Manufacturer's Product Data: Submit manufacturer's descriptive product data for project.

D. Shop Drawings: Manufacturer to submit shop drawings sealed by a registered professional engineer and schedules for type, location, quantity, and details of steel and aluminum components required for project.

E. Shop drawing sheets that include engineering information designed by the Contractor's Delegated Design Engineer shall be signed and sealed in accordance with the Texas Engineering Practice Act. Sheets that do not provide information designed by the Contractor's Engineer do not require being signed and sealed. Calculation packages require a signed and sealed cover sheet only. Any submittals requiring to be signed and sealed that are received without the signature and seal will be rejected without review.

F. Product Sample: Submit one 18-inch seat sample.

G. Color Sample: If applicable, submit sample.

H. Manufacturer's recommended installation procedures which, when approved by the Architect, will become the basis for accepting or rejecting actual installation procedures used on the Work.

1.06 PRODUCT HANDLING

A. Comply with pertinent provisions of Section 01 6000 – Product Requirements.

1.07 WARRANTY

A. Grandstands/Bleachers shall be under warranty for a period of one year beginning at Date of Substantial Completion. The system is warranted to be free from defect in materials and workmanship in the course of manufacture.

PART 2 – PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Southern Bleacher Company: www.southernbleacher.com

B. Sturdi-Steel: www.sturdisteel.com.

C. Equal products of other manufacturers with Architect's approval prior to bidding.

2.02 DESIGN REQUIREMENTS

A. Provide labor, material, equipment and supervision necessary to complete installation of pre-engineered grandstands and bleachers including, but not limited to the following: steel substructure, decking system, concrete foundation/piers and support structure. This scope is a performance-based specification. The scope includes all design and installation as required for a complete installation. A full copy of the geotechnical report copy has been included in the project manual. Design shall comply with all applicable codes and accessibility regulations.

B. Design: Conform to AISC Steel Construction Manual and AA Aluminum Design Manual.

C. Applicable Codes: Design and workmanship shall be in accordance with IBC 2012 and ICC 300 Bleachers, Folding and Telescopic Seating, and Grandstands.

D. Design Loads:
   1. Live Loads:
      a. Uniform Loading, Structure: 100 psf.
      b. Uniform Loading, Seats: 120 plf.
   2. Sway Loads:
      a. Perpendicular to Seats: 10 plf.
      b. Parallel to Seats: 24 plf.
   3. Wind Loads: Local building code.
   4. Snow Loads: Local building code.
   5. Seismic Loads: Local building code.
   6. Handrail and Guardrail: 250 lbs. concentrated in any direction.

E. Shop Connections: Welded and capable of carrying stress put upon them.

F. Welding: AWS D1.1.

G. Concrete Foundations: Manufacturer shall design and install concrete foundations as specified in Section 03 3000.

2.03 PERMANENT STEEL GRANDSTAND

A. Product Description
   1. Beam Design: Vertical columns are placed laterally and front to back per delagated design engineered drawings. All horizontal beams are wide flange beams. Traverse bays are free of cross-bracing the total length of the grandstand.
   2. Stringers: Stringers are steel wide flange steel beams to be placed at 6 feet on center.
   3. Front Walkway:
      a. Clear width 68 inches minimum.
      b. Elevated 4 feet above grade at benchmark.
   4. Entry stairs to be firmly anchored to uniformly poured concrete bases.
      a. Stair rise: 6 inches, with aluminum closure and contrasting aluminum stair nose.
      b. Stair tread depth: 12 inches.
      c. Guardrails on Stair to be 48 inches above leading edge of step with intermediate rail spacing at 4 inches.
      d. Stairs to have handrail extension. The handgrip portion of handrails shall not be less than 1 1/2 inches or more than 2 inches in cross-sectional dimension or the shape shall provide an equivalent gripping surface. The handgrip portion of handrails shall have a smooth surface with no sharp corner. The top of handrails and handrail extensions shall be placed at 34 inches above the nosing of treads and landings. Handrails shall be continuous the full length of the stairs and shall extend in the direction of the stair run by 24 inches beyond the bottom riser, and 12 inches past the top riser. Ends shall be returned or shall terminate in newel posts or safety terminals.
   5. Aisles:
      a. Aisles with seating on both sides to have 34-inch high handrail with intermediate rail at approximately 22 inches above tread. Provide a continuous handrail with gaps not to exceed five rows at the center of the aisle. The gap shall be no less than 22 inches and not greater than 36 inches.
      b. Aluminum tread nosing of contrasting color on aisle steps.
      c. Half-steps shall provide equal rise and run throughout aisle. Each shall have aisle nosing with non-skid black powder coated finish or other paint system meeting AAMA 603.8-92 specifications with a hardness rating of 2H and riser closure with clear anodized finish.
   6. Decking:
      a. Reference drawings for rise and depth per row.
      b. Each seat is 17 inches above its respective tread.
      c. Decking Arrangement: Closed Deck Aluminum Arrangement
   7. Seating Selection – Reference drawings for locations.
      a. Stadium Chair Model _____, as manufactured by _____.
         1) Self-rising
         2) Quantity: Reference drawings
      b. Aluminum Bench: 2 x 10 with height of 1 1/2".
      c. Aluminum Backrest 2 x 6 with height of 5 1/2".
         1) Optional: Aluminum armrest, Die #T-2482.
      d. Joint Sleeve Assembly.
         1) Pair of aluminum sleeves to insert in flat plank to maintain true alignment in joining together two plank pieces. Splice cover is unacceptable between two flat plank pieces joined in a straight line.

8. Guard-railing: To be at all sides of bleacher, entry stairs and ramps, portals, and landings. Railing to be anodized aluminum with end plugs at ends of straight runs and/or elbows at corner. All guardrails shall be secured to angle rail risers by galvanized fasteners. Railing shall be 48" above walkways and entrances. Railing shall be 48" above any adjacent seat. Guard-railing on sides and back shall include 9 gauge galvanized chain link fencing fastened in place with galvanized fasteners and aluminum ties. Guard-railing at all locations shall haves members that will not allow a 4” diameter sphere to pass through.
9. Cross Aisles:
    a. Clear width: Reference drawings
    b. Guardrail to be 42 inches above tread with intermediate rail spacing at 5 inches o.c.
10. Ramps:
    a. Slope: 1:12 maximum. Ramps shall not exceed 30 inches in rise in a single run.
    b. Guardrail to be 42 inches above ramp with 9 gauge galvanized chain link fence and 2 x 6 toe-board. Guard-railing at all locations shall haves members that will not allow a 4” diameter sphere to pass through.
    c. Handrail: Ramps to have handrail extension. The handgrip portion of handrails shall not be less than 1 1/2 inches or more than 2 inches in cross-sectional dimension or the shape shall provide an equivalent gripping surface. The handgrip portion of handrails shall have a smooth surface with no sharp corners. The top of handrails and handrail extensions shall be at 34 inches above the ramp surface. Handrails shall be continuous the full length of the ramp and shall extend in the direction of the ramp not less than 12 inches beyond the end of the ramp. Ends shall be returned or shall terminate in newel posts or safety terminals.
11. Handicap provision:
    a. Quantity of wheelchair spaces: Refer to Section 01 4100 – Regulatory Requirements for required number of wheel chair spaces.
    b. Riser area adjacent to wheelchair spaces to have intermediate construction so four inch sphere cannot pass through opening.

B. Materials/Finishes
1. Substructures:
    a. Structural shapes meet one of the following ASTM specifications: A36, A36/A572 grade 50, A572 grade 50, A529-50, or A500 grade B. All steel and fabrication shall conform to AISC.
    b. Shop connections are seal welds.
    c. After fabrication, all steel is hot-dipped galvanized to ASTM-A-123 specifications.
    d. Painted steel finish is unacceptable.
2. Extruded Aluminum:
    a. 5000 Series Stadium Chairs, Seat Planks, Backrests, Stanchions, Riser Planks: Extruded aluminum alloy, 6063-T6
        1) Clear anodized 204R1, AA-M10C22A31, Class II.
        2) Powder Coated or other paint system meeting AAMA 603.8-92 specifications with a hardness rating of 2H. Color to be selected by Architect from full range of manufacturer’s standard color.
    b. Tread Planks: Extruded aluminum alloy, 6063-T6 mill finish.
    c. Joint Sleeve Assembly to be inserted in flat plank to maintain true alignment in joining together two plank pieces. Extruded aluminum alloy, 6063-T6, mill finish. Splice cover is unacceptable between two flat plank pieces joined in a straight line.
    d. Railing: Extruded aluminum alloy, 6063-T6 clear anodized 204R1, AA-M10C22A31, Class II.
3. Accessories:
    a. Channel End Caps: Aluminum alloy 6063-T6, clear anodized 204R1, AA-M10C22A31, Class II.
    b. Cast End Caps: Aluminum 319 alloy, cast finish.
    c. Hardware:

1) Bolts, Nuts: Hot-dipped galvanized or mechanically galvanized.
2) Hold-down Clip Assembly: Aluminum alloy 6005A-T6, mill finish.
3) Structural Hardware: Equal to or greater than hot-dipped galvanized ASTM-A307. No connections utilizing high strength bolts are classed as slip critical.

d. Aisle Nose and Stair Nose: Aluminum alloy, 6063-T6, non-skid black powder coated finish or other paint system meeting AAMA 603.8-92 specifications with a hardness rating of 2H. Color to be selected by Architect from full range of manufacturers standard colors.

C. Fabrication:
1. Design Load:
a. Live Load: 100 psf gross horizontal projection.
b. Lateral Sway Load: 24 plf seat plank.
c. Perpendicular Sway Load: 10 plf seat plank.
1) Live Load of Seat and Tread Planks: 120 plf.
2) Guardrail: Per local building Code.
3) Wind load: Per Building Code, reference drawings, using exposure C.
2. All manufactured connections to be shop welded.
a. Manufactured by certified welders conforming to AWS Standards.

2.04 ANGLE FRAME-TYPE BLEACHERS - ELEVATED SERIES

A. Product Description
1. Elevated Frame-Type Bleachers:
a. Rise and Depth Dimensions: Vertical rise and horizontal depth per row: 8 inches x 24 inches. Seat is 17 inches above its respective tread.
b. Framework: Prefabricated angle bleacher frames are spaced at 6-foot (max.) intervals and connected by cross-braces.
c. Seats: Nominal 2 x 10 anodized aluminum plank with 2 x 10 anodized end caps.
d. Treads: Two nominal 2 x 11 mill aluminum planks with 2 x 11 anodized end caps.
e. Risers: Nominal 1 x 6-1/2 anodized aluminum riser planks beginning at Row 1; two 1 x 6-1/2 aluminum riser plank on top row.
f. Guard-railing: Two lines of aluminum rail with chain link 48 inches above seat on both sides of bleacher and across back of bleacher. Front rail, 3 line with chain link 48 inches above front walk. Guard-railing at all locations shall haves members that will not allow a 4” diameter sphere to pass through.
g. Entry Steps: Frames with 2 x 12 mill aluminum plank with step riser, contrasting aluminum stair nose and 2 line rail 36 inches above nose of step. Handrails shall extend in the direction of the exit steps 12 inches beyond the end of the steps. Ends shall terminate in newel posts.
h. Front Walkway: 30-inch elevation and 68-inch clear width.
i. Aisle: Aisle to be provided with 34” high handrail and intermediate rail at approximately 22” above tread. Handrails with rounded ends are discontinuous to allow access to seating through a 24” wide space. Aluminum tread nosing of contrasting color on aisle steps.
2. Wheelchair Area:
a. Wheelchair area to be 5’ 6” wide for two wheelchairs (33" each) and 36" for single.
b. Ramp: Slope: 1:12.
c. Guard-railing: Two-line aluminum rail 36 inches above ramp tread with intermediate rail at approximately 20 inches. Railing shall be continuous the full length of the ramp, and shall extend in the direction of the ramp 12 inches beyond the end of the ramp, returning to end at a newel post. Guard-railing all locations shall member that will not allow a 4” diameter sphere to pass through.
d. Landing: 74” Return Landing: 74” Landing to have 3-line 36” chain link with rail at 42” above front walk plank.

B. Materials and Finishes

1. Framework:
   a. Galvanized Steel: Structural fabrication with ASTM-A529 steel. Shop connections are seal welded. All steel and fabrication shall conform to AISC. After fabrication, all steel is hot-dipped galvanized to ASTM-A123 specification.
2. Extruded Aluminum:
   a. Seat Planks, Riser Planks, Step Risers: Extruded aluminum alloy 6063-T6, clear anodized 204R1, AA-M10C22A31, Class II.
   b. Tread Planks: Extruded aluminum alloy 6063-T6, mill finish.
3. Accessories:
   a. Channel End Caps: Aluminum alloy 6063-T6, clear anodized 204R1, AA-M10C22A31, Class II.
   b. Hardware:
      1) Bolts, Nuts: Galvanized or plated.
      2) Hold-Down Clip Assembly: Aluminum alloy 6061-T6.
   c. Guard-railing: Front, sides and back anodized aluminum rail 1-5/8” O.D. with galvanized chain link. Guard-railing at all locations shall haves members that will not allow a 4” diameter sphere to pass through.
   d. Handrails: Anodized aluminum rail 1-5/8” O.D.
   e. Cross-braces: Extruded aluminum angle alloy 6061-T6, mill finish.
   f. Aisle Nose and Stair Nose: Aluminum alloy, 6063-T6, black powder coat finish.

2.05 ANGLE FRAME-TYPE BLEACHERS - NON-ELEVATED

A. Product Description
   1. Non-Elevated Frame-Type Bleachers:
      a. Rise and Depth Dimensions: Vertical rise and horizontal depth per row: 8 inches x 24 inches. Seat is 17 inches above its respective tread.
      b. Framework: Prefabricated angle bleacher frames are spaced at 6-foot (max.) intervals and connected by cross-braces.
      c. Seats: Nominal 2 x 10 anodized aluminum plank with 2 x 10 anodized end caps.
      d. Treads: Two nominal 2 x 11 mill aluminum planks with 2 x 11 anodized end caps.
      e. Risers: Nominal 1 x 6-1/2 anodized aluminum riser plank beginning at Row 2; two 1 x 6-1/2 aluminum riser plank on top row.
      f. Guard-railing: Two lines of aluminum rail with chain link 48 inches above seat on both sides of bleacher and across back of bleacher. Guard-railing at all locations shall haves members that will not allow a 4” diameter sphere to pass through.
      g. Aisle: Aisle to be provided with 34” high handrail and intermediate rail at approximately 22” above tread. Handrails with rounded ends are discontinuous to allow access to seating through a 24” wide space. Aluminum tread nosing of contrasting color on aisle steps.
      h. Wheelchair Area:
         1) Wheelchair area to be 5’ 6” wide for two wheelchairs (33" each) and 36" for single.

B. Materials and Finishes
   1. Framework:
      a. Galvanized Steel: Structural fabrication with ASTM-A529 steel. Shop connections are seal welded. After fabrication, all steel is hot-dipped galvanized to ASTM-A123 specification. All steel and fabrication shall conform to AISC.
   2. Extruded Aluminum:
      a. Seat Planks, Riser Planks, Step Risers: Extruded aluminum alloy 6063-T6, clear anodized 204R1, AA-M10C22A31, Class II.
      b. Tread Planks: Extruded aluminum alloy 6063-T6, mill finish.
   3. Accessories:
      a. Channel End Caps: Aluminum alloy 6063-T6, clear anodized 204R1, AA-M10C22A31, Class II.

b. Hardware:
   1) Bolts, Nuts: Galvanized or plated.
   2) Hold-Down Clip Assembly: Aluminum alloy 6061-T6.
c. Guard-railing: Anodized aluminum rail 1-5/8" O.D. with galvanized chain link. Guard-railing at all locations shall haves members that will not allow a 4" diameter sphere to pass through.
d. Cross-braces: Extruded aluminum angle alloy 6061-T6, mill finish.
e. Aisle Nose: Aluminum alloy, 6063-T6, black powder-coat finish.

C. Fabrication
1. Design Load:
   a. Live Load: 100 psf gross horizontal projection
   b. Lateral Sway Load: 24 plf seat plank
   c. Perpendicular Sway Load: 10 plf seat plank
   d. Live Load of Seat and Tread Plank: 120 plf
   e. Guardrail: 100 plf vertical and 50 plf horizontal.
2. All connections made in shop to be shop welded.
   a. Manufactured by certified welders conforming to AWS Standards.

PART 3 – EXECUTION

3.01 GENERAL

A. All workmanship must be first-class in all respects and any members not presenting a finished and workmanlike appearance will be rejected. All finished members shall be free from twists, bends or open joints.

B. All members shall be true to length so that assembly may be done without fillers, except where same are required as detailed. There shall be no projecting edges or corners where different members are assembled. All coping, blocking or mitering shall be done with care. Shop edges and corners caused by shearing or other tooling shall be eased where exposed.

C. All details and connections shall be close fitting and carefully made and fitted, and special care shall be exercised to product a thoroughly neat and workmanlike appearance. All detail pieces shall be made in exact accordance with Detail Drawings, with all projecting corners clipped and all filler pieces made flush. Provide all lugs, clips, connections, rivets, bolts, etc. necessary to complete fabrication and erection.

D. Clean up all debris caused by work of this Section, keeping the premises clean and neat at all times.

E. The angle frame bleacher units shall be securely anchored to the concrete foundation.

END OF SECTION

SECTION 13 3419
METAL BUILDING SYSTEMS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Manufacturer-engineered, shop-fabricated structural steel building frame.
B. 'R' Panel Roof Panels.
C. Utility Standing Seam Roof Panels.
D. Panel Rib Wall Panels.
E. Interior Metal Liner Panels.
F. Metal Soffit Panels.
G. Gutters and Downspouts.
H. Building Insulation.
I. Roof Accessories including Roof Curbs and Pipe Flashing.

1.02 RELATED REQUIREMENTS

A. Section 03 3000 - Cast-in-Place Concrete.
B. Section 05 5000 - Metal Fabrications.
C. Section 07 2100 - Thermal Insulation: Insulation not part of metal building system.
D. Section 07 9005 - Joint Sealers: Sealing joints between accessory components and wall system.
E. Section 08 1113 - Hollow Metal Doors and Frames.
F. Section 09 9000 - Painting and Coating.

1.03 REFERENCE STANDARDS

A. AISC 360 - Specification for Structural Steel Buildings 2016.
B. ASTM A36/A36M - Standard Specification for Carbon Structural Steel 2019.
C. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware 2016a.
D. ASTM A307 - Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength 2014 (Editorial 2017).
E. ASTM A490 - Standard Specification for Structural Bolts, Alloy Steel, Heat Treated, 150 ksi Minimum Tensile Strength 2014a.
F. ASTM A490M - Standard Specification for High-Strength Steel Bolts, Classes 10.9 and 10.9.3, for Structural Steel Joints (Metric) 2014a.
G. ASTM A500/A500M - Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes 2021a.
H. ASTM A501/A501M - Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing 2021.
I. ASTM A529/A529M - Standard Specification for High-Strength Carbon-Manganese Steel of Structural Quality 2019.
J. ASTM A572/A572M - Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel 2021, with Editorial Revision.
K. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process 2020.

L. ASTM A792/A792M - Standard Specification for Steel Sheet, 55% Aluminum-Zinc Alloy-Coated by the Hot-Dip Process 2010 (Reapproved 2015).

M. ASTM A992/A992M - Standard Specification for Structural Steel Shapes 2022.

N. ASTM C665 - Standard Specification for Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing 2023.

O. ASTM C991 - Standard Specification for Flexible Fibrous Glass Insulation for Metal Buildings 2023.

P. ASTM C1107/C1107M - Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink) 2020.

Q. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials 2021.

R. AWS A2.4 - Standard Symbols for Welding, Brazing, and Nondestructive Examination 2012.

S. AWS D1.1/D1.1M - Structural Welding Code - Steel 2015, with Errata (2016).

T. IAS AC472 - Accreditation Criteria for Inspection Programs for Manufacturers of Metal Building Systems 2017.

U. MBMA (MBSM) - Metal Building Systems Manual 2019.

V. UL 580 - Standard for Tests for Uplift Resistance of Roof Assemblies Current Edition, Including All Revisions.

1.04 DESIGN REQUIREMENTS

A. Design members to comply with all governing building code requirements and withstand the design loads indicated on the drawings. Unless a greater load is indicated otherwise, design for a minimum 20 psf roof live load without any live load reduction, 6 psf collateral load, 5 psf nominal snow load, dead load as determined by the Pre-Engineered Metal Buiding Engineer, and calculate positive and negative wind loads in accordance with applicable code.

B. Design members to withstand UL 580 uplift class 90.

C. Exterior wall and roof system shall withstand imposed loads with a maximum allowable live load deflection and maximum allowable wind load deflection of L/180 over areas without a ceiling, L/240 over areas with a nonplaster ceiling, L/360 over areas with a plaster ceiling and L/600 over areas supporting masonry veneer either vertically or horizontally. The lateral force resisting system shall withstand imposed Main Wind Force Resisting system wind pressures with a maximum allowable lateral deflection of H/180 over buildings with no applied veneer (e.g. brick, concrete masonry, stucco, etc...), H/300 over buildings with applied veneer that does not extend higher than 4 feet above the foundation, and H/600 over buildings with applied veneer that extends higher than 4 feet above the foundation, or 1" maximum drift, whichever is the more stringent deflection requirement. The Pre-Engineered Metal Building Engineer shall have the option to design the Main Wind Force Resisting system for 10-year MRI wind speeds (minimum), in lieu of the wind speeds required for strength as determined by the building Risk Category, for deflection purposes only if the Pre-Engineered Metal Building Engineer deems these deflections appropriate.

D. Seismic Loads: Calculate and apply seismic loads in accordance with the requirements of applicable building code and as indicated in the structural drawings.

E. Anchor Bolts: Furnish anchor bolt diameters, calculated on the basis of stress in the steel bolt, to resist the column reactions induced by the design loads on the structure. Anchor bolt lengths and embedment details shall be as shown on the structural drawings.

F. Provide drainage to exterior for water entering or condensation occurring within wall or roof system.

G. Permit movement of components without buckling, failure of joint seals, undue stress on fasteners or other detrimental effects, when subject to temperature range of 120 degrees Farenheit.

H. Size and fabricate wall and roof systems free of distortion or defects detrimental to appearance or performance.

1.05 ADMINISTRATIVE REQUIREMENTS

A. Preinstallation Meeting: Convene one week before starting work of this section.

1.06 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide data on profiles, component dimensions, fasteners.

C. Shop Drawings: Indicate assembly dimensions, locations of structural members, connections, attachments, openings, cambers, and loads; wall and roof system dimensions, panel layout, general construction details, anchorages and method of anchorage, installation ; framing anchor bolt settings, sizes, and locations from datum, foundation loads; indicate welded connections with AWS A2.4 welding symbols; indicate net weld lengths; provide professional seal and signature. The Metal Building Engineer shall seal all metal building shop drawing submittals.

D. Shop drawing sheets that include engineering information designed by the Contractor's Delegated Design Engineer shall be signed and sealed in accordance with the Texas Engineering Practice Act. Sheets that do not provide information designed by the Contractor's Engineer do not require being signed and sealed. Calculation packages require a signed and sealed cover sheet only. Any submittals requiring to be signed and sealed that are received without the signature and seal will be rejected without review.

E. Samples: Submit two samples of precoated metal panels for each color selected, 2 by 3 inch in size illustrating color and texture of finish.

F. Manufacturer's Instructions: Indicate preparation requirements, anchor bolt placement.

G. Erection Drawings: Indicate members by label, assembly sequence, and temporary erection bracing.

H. Project Record Documents: Record actual locations of concealed components and utilities.

I. Closeout Submittals:
   1. Submit under provisions of Section 01 7800 – Closeout Submittals.
   2. Maintenance Data: Include draft specimen warranty.

J. Submit Material Safety Data Sheets under provisions of Section 01 7800 – Closeout Submittals for the following items:
   1. All mastics, glues, and adhesives
   2. Sealant (interior use only).

1.07 QUALITY ASSURANCE

A. Designer Qualifications: Design structural components, develop shop drawings, and perform shop and site work under direct supervision of a Professional Structural Engineer experienced in design of this type of work.
   1. Design Engineer Qualifications: Licensed in Texas.
   2. Comply with applicable code for submission of design calculations as required for acquiring permits.
   3. Cooperate with regulatory agency or authorities having jurisdiction (AHJ), and provide data as requested.

B. Perform work in accordance with AISC 360 and MBMA (MBSM).
   1. Maintain one copy on site.

C. Perform welding in accordance with AWS D1.1/D1.1M.

D. Manufacturer Qualifications: Company specializing in the manufacture of products similar to those required for this project.
   1. Accredited by IAS in accordance with IAS AC472.

E. Erector Qualifications: Company specializing in performing the work of this section approved by manufacturer.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Comply with requirements of Section 01 6000 – Product Requirements.

B. Storage and Protection
   1. Protect materials in accordance with manufacturer's instructions.
   2. Damaged materials will be rejected, whether built-in or not.

1.09 WARRANTY

A. See Section 01 7800 - Closeout Submittals, for additional warranty requirements.

B. Manufacturer shall warranty installed system for the periods described herein, starting from Date of Substantial Completion against all the conditions indicated below. When notified in writing from Owner, manufacturer/installer shall, promptly and without inconvenience and cost to Owner, correct said deficiencies.
   1. Materials and Workmanship Warranty: 5 years.
   2. Finish Warranty:
      a. Include coverage for exterior pre-finished surfaces to cover pre-finished color coat against chipping, cracking or crazing, blistering, peeling, chalking, or fading.
         1) Panel finish: 20 years.
   3. 'R' Panel Performance Warranty: Furnish written, single source, stating sheet metal roofing system and flashing under this Section will be maintained in watertight condition and defects resulting from the following items will be corrected without cost to Owner for a period of 1 year.
      a. Faulty workmanship.
      b. Defective materials including sealants and fasteners.
      c. Water infiltration.
      d. Weathertightness
   4. Standing Seam Roof (SSR) Panel Performance Warranty: Furnish written, single source, no dollar limit warranty, stating sheet metal roofing system and flashing under this Section will be maintained in watertight condition and defects resulting from the following items will be corrected without cost to Owner for a period of 20 years.
      a. Faulty workmanship.
      b. Defective materials including sealants and fasteners.
      c. Water infiltration.
      d. Weathertightness.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Metal Buildings Systems:
   1. Alliance Steel, Inc.: www.allianceokc.com.
   2. Butler Manufacturing Company: www.butlermfg.com/#sle.
   3. Ceco Building Systems: www.cecobuildings.com/#sle.
   4. Kirby Building Systems: www.kirbybuildingsystems.com.
   5. Mesco Building Solutions; www.mescobuildingsolutions.com
   6. Nucor Building Systems: www.nucorbuildingsystems.com/#sle.
   7. Red Dot Buildings: www.reddotbuildings.com
   8. Star Manufacturing: www.starbuildings.com.
   9. VP Buildings: www.vp.com.
   10. Substitutions: See Section 01 6000 - Product Requirements.

2.02 ASSEMBLIES

A. Primary Framing: Rigid Frame solid web framing consisting of tapered or uniform depth rafters rigidly connected to tapered or uniform depth columns. Provide a clear span that supports the loads at bay spacings indicated.
   1. Rigid frames shall consist of welded up plate section columns and roof beams complete with necessary splice members and plates for bolted field assembly.
   2. All base plates, cap plates, ridge plates and stiffener plates as required shall be factory welded into place and have the proper bolt connection holes shop fabricated.
   3. All splice plates shall be shop fabricated in proper sizes with bolt connection holes shop fabricated.
   4. All bolts for field assembly of frame members shall be high strength bolts of proper sizes complete with washers as indicated on erection drawings.
   5. There will be no field modification of rigid frame members, unless authorized and specified on the manufacturer's drawings.
   6. Bay Spacing: As noted on drawings.

B. Endwall Framing: Corner posts, endposts and rake beams.
   1. All base plates, cap plates, ridge plates and stiffeners as required shall be factory welded into place and have the proper bolt connection holes shop fabricated.
   2. All splice plates shall be shop fabricated in proper sizes with bolt connection holes shop fabricated.
   3. Columns, beams and posts shall be shop fabricated complete with proper holes for the attachment of secondary structural members in proper locations.

C. Secondary Framing: Purlins, Girts, Eave struts, Flange bracing, Sill supports, and Clips, and other items detailed.
   1. Purlins: Zee-shaped; 8" and 9 1/2" depth as required; with minimum yield strength of 55,000 psi; simple span or continuous span as required for design.
      a. Outer flange of all girts and purlins shall contain factory punched holes for panel connections.
   2. Girts: Zee-shaped (unless otherwise noted on the drawings); 8" and depth as required, with minimum yield strength of 55,000 psi; simple span or continuous span as required for design.
      a. Outer flange of all girts and purlins shall contain factory punched holes for panel connections.
   3. Transbay Members: Open web, parallel chord, secondary joists; simple span, utilizing materials, sizes and yield strength as required.
   4. Wind Bracing: Portal, torsional, diagonal bracing with or without diaphragm in accordance with manufacturer’s standard design practices; utilizing rods, angles, and other members, with minimum yield strengths as required for design.
      a. Bracing will be located in second bay from each end of the building or as indicated on the drawings.
   5. Primary Frame Flange Bracing: Attached from purlins or girts to the primary framing, minimum yield strength as required for design.
   6. Base Angles: 2 inch x 3 inch x 0.059 inch steel angles, with minimum yield strength of 55,000 psi, anchored to the floor slab or grade beam with power driven fasteners or equivalent at a maximum spacing of 2 feet on center and not more than 6 inches from the end of any angle member.
   7. Door Headers and Jambs: Cee-shaped; depth as required; with minimum yield strength of 55,000 psi.
   8. Sag Angles and Bridging: Steel angles, with minimum yield strength of 36,000 psi.

D. Wall System: Preformed metal panels of vertical profile, with sub-girt framing/anchorage assembly, insulation, and liner sheets, and accessory components.

E. Roof System: Preformed metal panels oriented parallel to eave, with sub-girt framing/anchorage assembly and insulation, and accessory components.

F. Roof Slope: As noted on drawings

2.03 MATERIALS - FRAMING

A. Select materials and material yield strengths based on building design requirements; use the following unless required otherwise.
   1. Structural Steel Plate, Bar, Sheet, and Strip for Use in Bolted and Welded Constructions: ASTM A 572 /A 570, A 529, ASTM A 607 with minimum yield strength of 50,000 psi.
   2. Structural Steel Material for Use in Roll Formed or Press Broken Secondary Structural Members: ASTM A 570,or A 607 with minimum yield strength of 55,000 psi.
   3. Galvanized Steel Sheet for Roll Formed or Press Broken Roof and Wall Coverings, Trim and Flashing: ASTM A 653, with minimum yield strength of 50,000 psi.
   4. Galvalume Steel Sheet Used in Roll Formed or Press Broken Roof Covering: Aluminum-zinc alloy-coated steel sheet, ASTM A 792, with minimum yield strength of 50,000 psi; nominal coating weight of 0.5 oz per sq. ft both sides, equivalent to an approximate coating thickness of 0.0018 inch both sides.
   5. Hot Rolled Steel Shapes: W, M and S shapes, angles, rods, channels and other shapes; ASTM A 572/A 529/A 500 or ASTM A 36 as applicable; with minimum yield strengths required for the design.
   6. Structural Bolts and Nuts Used with Primary Framing: High strength, ASTM A 325 or A 490.
   7. Bolts and Nuts Used with Secondary Framing Members: ASTM A 307.
   8. Shop Coat: Manufacturer’s standard rust inhibitive primer paint; manufacturer’s standard color.
   9. Pre-Painted Finish: 1 mil PVDF coating, minimum 70% Kynar 500 or Hylar 5000 on exterior surface.
      a. Color: As selected from manufacturer’s full line.
   10. Interior finish: Off white 0.5 mil washcoat.

B. Grout: ASTM C1107/C1107M; Non-shrink; premixed compound consisting of non-metallic aggregate, cement, water reducing and plasticizing agents.
   1. Minimum Compressive Strength at 48 Hours: 2,000 pounds per square inch.
   2. Minimum Compressive Strength at 28 Days: 7,000 pounds per square inch.

2.04 ROOF AND WALL PANEL COMPONENTS

A. Roof Panels, See drawings for locations: ‘R’ Panel; 36 inch wide net coverage, with 1 1/2" high major ribs at 12 inches on center with minor ribs spaced between the major ribs.
   1. Material: Galvanized steel, with G90/Z275 coating or Galvalume Steel, with AZ55 coating.
   2. Thickness: 26 gauge design base metal.
   3. Side laps: At least one full major rib, with a supporting member bearing edge on the lower panel and an anti-capillary groove on the upper panel. Factory applied sealant.
   4. Length: Continuous from eave to ridge up to 39 feet in length.
   5. Endlaps: 6 inches wide, located at a support member.
   6. Finish: Factory applied finish, PVDF coating, minimum 70% Kynar 500 or Hylar 5000, color as selected by Architect.
   7. Roof panels shall be factory-punched holes to match structural connections.
   8. The roof shall be tested and certified to meet UL uplift rating:
      a. The design of the roof for this project shall meet UL 90 - UL design.
   9. Product: Butler – Butlerib II Roof System.

B. Roof Panels, See drawings for locations: “Utility Standing Seam Roof Panels"; 24 inches wide net coverage, with 2 inch high major ribs formed at the panel side laps, factory formed for field seaming using electrically operated seaming machine.
   1. Side Joints: Factory applied sealant for field seaming.

2. Material: Galvanized steel, with G90/Z275 coating or Galvalume Steel, with AZ55 coating.
3. Thickness: 24 gauge design base metal.
4. Side laps: Two factory-formed interlocking ribs, with one weather sealed joint, mechanically field-seamed into place to form a double-fold 360 degree seam.
5. Length: Continuous from eave to ridge up to 41 feet in length.
6. Endlaps: 7 inches wide, located at a support member.
7. Finish: Factory applied finish, PVDF coating, minimum 70% Kynar 500 or Hylar 5000, color as selected by Architect.
8. Panel-to-roof purlin structural attachments: SSR clips with movable tabs which interlock with seamed SSR panel ribs and provide for 1-1/4 inch of panel movement in either direction from center of clip to compensate for thermal effects.
9. The SSR Roof System shall be tested and certified by Factory Mutual to meet the following tests: FM 1-90. The design of the SSR Roof for this project shall meet FM 1-90 Factory Mutual design.
10. The SSR Roof System shall be tested and certified to meet Underwriters Laboratory UL 90 wind uplift rating. The UL 90 is a requirement for this project.
11. Panels shall have been tested in accordance to ASTM E-1592.
12. Panel fastening to meet uplift requirements shall be based on tested fastener values with appropriate Safety Factors.
13. Purlin strength with the SSR roof panel shall be determined and tested in accordance with AISI procedures.
14. Product: Butler – MR-24 Roof System.

C. R-Panel Light Transmitting Panel, See drawings for locations:
   1. Material: Polycarbonate.
   2. Color: Clear.
   3. Product: MBCI, HW-1520 Light Transmitting Panel.

D. Ridge Assembly for SSR Ridge; draw-formed aluminum seam caps factory-attached to SSR ridge panels that are mechanically field-seamed together along the center of the ridge, utilizing only one weather sealed joint and providing a true expansion joint for panel movement.

E. Wall Panels: Panel Rib; 36 inch wide net coverage, with 11/2" high major ribs at 12 inches on center with minor ribs spaced between the major ribs.
   1. Material: Galvanized steel, with G90/Z275 coating or Galvalume Steel, with AZ55 coating.
   2. Thickness: 24 gauge design base metal.
   3. Side laps: Two fully overlapping major ribs secured together with 1/4 inch diameter color-matched carbon steel fasteners.
   4. Length: Continuous from sill to eave up to 38 feet in length.
   5. Endlaps: 6 inches wide, located at a support member.
   6. Cut panels square at each end; provide base trim at sill.
   7. Finish: Factory applied finish, PVDF coating, minimum 70% Kynar 500 or Hylar 5000, color as selected by Architect.

F. Liner Panels: Panel Rib Liner Panels; 36 inch wide net coverage, with 11/2" high major ribs with minor ribs spaced between the major ribs.
   1. Material: Galvanized steel, with G90/Z275 coating.
   2. Thickness: 26 gauge design base metal.
   3. Finish: Factory applied finish, PVDF coating, minimum 70% Kynar 500 or Hylar 5000, color as selected by Architect. Provide wall liner panels as shown on the drawings.

G. Soffit Panels: Architectural Soffit Panels; 12 inch wide net coverage, with two 6 inch wide flat surfaces in the same plane separated by a V-groove at 6 inches on center after adjacent panels have been installed.
   1. Material: Galvanized steel, with G90/Z275 coating or Galvalume Steel, with AZ55 coating.
   2. Thickness: 26 gauge design base metal.

3. Finish: Factory applied finish, PVDF coating, minimum 70% Kynar 500 or Hylar 5000, color as selected by Architect.
4. Side Joints: Factory applied gasket; tongue-in-groove connection with adjacent panels, with the connection reinforced by clips.

H. Panel Fasteners:
1. For Galvalume and factory applied finish roof panels: Stainless steel-capped carbon steel fasteners with integral sealing washer.
2. For wall panels: Coated carbon steel.
3. Color of exposed fastener heads to match the wall panel finish.
4. Concealed Fasteners: Self-drilling type, of size as required.
5. Provide fasteners in quantities and location as required by the manufacturer.

I. Flashing and Trim: Match material and color of adjacent components. Provide trim at rakes, including peak and corner assemblies, high and low eaves, corners, bases, framed openings and as required or specified to provide weathertightness and a finished appearance.

J. Sealants, Mastics and Closures: Manufacturer’s standard type.
1. Provide at roof panel endlaps, sidelaps, rake, eave, transitions and accessories as required to provide a weather resistant roof system; use tape mastic or gunnable sealant at sidelaps and endlaps.
2. Provide at wall panel rakes, eaves, transitions and accessories.
3. Closures: Formed to match panel profiles; closed cell elastic material, manufacturer’s standard color.
4. Tape Mastic: Pre-formed butyl rubber-based, non-hardening, non-corrosive to metal; white or light gray.
5. Sealant: Non-skinning synthetic elastomer based material; gray or bronze.

K. Building Insulation System:
1. Basis of Design:
a. Thermal Design, Inc., Simple Saver System: www.thermaldesign.com.
b. Substitutions: See Section 01 6000 - Product Requirements.
2. System Components: Batt Insulation, Roof Insulation, Wall Insulation, Vapor Barrier Liner Fabric, Thermal Breaks, Straps, and other devices and components to for an insulation system as follows:
a. Thermal Resistance as required by 2015 IECC:
1) Roofs: R-19 + R-11 LS.
2) Walls: R-13 + R-6.5ci. or R-25 with 1/8" foam thermal break strips.
b. Batt Insulation: ASTM C 991 Type 1; preformed formaldehyde-free glass fiber.
1) Batt Size: Equal to purlin/girt spacing by manufacturer's standard lengths.
2) Unfaced.
c. Roof Insulation: Formaldehyde-free fiberglass batt or fiberglass blanket complying with ASTM C 991 Type 1 and ASTM E 84 with a thermal resistance and thickness as required to comply with 2015 IECC.
d. Wall Insulation: Formaldehyde-free fiberglass blanket or batt complying with ASTM C 991 Type 1, ASTM E 136 and ASTM E 84 with a thermal resistance and thickness as required to comply with 2015 IECC.
e. Vapor Barrier Liner Fabric: Syseal® type woven, reinforced, high-density polyethylene yarns coated on both sides with a continuous white or colored polyethylene coatings, as follows:
1) Product complies with ASTM C 1136, Types I through Type VI.
2) Perm rating: 0.02 for fabric and for seams in accordance with ASTM E 96.
3) Flame/Smoke Properties:
(a) 25/50 in accordance with ASTM E 84.
(b) Self-extinguishes with field test using matches or butane lighter.
4) Ultra violet radiation inhibitor to minimum UVMAX® rating of 8.

5) Size and seaming: Manufactured in large custom pieces by extrusion welding from roll goods, and fabricated to substantially fit defined building area with minimum practicable job site sealing.
6) Provide with factory double, extrusion welded seams. Stapled seams or heat-melted seams are not acceptable due to degradation of fabric.
7) Factory-folded to allow for rapid installation.
8) Color: White

f. Vapor Barrier Lap Sealant: Solvent-based, Simple Saver polyethylene fabric adhesive.
g. Vapor Barrier Tape: Double-sided sealant tape 3/4 inch (19 mm) wide by 1/32 inch (.79 mm) thick.
h. Vapor Barrier Patch Tape: Single-sided, adhesive backed sealant tape 3 inches (76 mm) wide made from same material as Syseal® type liner fabric.
i. Thermal Breaks:
1) Thermal Blocks: 1 x 3-1/2 inch extruded polystyrene thermal spacer strips capped by 22 gage galvanized channels, with swagged end for interconnection along the purlin run, metal tabs at 2'-0" on center at clip locations, and pre-punched fastener holes.
2) Thermal Blocks: 1 x 3-1/2 inch extruded polystyrene thermal spacer strips at 2'-0" on center at SSR clip locations, and pre-punched fastener holes.
j. Straps:
1) 100 KSI minimum yield tempered, high-tensile-strength steel.
2) Size: Not less than 0.020 inch (0.50 mm) thick by 1 inch (25 mm) by continuous length.
3) Galvanized, primed, and painted to match specified finish color on the exposed side.
4) Color: White
k. Fasteners:
1) For light gage steel: #12 by 3/4 (19 mm) inch plated Tek 2 type screws with sealing washer, painted to match specified color.
2) For heavy gage steel: #12 by 1-1/2 inch (38 mm) plated Tek 4 type screws with sealing washer, painted to match specified color.
3) For wood, concrete, other materials: As recommended by manufacturer.
l. Wall Insulation Hangers: Fast-R preformed rigid hangers, 32 inch (813 mm) long galvanized steel strips with barbed arrows every 8 inches (203 mm) along its length.

2.05 FABRICATION - FRAMING

A. Fabricate members in accordance with AISC 360 for plate, bar, tube, or rolled structural shapes.

B. Anchor Bolts: Formed with straight shank, assembled with template for casting into concrete.

C. Provide framing for all roof openings.

D. Component Identification: Mark all fabricated parts, either individually or by lot or group, using an identification marking corresponding to the marking shown on the shop drawings, using a method that remains visible after shop painting.

E. Shop Priming: Finish all structural steel members using one coat of manufacturer's standard shop coat, after cleaning of oil, dirt, loose scale and foreign matter.
1. Finish primary frames with a minimum coating of 1.0 mil.
2. Finish secondary structural with a minimum coating of 0.5 mil.

2.06 FABRICATION - GUTTERS AND DOWNSPOUTS

A. Eave Gutters: Roll-formed 26 gage Galvanized or Galvalume steel sheet, with gutter straps, fasteners and joint sealant.

1. Downspouts: 4 x 5 inches in 10 foot lengths, with downspout elbows and downspout straps. Provide expansion joints in gutters per SMACNA guidlines, 50'-0" o.c. max.

B. Downspouts
1. Downspouts shall be fabricated from 26 ga. Galvanized or Galvalume steel factory colored with PVDF coating, minimum 70% Kynar 500 or Hylar 5000, color as selected by Architect and shall have a minimum cross section area of 16 square inches.
2. Downspout sleeve shall be furnished for attachment to the gutter. This attachment shall be made with 1/8" diameter stainless steel pop rivets and sealed with aluminized sealant.
3. Downspout splices shall be lapped 2" and secured with 1/8" diameter stainless steel pop rivets.
4. A 45 degree elbow shall be provided at the base of all downspouts to direct the water flow away from the foundation for on-grade drainage. Refer to architectural drawings for details for below-grade drainage.
5. Downspouts shall return from the edge of eave canopies to the building wall.
6. Refer to architectural drawings for downspout steel boot requirements and connections.

2.07 ROOF ACCESSORIES

A. Metal Building Manufacturer shall furnish or approve all roof accessories.

B. Roof Curbs: Welded units fabricated for shingled installation with roof panels; minimum 18 gage Galvanized steel, with welds cleaned and treated with protective coating compatible with the Galvanized substrate.
1. Top of curbs horizontal with 1-1/2 inch perimeter flange.
2. Curb walls insulated with 1-1/2 inch, 3 pcf density rigid glass fiber insulation.
3. Water Diversion: Integral 4 inch high by full length cricket on upslope side.
4. Exposed curb flanges pre-drilled for correct fastener locations.
5. Upslope and downslope curb flanges with integral welded inside and outside cell closures compatible with the roof panel profile.
6. Curb Framing: Mounted on secondary structural members and installed from the top; compatible with the thermal expansion and contraction properties of the roof on which it is used.
7. Opening Size: As indicated on drawings.
8. Curbs for SSR Roof Panels: One-piece type.
9. Finish: Factory applied finish, PVDF coating, minimum 70% Kynar 500 or Hylar 5000, color as selected by Architect.

C. Pipe flashing shall consist of a molded rubber cone with an aluminum ring bonded to the base. Pipe flashing shall accommodate pipe diameter as specified and be capable of flashing penetration at any location of the roof panel. Flashing shall be sealed and fastened in accordance with manufacturer's drawings.
1. Stack or pipe penetration shall be at the centerline of a major corrugation of the roof panel.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that foundation, floor slab, mechanical and electrical utilities, and placed anchors are in correct position

3.02 ERECTION - FRAMING

A. Erect framing in accordance with AISC 360.

B. Provide for erection and wind loads. Provide temporary bracing to maintain structure plumb and in alignment until completion of erection and installation of permanent bracing.

C. Set column base plates with non-shrink grout to achieve full plate bearing.

D. Do not field cut or alter structural members without approval.

E. After erection, prime welds, abrasions, and surfaces not shop primed.

3.03 ERECTION - WALL AND ROOF PANELS

A. Install in accordance with manufacturer's instructions.

B. Exercise care when cutting prefinished material to ensure cuttings do not remain on finish surface.

C. Fasten cladding system to structural supports, aligned level and plumb.

D. Provide expansion joints where indicated.

E. Install sealant and gaskets, providing weather tight installation.

3.04 ERECTION - GUTTERS AND DOWNSPOUTS

A. Rigidly support and secure components. Join lengths with formed seams sealed watertight. Flash and seal gutters to downspouts.

B. Apply bituminous paint on surfaces in contact with cementitious materials.

3.05 INSTALLATION - ACCESSORY COMPONENTS IN WALL SYSTEM

A. Install door frames, doors, overhead doors, and windows and glass in accordance with manufacturer's instructions.

3.06 TOLERANCES

A. Framing Members: 1/4 inch from level; 1/8 inch from plumb.

B. Siding and Roofing: 1/8 inch from true position.

END OF SECTION

SECTION 14 2400
HYDRAULIC ELEVATORS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Complete hydraulic elevator systems.
   1. Passenger type without machine room

B. Elevator Maintenance Contract.

1.02 RELATED REQUIREMENTS

A. Section 03 3000 - Cast-in-Place Concrete: Includes elevator pit.

B. Section 04 2000 - Unit Masonry: Masonry hoistway enclosure; building-in and grouting hoistway door frames.

C. Section 05 1200 - Structural Steel Framing: Includes hoistway framing and overhead hoist beams.

D. Section 07 1300 - Sheet Waterproofing: Waterproofing of elevator pit walls and floor.

E. Section 07 8400 - Firestopping: Fire rated sealant in hoistway.

F. Section 08 7100 - Door Hardware: Product requirements for key cylinders and card readers for placement by this section.

G. Section 09 2116.23 - Gypsum Board Shaft Wall Assemblies.

H. Division 21 - Fire Suppression: Fire Sprinkler System in Hoistway

I. Division 22 - Plumbing: Motor for sump pump in pit.

J. Division 26 - Electrical: Conduit and wiring connections.

K. Division 28 - Electronic Safety and Security: Fire detection and alarm systems.

1.03 REFERENCE STANDARDS

A. 16 CFR 1201 - Safety Standard for Architectural Glazing Materials Current Edition.

B. ADA Standards - 2010 ADA Standards for Accessible Design 2010.

C. AISC 360 - Specification for Structural Steel Buildings 2022.

D. ANSI Z97.1 - American National Standard for Safety Glazing Materials Used in Buildings - Safety Performance Specifications and Methods of Test 2015 (Reaffirmed 2020).

E. ASCE 7 - Minimum Design Loads and Associated Criteria for Buildings and Other Structures Most Recent Edition Cited by Referring Code or Reference Standard.

F. ASME A17.1 - Safety Code for Elevators and Escalators Includes Requirements for Elevators, Escalators, Dumbwaiters, Moving Walks, Material Lifts, and Dumbwaiters with Automatic Transfer Devices 2019, with Errata (2021).

G. ASME A17.2 - Guide for Inspection of Elevators, Escalators, and Moving Walks Includes Inspection Procedures for Electric Traction and Winding Drum Elevators, Hydraulic Elevators, Inclined Elevators, Limited-Use/Limited-Application Elevators, Private Residence Elevators, Escalators, Moving Walks, and Dumbwaiters 2020.

H. ASME QEI-1 - Standard for the Qualification of Elevator Inspectors 2018.

I. ASTM A36/A36M - Standard Specification for Carbon Structural Steel 2019.

J. ASTM A139/A139M - Standard Specification for Electric-Fusion (Arc)-Welded Steel Pipe (NPS 4 and Over) 2022.

K. ASTM A276/A276M - Standard Specification for Stainless Steel Bars and Shapes 2023.

L. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process 2023.

M. ASTM A666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar 2023.

N. ASTM A1008/A1008M - Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Required Hardness, Solution Hardened, and Bake Hardenable 2021a.

O. ASTM B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes 2021.

P. ASTM B221M - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes (Metric) 2021.

Q. ASTM C1048 - Standard Specification for Heat-Strengthened and Fully Tempered Flat Glass 2018.

R. ASTM C1172 - Standard Specification for Laminated Architectural Flat Glass 2019.

S. AWS D1.1/D1.1M - Structural Welding Code - Steel 2020, with Errata (2023).

T. ITS (DIR) - Directory of Listed Products Current Edition.

U. NEMA MG 1 - Motors and Generators 2021.

V. NFPA 13 - Standard for the Installation of Sprinkler Systems Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

W. NFPA 70 - National Electrical Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

X. NFPA 80 - Standard for Fire Doors and Other Opening Protectives 2022.

Y. UL (DIR) - Online Certifications Directory Current Edition.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate work with other installers to provide conduits necessary for installation of wiring including but not limited to:
      a. Elevator equipment devices remote from elevator machine room or hoistway.
      b. Remote group automatic panel from controller cabinet.
      c. Elevator pit for lighting and sump pump.
      d. Automatic transfer switch from controller cabinet.
      e. Fire alarm panel from controller cabinet.
   2. Coordinate work with other installers for equipment provisions necessary for proper elevator operation, including but not limited to, the following:
      a. Automatic transfer switches with auxiliary contacts for emergency power transfer status indication.
      b. Shunt trip devices for automatic disconnection of elevator power prior to fire suppression system activation.
      c. Overcurrent protection devices selected to achieve required selective coordination.

B. Preinstallation Meeting: Convene meeting at least one week prior to start of this work.
   1. Review schedule of installation, proper procedures and conditions, and coordination with related work.
   2. Review use of elevator for construction purposes, hours of use, scheduling of use, cleanliness of car, employment of operator, and maintenance of system.

C. Construction Use of Elevator: Provide designated elevator for transport of construction personnel and materials in compliance with ASME A17.1.
   1. Owner to negotiate with manufacturer/installer for construction use of elevator in accordance with terms and conditions of manufacturer's temporary acceptance form.
   2. Make elevator available for construction use as early as possible.
   3. Enclose car with protective plywood on floor, walls, and ceiling.

4. Provide temporary lighting.
5. Provide control panel with manual and emergency operation.

1.05 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements, for submittal procedures.

B. Product Data: Submit data on following items:
   1. Signal and operating fixtures, operating panels, and indicators.
   2. Car design, dimensions, layout, and components.
   3. Car and hoistway door and frame details.
   4. Electrical characteristics and connection requirements.

C. Shop Drawings: Include appropriate plans, elevations, sections, diagrams, and details on following items:
   1. Elevator Equipment and Machines: Size and location of driving machines, power units, controllers, governors, and other components.
   2. Hoistway Components: Size and location of car guide rails, buffers, jack unit and other components.
   3. Rail bracket spacing; maximum loads imposed on guide rails requiring load transfer to building structural framing.
   4. Clearances and over-travel of car.
   5. Locations in hoistway and machine room of traveling cables and connections for car lighting and telephone.
   6. Location and sizes of hoistway and car doors and frames.
   7. Interface with building security system.
   8. Electrical characteristics and connection requirements.
   9. Indicate arrangement of elevator equipment and allow for clear passage of equipment through access openings.

D. Samples: Submit samples illustrating car interior finishes, car and hoistway door and frame finishes, and handrail material and finish in the form of cut sheets or finish color selection brochures.

E. Testing Agency's Qualification Statement.

F. Warranty Documentation: Submit manufacturer warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.

G. Operation and Maintenance Data:
   1. Parts catalog with complete list of equipment replacement parts; identify each entry with equipment description and identifying code.
   2. Operation and maintenance manual.
   3. Schematic drawings of equipment and hydraulic piping, and wiring diagrams of installed electrical equipment with list of corresponding symbols to identify markings on machine room and hoistway apparatus.

1.06 QUALITY ASSURANCE

A. Maintain one copy of each quality standard document on site.

B. Designer Qualifications: Design guide rails, brackets, anchors, and machine anchors under direct supervision of a licensed Professional Structural Engineer experienced in design of this type of work and licensed in Texas.

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

D. Installer Qualifications: Trained personnel and supervisor on staff of elevator equipment manufacturer.

E. Testing Agency Qualifications: Independent firm specializing in performing testing and inspections of type specified in this section.

F. Products Requiring Fire Resistance Rating: Listed and classified by ITS (DIR), UL (DIR), or testing agency acceptable to authorities having jurisdiction.

G. Products Requiring Electrical Connection: Listed and classified by UL (DIR) or testing agency acceptable to authorities having jurisdiction as suitable for the purpose indicated in construction documents.

1.07 WARRANTY

A. See Section 01 7800 - Closeout Submittals, for additional warranty requirements.

B. Provide manufacturer's warranty for elevator operating equipment and devices for one year from Date of Substantial Completion.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Hydraulic Elevators:
   1. Otis Elevator Company: www.otis.com.
   2. Schindler Elevator Corporation: www.schindler.com.

B. Substitutions: See Section 01 6000 - Product Requirements.

C. Source Limitations: Provide elevator and associated equipment and components produced by a single manufacturer and obtained from a single supplier .

2.02 HYDRAULIC ELEVATORS

A. Hydraulic Passenger Elevator:
   1. Hydraulic Elevator Equipment:
      a. Holeless hydraulic with cylinder mounted within hoistway.
   2. Operation Control Type:
      a. Selective Collective Automatic Operation Control.
   3. Service Control Types:
      a. Standard service control.
      b. Independent service control.
      c. Restricted Access service control.
   4. Interior Car Height: 96 inch.
   5. Electrical Power: 480 volts; alternating current (AC); three phase; 60 Hz.
   6. Freight Car Loading Classification: Class A - General Freight Loading in compliance with ASME A17.1.
   7. Rated Net Capacity: 3500 pounds.
   8. Rated Speed: 100 to 125 feet per minute.
   9. Hoistway Size: As indicated on drawings.
   10. Interior Car Platform Size: As indicated on drawings.
   11. Travel Distance: As indicated on drawings.
   12. Number of Stops: As indicated on drawings.
   13. Hydraulic Equipment Locations:
      a. In Hoistway

2.03 COMPONENTS

A. Elevator Equipment:
   1. Motors, Hydraulic Equipment, Controllers, Controls, Buttons, Wiring, Devices, and Indicators: Comply with NFPA 70. Refer to Section 26 0583
   2. Guide Rails, Cables, Buffers, Attachment Brackets and Anchors: Design criteria for components includes safety factors in accordance with applicable requirements of Elevator Code, ASME A17.1.
   3. Buffers:
      a. Spring type for elevators with speed less than or equal to 200 feet per minute.
   4. Lubrication Equipment:

a. Provide grease fittings for periodic lubrication of bearings.
b. Grease Cups: Automatic feed type.
c. Lubrication Points: Visible and easily accessible.

5. Power Unit (Oil Pumping and Control Mechanism): A self-contained unit located in the elevator hoistway consisting of the following items:
   a. An oil hydraulic pump.
   b. An electric motor.
   c. 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.
   d. 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.
   e. 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.
   f. 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.
   g. Solid State Starting: Provide an electronic starter featuring adjustable starting currents.
   h. Oil Type: Readily biodegradable that is USDA certified biobased product, ultra low toxicity, readily biodegradable, energy efficient, high performing fluid made from canola oil with antioxidant, anticorrosive, antifoaming, and metal-passivating additives. Especially formulated for operating in environmentally sensitive areas. USDA certified biobased product, 95% bio-based content, per ASTM D6866.
6. 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.)

B. Electrical Equipment:
   1. Motors: NEMA MG 1.
   2. Boxes, Conduit, Wiring, and Devices: As required by NFPA 70. Refer to Sections 26 0533.13 and 26 0583.
   3. Sump Pump in Pit: Refer to Section 22 0513.
   4. Spare Conductors: Provide ten percent in extra conductors and two pairs of shielded audio cables in traveling cables.

2.04 PERFORMANCE REQUIREMENTS

A. Regulatory Requirements: Comply with ASME A17.1, applicable local codes, and authorities having jurisdiction (AHJ).

B. Accessibility Requirements: Comply with ADA Standards.

C. Perform structural steel design, fabrication, and installation in accordance with AISC 360.

D. Comply with seismic design requirements in accordance with ASME A17.1, applicable local codes, and authorities having jurisdiction (AHJ).
   1. Complying with Elevator Safety Requirements for Seismic Risk Zone in accordance with ASME A17.1, ASCE 7 and other related requirements.
      a. Project Seismic Risk: As indicated on drawings.
   2. Provide earthquake emergency operations in accordance with ASME A17.1 requirements.

E. Perform welding of steel in accordance with AWS D1.1/D1.1M.

F. Fabricate and install door and frame assemblies in accordance with NFPA 80 and in compliance with requirements of authorities having jurisdiction.

G. Perform electrical work in accordance with NFPA 70.

H. Comply with fire protection sprinkler system of hoistway design in accordance with NFPA 13 requirements and authorities having jurisdiction (AHJ). Refer to Division 21 - Fire Suppression.

2.05 OPERATION CONTROLS

A. Elevator Controls: Provide vandal resistant landing operating panels and landing indicator panels.
   1. Landing Operating Panels: Metallic type, one for originating "Up" and one for originating "Down" calls, one button only at terminating landings; with illuminating indicators.
   2. Landing Indicator Panels: Illuminating.
   3. Comply with ADA Standards for elevator controls.

B. Car Lantern and Chime: A directional lantern visible from the corridor shall be provided in the car entrance. When the car stops and the doors are opening, the lantern shall indicate the direction in which the car is to travel and a chime will sound.

C. Hoistway Access key-switch at top floor in entrance jamb.

D. Hoistway Access key-switch at lowest floor in entrance jamb.

E. Interconnect elevator control system with building security, fire alarm, card access, and smoke alarm systems.

F. Door Operation Controls:
   1. Program door control to open doors automatically when car arrives at floor landing.
   2. Render "Door Close" button inoperative when car is standing at dispatch landing with doors open.
   3. Door Operation: Provide a direct current motor driven heavy duty operator designed to operate the car and hoistway doors simultaneously. Door movements shall be electrically cushioned at both limits of travel and the 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. Closed-loop, microprocessor controlled motor-driven linear door operator, with adjustable torque limits, also acceptable. AC controlled units with oil checks or other deviations are not acceptable.
      a. 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.
      b. 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.

c. 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 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 will sound. When the obstruction is removed, the door will begin to close at reduced speed. If the infra-red door protection system detects a person or object while closing on nudging, the doors will stop and resume closing only after the obstruction has been removed.
d. Limited Door Reversal: If the doors are closing and the infra-red beam(s) is interrupted, the doors will reverse and reopen partially. After the obstruction is cleared, the doors will begin to close.
e. Door Open Watchdog: If the doors are opening, but do not fully open after a field adjustable time, the doors will recycle closed then attempt to open six times to try and correct the fault.
f. Door Close Watchdog: If the doors are closing, but do not fully close after a field adjustable time, the doors will recycle open then attempt to close six times to try and correct the fault.
g. 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.

4. Door Safety:
a. Primary door protection shall consist of a two-dimensional, multi-beam array projecting across the car door opening. Under normal operation and for any door position, the system shall detect as a blockage an opaque object that is equal to or greater than 1.3 inches in diameter when inserted between the car doors at vertical positions from within 1 inch above the sill to 71 inches above the sill. Under degraded conditions (one or more blocked or failed beams), the primary protection shall detect opaque objects that are equal to or greater than 4” in diameter for the same vertical coverage. If the system performance is degraded to the point that the 4” object cannot be detected, the system shall maintain the doors open or permit closing only under nudging force conditions.
b. The door reopening device shall also include a secondary, three dimensional, triangular infrared multi-beam array projecting across the door opening and extending into the hoistway door zone. The door opening device will cause the doors to reopen when it detects a person(s) or object(s) entering or exiting the car in the area between the hoistway doors or the entryway area adjacent to the hoistway doors.
c. The secondary protection shall have an anti-nuisance feature which will ignore detection in the secondary zone after continual detection occurs for a significant time period in the secondary zone without corresponding detection in the primary protection zone; i.e. a person/object is in the entryway but does not enter. Normal secondary protection shall be re-enabled whenever a detection occurs in the primary zone.
d. The reaction time of the door detector sub-system shall not exceed 60 milliseconds when both primary and secondary protection capabilities are active; nor 40 milliseconds when the secondary protection is disabled.
e. Door nudging operation to occur if doors are prevented from closing for an adjustable period of time.

G. Provide microprocessor-based control system with utilizes on-board diagnostics for servicing, trouble-shooting, and adjusting without requiring the use of an outside service tool. If an on-board diagnostic system is not provided, a handheld service tool (or laptop), owner's license, operation manual, and tool instructions must be provided in addition to the control system. System shall be a non-proprietary control system/open protocol. Provide remote elevator monitoring capabilities
1. Locate controller in hoistway or machine room as indicated.

H. Hall Stations
   1. Floor Identification Pads: Provide door jamb pads at each floor. Jamb pads shall comply with applicable accessibility standards.
   2. All fixtures shall be designed to be VANDAL RESISTANT.
   3. Provide keyed hall stations for access at hall stations.

I. Signal Devices and Fixtures
   1. Car-Operating Panel: A panel shall be provided which contains all push buttons, key switches, and message indicators for elevator operation. Raised markings Braille markings shall be provided for each push-button.
   2. Car Fixture Finish:
      a. Satin stainless steel
      b. Applied car operating panel shall be furnished. It shall contain a bank of round metal mechanical illuminated buttons. Flush mounted to the panel and marked to correspond to the landings served, an emergency call button, door open and door close buttons, and switches for lights, inspection and the exhaust fan. The emergency call button shall be connected to a bell that serves as an emergency signal. All buttons to have raised numerals and Braille markings. Red LED halo illumination with Flat Flush Target finishes: satin stainless steel.
   3. Car Position Indicator.
   4. A compliant communication device shall be provided which has been designed in response to applicable accessibility requirements integral with the car operating panel.
   5. Car Lantern and Chime: A directional lantern visible from the corridor shall be provided in the car entrance. When the car stops and the doors are opening, the lantern shall indicate the direction in which the car is to travel and a chime will sound.
   6. Hall Fixtures: Hall fixtures shall be provided with necessary push buttons and key switches for elevator operation. Raised markings shall be provided for each push-button.
   7. Fixture Finish: satin stainless steel.
   8. Landing Passing Signal: A chime bell shall sound in the car to tell a passenger that the car is either stopping at or passing a floor served by the elevator.

J. Provide "Firefighter's Emergency Operation" in accordance with ASME A17.1, applicable building codes, and authorities having jurisdiction (AHJ).
   1. Designated Landing: Main Lobby.

2.06 OPERATION CONTROL TYPE

A. Selective Collective Automatic Operation Control: Applies to car in single elevator shaft.
   1. Refer to description provided in ASME A17.1.
   2. Automatic operation by means of one button in the car for each landing served and by "UP" and "DOWN" buttons at the landings.
   3. Stops are registered by momentary actuation of landing car buttons without consideration of the number of buttons actuated or the sequence buttons are actuated, but the stops are made in the order that landings are reached in each direction of travel.
   4. All "UP" landing calls are made when car is traveling in the up direction.
   5. All "DOWN" landing calls are made when car is traveling in the down direction.
   6. Uppermost and lowermost calls are answered as soon as they are reached without consideration of the car travel direction.

2.07 SERVICE CONTROL TYPE

A. Independent Service Control:
   1. Provide key operated "Independent Service" on car operating panel. Key activation will remove that car from normal operation and cancel pre-registered car calls.
   2. Car will respond to selected floor. Car will not respond to any calls from landing call buttons. Car will only respond to calls placed on the car operating panel. Doors will remain open at last landing requested. Doors will close with a constant pressure on "Door Close" button.

3. Key activation to normal operation will return car to normal operation.

B. Restricted Access Service Control:
   1. Landing Call Lock-out: Provide a key operated switch with spring return with key removable only in "Lock-Out" position in landing control station that performs the following when activated:
      a. Restricts or permits landing call registration for that landing.
      b. Causes the elevator to not respond to that landing.
   2. Allow "Firefighter's Emergency Operation" to take control priority over "Restricted Access Service Control".

2.08 EMERGENCY POWER

A. Set-up elevator operation to run with elevator emergency power supply when the normal building power supply fails, and in compliance with ASME A17.1 requirements.

B. Elevator Emergency Power Supply: Supplied by battery backup; provide elevator system components as required for emergency power characteristics.

C. Emergency Lighting: As selected from manufacturers standard line.

D. Provide operational control circuitry for adapting the change from normal to emergency power.

E. Upon transfer to emergency power, advance one elevator at a time to a pre-selected landing, stop car, open doors, disable operating circuits, and hold in standby condition.

2.09 MATERIALS

A. Steel Cylinder Casing: ASTM A139/A139M, Grade A steel.

B. Rolled Steel Sections, Shapes, Rods: ASTM A36/A36M.

C. Steel Sheet: ASTM A1008/A1008M, Designation CS (commercial steel), with matte finish.

D. Sheet Steel: Hot-dipped galvanized steel sheet, ASTM A653/A653M, with G90/Z275 coating.

E. Stainless Steel Sheet: ASTM A666, Type 441; No. 4 Brushed finish unless otherwise indicated.

F. Stainless Steel Bars, Shapes and Moldings: ASTM A276/A276M, Type 441.

G. Extruded Aluminum: ASTM B221 (ASTM B221M), natural anodized finish unless otherwise indicated.

H. Aluminum Sheet: ASTM B209 (ASTM B209M), 3105 alloy, O temper.

I. Tempered Glass: 1/4 inch minimum thickness, fully tempered in compliance with ASME A17.1, 16 CFR 1201, ANSI Z97.1, and ASTM C1048 tempered glass requirements.

J. Laminated Glass: 3/8 inch minimum thickness, and in compliance with ASME A17.1, 16 CFR 1201, ANSI Z97.1, and ASTM C1172 laminated glass requirements.

2.10 CAR AND HOISTWAY ENTRANCES

A. Elevator, as indicated on drawings:
   1. Car and Hoistway Entrances, Each Elevator Floor Lobby:
      a. Hoistway Fire Rating: As indicated on drawings.
      b. Elevator Door Fire Rating: As indicated on drawings.
      c. Framed Opening Finish and Material: Brushed stainless steel.
      d. Car Door Material: Stainless steel, with rigid sandwich panel construction.
      e. Hoistway Door Material: Stainless steel, with rigid sandwich panel construction.
      f. Door Operation: As indicated on the drawings.
      g. Door Width: As indicated on drawings.
      h. Door Height: As indicated on drawings.
      i. Sills: Extruded aluminum.

B. Sills/Thresholds: Configure to align with frame return and coordinate with floor finish.

C. Gasketing: Provide acoustic type gasketing at hoistway doors and frames to minimize audible noise due to car activities in the hoistway, and air pressure differential between hoistway and landing floors.

2.11 CAR EQUIPMENT AND MATERIALS

A. Elevator Car:
   1. Car Operating Panel: Provide main; flush-mounted applied face plate, with vandal resistant illuminated call buttons corresponding to floors served with hoistway access, "Door Open/Door Close" buttons, "Door Open" button, "Door Close" button, alarm button, and top of car inspection.
      a. Panel Material: Integral with front return; one per car.
      b. Car Floor Position Indicator: Above door with illuminating position indicators.
      c. Locate alarm button where it is unlikely to be accidentally actuated; not more than 54 inch above car finished floor.
      d. Provide hands-free telephone with hardwired connection.
   2. Ventilation: Two speed fan with ventilation per manufacturer standard operation.
   3. Subfloor: Underlayment grade, exterior plywood, 5/8" nominal thickness.
   4. Flooring: See Section 01 6210 - Schedule of Materials and Colors for required flooring. Adjust recess for flooring material as well as load capacity of car.
   5. Wall Base: Recessed stainless steel, 4 inch high.
   6. Front Return Panel: Stainless steel.
   7. Side Walls: Plastic laminate on plywood.
   8. Rear Wall: Plastic laminate on plywood.
   9. Hand Rail: Stainless steel, at rear wall. Provide open clearance space 1-1/2 inch (38 mm) wide to face of wall.
      a. Round, Metal Tube: 1-1/2 inch diameter.
      b. Stainless Steel Finish: No. 4 Brushed.
   10. Ceiling: Downlight type, metal pans with suspended LED downlights.
      a. Canopy Ceiling: Stainless steel.
   11. Provide emergency access panel for egress from car at ceiling.
   12. On/Off Light Switch located in car operating panel.

B. Car Accessories:
   1. Certificate Frame: Stainless steel frame glazed with tempered glass, and attached with tamper-proof screws.
   2. Protective Pads: Canvas cover, padded with impact-resistant fill material, sewn with piping edges; fire resistant in compliance with ASME A17.1, covering side and rear walls and front return; provide one set for each elevator.
      a. Color: As selected by Architect.
      b. Provide at least 4 inch clearance from bottom of pad to finished floor.
      c. Pad Supports: Stainless steel studs, and mounted from ceiling frame.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify existing conditions before starting this work.

B. Verify that hoistway, pit, and machine room are ready for work of this section.

C. Verify hoistway shaft and openings are of correct size and within tolerance.

D. Verify location and size of machine foundation and position of machine foundation bolts.

E. Verify that electrical power is available and of correct characteristics.

F. Installation constitutes acceptance of existing conditions and responsibility for satisfactory performance.

3.02 PREPARATION

A. Arrange for temporary electrical power for installation work and testing of elevator components, and comply with requirements of Section 01 5000 - Temporary Facilities and Controls.

B. Maintain elevator pit excavation free of water.

3.03 INSTALLATION

A. Coordinate this work with installation of hoistway wall construction.

B. Install system components, and connect equipment to building utilities.

C. Provide conduit, electrical boxes, wiring, and accessories. Refer to Sections 26 0533.13 and 26 0583.

D. Install hydraulic piping between cylinder and pump unit.

E. Mount machines, motors, and pumps on vibration and acoustic isolators.
   1. Place on structural supports and bearing plates.
   2. Securely fasten to building supports.
   3. Prevent lateral displacement.

F. Install hoistway, elevator equipment, and components in accordance with approved shop drawings.

G. Install guide rails to allow for thermal expansion and contraction movement of guide rails.

H. Accurately machine and align guide rails, forming smooth joints with machined splice plates.

I. Bolt brackets to self drilling expansion shell anchors.

J. Field Welds: Chip and clean away oxidation and residue with wire brush; spot prime surface with two coats.

K. Install hoistway door sills, frames, and headers in hoistway walls; grout sills in place, set hoistway floor entrances in alignment with car openings, and align plumb with hoistway.

L. Fill hoistway door frames solid with grout in accordance with Section 04 2000.

M. Structural Metal Surfaces: Clean surfaces of rust, oil or grease; wipe clean with solvent; prime two coats.

N. Machine Room Components: Clean and degrease; prime one coat, finish with one coat of enamel.

O. Wood Surfaces not Exposed to Public View: Finish with one coat primer; one coat enamel.

P. Adjust equipment for smooth and quiet operation.

3.04 TOLERANCES

A. Guide Rail Alignment: Plumb and parallel to each other in accordance with ASME A17.1 and ASME A17.2.

B. Car Movement on Aligned Guide Rails: Smooth movement, without any objectionable lateral or oscillating movement or vibration.

3.05 FIELD QUALITY CONTROL

A. See Section 01 4000 - Quality Requirements, for additional requirements.

B. Testing and inspection by regulatory agencies will be performed at their discretion.
   1. Schedule tests with agencies and notify Owner and Architect.
   2. Obtain permits as required to perform tests.
   3. Document regulatory agency tests and inspections in accordance with requirements.
   4. Perform tests required by regulatory agencies.
   5. Furnish test and approval certificates issued by authorities having jurisdiction.

C. Perform testing and inspection in accordance with requirements.
   1. Inspectors shall be certified in accordance with ASME QEI-1.

2. Perform tests as required by ASME A17.2.
3. Provide at least two weeks written notice of date and time of tests and inspections.
4. Supply instruments and execute specific tests.

D. Perform tests in the presence of Owner and Architect.

E. Operational Tests:
1. Perform operational tests in the presence of Owner and Architect.
2. At an agreed time, and the building occupied with normal building traffic, conduct tests to verify performance.
a. Furnish event recording of each landing call registrations, time initiated, and response time throughout entire working day.

3.06 ADJUSTING

A. Adjust for smooth acceleration and deceleration of car to minimize passenger discomfort.

B. Adjust with automatic floor leveling feature at each floor landing to reach 1/4 inch maximum from flush with sill.

3.07 CLEANING

A. Remove protective coverings from finished surfaces.

B. Clean surfaces and components in accordance with manufacturers written instructions.

3.08 CLOSEOUT ACTIVITIES

A. See Section 01 7800 - Closeout Submittals, for closeout submittals.

B. See Section 01 7900 - Demonstration and Training, for additional requirements.

C. Demonstrate proper operation of equipment to Owner's designated representative.

D. Demonstration: Demonstrate operation of system to Owner's personnel.
1. Use operation and maintenance data as reference during demonstration.
2. Conduct walking tour of project.
3. Briefly describe function, operation, cleaning and maintenance of each component.

E. Training: Train Owner's personnel on cleaning and operation and maintenance of system.
1. Use operation and maintenance manual as training reference, supplemented with additional training materials as required.
2. Provide minimum of two hours of training.
3. Instructor: Manufacturer's training personnel.
4. Location: At project site, unless noted otherwise.

3.09 PROTECTION

A. Do not permit construction traffic within car after cleaning.

B. Protect installed products until Date of Substantial Completion.

C. Touch-up, repair, or replace damaged products and materials prior to Date of Substantial Completion.

3.10 MAINTENANCE

A. Refer to Section 01 7000 - Execution and Closeout Requirements, for additional requirements relating to initial maintenance service.

B. Provide Initial Maintenance Contract of elevator system and components in accordance with ASME A17.1 and requirements as indicated for 12 months from Date of Substantial Completion.

C. Perform maintenance contract services using competent and qualified personnel under the supervision and direct employ of the elevator manufacturer or original installer.

D. Maintenance contract services shall not be assigned or transferred to any agent or other entity without prior written consent of Owner.

E. Examine system components periodically.

F. Include systematic examination, adjustment, and lubrication of elevator equipment.

G. Maintain and repair or replace parts, whenever required, using parts produced by original equipment manufacturer.

H. Perform work without removing cars from use during peak traffic periods.

I. Provide emergency call back service during regular working hours throughout period of this maintenance contract.

J. Maintain an adequate stock of parts for replacement or emergency purposes, and have personnel available to ensure the fulfillment of this maintenance contract without unreasonable loss of time.

END OF SECTION

SECTION 14 4100
PEOPLE LIFTS

PART 1 – GENERAL

1.01 SECTION INCLUDES

A. Ceiling-mounted patient transfer system.

1.02 RELATED SECTIONS:

A. Section 05 5000 – Metal Fabrications.

B. Section 06 1000 – Rough Carpentry.

C. Section 09 5100 – Acoustical Ceilings.

1.03 REFERENCES

A. Americans with Disabilities Act (ADA).

B. Texas Accessibility Standards (TAS).

1.04 DEFINITIONS

A. Ceiling Mounted Patient Transfer System includes remote hand control, battery charging system, patient slings, warranty and devices as indicated and required for the safe operation of the ceiling mounted patient transfer system.

1.05 SUBMITTALS

A. Shop Drawings: Submit in accordance with Section 01 3000 – Administrative Procedures, Shop Drawings, Product Data and Samples. Include manufacturer's installation instructions and track layout.

B. Closeout Submittals:
   1. Submit under provisions of Section 01 7800 - Closeout Submittals.
   2. Submit Material Safety Data Sheets under provisions of Section 01 7800 - Closeout Submittals for the following items:
      a. All mastics, glues, and adhesives

PART 2 – PRODUCTS

2.01 MANUFACTURERS

A. Amico Mobility Solutions Corporation: www.amico.com.

B. Guldmann, Inc.: www.guldmann.net

C. Horcher Lifts: www.horcherlifts.com.

D. Substitutions: See Section 01 6000 - Product Requirements.

2.02 OVERHEAD LIFTING SYSTEM

A. System Description: Provide ceiling-mounted battery operated personnel transfer system complete with sling, straight and curved track system.
   1. Basis of Design: Horcher Lifts, Model PC-2.

B. System Requirements:
   1. Load rating for portable lifts: 350 pound capacity
   2. Travel (up/down): 6-8 feet per minute..
   3. Charger: 110 volts/24v-1 amp.
   4. Motor: 1 per room where patient transfer is required.
   5. Battery: High Capacity, Nickel Metal Hydride (NiMH)
   6. Emergency Lowering: Electrical and Mechanical
   7. Provide all accessories and equipment required for transfer between rooms.

C. Provide Warranty for ceiling mounted patient transfer system that matches or exceeds:
   1. 2 years on all overhead lift system parts

2. 1 years on all labor
3. 1 year on all patient slings

PART 3 – EXECUTION

3.01 INSTALLATION

A. Installed transfer system securely anchored to provide rigid installation. Lift shall be installed in strict accordance with manufacturer's instructions.

B. Coordinate adequate supports in ceiling per manufacturers requirements for pendant support system.

C. Maximum suspension from support steel to finished ceiling shall be no greater than 60". Any distance greater than 60" shall require additional support steel provided by others.

3.02 FIELD QUALITY CONTROL

A. Certificate: The distributor or manufacturer's representative shall certify, in writing, to the Owner that the installation, adjustment and performance are in accordance with the manufacturer's recommendations.

3.03 ADJUST AND CLEAN

A. Adjusting: Carefully adjust and regulate the transfer system after installation.

END OF SECTION

SECTION 14 4216
VERTICAL WHEELCHAIR LIFTS

PART 1 - GENERAL

1.01 SUMMARY

A. Related Documents: General and Supplementary Conditions of the Contract, Division 1 General Requirements, and Drawings are applicable to this Section.

B. Section Includes, but is not limited to:
   1. Vertical wheelchair lifts.

C. Related Sections:
   1. Section 03 3000 - Cast-In-Place Concrete
   2. Section 08 7100 - Door Hardware
   3. Division 26 – Electrical.

1.02 SUBMITTALS

A. Shop drawings, product data, and samples under provisions of Section 01 3000 - Submittal Procedures.

B. Product Data:
   1. Submit the manufacturer’s specifications and installation instructions for each complete system.
   2. Include a complete listing and description of performance and operating characteristics.
   3. Show maximum and average power demands.

C. Shop Drawings:
   1. Include shop drawings for each platform lift system, including typical details of assembly, erection and anchorage drawn to scale.
   2. Include wiring diagrams of power distribution, control and signals for the entire system.
   3. Before beginning work, the Contractor shall submit to the Architect for his approval, detailed drawings, showing the complete layout of the lift equipment, location of all machinery and apparatus, together with any suggested alterations to the items specified.

D. Samples:
   1. Submit color samples of each exposed finish required for platform lift work.

E. Closeout Submittals:
   1. Submit under provisions of Section 01 7800 - Closeout Submittals.

1.03 QUALITY ASSURANCE

A. Qualifications:
   1. Manufacturer Qualifications:
      a. Minimum ten (10) years experience in manufacture of lifts.
   2. Installer Qualifications:
      a. Specializing in lifts having minimum of five (5) years successful documented experience with work comparable to that required for this project.
      b. Installer must be licensed to install equipment of this scope, with evidence of experience with this equipment.

B. Regulatory Requirements:
   1. Materials and construction shall comply with the current edition of the following codes, standards and guidelines.
      a. ASME A18.1 “Safety Standard for Platform Lifts and Stairway Chairlifts.”
      b. ANSI A117.1 “Providing Accessibility and Usability for Physically Handicapped People.”
      c. NFPA 70 National Electric Code.
      d. ADA / TDLR Accessibility Guidelines.
   2. Refer to drawings for applicable Building Codes.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Comply with requirements of Section 01 6000 - Product Requirements.

1.05 PROJECT CONDITIONS

A. Project Environmental Requirements
   1. Comply with requirements of referenced standards and recommendations of material manufacturers for environmental conditions before, during, and after installation.
   2. The wheelchair lift shall not be used for the hoisting of materials or personnel during the construction period.

1.06 WARRANTY

A. Comply with requirements of Section 01 7800 - Closeout Submittals.

B. Submit a written warranty, executed by the Contractor, Installer, and Manufacturer, agreeing to repair or replace tile that fails in materials or workmanship within the specified warranty period.
   1. Warranty Period: Manufacturer shall warrant the wheelchair lift materials and workmanship for three (3) years following substantial completion.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Subject to compliance with requirements indicated herein, provide products of one of the listed manufacturers.

B. Manufacturers:
   1. Garaventa Accessibility: www.garventa.com.
   2. ThyssenKrupp Elevator: www.thyssenkruppelevator.com
   3. Substitutions: Under provisions of Section 01 6000 - Product Requirements.

2.02 UNENCLOSED VERTICAL WHEELCHAIR LIFT

A. Capacity: 750 lbs (340 kg) rated capacity.

B. Mast Height:
   1. Basis of Design: Model GVL-OP-42; 45 inches (1143 mm) maximum lifting height.

C. Platform Size and Nominal Clear Platform Dimensions:
   1. Large 90 degree: 42 inches by 60 inches with 90 degree entry/exit configuration.

D. Platform Configuration:
   1. 90 Degree: Front and side openings.

E. Landing Openings: Gates shall be self closing type.
   1. Gate Height: 42-1/8 inches (1070 mm).
   2. Platform Gate: Travels with platform and opens at lower landing.
   3. Upper Landing Gate: Detached, freestanding type.

F. Power Gate Operators:
   1. Location:
      a. Platform Gate: Travels with platform and opens lower landing.
      b. Upper Landing Gate.

G. Lift Components:
   1. Machine Tower: Custom aluminum extrusion.
   2. Base Frame: Structural steel.
   3. Platform Side Wall Panels: 16 gauge (1.5 mm) galvanized steel sheet.
   4. Side Guard Panels: 42-1/8 inches (1070 mm) high mounted on platform.
   5. Outdoor Protection: Lift shall include modifications recommended by manufacturer for reliable performance in outdoor climate of project site.

H. Base Mounting at Lower Landing:

1. Pit Mount: Lift to be mounted in pit with dimensions to meet manufacturer's requirements for the platform size specified. Pit construction shall be in accordance to Section 033000.

I. Hydraulic Drive:
   1. Drive Type: Chain hydraulic.
   2. Emergency Operation: Manual device to lower platform and battery auxiliary power to raise or lower platform.
   3. Safety Devices:
      a. Slack chain safety device.
      b. Shoring device.
   4. Travel Speed: 17 fpm (5.2 m/minute).
   5. Motor: 3.0 hp (2.2 kW); 24 volts DC.
   6. Power Supply:
      a. 120 VAC single phase; 60 Hz on a dedicated 15 amp circuit.
      b. Powered by continuous building mains converted to 24 VDC, equipped with auxiliary power system capable of running lift up and down for a minimum of 5 trips with rated load.

J. Platform Controls: 24 VDC control circuit with the following features.
   1. Direction Control: Constant pressure rocker switch.
   2. Illuminated and audible emergency stop switch shuts off power to lift and activates audio alarm with battery backup.
   3. Keyed operation.

K. Call Station Controls: 24 VDC control circuit with the following features.
   1. Direction Control:
      a. Constant pressure rocker switch.
   2. Keyed operation.
   3. Call Station Mounting:
      a. Upper:
         1) Wall mounted surface.

L. Safety Devices and Features:
   1. Grounded electrical system with upper, lower, and final limit switches.
   2. Tamper resistant interlock to electrically monitor that the gate is in the closed position and the lock is engaged before lift can move from landing.
   3. Electrical disconnect shall shut off power to the lift.
   4. Under platform safety pan with five waterproof safety switches to detect obstruction under platform.

M. Finishes
   1. Aluminum Extrusions: Champagne anodized finish.
   2. Ferrous Components: Electrostatically applied baked powder finish, fine textured.
      a. Color: Satin Grey, RAL 7030.

PART 3 - EXECUTION

3.01 PREPARATION

A. Comply with provisions of Section 01 7000 – Execution and Closeout Requirements.

3.02 INSTALLATION

A. Comply with provisions of Section 01 7000 – Execution and Closeout Requirements.

3.03 CLEANING

A. Comply with requirements of Section 01 7000 – Execution and Closeout Requirements.

3.04 PROTECTION

A. Protect work so that it will be without any evidence of damage or use at time of acceptance.

END OF SECTION

SECTION 21 0500
COMMON WORK RESULTS FOR FIRE SUPPRESSION

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Above ground piping.

B. Escutcheons.

C. Mechanical couplings.

D. Pipe hangers and supports.

E. Pipe sleeves.

F. Pipe sleeve-seal systems.

G. Pressure gauges.

1.02 RELATED REQUIREMENTS

A. Section 21 1300 - Fire-Suppression Sprinkler Systems: Sprinkler systems design.

1.03 REFERENCE STANDARDS

A. ASME A112.18.1 - Plumbing Supply Fittings 2018, with Errata.

B. ASME B40.100 - Pressure Gauges and Gauge Attachments 2022.

C. ASME BPVC-IX - Boiler and Pressure Vessel Code, Section IX - Qualification Standard for Welding, Brazing, and Fusing Procedures; Welders; Brazers; and Welding, Brazing, and Fusing Operators 2023.

D. ASME B16.1 - Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250 2020.

E. ASME B16.3 - Malleable Iron Threaded Fittings: Classes 150 and 300 2021.

F. ASME B16.4 - Gray Iron Threaded Fittings: Classes 125 and 250 2021.

G. ASME B16.5 - Pipe Flanges and Flanged Fittings: NPS 1/2 through NPS 24 Metric/Inch Standard 2020.

H. ASTM A47/A47M - Standard Specification for Ferritic Malleable Iron Castings 1999, with Editorial Revision (2022).

I. ASTM A536 - Standard Specification for Ductile Iron Castings 1984, with Editorial Revision (2019).

J. ASTM A795/A795M - Standard Specification for Black and Hot-Dipped Zinc-Coated (Galvanized) Welded and Seamless Steel Pipe for Fire Protection Use 2021.

K. AWWA C606 - Grooved and Shouldered Joints 2022.

L. NFPA 13 - Standard for the Installation of Sprinkler Systems Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

M. UL 393 - Indicating Pressure Gauges for Fire-Protection Service Current Edition, Including All Revisions.

1.04 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements for submittal procedures.

B. Product Data: Provide manufacturer's catalog information. Indicate valve data and ratings.

C. Shop Drawings: Indicate pipe materials used, jointing methods, supports, and floor and wall penetration seals. Indicate installation, layout, weights, mounting and support details, and piping connections.

D. Installer's qualification statement.

E. Project Record Documents: Record actual locations of components and tag numbering.

1.05 QUALITY ASSURANCE

A. Delegated-Design Submittal: Design system under direct supervision of a Professional Fire Protection Engineer experienced in design of this type of work and licensed in the State in which the Project is located.

B. Products Requiring Electrical Connection: Listed and classified as suitable for the purpose specified and indicated.

C. Clean equipment, pipes, valves, and fittings of grease, metal cuttings, and sludge that may have accumulated from the installation and testing of the system.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Deliver and store valves in shipping containers, with labeling in place.

1.07 WARRANTY

A. See Section 01 7800 - Closeout Submittals for additional warranty requirements.

B. Correct defective Work within a five year period after Date of Substantial Completion.

PART 2 PRODUCTS

2.01 GENERAL REQUIREMENTS

A. Sprinkler-based System:
   1. Comply with NFPA 13.
   2. See Section 21 1300.

B. Welding Materials and Procedures: Comply with ASME BPVC-IX.

C. Provide system pipes, fittings, sleeves, escutcheons, seals, and other related accessories.

2.02 ABOVE GROUND PIPING

A. Steel Pipe: ASTM A795 Schedule 10 or ASTM A795 Schedule 40, black.
   1. Steel Fittings: ASME B16.5 steel flanges and fittings.
   2. Cast Iron Fittings: ASME B16.1, flanges and flanged fittings and ASME B16.4, threaded fittings.
   3. Malleable Iron Fittings: ASME B16.3, threaded fittings and ASTM A47/A47M.
   4. Mechanical Grooved Couplings: Malleable iron housing clamps to engage and lock, "C" shaped elastomeric sealing gasket, steel bolts, nuts, and washers; galvanized for galvanized pipe.

2.03 PIPE SLEEVES

A. Vertical Piping:
   1. Sleeve Length: 1 inch above finished floor.
   2. Provide sealant for watertight joint.
   3. Blocked Out Floor Openings: Provide 1-1/2 inch angle set in silicon adhesive around opening.
   4. Drilled Penetrations: Provide 1-1/2 inch angle ring or square set in silicone adhesive around penetration.

2.04 PIPE SLEEVE-SEAL SYSTEMS

A. Modular Mechanical Seals:
   1. Elastomer-based interlocking links to continuously fill annular space between pipe and wall-sleeve, wall or casing opening.
   2. Watertight seal between pipe and wall-sleeve, wall or casing opening.
   3. Size and select seal component materials in accordance with service requirements.
   4. Service Requirements:

a. Underground, buried, and wet conditions.

5. Glass-reinforced plastic pressure end plates.

B. Wall Sleeve: PVC material with waterstop collar, and nailer end caps.

C. Sleeve-Forming Disk: Nonconductive plastic-based material, 3 inch thick.

D. Pipeline-Casing Seals:
1. Coated-metallic boltless casing-spacer for 4 inch carrier pipe.
2. Coated-metallic boltless modular seal for 6 inch carrier pipe.
3. Carbon steel band with riser for 12 inch carrier pipe.
4. End Seals: 1/8 inch, pull-on type, rubber or synthetic rubber based.

2.05 ESCUTCHEONS

A. Material:
1. Metals and Finish: Comply with ASME A112.18.1.

B. Construction:
1. One-piece for mounting on chrome-plated tubing or pipe and one-piece or split-pattern type elsewhere.
2. Internal spring tension devices or setscrews to maintain a fixed position against a surface.

2.06 PIPE HANGERS AND SUPPORTS

A. Hangers for Pipe Sizes 1/2 to 1-1/2 inch: Malleable iron, adjustable swivel, split ring.

B. Hangers for Pipe Sizes 2 inches and Over: Carbon steel, adjustable, clevis.

C. Vertical Support: Steel riser clamp.

2.07 MECHANICAL COUPLINGS

A. Manufacturers:
1. Anvil International: www.anvilintl.com/#sle.
2. Shurjoint Piping Products, Inc: www.shurjoint.com/#sle.
3. Tyco Fire Protection Products: www.tyco-fire.com/#sle.
4. Victaulic Company; FireLock Style 009H: www.victaulic.com/#sle.
5. Substitutions: See Section 01 6000 - Product Requirements.

B. Rigid Mechanical Couplings for Grooved Joints:
1. Dimensions and Testing: Comply with AWWA C606.
2. Minimum Working Pressure: 300 psig.
3. Housing Material: Fabricate of ductile iron complying with ASTM A536.
4. Housing Coating: Factory applied orange enamel.
5. Gasket Material: EPDM suitable for operating temperature range from minus 30 degrees F to 230 degrees F.
6. Bolts and Nuts: Hot-dipped-galvanized or zinc-electroplated steel.
7. Provide stops for direct stab installation without field assembly.

2.08 PRESSURE GAUGES

A. Pressure Gauges: ASME B40.100, UL 393 drawn steel case, phosphor bronze bourdon tube, rotary brass movement, brass socket, with front recalibration adjustment, black scale on white background.

PART 3 EXECUTION

3.01 PREPARATION

A. Remove scale and foreign material, from inside and outside, before assembly.

B. Prepare piping connections to equipment with flanges or unions.

3.02 INSTALLATION

A. Install sprinkler system and service main piping, hangers, and supports in accordance with NFPA 13.

B. Route piping in orderly manner, plumb and parallel to building structure. Maintain gradient.

C. Install piping to conserve building space, to not interfere with use of space and other work.

D. Group piping whenever practical at common elevations.

E. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.

F. Pipe Hangers and Supports:
   1. Install hangers to provide minimum 1/2 inch space between finished covering and adjacent work.
   2. Place hangers within 12 inches of each horizontal elbow.
   3. Use hangers with 1-1/2 inch minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.
   4. Support vertical piping at every other floor. Support riser piping independently of connected horizontal piping.
   5. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.

G. Slope piping and arrange systems to drain at low points. Use eccentric reducers to maintain top of pipe level.

H. Prepare pipe, fittings, supports, and accessories for finish painting. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc-rich primer to welding.

I. Provide sleeves when penetrating footings, floors, walls, and partitions. Seal pipe including sleeve penetrations to achieve fire resistance equivalent to fire separation required.

J. Manufactured Sleeve-Seal Systems:
   1. Install manufactured sleeve-seal systems in sleeves located in grade slabs and exterior concrete walls at piping entrances into building.
   2. Provide sealing elements of the size, quantity, and type required for the piping and sleeve inner diameter or penetration diameter.
   3. Locate piping in center of sleeve or penetration.
   4. Install field assembled sleeve-seal system components in annular space between sleeve and piping.
   5. Tighten bolting for a watertight seal.
   6. Install in accordance with manufacturer's recommendations.

K. Escutcheons:
   1. Install and firmly attach escutcheons at piping penetrations into finished spaces.
   2. Provide escutcheons on both sides of partitions separating finished areas through which piping passes.
   3. Use chrome plated escutcheons in occupied spaces and to conceal openings in construction.

L. When installing more than one piping system material, ensure system components are compatible and joined to ensure the integrity of the system. Provide necessary joining fittings. Ensure flanges, unions, and couplings for servicing are consistently provided.

3.03 CLEANING

A. Upon completion of work, clean all parts of the installation.

B. Clean equipment, pipes, valves, and fittings of grease, metal cuttings, and sludge that may have accumulated from the installation and testing of the system.

END OF SECTION

SECTION 21 0523
GENERAL-DUTY VALVES FOR WATER-BASED FIRE-SUPPRESSION PIPING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Two-piece ball valves with indicators.

B. Bronze butterfly valves with indicators.

C. Iron butterfly valves with indicators.

D. Check valves.

E. Iron OS&Y gate valves.

F. Trim and drain valves.

1.02 RELATED REQUIREMENTS

A. Section 21 0553 - Identification for Fire Suppression Piping and Equipment.

B. Section 21 1200 - Fire-Suppression Standpipes.

C. Section 21 1300 - Fire-Suppression Sprinkler Systems.

D. Section 21 1339 - Foam-Water Systems.

E. Section 33 1416 - Site Water Utility Distribution Piping.

1.03 REFERENCE STANDARDS

A. ASME B1.20.1 - Pipe Threads, General Purpose, Inch 2013 (Reaffirmed 2018).

B. ASME B16.1 - Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250 2020.

C. ASME B31.9 - Building Services Piping 2020.

D. AWWA C606 - Grooved and Shouldered Joints 2022.

E. FM (AG) - FM Approval Guide Current Edition.

F. NFPA 13 - Standard for the Installation of Sprinkler Systems Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

G. UL 1091 - Standard for Butterfly Valves for Fire-Protection Service Current Edition, Including All Revisions.

PART 2 PRODUCTS

2.01 GENERAL REQUIREMENTS

A. FM Global Approved: Provide valves listed in FM (AG) Approval Guide under the following headings:
   1. Automated Sprinkler Systems:
      a. Indicator posts.
      b. Valves:
         1) Gate valves.

B. ASME Compliance:
   1. ASME B16.1 for flanges on iron valves.
   2. ASME B1.20.1 for threads on threaded-end valves.
   3. ASME B31.9 for building services piping valves.

C. Comply with AWWA C606 for grooved-end connections.

D. Comply with NFPA 13 for valves.

E. Valve Pressure Ratings: Not less than minimum pressure rating indicated or higher as required.

F. Valve Sizes: Same as upstream piping unless otherwise indicated.

2.02 TWO-PIECE BALL VALVES WITH INDICATORS

A. UL 1091, except with ball instead of disc and FM (AG) standard listing for indicating valves (butterfly or ball type), Class Number 1112.

B. Description:
   1. Minimum Pressure Rating: 175 psig.
   2. Body Design: Two piece.
   3. Body Material: Forged brass or bronze.
   4. Port Size: Full or standard.
   5. Seat: PTFE.
   6. Stem: Bronze or stainless steel.
   7. Ball: Chrome-plated brass.
   8. Actuator: Worm gear or traveling nut.

2.03 BRONZE BUTTERFLY VALVES WITH INDICATORS

A. Minimum Pressure Rating: 175 psig.

B. Body Material: Bronze.

C. Seat: EPDM.

D. Stem: Bronze or stainless steel.

E. Disc: Bronze with EPDM coating.

F. Actuator: Worm gear or traveling nut.

G. Supervisory Switch: Internal or external.

2.04 IRON BUTTERFLY VALVES WITH INDICATORS

A. Minimum Pressure Rating: 175 psig.

B. Body Material: Cast or ductile iron with nylon, EPDM, epoxy, polyamide, or _____ coating.

C. Seat: EPDM.

D. Stem: Stainless steel.

E. Disc: Ductile iron, nickel plated.

F. Actuator: Worm gear or traveling nut.

G. Supervisory Switch: Internal or external.

H. Body Design: Grooved-end connections.

2.05 CHECK VALVES

A. Minimum Pressure Rating: 175 psig.

B. Type: Center guided check valve.

C. Body Material: Cast iron, ductile iron.

D. Center guided check with elastomeric seal.

E. Hinge Spring: Stainless steel.

F. End Connections: Flanged, grooved, or threaded.

2.06 IRON OS&Y GATE VALVES

A. Maximum Working Pressure: 175 psi.

B. Body and Bonnet Material: Cast or ductile iron.

C. Wedge: Cast or ductile iron, or bronze with elastomeric coating.

D. Stem: Brass, bronze, or stainless steel.

E. Packing: Non-asbestos PTFE.

F. Supervisory Switch: External.

2.07 TRIM AND DRAIN VALVES

A. Ball Valves:
   1. Description:
      a. Pressure Rating: 175 psig.
      b. Body Design: Two piece.
      c. Body Material: Forged brass or bronze.
      d. Port Size: Full or standard.
      e. Seat: PTFE.
      f. Stem: Bronze or stainless steel.
      g. Ball: Chrome-plated brass.
      h. Actuator: Hand-lever.

B. Angle Valves:
   1. Description:
      a. Pressure Rating: 175 psig.
      b. Body Material: Brass or bronze.
      c. Ends: Threaded.
      d. Stem: Bronze.
      e. Disc: Bronze.
      f. Packing: Asbestos free.
      g. Handwheel: Malleable iron, bronze, or aluminum.

C. Globe Valves:
   1. Description:
      a. Pressure Rating: 175 psig.
      b. Body Material: Bronze with integral seat and screw-in bonnet.
      c. Ends: Threaded.
      d. Stem: Bronze.
      e. Disc Holder and Nut: Bronze.
      f. Disc Seat: Nitrile.
      g. Packing: Asbestos free.
      h. Handwheel: Malleable iron, bronze, or aluminum.

PART 3 EXECUTION

3.01 INSTALLATION

A. Comply with specific valve installation requirements and application in the following Sections:
   1. Section 21 1200 for application of valves in fire-suppression standpipes.
   2. Section 21 1300 for application of valves in wet and dry pipe, fire-suppression sprinkler systems.
   3. Section 21 1339 for application of valves in foam-water, fire-suppression sprinkler systems.

4. Section 33 1416 for application of valves in fire-suppression water-service piping outside the building.

B. Install listed fire protection shutoff valves supervised-open, located to control sources of water supply except from fire department connections.
   1. Install permanent identification signs indicating portion of system controlled by each valve.

C. Valves in horizontal piping installed with stem at or above the pipe center.

D. Position valves to allow full stem movement.

E. Install valve tags. Comply with Section 21 0553 requirements for valve tags, schedules, and signs on surfaces concealing valves; and the appropriate NFPA standard applying to the piping system in which valves are installed.

END OF SECTION

SECTION 21 0553
IDENTIFICATION FOR FIRE SUPPRESSION PIPING AND EQUIPMENT

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Nameplates.

B. Tags.

C. Pipe markers.

D. Ceiling tacks.

1.02 REFERENCE STANDARDS

1.03 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide manufacturers catalog literature for each product required.

PART 2 PRODUCTS

2.01 IDENTIFICATION APPLICATIONS

A. Automatic Controls: Tags.

B. Control Panels: Nameplates.

C. Major Control Components: Nameplates.

D. Valves: Nameplates and ceiling tacks where above lay-in ceilings.

2.02 NAMEPLATES

A. Description: Laminated three-layer plastic with engraved letters.
   1. Letter Color: White.

2.03 TAGS

A. Plastic Tags: Laminated three-layer plastic with engraved black letters on light contrasting background color. Tag size minimum 1-1/2 inch diameter.

2.04 PIPE MARKERS

A. Underground Plastic Pipe Markers: Bright-colored continuously printed plastic ribbon tape, minimum 6 inches wide by 4 mil, 0.004 inch thick, manufactured for direct burial service.

2.05 CEILING TACKS

A. Description: Steel with 3/4 inch diameter color coded head.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install nameplates with corrosive-resistant mechanical fasteners, or adhesive. Apply with sufficient adhesive to ensure permanent adhesion and seal with clear lacquer.

B. Install tags with corrosion resistant chain.

C. Locate ceiling tacks to locate valves above T-bar type panel ceilings. Locate in corner of panel closest to equipment.

END OF SECTION

SECTION 21 1300
FIRE-SUPPRESSION SPRINKLER SYSTEMS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Wet-pipe sprinkler system.

B. Dry-pipe sprinkler system.

C. System design, installation, and certification.

D. Fire department connections.

1.02 REFERENCE STANDARDS

A. FM (AG) - FM Approval Guide Current Edition.

B. NFPA 13 - Standard for the Installation of Sprinkler Systems Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

C. NFPA 13R - Standard for the Installation of Sprinkler Systems in Low-Rise Residential Occupancies 2022, with Errata.

D. NFPA 1963 - Standard for Fire Hose Connections 2019.

E. UL (DIR) - Online Certifications Directory Current Edition.

F. UL 405 - Standard for Safety Fire Department Connection Devices Current Edition, Including All Revisions.

1.03 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements for submittal procedures.

B. Product Data: Provide data on sprinklers, valves, and specialties, including manufacturers catalog information. Submit performance ratings, rough-in details, weights, support requirements, and piping connections.

C. Shop Drawings:
   1. Indicate hydraulic calculations, detailed pipe layout, hangers and supports, sprinklers, components, and accessories. Indicate system controls.
   2. Submit shop drawings to Authorities Having Jurisdiction for approval. Submit proof of approval to Architect.

D. Manufacturer's Certificate: Certify that system has been tested and meets or exceeds specified requirements and code requirements.

E. Designer's qualification statement. The designer shall be a licensed individual and certify the following:
   1. The layout is within the scope of the applicable prescriptive codes or standards, such as the National Fire Protection Association (NFPA) Standard 13 "Standard for the Installation of Sprinkler Systems" as specified, or adopted by the state or local jurisdiction.
   2. The licensed individual currently holds a valid Responsible Managing Employee License (RME) issued by the Texas State Fire Marshal's Office, in accordance with the Texas Insurance Code Article 5.43-3.
   3. The licensed individual is certified to a minimum Level III, in the subfield of "Automatic Sprinkler Systems Layout", through the National Institute for Certification in Engineering Technologies (NICET).
   4. Upon completion of the installation a licensed individual, where given the specific authority by Texas Statute, will certify in writing that the installation meets the standards provided for by law and/or is in compliance with the plans and specifications of the licensed professional engineer.

F. Installer's qualification statement.

G. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
   1. See Section 01 6000 - Product Requirements for additional provisions.
   2. Extra Sprinklers: Type and size matching those installed in quantity required by referenced NFPA design and installation standard.
   3. Sprinkler Wrenches: For each sprinkler type.

H. Project Record Documents: Record actual locations of sprinklers and deviations of piping from drawings. Indicate drain and test locations.

1.04 QUALITY ASSURANCE

A. Comply with FM (AG) requirements.

B. Designer Qualifications: Design system under direct supervision of a Professional Fire Protection Engineer experienced in design of this type of work and licensed in the State in which the Project is located.

C. Equipment and Components: Provide products that bear FM (AG) label or marking.

D. Products Requiring Electrical Connection: Listed and classified by UL (DIR) as suitable for the purpose specified and indicated.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Sprinklers, Valves, and Equipment:
   1. Anvil International: www.anvilintl.com/#sle.
   2. Tyco Fire Protection Products: www.tyco-fire.com/#sle.
   3. Viking Corporation: www.vikinggroupinc.com/#sle.
   4. Substitutions: See Section 01 6000 - Product Requirements.

2.02 SPRINKLER SYSTEM

A. Sprinkler System: Provide coverage for entire building.

B. Occupancy: Ordinary hazard, Group 1; comply with NFPA 13.
   1. Building Service Areas: Ordinary hazard, Group 1; comply with NFPA 13.
   2. Electrical Equipment Rooms: Ordinary hazard, Group 1; comply with NFPA 13.
   3. General Storage Areas: Ordinary hazard, Group 1; comply with NFPA 13.
   4. All other areas: Light hazard; comply with NFPA 13.

C. Water Supply: Determine volume and pressure from water flow test data.

D. Provide fire department connections where indicated.

E. Storage Cabinet for Spare Sprinklers and Tools: Steel, located adjacent to alarm valve.

2.03 SPRINKLERS

A. Suspended Ceiling Type: Semi-recessed pendant type with matching push on escutcheon plate.
   1. Response Type: Quick.
   2. Coverage Type: Standard.
   3. Finish: Enamel, color White unless noted otherwise .
   4. Fusible Link: Glass bulb type temperature rated for specific area hazard.

B. Exposed Area Type: Pendant type.
   1. Response Type: Quick.
   2. Coverage Type: Standard.
   3.
   4. Fusible Link: Glass bulb type temperature rated for specific area hazard.

C. Sidewall Type: Semi-recessed horizontal sidewall type with matching push on escutcheon plate.
   1. Response Type: Quick.
   2. Coverage Type: Standard.
   3. Fusible Link: Glass bulb type temperature rated for specific area hazard.

D. Dry Sprinklers: Concealed pendant type with matching push on escutcheon plate.
   1. Response Type: Quick.
   2. Fusible Link: Fusible solder link type temperature rated for specific area hazard.

E. Flexible Drop System: Stainless steel, multiple use, open gate type.
   1. Application: Use to properly locate sprinkler heads.
   2. Include all supports and bracing.
   3. Provide braided type tube as required for the application.
   4. Manufacturers:
      a. FlexHead Industries, a brand of Anvil International: www.anvilintl.com/#sle.
      b. Victaulic Company; Vic-Flex: www.victaulic.com/#sle.

2.04 PIPING SPECIALTIES

A. Wet Pipe Sprinkler Alarm Valve: Check type valve with divided seat ring, rubber-faced clapper to automatically actuate water motor alarm, pressure retard chamber and variable pressure trim with the following additional capabilities and features:
   1. Activate electric alarm.
   2. Test and drain valve.

B. Dry Pipe Sprinkler Alarm Valve: Check type valve with divided seat ring, rubber faced clapper to automatically actuate water motor alarm, accelerator, and with the following additional capabilities and features:
   1. Activate electric alarm.
   2. Test and drain valve.

C. Electric Alarm: Electrically operated chrome plated gong with pressure alarm switch.

D. Water Flow Switch: Vane type switch for mounting horizontal or vertical, with two contacts; rated 10 amp at 125 volt AC and 2.5 amp at 24 volt DC.

E. Fire Department Connections:
   1. Type: Free standing made of corrosion resistant metal complying with UL 405.
      a. Inlets: Two way, 2-1/2 inch swivel fittings, internal threaded. Thread size and inlets according to NFPA 1963 or Authority Having Jurisdiction. Brass caps with gaskets, chains, and lugs.
      b. Sleeve: Brass, 18 inches height.

2.05 AIR COMPRESSOR

A. Compressor: Single-unit, electric motor driven, motor, motor starter, safety valves, check valves, air maintenance device incorporating electric pressure switch and unloader valve.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with referenced NFPA design and installation standard.

B. Install equipment in accordance with manufacturer's instructions.

C. Locate outside alarm gong on building wall as indicated.

D. Place pipe runs to minimize obstruction to other work.

E. Place piping in concealed spaces above finished ceilings.

F. Apply masking tape or paper cover to ensure concealed sprinklers, cover plates, and sprinkler escutcheons do not receive field paint finish. Remove after painting. Replace painted sprinklers.

G. Flush entire piping system of foreign matter.

H. Hydrostatically test entire system.

I. Require test be witnessed by Fire Marshal.

END OF SECTION

SECTION 22 0150
PLUMBING & PIPING MATERIALS & METHODS

PART 1 GENERAL

1.01 APPLICABILITY

A. This section covers basic materials and methods and applies to and forms a part of each of the sections of Division 22.

B. This work shall be in accordance with this and other applicable sections and/or provisions of these specifications and with the applicable drawings.

1.02 MATERIALS & MANUFACTURERS

A. All materials and equipment shall be new, free of defects, installed in accordance with manufacturer's current published recommendations in a neat manner and in accordance with standard practice of the industry.

B. Certain materials and/or equipment in this specification are specified by manufacturer and catalog numbers. The design was based on the specified equipment and establishes a degree of quality, performance, physical configuration, etc. If the contractor should elect to use equipment other than the equipment used as a basis for design but listed as "acceptable" in the specifications, he shall be responsible for space requirements, configuration, performance, and changes in bases, supports, vibration isolators, structural members, openings in structure and other apparatus that may be affected by its use.

PART 2 PRODUCTS

2.01 NOT USED

PART 3 EXECUTION

3.01 COORDINATION OF OPENINGS

A. This contractor shall coordinate all openings required for new piping, equipment, controls, etc. through any structural slabs, beams, or walls. Contractor shall request a copy of the precast concrete shop drawings and verify locations and sizes of all openings required.

B. All costs associated with structural field changes or redesigns of the building systems due to lack of field coordination shall be responsibility of this contractor.

3.02 PIPE AND FITTING INSTALLATION

A. Plastic DWV piping shall be installed as addressed by IAPMO (UPC) code section on Expansion and Contraction. Any straight runs of plastic DWV piping exceeding 30 feet shall be installed to accommodate thermal expansion.

B. Piping is to be installed as shown on the drawings as much as practical. When a pipe size is not indicated, the subcontractor shall request the pipe size from the Architect through the Plumbing Contractor.

C. Provide sufficient swing joints, expansion loops, and/or devices necessary and install so as to permit free expansion and contraction of piping without causing undue stresses. Make all changes in direction with fittings. Support piping independently at all equipment so that its weight shall not be supported by the equipment.

D. Install piping without springing or forcing and clear all windows, doors, and other openings. Excessive cutting or other weakening of the building structure to facilitate piping installation will not be permitted.

E. All pipes shall be reamed to full pipe diameter before joining.

F. Install vertical risers plumb and straight, horizontal lines parallel with walls and partitions. Conceal piping above ceilings and within furring and/or walls when practical.

G. Provide shut-off valves and unions suitably located to isolate each item of equipment, branch circuit or section of piping.

H. Provide 1/2" drain valves at all low points of each system to enable complete drainage.

I. Provide "Clearflow" dielectric waterways at all junctions of dissimilar metals in potable water systems.

J. All piping shall be adequately supported from the building structure with adjustable hangers to maintain uniform grading where required and to prevent sagging or pocketing.

K. Provide supports between piping and building structure where necessary to prevent swaying.

L. The use of wire or perforated metal to support pipe will not be permitted.

3.03 PROTECTION, DELIVERY AND STORAGE OF MATERIALS

A. Make provisions for the delivery and storage of materials and make the required arrangements with other contractors for the introduction into the building of equipment too large to pass through finished openings.

B. Protect materials and equipment stored on site from weather and moisture by maintaining factory covers and/or suitable weather-proof coverings. For extended outdoor storage, motors shall be removed from equipment and stored separately.

C. The open ends of all piping shall be covered whenever that system is not being worked on, i.e. end of the workday, completion of a section, etc. Covering shall keep dust, garbage, vermin, and other foreign objects out of the piping when the contractor is not on the jobsite.

3.04 CUTTING AND REPAIRING

A. All holes and penetrations required for the installation of the plumbing equipment shall be by the plumbing contractor. This shall include all piping, ductwork, and any other penetration through the wall, floor, or roof.

B. Cutting construction shall be done only with the written permission of the Architect. Cutting shall be done carefully and damage to buildings, pipes, wiring, or equipment as a result of cutting for installation shall be repaired by skilled mechanics of the trade involved at no additional charge to the Owner. This Contractor shall be responsible for all cutting and patching unless such work has been delegated to the General Contractor.

C. All holes cut into concrete shall be cut by means of power saws or core drills. All unsightly spalls or chips shall be repaired.

D. All openings remaining around duct and pipe penetrations shall be filled, caulked, and painted to match wall. Code approved fire caulking shall be used for all rated penetrations.

3.05 SEALING FLOOR, CEILINGS AND WALL OPENINGS

A. Where pipes pass through walls, ceilings, floors, or partitions, (other than those through fire rated walls or chases) the opening in the construction around the pipe shall not exceed ½ inch average clearance on all sides and shall be sealed to prevent the passage of sound and air. Coordinate wall openings to allow insulation thickness to pass through walls if allowed.

B. The material used to seal space between the wall and the pipe shall be non-combustible caulk type, or wrap type, as conditions require. Provide sheet metal angles or flanges as may be required to contain the stopping material. Use of expanding foam will be allowed if surfaces are cleaned of an excess material and all edges are trimmed smooth. Penetrations through exterior walls shall be sealed weather tight.

C. Special attention shall be given to penetrations of mechanical room walls. Fill gaps around entire exterior area of the pipes with sound insulation (batt or mineral wool) to within ½" of the wall surface. Use silicone caulking to finish filling the opening smooth with the wall surface or provide sheet metal angles. All sealer shall meet flame spread 25 and smoke developed less than 50.

D. Where pipes pass through fire-rated walls, ceilings, floors, vertical service shafts walls, or partitions, the opening in the construction around the pipe or duct shall be fire-stopped to prevent the passage of flame and smoke. All assemblies shall be UL or ASTM listed to provide a fire rating equal to that of the construction being penetrated. For the firestop applications that exist for which no UL tested system is available through a manufacturer, an engineering judgment derived from similar UL system designs or other tests shall be submitted from the manufacturer to the local authorities having jurisdiction for their review and approval prior to installation. Individuals installing the firestopping shall be experienced and certified as required by the manufacturer whose product is being applied. Refer to firestopping spec section for reposition finned element to be centered under windows as required.more information.

E. Manufacturer's assembly drawings shall be provided in O & M Manuals for each type of penetration. Printed metal or plastic labels shall be permanently applied on the structure within 6" of the edge of the firestop system. Metal labels shall be applied with mechanical fasteners & plastic labels shall be the self-adhering type with adhesive capable of permanently bonding labels to the surfaces on which the labels are placed. The information required on the label include UL/ASTM assembly number, date of installation, fire stopping material manufacture name, Contractor's name, address & phone number & the installer's name.

F. Acceptable manufacturers shall be Hilti, 3M Brand, or a prior approved product.

3.06 CLEANING AND PAINTING

A. Clear away all debris, surplus materials, etc., resulting from work or operations, leaving the job and equipment furnished under this contract in a clean condition.

B. All equipment being furnished with finished paint coat shall be examined upon job completion for scratches and other surface damage. All finished surfaces where necessary shall be touched up with touch-up paint of color to match the factory finish.

C. Paint all exposed bare pipe exterior of the building. Bare pipe shall be painted one coat of No. 7769402 damp-proof red primer as manufactured by Rust-Oleum Corporation, or equal, and one coat of oil paint. Final coat shall be of a color selected by the architect.

D. Paint all exposed iron and steel work, pipe hangers, pipe stands, uninsulated tanks, supporting steel for equipment and exposed bare pipe in mechanical areas. Iron and steel work and bare pipe shall be painted one coat of No. 4769402 damp-proof red primer as manufactured by Rust-Oleum Corporation, or equal, and one coat of oil paint. Iron and steel work shall be painted black.

E. Refer to Section 09 900, Painting for additional requirements.

3.07 ASBESTOS FREE BUILDING

A. There shall be no products or building materials used as a temporary or permanent element in the construction of this building, which has in its make-up any form of asbestos. The contractors shall be responsible to monitor shop drawings and product literature to verify the make-up of materials to be used in the building and remind material suppliers that their products must be asbestos free.

B. Notify the Architect immediately of any existing materials which are suspected of containing asbestos. Do not disturb or attempt to remove any asbestos containing material. The Architect will contact the Owner and inform them of the Contractors observations. The Owner will obtain and provide the services of professionals skilled in asbestos removal.

END OF SECTION

SECTION 22 0513
COMMON MOTOR REQUIREMENTS FOR PLUMBING EQUIPMENT

PART 1 GENERAL

1.01 SECTION INCLUDES

A. General construction and requirements.

B. Applications.

C. Single phase electric motors.

D. Three phase electric motors.

1.02 REFERENCE STANDARDS

A. NEMA MG 1 - Motors and Generators 2021.

B. NFPA 70 - National Electrical Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.03 DELIVERY, STORAGE, AND HANDLING

A. Protect motors stored on site from weather and moisture by maintaining factory covers and suitable weather-proof covering.

1.04 WARRANTY

A. See Section 01 7800 - Closeout Submittals for additional warranty requirements.

B. Provide five year manufacturer warranty for motors larger than 20 horsepower.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Baldor Electric Company/ABB Group; _____: www.baldor.com/#sle.

B. Regal-Beloit Corporation (Century); _____: www.centuryelectricmotor.com/#sle.

C. Substitutions: See Section 01 6000 - Product Requirements.

2.02 GENERAL CONSTRUCTION AND REQUIREMENTS

A. Construction:
   1. Open drip-proof type except where specifically noted otherwise.
   2. Design for continuous operation in 104 degrees F environment.
   3. Design for temperature rise in accordance with NEMA MG 1 limits for insulation class, service factor, and motor enclosure type.

B. Visible Nameplate: Indicating motor horsepower, voltage, phase, cycles, RPM, full load amps, locked rotor amps, frame size, manufacturer's name and model number, service factor, power factor, efficiency.

C. Wiring Terminations:
   1. Provide terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated. Enclose terminal lugs in terminal box sized to NFPA 70, threaded for conduit.
   2. For fractional horsepower motors where connection is made directly, provide threaded conduit connection in end frame.

2.03 APPLICATIONS

A. Single phase motors for shaft mounted fans or blowers: Permanent split capacitor type.

B. Motors located in exterior locations, direct drive axial fans, and dust collection systems: Totally enclosed type.

C. Motors located in in draw through cooling towers: Totally enclosed weatherproof epoxy-treated type.

2.04 SINGLE PHASE POWER - PERMANENT-SPLIT CAPACITOR MOTORS

A. Starting Torque: Exceeding one fourth of full load torque.

B. Starting Current: Up to six times full load current.

C. Multiple Speed: Through tapped windings.

D. Open Drip-proof or Enclosed Air Over Enclosure: Class A (50 degrees C temperature rise) insulation, minimum 1.0 Service Factor, prelubricated sleeve or ball bearings, automatic reset overload protector.

2.05 THREE PHASE POWER - SQUIRREL CAGE MOTORS

A. Starting Torque: Between 1 and 1-1/2 times full load torque.

B. Starting Current: Six times full load current.

C. Power Output, Locked Rotor Torque, Breakdown or Pull Out Torque: NEMA Design B characteristics.

D. Design, Construction, Testing, and Performance: Comply with NEMA MG 1 for Design B motors.

E. Insulation System: NEMA Class B or better.

F. Motor Frames: NEMA Standard T-Frames of steel, aluminum, or cast iron with end brackets of cast iron or aluminum with steel inserts.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install securely on firm foundation. Mount ball bearing motors with shaft in any position.

C. Check line voltage and phase and ensure agreement with nameplate.

END OF SECTION

SECTION 22 0519
METERS AND GAUGES FOR PLUMBING PIPING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Pressure gauges.

B. Thermometers.

C. Pressure-temperature test plugs.

1.02 REFERENCE STANDARDS

A. ASME B40.100 - Pressure Gauges and Gauge Attachments 2022.

B. ASTM E1 - Standard Specification for ASTM Liquid-in-Glass Thermometers 2014 (Reapproved 2020).

C. ASTM E77 - Standard Test Method for Inspection and Verification of Thermometers 2014 (Reapproved 2021).

1.03 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements for submittal procedures.

B. Product Data: Provide red-marked product data sheets for each furnished item with associated components and accessories.

PART 2 PRODUCTS

2.01 PRESSURE GAUGES

A. Bourdon Tube for Liquids and Gases:
   1. Dial Size and Cover: 4-1/2 inch diameter scale with polycarbonate window.
   2. Accuracy: ASME B40.100, adjustable commercial grade (D) with 5 percent of span.
   3. Process Connection: Lower-back, 1/4 inch NPT male except where noted.

2.02 THERMOMETERS

A. General:
   1. Product Compliance: ASTM E1.
   2. Lens: Clear glass, except where stated.
   3. Accuracy: One percent, when tested in accordance with ASTM E77, except where stated.
   4. Scale: Black markings depicting single scale in degrees F where expected process value falls half-span of standard temperature range.

B. Thermometers - Dial Type:
   1. Fixed: 5 inch diameter dial with black pointer, stainless steel case, silicone damping bimetal element, hermetically sealed lens, recalibrating screw, and 2-1/2 inch NPT stem.

2.03 PRESSURE-TEMPERATURE TEST PLUGS:

A. Size: 500 psi capacity; 1/2 inch MPT brass fitting with gasket, cap, and retaining strap for 1/8 inch pressure gauge or temperature probe.

B. Wetted Materials per Temperature Range:
   1. Up to 200 degrees F: Brass probe with neoprene core.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install pressure gauges as follows:
   1. At Pumps: Place single gauge before strainer, suction side and discharge side.

B. Install thermometers as follows:

1. Hot Water Heaters: Place upstream and downstream of heater. Add one on the inlet end when using steam as the water heating medium.

END OF SECTION

SECTION 22 0523
GENERAL-DUTY VALVES FOR PLUMBING PIPING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Ball valves.

B. Butterfly valves.

C. Check valves.

D. Lubricated plug valves.

1.02 ABBREVIATIONS AND ACRONYMS

A. CWP: Cold working pressure.

B. EPDM: Ethylene propylene copolymer rubber.

C. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.

D. NRS: Non-rising stem.

E. OS&Y: Outside screw and yoke.

F. PTFE: Polytetrafluoroethylene.

G. RS: Rising stem.

H. TFE: Tetrafluoroethylene.

I. WOG: Water, oil, and gas.

1.03 REFERENCE STANDARDS

A. ASME B1.20.1 - Pipe Threads, General Purpose, Inch 2013 (Reaffirmed 2018).

B. ASME B16.1 - Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250 2020.

C. ASME B16.5 - Pipe Flanges and Flanged Fittings: NPS 1/2 through NPS 24 Metric/Inch Standard 2020.

D. ASME B16.10 - Face-to-Face and End-to-End Dimensions of Valves 2022.

E. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings 2021.

F. ASME B16.34 - Valves — Flanged, Threaded, and Welding End 2020.

G. ASME B31.9 - Building Services Piping 2020.

H. ASTM A48/A48M - Standard Specification for Gray Iron Castings 2022.

I. ASTM A126 - Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings 2004 (Reapproved 2019).

J. ASTM A536 - Standard Specification for Ductile Iron Castings 1984, with Editorial Revision (2019).

K. ASTM B61 - Standard Specification for Steam or Valve Bronze Castings 2015 (Reapproved 2021).

L. ASTM B62 - Standard Specification for Composition Bronze or Ounce Metal Castings 2017.

M. AWWA C606 - Grooved and Shouldered Joints 2022.

N. MSS SP-45 - Drain and Bypass Connections 2020.

O. MSS SP-67 - Butterfly Valves 2022.

P. MSS SP-71 - Gray Iron Swing Check Valves, Flanged and Threaded Ends 2018.

Q. MSS SP-72 - Ball Valves with Flanged or Butt-Welding Ends for General Service 2010a.

R. MSS SP-78 - Gray Iron Plug Valves, Flanged and Threaded Ends 2011.

S. MSS SP-80 - Bronze Gate, Globe, Angle, and Check Valves 2019.

T. MSS SP-110 - Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends 2010, with Errata .

U. NSF 61 - Drinking Water System Components - Health Effects 2022, with Errata.

V. NSF 372 - Drinking Water System Components - Lead Content 2022.

1.04 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements for submittal procedures.

B. Product Data: Provide data on valves including manufacturers catalog information. Submit performance ratings, rough-in details, weights, support requirements, and piping connections.

1.05 QUALITY ASSURANCE

A. Manufacturer:
   1. Obtain valves for each valve type from single manufacturer.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Use the following precautions during storage:
   1. Maintain valve end protection and protect flanges and specialties from dirt.
      a. Provide temporary inlet and outlet caps.
      b. Maintain caps in place until installation.
   2. Store valves in shipping containers and maintain in place until installation.
      a. Store valves indoors in dry environment.
      b. Store valves off the ground in watertight enclosures when indoor storage is not an option.

1.07 EXERCISE THE FOLLOWING PRECAUTIONS FOR HANDLING:

A. Handle large valves with sling, modified to avoid damage to exposed parts.

B. Avoid the use of operating handles or stems as rigging or lifting points.

PART 2 PRODUCTS

2.01 APPLICATIONS

A. See drawings for specific valve locations.

B. Listed pipe sizes shown using nominal pipe sizes (NPS) and nominal diameter (DN).

C. Provide the following valves for the applications if not indicated on drawings:
   1. Shutoff: Ball, butterfly, gate.
   2. Dead-End: Single-flange butterfly (lug) type.
   3. Throttling: Provide ball.
   4. Swing Check (Pump Outlet):
      a. 2 inch and Smaller: Bronze swing check valves with bronze or nonmetallic disc.

D. Low Pressure, Compressed Air Valves 150 psi or Less:
   1. 2 inch and Smaller:
      a. Ball: One piece, full port, brass with brass trim.
      b. Bronze Lift Check: Class 125, bronze disc.

E. Domestic, Hot and Cold Water Valves:
   1. 2 inch and Smaller:
      a. Ball: One piece, full port, brass with brass trim.
      b. Bronze Swing Check: Class 125, bronze disc.
   2. 2-1/2 inch and Larger:

a. Iron, 2-1/2 inch to 4 inch: Provide with threaded or flanged ends.
b. Iron Ball: Class 150.
c. Iron Single-Flange Butterfly: 200 CWP, EPDM seat, aluminum-bronze disc.
d. Iron Grooved-End Butterfly: 175 CWP.
e. Iron Swing Check: Class 125, metal seats.
f. Iron Gate: Class 125, NRS.

2.02 GENERAL REQUIREMENTS

A. Valve Pressure and Temperature Ratings: No less than rating indicated; as required for system pressures and temperatures.

B. Valve Sizes: Match upstream piping unless otherwise indicated.

C. Valve Actuator Types:
1. Handwheel: Valves other than quarter-turn types.
2. Hand Lever: Quarter-turn valves 6 inch and smaller except plug valves.

D. Insulated Piping Valves: With 2 inch stem extensions and the following features:
1. Ball Valves: Extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.
2. Butterfly Valves: Extended neck.
3. Memory Stops: Fully adjustable after insulation is installed.

E. Valve-End Connections:
1. Threaded End Valves: ASME B1.20.1.
2. Flanges on Iron Valves: ASME B16.1 for flanges on iron valves.
3. Pipe Flanges and Flanged Fittings 1/2 inch through 24 inch: ASME B16.5.
4. Solder Joint Connections: ASME B16.18.
5. Grooved End Connections: AWWA C606.

F. General ASME Compliance:
1. Ferrous Valve Dimensions and Design Criteria: ASME B16.10 and ASME B16.34.
2. Solder-joint Connections: ASME B16.18.
3. Building Services Piping Valves: ASME B31.9.

G. Potable Water Use:
1. Certified: Approved for use in compliance with NSF 61 and NSF 372.
2. Lead-Free Certified: Wetted surface material includes less than 0.25 percent lead content.

H. Valve Bypass and Drain Connections: MSS SP-45.

I. Source Limitations: Obtain each valve type from a single manufacturer.

2.03 BRASS, BALL VALVES

A. One Piece, Full Port with Brass Trim and Press or Soldered Connections:
1. Comply with MSS SP-110.
2. CWP Rating: 200 psi.
3. Body: Forged brass.
4. Seats: PTFE.
5. Stem: Brass.
6. Ball: Chrome-plated brass.
7. Operator: Handle.
8. Manufacturers:
a. NIBCO.

2.04 IRON, BALL VALVES

A. Class 125, Full Port, Stainless Steel Trim:
   1. Comply with MSS SP-72.
   2. CWP Rating: 200 psi.
   3. Body: ASTM A536 Grade 65-45-12, ductile iron.
   4. End Connections: Flanged.
   5. Seats: PTFE.
   6. Stem: Stainless steel.
   7. Ball: Stainless steel.
   8. Operator: Lever with locking handle.
   9. Manufacturers:
      a. NIBCO.

2.05 IRON, SINGLE FLANGE BUTTERFLY VALVES

A. Lug Style; Bi-directional dead-end service without use of downstream flange:
   1. Class 125, or Class 150 flanges.
   2. Comply with MSS SP-67, Type I.
   3. Lug Style, Service Pressure Ratings:
      a. 150 psi for sizes 14 to 24 inch.
      b. 150 psi for sizes 14 to 24 inch.
      c. Vacuum down to 29.9 in-Hg.
   4. Body Material: ASTM A126, cast iron or ASTM A536, ductile iron.
   5. Stem: One or two-piece stainless steel.
   6. Seat: EPDM.
   7. Disc: Aluminum-bronze.
   8. Finish: Epoxy coated.
   9. Operator: Lockable handle over direct-mount actuator base.
   10. Manufacturers:
      a. NIBCO.

2.06 IRON, GROOVED-END BUTTERFLY VALVES

A. CWP Rating: 175 psi.
   1. Comply with MSS SP-67, Type I.
   2. Body: Coated ductile iron.
   3. Stem: Two-piece stainless steel.
   4. Disc: Coated ductile iron.
   5. Disc Seal: EPDM.

2.07 BRONZE, LIFT CHECK VALVES

A. General:
   1. Fabricate from dezincification resistant material.
   2. Copper alloys containing more than 15 percent zinc are not permitted.

B. Class 125:
   1. Comply with MSS SP-80, Type 1, Metal Disc to Metal Seat and Type 2, Nonmetallic Disc to Metal Seat.
   2. CWP Rating: 200 psi.
   3. Design: Vertical flow.
   4. Body: Comply with ASTM B61 or ASTM B62, bronze.
   5. End Connections: Threaded.
   6. Disc (Type 1): Bronze.
   7. Manufacturers:

a. NIBCO.

2.08 BRASS, INLINE CHECK VALVES

A. Class 150:
1. Maximum Service Temperature: 250 degrees F.
2. Body: Forged brass.
3. Disc: Forged brass.
4. Seal: PTFE, bubble-tight.
5. End Connections: Press.
6. Manufacturers:
a. NIBCO.

2.09 BRONZE, SWING CHECK VALVES

A. General:
1. Fabricate from dezincification resistant material.
2. Copper alloys containing more than 15 percent zinc are not permitted.

B. Class 125:
1. Pressure and Temperature Rating: MSS SP-80, Type 3.
2. Design: Y-pattern, horizontal or vertical flow.
3. WOG Rating: 200 psi.
4. Body: Bronze, ASTM B62.
5. End Connections: Threaded.
6. Disc: Bronze.
7. Manufacturers:
a. NIBCO.

2.10 IRON, HORIZONTAL SWING CHECK VALVES

A. Class 125:
1. Pressure and Temperature Rating: MSS SP-71, Type I.
2. Design: T-body style for clear or full waterways.
3. WOG Rating: 200 psi.
4. Body: ASTM A126, gray cast iron with bolted bonnet.
5. End Connections: Flanged.
6. Trim: Composition.
7. Seat Ring and Disc Holder: Bronze.
8. Disc: PTFE.
9. Gasket: Asbestos free.
10. Manufacturers:
a. NIBCO.

2.11 LUBRICATED PLUG VALVES

A. Regular Gland with Flanged Ends:
1. Comply with MSS SP-78, Type II.
2. Body: ASTM A48/A48M or ASTM A126, cast iron with lubrication sealing system.
3. Pattern: Regular or short.
4. Plug: Cast iron or bronze with sealant groove.

PART 3 EXECUTION

3.01 INSTALLATION

A. Provide unions or flanges with valves to facilitate equipment removal and maintenance while maintaining system operation and full accessibility for servicing.

B. Provide separate valve support as required and locate valve with stem at or above center of piping, maintaining unimpeded stem movement.

C. Install check valves where necessary to maintain direction of flow as follows:
   1. Lift Check: Install with stem plumb and vertical.
   2. Swing Check: Install horizontal maintaining hinge pin level.

END OF SECTION

SECTION 22 0529
HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Prefabricated trapeze-framed systems.

B. Strut systems for pipe or equipment support.

C. Beam clamps.

D. Pipe hangers.

1.02 RELATED REQUIREMENTS

A. Section 05 5000 - Metal Fabrications.

1.03 REFERENCE STANDARDS

A. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products 2017.

B. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware 2023.

C. ASTM A181/A181M - Standard Specification for Carbon Steel Forgings, for General-Purpose Piping 2022.

D. ASTM A36/A36M - Standard Specification for Carbon Structural Steel 2019.

E. ASTM A47/A47M - Standard Specification for Ferritic Malleable Iron Castings 1999, with Editorial Revision (2022).

F. ASTM A283/A283M - Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates 2018.

G. ASTM A395/A395M - Standard Specification for Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures 1999 (Reapproved 2022).

H. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process 2022.

I. ASTM A1011/A1011M - Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength 2023.

J. ASTM B633 - Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel 2023.

K. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials 2023.

L. FM (AG) - FM Approval Guide Current Edition.

M. MFMA-4 - Metal Framing Standards Publication 2004.

N. MSS SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation 2018, with Amendment (2019).

O. UL (DIR) - Online Certifications Directory Current Edition.

P. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials Current Edition, Including All Revisions.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate sizes and arrangement of supports and bases with the actual equipment and components to be installed.
2. Coordinate the work with other trades to provide additional framing and materials required for installation.
3. Coordinate compatibility of support and attachment components with mounting surfaces at the installed locations.
4. Coordinate the arrangement of supports with ductwork, piping, equipment and other potential conflicts installed under other sections or by others.
5. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

1.05 SUBMITTALS

A. Product Data: Provide manufacturer's standard catalog pages and data sheets for metal channel (strut) framing systems, nonpenetrating rooftop supports, post-installed concrete and masonry anchors, and thermal insulated pipe supports.

B. Shop Drawings: Include details for fabricated hangers and supports where materials or methods other than those indicated are proposed for substitution.
   1. Application of protective inserts, saddles, and shields at pipe hangers for each type of insulation and hanger.

PART 2 PRODUCTS

2.01 GENERAL REQUIREMENTS

A. Provide required hardware to hang or support piping, equipment, or fixtures with related accessories as necessary to complete installation of plumbing work.

B. Provide hardware products listed, classified, and labeled as suitable for intended purpose.

C. Where support and attachment component types and sizes are not indicated, select in accordance with manufacturer's application criteria as required for the load to be supported. Include consideration for vibration, equipment operation, and shock loads where applicable.

D. Do not use wire, chain, perforated pipe strap, or wood for permanent supports unless specifically indicated or permitted.

E. Materials for Metal Fabricated Supports: Comply with Section 05 5000.
   1. Zinc-Plated Steel: Electroplated in accordance with ASTM B633 unless stated otherwise.
   2. Galvanized Steel: Hot-dip galvanized in accordance with ASTM A123/A123M or ASTM A153/A153M unless stated otherwise.

F. Corrosion Resistance: Use corrosion-resistant metal-based materials fully compatible with exposed piping materials and suitable for the environment where installed.

2.02 PREFABRICATED TRAPEZE-FRAMED SYSTEMS

A. Prefabricated Trapeze-Framed Metal Strut Systems:
   1. MFMA-4 compliant, pre-fabricated, MSS SP-58 Type 59 continuous-slot metal strut channel with associated tracks, fittings, and related accessories.
   2. Strut Channel or Bracket Material:
      a. Indoor Dry Locations: Use zinc-plated steel or galvanized steel.
      b. Outdoor and Damp or Wet Indoor Locations: Use galvanized steel.
   3. Accessories: Provide bracket covers, cable basket clips, cable tray clips, clamps, conduit clamps, fire-retarding brackets, j-hooks, protectors, and vibration dampeners.

2.03 STRUT SYSTEMS FOR PIPE OR EQUIPMENT SUPPORT

A. Strut Channels:
   1. ASTM A653/A653M galvanized steel bracket with clamps for surface mounting of piping or plumbing equipment support.

2. Channel or Bracket Kits: Include rods, brackets, end-fixed fittings, covers, clips, and other related hardware required to complete sectional trapeze section for piping or other support.

B. Hanger Rods:
1. Threaded zinc-plated steel unless otherwise indicated.
2. Minimum Size, Unless Otherwise Indicated or Required:
a. Equipment Supports: 1/2 inch diameter.
b. Piping up to 1 inch: 1/4 inch diameter.
c. Piping larger than 1 inch: 3/8 inch diameter.
d. Trapeze Support for Multiple Pipes: 3/8 inch in length.

C. Channel Nuts:
1. Provide carbon steel channel nut with epoxy copper or zinc finish and long, regular, or short spring as indicated on drawings.

2.04 BEAM CLAMPS

A. MSS SP-58 types 19 through 23, 25 or 27 through 30 based on required load.

B. C-Clamp: MSS SP-58 type 23, malleable iron and steel with plain, stainless steel, and zinc finish.

C. Small or Junior Beam Clamp: MSS SP-58 type 19, malleable iron with plain finish. For inverted usage provide manufacturer listed size(s).

D. Wide Mouth Beam Clamp: MSS SP-58 type 19, malleable iron with plain finish.

E. Centerload Beam Clamp with Extension Piece: MSS SP-58 type 30, malleable iron with plain finish.

F. FM (AG) and UL (DIR) Approved Beam Clamp: MSS SP-58 type 19, plain finish.

G. Provide clamps with hardened steel cup-point set screws and lock-nuts for anchoring in place.

H. Material: ASTM A395/A395M ductile iron, ASTM A36/A36M carbon steel, ASTM A47/A47M malleable iron, ASTM A181/A181M forged steel, or ASTM A283/A283M steel.

2.05 PIPE HANGERS

A. Band Hangers, Adjustable:
1. MSS SP-58 type 7 or 9, zinc-plated ASTM A1011/A1011M steel or ASTM A653/A653M carbon steel.

B. Clevis Hangers, Adjustable:
1. Copper Tube: MSS SP-58 type 1, epoxy-plated copper.

2.06 PIPE CLAMPS

A. Riser Clamps:
1. For insulated pipe runs, provide two bolt-type clamps designed for installation under insulation.
2. MSS SP-58 type 1 or 8, carbon steel or steel with epoxy plated, plain, stainless steel, or zinc plated finish.
3. UL (DIR) listed: Pipe sizes 1/2 to 8 inch.

B. Extension Split Pipe Clamp:
1. MSS SP-58 type 12, hinged split ring and yoke roller hanger with epoxy copper or plain finish.
2. Material: ASTM A47/A47M malleable iron or ASTM A36/A36M carbon steel.
3. Provide hanger rod and nuts of the same type and material for a given pipe run.
4. Provide coated or plated hangers to isolate steel hangers from dissimilar metal tube or pipe.

C. Strut Clamps:
   1. Pipe Clamp: Two-piece rigid, universal, or outer diameter type, carbon steel with epoxy copper or zinc finish.

2.07 PIPE SUPPORTS, GUIDES, SHIELDS, AND SADDLES

A. Dielectric Barriers: Provide between metallic supports and metallic piping and associated items of dissimilar type; acceptable dielectric barriers include rubber or plastic sheets or coatings attached securely to pipe or item.

B. Stanchions:
   1. Material: Malleable iron, ASTM A47/A47M; or carbon steel, ASTM A36/A36M.
   2. Provide coated or plated saddles to isolate steel hangers from dissimilar metal tube or pipe.

C. U-Bolts:
   1. MSS SP-58 type 24, carbon steel u-bolt for pipe support or anchoring.

D. Pipe Shields for Insulated Piping:
   1. MSS SP-58 type 40, ASTM A1011/A1011M steel or ASTM A653/A653M carbon steel.
   2. General Construction and Requirements:
      a. Surface Burning Characteristics: Comply with ASTM E84 or UL 723.
      b. Shields Material: UV-resistant polypropylene with glass fill.
      c. Maximum Insulated Pipe Outer Diameter: 12-5/8 inch.
      d. Service Temperature: Minus 40 to 178 degrees F.
      e. Pipe shields to be provided at hanger, support, and guide locations on pipe requiring insulation or additional support.

E. Pipe Supports:
   1. Material: ASTM A395/A395M ductile iron, ASTM A36/A36M carbon steel, ASTM A47/A47M malleable iron, ASTM A181/A181M forged steel, or ASTM A283/A283M steel.
   2. Liquid Temperatures Up to 122 degrees F:
      a. Overhead Support: MSS SP-58 types 1, 3 through 12 clamps.
      b. Support From Below: MSS SP-58 types 35 through 38.

F. Copper Pipe Supports:
   1. Manufacturers:
      a. B-Line, a brand of Eaton Corporation: www.eaton.com/#sle.
      b. HoldRite, a brand of Reliance Worldwide Corporation: www.holdrite.com/#sle.

2.08 ANCHORS AND FASTENERS

A. Unless otherwise indicated and where not otherwise restricted, use the anchor and fastener types indicated for the specified applications.

B. Concrete: Use preset concrete inserts, expansion anchors, or screw anchors.

C. Solid or Grout-Filled Masonry: Use expansion anchors or screw anchors.

D. Hollow Masonry: Use toggle bolts.

E. Hollow Stud Walls: Use toggle bolts.

F. Steel: Use beam ceiling clamps, beam clamps, machine bolts, or welded threaded studs.

G. Sheet Metal: Use sheet metal screws.

H. Wood: Use wood screws.

I. Plastic and lead anchors are not permitted.

J. Powder-actuated fasteners are not permitted.

K. Hammer-driven anchors and fasteners are not permitted.

L. Preset Concrete Inserts: Continuous metal strut channel and spot inserts specifically designed to be cast in concrete ceilings, walls, and floors.
   1. Channel Material: Use galvanized steel.
   2. Manufacturer: Same as manufacturer of metal strut channel framing system.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Install anchors and fasteners in accordance with ICC Evaluation Services, LLC (ICC-ES) evaluation report conditions of use where applicable.

C. Provide independent support from building structure. Do not provide support from piping, ductwork, conduit, or other systems.

D. Do not penetrate or otherwise notch or cut structural members without approval of Structural Engineer.

E. Equipment Support and Attachment:
   1. Use metal fabricated supports or supports assembled from metal channel (strut) to support equipment as required.
   2. Use metal channel (strut) secured to studs to support equipment surface-mounted on hollow stud walls when wall strength is not sufficient to resist pull-out.
   3. Use metal channel (strut) to support surface-mounted equipment in wet or damp locations to provide space between equipment and mounting surface.
   4. Securely fasten floor-mounted equipment. Do not install equipment such that it relies on its own weight for support.

F. Preset Concrete Inserts: Use manufacturer-provided closure strips to inhibit concrete seepage during concrete pour.

END OF SECTION

SECTION 22 0533
HEAT TRACING FOR PLUMBING PIPING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Self-regulating parallel resistance electric heating cable.

B. Cable outer jacket markings.

C. Connection kits.

D. Controls.

1.02 REFERENCE STANDARDS

A. IEEE 515.1 - IEEE Standard for the Testing, Design, Installation, and Maintenance of Electrical Resistance Trace Heating for Commercial Applications 2022.

B. ITS (DIR) - Directory of Listed Products Current Edition.

C. NFPA 70 - National Electrical Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

D. UL (DIR) - Online Certifications Directory Current Edition.

1.03 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide data for electric heat tracing.

C. Operation and Maintenance Data: Include manufacturer's descriptive literature, operating instructions of equipment and controls, maintenance and repair data, and parts listings.

D. Warranty: Submit manufacturer warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.

1.04 WARRANTY

A. See Section 01 7800 - Closeout Submittals, for additional warranty requirements.

B. Provide two year manufacturer warranty for cables, connection kits, accessories, and controls.

PART 2 PRODUCTS

2.01 SELF-REGULATING PARALLEL RESISTANCE ELECTRIC HEATING CABLE

A. Manufacturers:
   1. Chromalox, Inc; _____: www.chromalox.com/#sle.
   2. Pentair; _____: www.pentairthermal.com/#sle.
   3. Thermon Manufacturing Company; _____: www.thermon.com/#sle.

B. Provide products listed, classified, and labeled by UL (DIR), ITS (DIR), or testing firm acceptable to authorities having jurisdiction (AHJ).

C. Factory Rating and Testing: Comply with IEEE 515.1.

D. Heating Element:
   1. Provide pair of parallel No.16 tinned or nickel coated stranded copper bus wires embedded in cross linked conductive polymer core with varying heat output in response to temperature along its length.
   2. Terminations: Waterproof, factory assembled, non-heating leads with connector at one end and water-tight seal at opposite end.
   3. Capable of crossing over itself without overheating.

E. Insulated Jacket: Flame retardant polyolefin.

F. Cable Cover: Provide tinned copper and polyolefin outer jacket with UV inhibitor.

G. Maximum Power-On Operating Temperature: 150 degrees F.

H. Maximum Power-Off Exposure Temperature: 185 degrees F.

I. Electrical Characteristics:
   1. 277 volts, single phase, 60 Hz.

2.02 CABLE OUTER JACKET MARKINGS

A. Name of manufacturer, trademark, or other recognized symbol of identification.

B. Catalog number, reference number, or model.

C. Month and year of manufacture, date coding, applicable serial number, or equivalent.

D. Agency listing or approval.

2.03 CONNECTION KITS

A. Provide power connection, splice/tee, and end seal kits compatible with the heating cable and without requiring cutting of the cable core to expose bus wires.

B. Provide with NEMA 4X rating for prevention of corrosion and water ingress.

2.04 CONTROLS

A. Pipe Mounted Thermostats:
   1. Remote bulb unit with adjustable temperature range from 30 to 50 degrees F.
   2. Snap-action, open-on-rise, single pole switch with minimum current rating adequate for the connected cable.
   3. Control Enclosure: Corrosion resistant and waterproof.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's written installation instructions.

B. Comply with installation requirements of IEEE 515.1 and NFPA 70, Article 427.

C. Apply heating cable linearly on pipe with fiberglass tape only after piping has successfully completed any required pressure testing.

D. Comply with applicable local building codes and requirements of authorities having jurisdiction.

E. Identification:
   1. After thermal insulation installation, apply external pipeline decals to indicate presence of the thermal insulation cladding at intervals not to exceed 20 ft including cladding over each valve or other equipment that may require maintenance.

3.02 CLOSEOUT ACTIVITIES

A. See Section 01 7800 - Closeout Submittals.

B. See Section 01 7900 - Demonstration and Training, for additional requirements.

C. Demonstrate operation of controls.

END OF SECTION

SECTION 22 0553
IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Nameplates.

B. Tags.

C. Ceiling tacks.

1.02 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements for submittal procedures.

B. Schedules:
   1. Submit plumbing component identification schedule listing equipment, piping, and valves.
   2. Detail proposed component identification data in terms of of wording, symbols, letter size, and color coding to be applied to corresponding product.
   3. Valve Data Format: Include id-number, location, function, and model number.

PART 2 PRODUCTS

2.01 PLUMBING COMPONENT IDENTIFICATION GUIDELINE

A. Nameplates:
   1. Control panels, transducers, and other related control equipment products.

B. Pipe Markers: 3/4 inch diameter and higher.

2.02 NAMEPLATES

A. Description: Laminated piece with up to three lines of text.
   1. Letter Color: White.
   2. Letter Height: 1/4 inch.

2.03 TAGS

A. Metal: Brass, 19 gauge 1-1/2 inch in diameter with smooth edges, blank, smooth edges, and corrosion-resistant ball chain. Up to three lines of text.

B. Valve Tag Chart: Typewritten 12-point letter size list in anodized aluminum frame.

2.04 CEILING TACKS

A. Description: Steel with 3/4 inch diameter color coded head.

B. Color code as follows:
   1. Plumbing Equipment: Yellow.
   2. Plumbing Valves: Green.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install flexible nameplates with corrosive-resistant mechanical fasteners, or adhesive. Apply with sufficient adhesive to ensure permanent adhesion and seal with clear lacquer.

B. Install tags in clear view and align with axis of piping

END OF SECTION

SECTION 22 0719
PLUMBING PIPING INSULATION

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Glass fiber insulation.

B. Jacketing and accessories.

1.02 RELATED REQUIREMENTS

A. Section 07 8400 - Firestopping.

1.03 REFERENCE STANDARDS

A. ASTM C177 - Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus 2019, with Editorial Revision (2023).

B. ASTM C195 - Standard Specification for Mineral Fiber Thermal Insulating Cement 2007 (Reapproved 2019).

C. ASTM C449 - Standard Specification for Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement 2007 (Reapproved 2019).

D. ASTM C547 - Standard Specification for Mineral Fiber Pipe Insulation 2022a.

E. ASTM C795 - Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel 2008 (Reapproved 2023).

F. ASTM C1423 - Standard Guide for Selecting Jacketing Materials for Thermal Insulation 2021.

G. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials 2023.

H. ASTM E96/E96M - Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials 2022a, with Editorial Revision (2023).

I. SAE AMS3779 - Tape, Adhesive, Pressure-Sensitive Thermal Radiation Resistant, Aluminum Coated Glass Cloth 2016b.

J. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials Current Edition, Including All Revisions.

1.04 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements for submittal procedures.

B. Product Data: Provide product description, thermal characteristics, list of materials and thickness for each service, and locations.

C. Manufacturer's Instructions: Indicate installation procedures that ensure acceptable workmanship and installation standards will be achieved.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Accept materials on site, labeled with manufacturer's identification, product density, and thickness.

1.06 FIELD CONDITIONS

A. Maintain ambient conditions required by manufacturers of each product.

B. Maintain temperature before, during, and after installation for minimum of 24 hours.

PART 2 PRODUCTS

2.01 REGULATORY REQUIREMENTS

A. Surface Burning Characteristics: Flame spread index/Smoke developed index of 25/50, maximum, when tested in accordance with ASTM E84 or UL 723.

2.02 GLASS FIBER INSULATION

A. Manufacturers:
   1. CertainTeed Corporation: www.certainteed.com/#sle.
   2. Johns Manville Corporation: www.jm.com/#sle.
   3. Owens Corning Corporation; Fiberglas Pipe Insulation ASJ: www.ocbuildingspec.com/#sle.
   4. Substitutions: See Section 01 6000 - Product Requirements.

B. Insulation: ASTM C547 and ASTM C795; rigid molded, noncombustible.
   1. K Value: ASTM C177, 0.24 at 75 degrees F.
   2. Maximum Service Temperature: 850 degrees F.
   3. Maximum Moisture Absorption: 0.2 percent by volume.

C. Vapor Barrier Jacket: White Kraft paper with glass fiber yarn, bonded to aluminized film; moisture vapor transmission when tested in accordance with ASTM E96/E96M of 0.02 perm.

D. Vapor Barrier Lap Adhesive: Compatible with insulation.

E. Insulating Cement/Mastic: ASTM C195; hydraulic setting on mineral wool.

F. Outdoor Vapor Barrier Mastic: Vinyl emulsion type acrylic or mastic, compatible with insulation, black color.

G. Outdoor Breather Mastic: Vinyl emulsion type acrylic or mastic, compatible with insulation, black color.

H. Insulating Cement: ASTM C449.

2.03 JACKETING AND ACCESSORIES

A. Aluminum Jacket:
   1. Thickness: 0.016 inch sheet.
   2. Finish: Smooth.
   3. Joining: Longitudinal slip joints and 2 inch laps.
   4. Fittings: 0.016 inch thick die-shaped fitting covers with factory-attached protective liner.
   5. Metal Jacket Bands: 3/8 inch wide; 0.015 inch thick aluminum.
   6. Metal Jacket Bands: 3/8 inch wide; 0.010 inch thick stainless steel.

B. Aluminum-Foil Laminate Jacket:
   1. Factory-applied, pressure sensitive adhesive jacketing on paper release liner.
   2. Finish: Aluminum smooth.
   3. Comply with ASTM C1775.

C. Reinforced Tape:
   1. FSK tape suitable for sealing seams between insulation, insulated pipe bends, and fittings resulting in a tight, smooth surface without wrinkles.
   2. Comply with UL 723 or ASTM E84.
   3. Moisture Vapor Permeability: 0.00 perm inch, when tested in accordance with ASTM E96/E96M.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that piping has been tested before applying insulation materials.

B. Verify that surfaces are clean and dry, with foreign material removed.

3.02 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Exposed Piping: Locate insulation and cover seams in least visible locations.

C. For hot piping conveying fluids 140 degrees F or less, do not insulate flanges and unions at equipment, but bevel and seal ends of insulation.

D. Inserts and Shields:
   1. Application: Piping 1-1/2 inches diameter or larger.
   2. Shields: Galvanized steel between pipe hangers or pipe hanger rolls and inserts.

E. Continue insulation through walls, sleeves, pipe hangers, and other pipe penetrations. Finish at supports, protrusions, and interruptions. At fire separations, see Section 07 8400.

F. Exterior Applications: Provide vapor barrier jacket. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe, and finish with glass mesh reinforced vapor barrier cement. Cover with aluminum jacket with seams located on bottom side of horizontal piping.

G. Heat Traced Piping: Insulate fittings, joints, and valves with insulation of like material, thickness, and finish as adjoining pipe. Size large enough to enclose pipe and heat tracer. Cover with aluminum jacket with seams located on bottom side of horizontal piping.

3.03 SCHEDULES

A. Plumbing Systems:
   1. Domestic Hot Water Supply:
      a. Glass Fiber Insulation:
         1) Pipe Size Range: All Pipe Sizes.
         2) Thickness: 2 inch.
   2. Domestic Hot Water Recirculation:
      a. Glass Fiber Insulation:
         1) Pipe Size Range: All sizes.
         2) Thickness: 1 inch.
   3. Roof Drain Bodies:
   4. Roof Drainage Run Horizontal:

END OF SECTION

SECTION 22 0800
COMMISSIONING OF PLUMBING

PART 1 GENERAL

1.01 RELATED WORK

A. Division 23 - HVAC

B. Division 26 - Electrical

1.02 REFERENCES

A. Drawings and general provisions of contract, including general and supplementary conditions, general mechanical provisions and Division-1 Specification sections, apply to work of this section.

B. ASHRAE Guideline 1-1996

C. ASHRAE Guideline 0-2005

D. ACG Commissioning Guideline – 2005

1.03 DESCRIPTION OF WORK

A. The purpose of the commissioning process is to provide the owner/operator of the facility with a high level of assurance that the mechanical systems have been installed in the prescribed manner, and operate within the performance guidelines set in the Basis of Design Documents (BOD). The CA shall provide the owner with an unbiased, objective view of the system's installation, operation, and performance. This process is not intended to take away or reduce the responsibility of the design team or installing contractors to provide a finished product. Commissioning is intended to enhance the quality of system start-up and aid in the orderly transfer of systems for beneficial use by the owner. The CA will be a member of the construction team, administrating and coordinating commissioning activities with the design team, construction manager, subcontractors, manufacturers and equipment suppliers.

B. The independent commissioning agent (CA) contracted directly with the owner for this project. This specification has been included for reference only to define contractors' responsibilities. Each contractor should review this procedure and include adequate time in their proposal.

PART 2 PRODUCTS

2.01 NOT USED

PART 3 EXECUTION

3.01 ROLES OF THE COMMISSIONING AGENCY

A. The primary point of responsibility is to inform the construction manager, the owner and design team on the status, integration, and performance of Plumbing systems within the facility.

B. The CA shall function as a catalyst and initiator to disseminate information and assist the design and construction teams in implementing completion of the construction process. This shall include system verification, functional performance testing, and conformance with the intended design of each system. Services include documenting construction observations, verification and functional performance testing, and documenting proper distribution of performance and operating information to the owner's O&M staff.

C. Assist the responsible parties to maintain a high quality level of installation by meeting or exceeding prevailing standards and specifications.

D. The CA shall observe and coordinate testing as required to assure system performance meets the design intent.

E. The CA shall document the results of the performance testing directly and/or assure that the appropriate technicians document testing. The CA shall approve standard forms to be used by

all parties for consistency of approach and type of information to be recorded.

F. The CA shall provide technical expertise to oversee and verify the correction of deficiencies found during the commissioning process.

G. The CA is to remain an independent party with specific knowledge of the project. The CA shall investigate the scope and extent of the problem and facilitate communication to determine responsibilities by delineating specifications. The CA shall monitor resolution for conformance with design intent and prevailing industry standards.

H. The CA shall document the date of acceptance as determined by the construction manager, owner and design team. System Verification Checklists and Functional Performance Test results may be used in determining the start of the warranty period for Plumbing systems and subsystems.

I. The CA will review operating and maintenance materials for Plumbing systems.

J. The CA will review phasing plans as provided by the GC relating to temporary use of Plumbing equipment, O&M considerations, warranty issues, impact of construction sequencing on occupied areas, and interruption of services from the existing equipment.

3.02 SYSTEMS INCLUDED IN THE COMMISSIONING PROCESS

A. Domestic Hot Water

B. Automatic Flush Valves

3.03 PLUMBING COMMISSIONING PLAN

A. Commissioning Team
   1. The Commissioning Team (CT) shall consist of key parties involved in design, construction and testing of this facility. It is necessary for each agency to appoint team members that will have long-term commitments to this project. Switching team members during the project will reduce the ability of the CT to provide continuity and acceptable results to the building owner. Team members must maintain an ongoing supervisory position on this project. One team member shall be provided by each of the parties listed below:
      a. Program Manager (PrM)
      b. Facilities Management Division (FMD)
      c. Commissioning Agent (CA)
      d. Design Team (DT)
      e. General Contractor (GC)
      f. GC's Mechanical Contractor (MC)
      g. GC's Plumbing Contractor (PC)
      h. Controls Contractor (CC)
      i. Test and Balance Contractor (TABC)
      j. Electrical Contractor (EC)

B. Basis of Design Document
   1. The Basis of Design Document (BOD) represents a composite of design drawings, project specifications, submittals, change orders and industry standards that describe the systems of this facility. References to design intent will be taken from these contract documents. The BOD is an evolving manuscript maintained by the design professional to track and incorporate design alterations that occur throughout the construction process. Any industry standards used for this project will be specifically noted when referenced.
   2. The CA will review the BOD documents for adequate commissioning provisions, functional performance, optimization of performance, accessibility, TAB provisions, and O&M considerations.

C. Commissioning Meetings

1. Commissioning meetings will be held in conjunction with progress meetings as necessary. Commissioning meetings will be used to address any problems that alter the design intent or affect the commissioning process. These meetings provide an open forum for exchange of ideas between contractors, vendors, designers, users and owners.

D. Resolution Tracking Forms (RTF)
1. The use of Resolution Tracking Forms is a method employed by the CA to monitor and record problems, their causes, and solutions. The use of these lists promotes communication between the installing contractors, design team, commissioning agent, and owner, in order to expedite their resolution in a timely manner.
2. The CA will regularly submit RTF's to the CT in order to document and resolve deficiencies as quickly as possible. The frequency of RTF submission will be adjusted as project conditions dictate.

E. System Verification Checklists (SVC) / Manufacturers' Checklists
1. The MC/PC shall provide SVC's based on the manufacturers start-up procedures. These tests will be created for systems and subsystems. See SYSTEMS INCLUDED IN THE COMMISSIONING PROCESS. Draft copies will be submitted to the CT for review and comment prior to placement on the job site. A master copy of the SVC's will be bound in a three-ring binder and placed on the job site for use by the installing contractors. No system will be started until the appropriate SVC's have been completed.
2. The CA will review the SVC for each piece of equipment prior to start-up. Equipment will be released for start-up only after these checklists have been completed by the installing contractor and reviewed by the CA.
3. The equipment manufacturers' checklists must also be reviewed by the CA prior to start-up. These lists must be completed by the installing contractor, and reviewed by the CA before start-up can commence.

F. Start-Up
1. The appropriate contractors and/or manufacturer's representative will be required on site to perform start-up. No system will be started until the appropriate SVC's have been completed. No system will be started until the Manufacturer's checklists have been completed. Start-up will be performed according to the Manufacturer's recommended procedures. The CA will visit the site to review completeness of installation in conjunction with progress meetings prior to starting Plumbing equipment.
2. CT members involved in installation, fabrication, manufacture, control, or design of equipment are required to be present at the time of start-up. A factory-authorized technician will be on site to start equipment when required by the specifications. This will minimize delays in bringing equipment on line and expedite acceptable functional performance in accordance with the BoD.

G. Functional Performance Tests (FPT)
1. The CA will write FPT's based on the BoD. These tests will be created for systems and subsystems. See SYSTEMS INCLUDED IN THE COMMISSIONING PROCESS above.
2. Each major system will be tested. A random sample of each subsystem will be tested. This will be coordinated and witnessed by the CA and the owner's maintenance staff. Witnessing the FPT's will serve as a compliment to the O&M Training. No FPT's will be performed until the system and related subsystems have been started, the TAB report has been submitted and reviewed, and the completion of the control system has been documented through point-to-point checklists and other documentation.
3. The Functional Performance Tests shall include Plumbing and related equipment.
   a. Hot water system will be tested.
   b. Heat Exchangers will be tested under relevant operating conditions.
   c. DDC control systems will be tested as necessary.
4. Deferred Testing

a. If tests cannot be completed because of a deficiency outside the scope of the responsible contractor, the deficiencies shall be documented and reported to the Owner. Deficiencies shall be resolved and corrected by the appropriate parties and test rescheduled.
b. Off-season mode testing will be implemented as necessary to assure conformance with the BoD. Installing contractors will be expected to participate as required by the project specifications.

5. Rescheduled Functional Performance Test
   a. During Functional Performance Testing period, it is assumed that the contractors will be complete with all checklists when the commissioning agents travel to site. If the work is not ready for commissioning when the commissioning personnel are on site, contractor shall reimburse the owner for all additional costs the owner incurs as a result of the contractor's failure to be complete and/or to provide operating compliant systems for commissioning. Additional costs include but are not limited to additional fees of $1500.00 per day charged by the architect, engineer, construction manager and commissioning agent.
   b. If the contractor has deficiencies that cannot be corrected at the time of the test, that part of the sequence will be retested at a later date. If the deficiency does not pass during the retest, the contractor will be billed $1500.00 per day for the commissioning personnel's return trip.

H. Building Turn-Over / Owner Orientation / User Training
1. The CA will assist contractors prepare, coordinate and review O&M manuals, working closely with each contractor to achieve specificity and completeness.
2. The CA will review as-built drawings, working closely with each contractor to achieve specificity and completeness.
3. Owner training will be coordinated with the assistance of the CA. The training will be provided by the installing contractor, or manufacturer's representative, and witnessed by the CA. This training should include both classroom training and hands-on operational training. The owner may choose to videotape this training for future use. The CA will visit the site during the Turn-Over and Training period to assure that any on-going Plumbing related problems are being addressed and corrected in a timely and efficient manner.
4. The CA will assist the owner/user with warranty issues.
5. The CA will assist in the coordination of off-season testing, calibrating, and servicing as specified in the contract documents.

3.04 RESPONSIBILITIES OF TEAM MEMBERS

A. General Contractor (GC)
1. Include commissioning requirements in the mechanical, electrical, and controls contracts, as well as other subcontracts, to assure full cooperation of all parties in the Plumbing commissioning process.
2. Assure acceptable representation, with the means and authority to prepare and coordinate execution of the mechanical commissioning program as described in the contract documents.
3. Assure that the CA shall receive a copy of all construction documents, addenda, change orders and appropriate approved submittals and shop drawings for review and use in development of the commissioning plan.
4. Coordinate inclusion of commissioning activities in the construction schedule.
5. Facilitate resolution of deficiencies identified by observation or performance testing.
6. Assist the CA in monitoring the duct leakage testing.

B. GC's Plumbing Contractor (PC)
1. Include cost for commissioning requirements in the contract price.
2. Attend commissioning meetings scheduled by the CA.

3. Verify proper installation and performance of all plumbing services provided.
4. Complete System Verification Checklists and manufacturer's pre-start checklists prior to scheduling startup of equipment.
5. Monitor and respond to Resolution Tracking Forms distributed by the CA in order to expedite corrective actions necessary to achieve design intent.
6. Provide an electrical system technician to assist during verification and performance testing.
7. Participate in the Functional Performance Tests as required to achieve design intent.
8. Participate in the off-season mode testing as required to achieve design intent.
9. Participate in O&M Training as required by project specifications.

END OF SECTION

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SECTION 22 1005
PLUMBING PIPING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Sanitary waste piping, buried within 5 feet of building.
B. Sanitary waste piping, above grade.
C. Chemical-resistant sanitary waste piping.
D. Domestic water piping, buried within 5 feet of building.
E. Domestic water piping, above grade.
F. Storm drainage piping, buried within 5 feet of building.
G. Storm drainage piping, above grade.
H. Natural gas piping, buried beyond 5 feet of building.
I. Natural gas piping, buried within 5 feet of building.
J. Natural gas piping, above grade.
K. Pipe flanges, unions, and couplings.
L. Pipe hangers and supports.
M. Ball valves.
N. Butterfly valves.
O. Pressure reducing valves.
P. Pressure relief valves.
Q. Pressure-temperature valves.
R. Strainers.

1.02 RELATED REQUIREMENTS

A. Section 22 0553 - Identification for Plumbing Piping and Equipment.
B. Section 31 2316 - Excavation.

1.03 REFERENCE STANDARDS

A. ANSI Z21.22 - American National Standard for Relief Valves for Hot Water Supply Systems 2015 (Reaffirmed 2020).
B. ASME B16.3 - Malleable Iron Threaded Fittings: Classes 150 and 300 2021.
C. ASME B16.5 - Pipe Flanges and Flanged Fittings: NPS 1/2 through NPS 24 Metric/Inch Standard 2020.
D. ASME B16.12 - Cast Iron Threaded Drainage Fittings 2019.
E. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings 2021.
F. ASME B16.22 - Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings 2021.
G. ASME B31.1 - Power Piping 2022.
H. ASME B31.9 - Building Services Piping 2020.
I. ASME BPVC-IV - Boiler and Pressure Vessel Code, Section IV - Rules for Construction of Heating Boilers 2023.
J. ASSE 1003 - Performance Requirements for Water Pressure Reducing Valves for Potable Water Distribution Systems 2020.

K. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless 2022.

L. ASTM A234/A234M - Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service 2023a.

M. ASTM B32 - Standard Specification for Solder Metal 2020.

N. ASTM B88 - Standard Specification for Seamless Copper Water Tube 2022.

O. ASTM B88M - Standard Specification for Seamless Copper Water Tube (Metric) 2020.

P. ASTM B813 - Standard Specification for Liquid and Paste Fluxes for Soldering of Copper and Copper Alloy Tube 2016.

Q. ASTM B828 - Standard Practice for Making Capillary Joints by Soldering of Copper and Copper Alloy Tube and Fittings 2016.

R. ASTM C564 - Standard Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings 2020a.

S. ASTM C1540 - Standard Specification for Heavy-Duty Shielded Couplings Joining Hubless Cast Iron Soil Pipe and Fittings 2020.

T. ASTM D2513 - Standard Specification for Polyethylene (PE) Gas Pressure Pipe, Tubing, and Fittings 2020.

U. ASTM D2564 - Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems 2020.

V. ASTM D2665 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings 2020.

W. ASTM D2683 - Standard Specification for Socket-Type Polyethylene Fittings for Outside Diameter-Controlled Polyethylene Pipe and Tubing 2020.

X. ASTM D2729 - Standard Specification for Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings 2021.

Y. ASTM D2855 - Standard Practice for the Two-Step (Primer and Solvent Cement) Method of Joining Poly (Vinyl Chloride) (PVC) or Chlorinated Poly (Vinyl Chloride) (CPVC) Pipe and Piping Components with Tapered Sockets 2020.

Z. ASTM D3034 - Standard Specification for Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings 2021.

AA. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials 2023.

BB. ASTM F876 - Standard Specification for Crosslinked Polyethylene (PEX) Tubing 2023.

CC. ASTM F877 - Standard Specification for Crosslinked Polyethylene (PEX) Hot- and Cold-Water Distribution Systems 2023.

DD. ASTM F1960 - Standard Specification for Cold Expansion Fittings with PEX Reinforcing Rings for Use with Cross-Linked Polyethylene (PEX) and Polyethylene of Raised Temperature (PE-RT) Tubing 2023a.

EE. AWWA C550 - Protective Interior Coatings for Valves and Hydrants 2017.

FF. AWWA C651 - Disinfecting Water Mains 2014, with Addendum (2020).

GG. CISPI 301 - Standard Specification for Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications 2021.

HH. CISPI 310 - Specification for Coupling for Use in Connection with Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications 2020.

II. FM 1680 - Approval Standard for Couplings Used in Hubless Cast Iron Systems for Drain, Waste or Vent, Sewer, Rainwater or Storm Drain Systems Above and Below Ground, Industrial/ Commercial and Residential 1989.

JJ. MSS SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation 2018, with Amendment (2019).

KK. MSS SP-67 - Butterfly Valves 2022.

LL. MSS SP-110 - Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends 2010, with Errata .

MM. NSF 61 - Drinking Water System Components - Health Effects 2022, with Errata.

NN. NSF 372 - Drinking Water System Components - Lead Content 2022.

OO. PPI TR-4 - PPI HSB Listing of Hydrostatic Design Basis (HDB), Hydrostatic Design Stress (HDS), Strength Design Basis (SDB), Pressure Design Basis (PDB) and Minimum Required Strength (MRS) Ratings for Thermoplastic Piping Materials or Pipe 2021.

PP. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials Current Edition, Including All Revisions.

1.04 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements for submittal procedures.

B. Product Data: Provide data on pipe materials, pipe fittings, valves, and accessories. Provide manufacturers catalog information. Indicate valve data and ratings.

1.05 QUALITY ASSURANCE

A. Perform work in accordance with applicable codes.

B. Valves: Manufacturer's name and pressure rating marked on valve body.

PART 2 PRODUCTS

2.01 GENERAL REQUIREMENTS

A. Potable Water Supply Systems: Provide piping, pipe fittings, and solder and flux (if used), that comply with NSF 61 and NSF 372 for maximum lead content; label pipe and fittings.

B. Plenum-Installed Acid Waste Piping: Flame-spread index equal or below 25 and smoke-spread index equal or below 50 according to ASTM E84 or UL 723 tests.

2.02 SANITARY WASTE PIPING, BURIED WITHIN 5 FEET OF BUILDING

A. PVC Pipe: ASTM D2665 or ASTM D3034.
   1. Fittings: PVC.
   2. Joints: Solvent welded, with ASTM D2564 solvent cement.

2.03 SANITARY WASTE PIPING, ABOVE GRADE

A. Cast Iron Pipe: CISPI 301, hubless, service weight.
   1. Fittings: Cast iron.
   2. Joints: CISPI 310, neoprene gaskets and stainless steel clamp-and-shield assemblies.

B. PVC Pipe: ASTM D2729.
   1. Fittings: PVC.
   2. Joints: Solvent welded, with ASTM D2564 solvent cement.

2.04 CHEMICAL-RESISTANT SANITARY WASTE PIPING

2.05 DOMESTIC WATER PIPING, BURIED WITHIN 5 FEET OF BUILDING

A. Cross-Linked Polyethylene (PEX) Pipe: ASTM F876 or ASTM F877.
   1. PPI TR-4 Pressure Design Basis:

a. 160 psig at maximum 73 degrees F.
2. Fittings: Below slab fittings are not allowed.
3. Joints: Below slab joints are not allowed.

2.06 DOMESTIC WATER PIPING, ABOVE GRADE

A. Copper Pipe: ASTM B88 (ASTM B88M), Type L (B), Drawn (H).
1. Fittings: ASME B16.18, cast copper alloy or ASME B16.22, wrought copper and bronze.
2. Joints: ASTM B32, alloy Sn95 solder.
3. Mechanical Press Sealed Fittings: Double-pressed type, NSF 61 and NSF 372 approved or certified, utilizing EPDM, nontoxic, synthetic rubber sealing elements.

B. Cross-Linked Polyethylene (PEX-a) Pipe: ASTM F876, SDR 9 manufactured using the Engel-method.
1. Cold-expansion Fittings: ASTM F877 or ASTM F1960, lead-free brass or engineered polymer (EP) fitting utilizing cold-expansion PEX-a reinforcing rings.
a. All PEX-a piping shall be provided with PEX-a ipe supports, coordinate sizing of support with manufacturer.
2. Metal to PEX Transition Fittings:
a. Flanges: ASME B16.5 , Class 150, with ASTM F1960 cold-expansion end.
b. Groove Adapter: One CSA B242-05 groove end and one ASTM F1960 cold-expansion end.
3. PPI TR-4 Pressure Design Basis:

2.07 STORM DRAINAGE PIPING, BURIED WITHIN 5 FEET OF BUILDING

A. PVC Pipe: ASTM D2665 or ASTM D3034.
1. Fittings: PVC.
2. Joints: Solvent welded, with ASTM D2564 solvent cement.

2.08 STORM DRAINAGE PIPING, ABOVE GRADE

A. Cast Iron Pipe: CISPI 301, hubless, service weight.
1. Fittings: Cast iron.
2. Joints: Neoprene gaskets and stainless steel clamp-and-shield assemblies.

B. PVC Pipe: ASTM D2665.
1. Fittings: PVC.
2. Joints: Solvent welded, with ASTM D2564 solvent cement.

2.09 NATURAL GAS PIPING, BURIED BEYOND 5 FEET OF BUILDING

A. Polyethylene Pipe: ASTM D2513, SDR 11.
1. Fittings: ASTM D2683 or ASTM D2513 socket type.
2. Joints: Fusion welded.

2.10 NATURAL GAS PIPING, BURIED WITHIN 5 FEET OF BUILDING

A. Polyethylene Pipe: ASTM D2513, SDR 11.
1. Fittings: ASTM D2683 or ASTM D2513 socket type.
2. Joints: Fusion welded.

2.11 NATURAL GAS PIPING, ABOVE GRADE

A. Steel Pipe: ASTM A53/A53M Schedule 40 black.
1. Fittings: ASME B16.3, malleable iron, or ASTM A234/A234M, wrought steel welding type.
2. Joints:
a. Gas pressure less than 0.5-psig: Threaded.
b. Gas pressure greater more than 0.5-psig and less than 5-psig: Welded to ASME B31.1.

2.12 PIPE FLANGES, UNIONS, AND COUPLINGS

A. Unions for Pipe Sizes 3 inch and Under:
   1. Ferrous Pipe: Class 150 malleable iron threaded unions.
   2. Copper Tube and Pipe: Class 150 bronze unions with soldered joints.

B. Flanges for Pipe Sizes Over 1 inch:
   1. Ferrous Pipe: Class 150 malleable iron threaded or forged steel slip-on flanges; preformed neoprene gaskets.
   2. Copper Tube and Pipe: Class 150 slip-on bronze flanges; preformed neoprene gaskets.

C. Shielded, Heavy Duty No-Hub Couplings:
   1. Testing: In accordance with ASTM C1540 and FM 1680.
   2. Gasket Material: Neoprene complying with ASTM C564.
   3. Band Material: Stainless steel.
   4. Eyelet Material: Stainless steel.
   5. Manufacturers:
      a. ANACO-Husky
      b. Ideal Clamp Products, Inc; Yellow Shield Heavy Duty: www.idealtridon.com//#sle.
      c. MIFAB, Inc; MI-QXHUB: www.mifab.com/#sle.

2.13 PIPE HANGERS AND SUPPORTS

A. Provide hangers and supports that comply with MSS SP-58.
   1. If type of hanger or support for a particular situation is not indicated, select appropriate type using MSS SP-58 recommendations.
   2. Overhead Supports: Individual steel rod hangers attached to structure or to trapeze hangers.
   3. Trapeze Hangers: Welded steel channel frames attached to structure.
   4. Vertical Pipe Support: Steel riser clamp.

B. Plumbing Piping - Drain, Waste, and Vent:
   1. Hangers for Pipe Sizes 1/2 to 1-1/2 inch: Malleable iron, adjustable swivel, split ring.
   2. Hangers for Pipe Sizes 2 inch and Over: Carbon steel, adjustable, clevis.
   3. Copper Pipe Support: Carbon steel ring, adjustable, copper plated.

C. Plumbing Piping - Water:
   1. Hangers for Pipe Sizes 1/2 to 1-1/2 inch: Malleable iron, adjustable swivel, split ring.
   2. Hangers for Cold Pipe Sizes 2 inch and Over: Carbon steel, adjustable, clevis.
   3. Hangers for Hot Pipe Sizes 2 to 4 inch: Carbon steel, adjustable, clevis.

2.14 BALL VALVES

A. Construction, 4 inch and Smaller: MSS SP-110, Class 150, 400 psi CWP, bronze or ductile iron body, 304 stainless steel or chrome plated brass ball, regular port, teflon seats and stuffing box ring, blow-out proof stem, lever handle with balancing stops, threaded or grooved ends with union.

2.15 BUTTERFLY VALVES

A. Construction 1-1/2 inch and Larger: MSS SP-67, 200 psi CWP, cast or ductile iron body, nickel-plated ductile iron disc, resilient replaceable EPDM seat, wafer ends, extended neck, 10 position lever handle.

B. Provide gear operators for valves 8 inches and larger, and chain-wheel operators for valves mounted over 8 feet above floor.

2.16 PRESSURE REDUCING VALVES

A. 2 inch and Smaller:

1. ASSE 1003, bronze body, stainless steel, and thermoplastic internal parts, fabric reinforced diaphragm, strainer, threaded single union ends.
2. Pressure Reducing Pilot-Operator:
   a. Operating Range: 5 to 50 psi.
   b. Connected into brass or bronze pilot piping and fittings.
   c. Fixed flow restrictor, pressure gauges, and isolation valves.

B. 2 inch and Larger:
1. ASSE 1003, cast iron body with interior lining complying with AWWA C550, bronze fitted, elastomeric diaphragm and seat disc, flanged.
2. Pressure Reducing Pilot-Operator:
   a. Operating Range: 5 to 50 psi.
   b. Connected into brass or bronze pilot piping and fittings.
   c. Fixed flow restrictor, strainer, pressure gauges, and isolation valves.

2.17 PRESSURE RELIEF VALVES

A. ANSI Z21.22, AGA certified, bronze body, teflon seat, steel stem and springs, automatic, direct pressure actuated.

2.18 PRESSURE-TEMPERATURE VALVES

A. ANSI Z21.22, AGA certified, bronze body, teflon seat, stainless steel stem and springs, automatic, direct pressure actuated, temperature relief maximum 210 degrees F, capacity ASME BPVC-IV certified and labelled.

2.19 STRAINERS

A. Size 1/2 inch to 3 inch:
1. Class 150, threaded forged bronze Y-pattern body, stainless steel perforated mesh screen with cap, and rated for 150 psi, 250 deg F WOG service.

B. Size 2 inch and Smaller:
1. Threaded brass body for 175 psi CWP, Y pattern with 1/32 inch stainless steel perforated screen.
2. Class 150, threaded bronze body 300 psi CWP, Y pattern with 1/32 inch stainless steel perforated screen.

C. Size 1-1/2 inch to 4 inch:
1. Class 125, flanged iron body, Y pattern with 1/16 inch stainless steel perforated screen.

PART 3 EXECUTION

3.01 PREPARATION

A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.

B. Remove scale and dirt, on inside and outside, before assembly.

C. Prepare piping connections to equipment with flanges or unions.

3.02 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Provide non-conducting dielectric connections wherever jointing dissimilar metals.

C. Route piping in orderly manner and maintain gradient. Route parallel and perpendicular to walls.

D. Install piping to maintain headroom, conserve space, and not interfere with use of space.

E. Group piping whenever practical at common elevations.

F. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings.

G. Excavate in accordance with Section 31 2316.

H. Install valves with stems upright or horizontal, not inverted. See Section 22 0523.

I. Install water piping to ASME B31.9.

J. Copper Pipe and Tube: Make soldered joints in accordance with ASTM B828, using specified solder, and flux meeting ASTM B813; in potable water systems use flux also complying with NSF 61 and NSF 372.

K. PVC Pipe: Make solvent-welded joints in accordance with ASTM D2855.

L. Pipe Hangers and Supports:
   1. Install in accordance with ASME B31.9.
   2. Install hangers to provide minimum 1/2 inch space between finished covering and adjacent work.
   3. Place hangers within 12 inches of each horizontal elbow.
   4. Use hangers with 1-1/2 inch minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.
   5. Support vertical piping at every other floor. Support riser piping independently of connected horizontal piping.
   6. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
   7. Provide copper plated hangers and supports for copper piping.

M. When installing more than one piping system material, ensure system components are compatible and joined to ensure the integrity of the system. Provide necessary joining fittings. Ensure flanges, union, and couplings for servicing are consistently provided.

3.03 APPLICATION

A. Install brass male adapters each side of valves in copper piped system. Solder adapters to pipe.

B. Install ball valves for shut-off and to isolate equipment, part of systems, or vertical risers.

C. Install globe valves for throttling, bypass, or manual flow control services.

D. Provide lug end butterfly valves adjacent to equipment when provided to isolate equipment.

E. Provide spring-loaded check valves on discharge of water pumps.

3.04 FIELD TESTS AND INSPECTIONS

A. Verify and inspect systems according to requirements by the Authority Having Jurisdiction. In the absence of specific test and inspection procedures proceed as indicated below.

B. Domestic Water Systems:
   1. Perform hydrostatic testing for leakage prior to system disinfection.
   2. Test Preparation: Close each fixture valve or disconnect and cap each connected fixture.
   3. General:
      a. Fill the system with water and raise static head to 10 psi above service pressure. Minimum static head of 50 to 150 psi. As an exception, certain codes allow a maximum static pressure of 80 psi.

C. Test Results: Document and certify successful results, otherwise repair, document, and retest.

3.05 DISINFECTION OF DOMESTIC WATER PIPING SYSTEM

A. Prior to starting work, verify system is complete, flushed, and clean.

B. Ensure acidity (pH) of water to be treated is between 7.4 and 7.6 by adding alkali (caustic soda or soda ash) or acid (hydrochloric).

C. Inject disinfectant, free chlorine in liquid, powder, tablet, or gas form throughout system to obtain 50 to 80 mg/L residual.

D. Bleed water from outlets to ensure distribution and test for disinfectant residual at minimum 15 percent of outlets.

E. Maintain disinfectant in system for 24 hours.

F. If final disinfectant residual tests less than 25 mg/L, repeat treatment.

G. Flush disinfectant from system until residual equal to that of incoming water or 1.0 mg/L.

H. Take samples no sooner than 24 hours after flushing, from 10 percent of outlets and from water entry, and analyze in accordance with AWWA C651.

3.06 SERVICE CONNECTIONS

A. Provide new sanitary sewer services. Before commencing work, check invert elevations required for sewer connections, confirm inverts and ensure that these can be properly connected with slope for drainage and cover to avoid freezing.

B. Provide new water service complete with approved reduced pressure backflow preventer and water meter with by-pass valves, and sand strainer.

3.07 SCHEDULES

A. Pipe Hanger Spacing:
   1. Metal Piping:
      a. Pipe Size: 1/2 inch to 1-1/4 inch:
         1) Maximum Hanger Spacing: 6.5 ft.
         2) Hanger Rod Diameter: 3/8 inches.
      b. Pipe Size: 1-1/2 inch to 2 inch:
         1) Maximum Hanger Spacing: 10 ft.
         2) Hanger Rod Diameter: 3/8 inch.
      c. Pipe Size: 2-1/2 inch to 3 inch:
         1) Maximum Hanger Spacing: 10 ft.
         2) Hanger Rod Diameter: 1/2 inch.
      d. Pipe Size: 4 inch to 6 inch:
         1) Maximum Hanger Spacing: 10 ft.
         2) Hanger Rod Diameter: 5/8 inch.
      e. Pipe Size: 8 inch to 12 inch:
         1) Maximum hanger spacing: 14 ft.
         2) Hanger Rod Diameter: 7/8 inch.
      f. Pipe Size: 14 inch and Over:
         1) Maximum Hanger Spacing: 20 ft.
         2) Hanger Rod Diameter: 1 inch.
   2. Plastic Piping:
      a. All Sizes:
         1) Maximum Hanger Spacing: 6 ft.
         2) Hanger Rod Diameter: 3/8 inch.

END OF SECTION

SECTION 22 1006
PLUMBING PIPING SPECIALTIES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Drains.
B. Cleanouts.
C. Hose bibbs.
D. Washing machine boxes and valves.
E. Refrigerator valve and recessed box.
F. Backflow preventers.
G. Double check valve assemblies.
H. Water hammer arrestors.
I. Sanitary waste interceptors.
J. Floor drain trap seals.
K. Electronic trap-seal primers.

1.02 REFERENCE STANDARDS

A. ASME A112.6.4 - Roof, Deck, and Balcony Drains 2022.
B. ASSE 1012 - Performance Requirements for Backflow Preventers with an Intermediate Atmospheric Vent 2021.
C. ASSE 1013 - Performance Requirements for Reduced Pressure Principle Backflow Prevention Assemblies 2021.
D. ASSE 1015 - Performance Requirements for Double Check Backflow Prevention Assemblies 2021.
E. NSF 61 - Drinking Water System Components - Health Effects 2022, with Errata.
F. NSF 372 - Drinking Water System Components - Lead Content 2022.
G. PDI-WH 201 - Water Hammer Arresters 2017.

1.03 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements for submittal procedures.
B. Product Data: Provide component sizes, rough-in requirements, service sizes, and finishes.
C. Shop Drawings: Indicate dimensions, weights, and placement of openings and holes.
D. Certificates: Certify that grease interceptors meet or exceed specified requirements.
E. Manufacturer's Instructions: Indicate Manufacturer's Installation Instructions: Indicate assembly and support requirements.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Accept specialties on site in original factory packaging. Inspect for damage.

PART 2 PRODUCTS

2.01 GENERAL REQUIREMENTS

A. Specialties in Potable Water Supply Systems: Provide products that comply with NSF 61 and NSF 372 for maximum lead content.

2.02 DRAINS

A. Manufacturers:
   1. Jay R. Smith Manufacturing Company; _____: www.jrsmith.com/#sle.
   2. Josam Company; _____: www.josam.com/#sle.
   3. MIFAB, Inc; _____: www.mifab.com/#sle.
   4. Zurn Industries, LLC; _____: www.zurn.com/#sle.

B. Roof Drains:
   1. Assembly: ASME A112.6.4.
   2. Body: Lacquered cast iron with sump.
   3. Strainer: Removable polyethylene dome with vandal proof screws.
   4. Accessories: Coordinate with roofing type, see Section _____:
      a. Membrane flange and membrane clamp with integral gravel stop.
      b. Adjustable under deck clamp.
      c. Roof sump receiver.
      d. Waterproofing flange.
      e. Adjustable extension sleeve for roof insulation.
      f. O-ring seal between male and female connection pipes.
   5. Manufacturers:
      a. Jay R. Smith Manufacturing Company; _____: www.jrsmith.com/#sle.
      b. MIFAB, Inc; _____: www.mifab.com/#sle.
      c. Zurn Industries, LLC; Z100F: www.zurn.com/#sle.

C. Parapet Drains:
   1. Lacquered cast iron body with aluminum flashing clamp collar and epoxy coated sloping grate.

D. Floor Drains:
   1. Manufacturers:
      a. Jay R. Smith Manufacturing Company; _____: www.jrsmith.com/#sle.
      b. MIFAB, Inc; FS1100-C Series: www.mifab.com/#sle.
      c. Zurn Industries, LLC; Z415-BZ1: www.zurn.com/#sle.

2.03 CLEANOUTS

A. Manufacturers:
   1. Jay R. Smith Manufacturing Company; _____: www.jrsmith.com/#sle.
   2. Josam Company; _____: www.josam.com/#sle.
   3. MIFAB, Inc; C1100-R: www.mifab.com/#sle.
   4. Zurn Industries, LLC; _____: www.zurn.com/#sle.

2.04 HOSE BIBBS

A. Manufacturers:
   1. Jay R. Smith Manufacturing Company; _____: www.jrsmith.com/#sle.
   2. Watts Regulator Company; _____: www.wattsregulator.com/#sle.
   3. Zurn Industries, LLC; _____: www.zurn.com/#sle.

2.05 WASHING MACHINE BOXES AND VALVES

A. Box Manufacturers:
   1. IPS Corporation/Water-Tite; _____: www.ipscorp.com/#sle.
   2. Oatey Supply Chain Services, Inc; _____: www.oatey.com/#sle.

B. Valve Manufacturers:
   1. IPS Corporation/Water-Tite; _____: www.ipscorp.com/#sle.
   2. Zurn Industries, LLC; _____: www.zurn.com/#sle.

C. Description: Plastic preformed rough-in box with brass long shank valves with wheel handles, socket for 2 inch waste, slip in finishing cover.

2.06 REFRIGERATOR VALVE AND RECESSED BOX

A. Box Manufacturers:
   1. IPS Corporation/Water-Tite; _____: www.ipscorp.com/#sle.
   2. Oatey Supply Chain Services, Inc; _____: www.oatey.com/#sle.

B. Valve Manufacturers:
   1. IPS Corporation/Water-Tite; _____: www.ipscorp.com/#sle.
   2. Zurn Industries, LLC; _____: www.zurn.com/#sle.

C. Description: Plastic preformed rough-in box with brass valves with wheel handle, slip in finishing cover.

2.07 BACKFLOW PREVENTERS

A. Reduced Pressure Backflow Preventer Assembly:
   1. ASSE 1013; cast bronze body and stainless steel springs; two independently operating, spring loaded check valves; diaphragm type differential pressure relief valve located between check valves; third check valve that opens under back pressure in case of diaphragm failure, and non-threaded vent outlet.
   2. Size: _____ inch assembly with threaded gate valves.

B. Reduced Pressure Backflow Preventer Assembly:
   1. ASSE 1013 and NSF 61 compliant reinforced-nylon body and stainless steel springs; two independently operating, spring loaded check valves; diaphragm type differential pressure relief valve located between check valves; third check valve that opens under back pressure in case of diaphragm failure, integral male test fittings, and non-threaded vent outlet.
   2. Size: 3/4 to 2 inch assembly with threaded gate valves.

C. Reduced Pressure Backflow Preventer Assembly:
   1. ASSE 1013 and NSF 61 compliant stainless steel body assembly with corrosion resistant internal parts, stainless steel springs, diaphragm type differential pressure relief valve located between check valves, third check valve that opens under back pressure in case of diaphragm failure, and non-threaded vent outlet.
   2. Configured to protect against backsiphonage and backpressure into potable water supply.
   3. Size: 2-1/2 to 10 inch assembly with flanged OS&Y gate valves.

2.08 DOUBLE CHECK-VALVE ASSEMBLIES

A. Double Check Valve Assembly:
   1. ASSE 1012; cast bronze body with corrosion resistant internal parts and stainless steel springs; two independently operating check valves with intermediate atmospheric vent.
   2. Size: 3/4 to 2 inch, NPS assembly with threaded full port ball valves.

B. Double Check Valve Assembly:
   1. ASSE 1015 and NSF 61 compliant cast bronze body with corrosion resistant internal parts and stainless steel springs; two independently operating check valves with intermediate atmospheric vent.
   2. Size: 3/4 to 2 inch, NPS assembly with threaded full port ball valves.

2.09 WATER HAMMER ARRESTORS

A. Manufacturers:
   1. Jay R. Smith Manufacturing Company; _____: www.jrsmith.com/#sle.
   2. Watts Regulator Company, a part of Watts Water Technologies; _____: www.wattsregulator.com/#sle.

B. Water Hammer Arrestors:
   1. Stainless steel construction, bellows type sized in accordance with PDI-WH 201, precharged suitable for operation in temperature range minus 100 to 300 degrees F and maximum 250 psi working pressure.

2.10 SANITARY WASTE INTERCEPTORS

A. Manufacturers:
   1. Park.

B. Grease Interceptors:
   1. Construction:
      a. Material: Precast concrete complying with ASTM C 913.
      b. Rough-in: On floor.
      c. Cover: Steel, epoxy coated, non-skid with gasket, securing handle, and enzyme injection port, recessed for floor finish.

2.11 FLOOR DRAIN TRAP SEALS

A. Description: Push-fit EPDM or silicone fitting with a one-way membrane.

2.12 ELECTRONIC TRAP-SEAL PRIMERS

A. Description: Enclosed electronic trap seal primer system with timer.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Extend cleanouts to finished floor or wall surface. Lubricate threaded cleanout plugs with mixture of graphite and linseed oil. Ensure clearance at cleanout for rodding of drainage system.

C. Encase exterior cleanouts in concrete flush with grade.

D. Install floor cleanouts at elevation to accommodate finished floor.

E. Install approved potable water protection devices on plumbing lines where contamination of domestic water may occur; on boiler feed water lines, janitor rooms, fire sprinkler systems, premise isolation, irrigation systems, flush valves, interior and exterior hose bibbs.

F. Pipe relief from backflow preventer to nearest drain.

G. Install water hammer arrestors complete with accessible isolation valve on hot and cold water supply piping to washing machine outlets or water closets.

END OF SECTION

SECTION 22 1123
DOMESTIC WATER PUMPS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Circulators.

1.02 REFERENCE STANDARDS

A. ICC (IPC) - International Plumbing Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

B. NSF 61 - Drinking Water System Components - Health Effects 2022, with Errata.

1.03 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements for submittal procedures.

B. Product Data:
   1. Provide certified pump curve with duty point marked over pump and system operating conditions and NPSH curve and power requirement by pump tag.
   2. Manufacturer's catalog sheets for fixtures, fittings, accessories, and supplies.

C. Shop Drawings: Include dimensions and performance data.

D. Test Reports: Plumbing fixture operational tests.

E. Operation and Maintenance Data: Include operation, maintenance, and inspection data, replacement part numbers and availability, and service depot location and telephone number.

PART 2 PRODUCTS

2.01 CIRCULATORS

A. Manufacturers:
   1. Armstrong Fluid Technology; _____: www.armstrongfluidtechnology.com/#sle.
   2. Bell & Gossett, a Brand of Xylem, Inc; _____: www.xylem.com/#sle.
   3. Grundfos Pumps Corporation; MAGNA 3: www.grundfos.com/#sle.

B. Casing: Bronze with bronze cast impeller, and stainless steel rotor assembly.

C. Shaft: Alloy steel with integral thrust collar and two oil-lubricated bronze sleeve bearings.

D. Mechanical Seal: Carbon rotating against a stationary ceramic seat.

E. Pipe-End Connection: Union connection.

F. Maximum Discharge Pressure: 145 psi.

G. Motor: 1,750 rpm, ECM duty with flexible coupling.

H. Service Temperature Range: Minus 30 to 250 degrees F.

I. Controls: Provide aquastat set for high-temp cutoff, electric plug, and illuminated hand switch.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install products with related fittings, and accessories according to manufacturer instructions.

B. Potable and Drinking Water Service: Provide NSF 61 certified; comply with ICC (IPC).

C. Ensure that small pressure gauges are installed on both upstream and downstream ends.

D. Ensure pumps operate at specified system fluid temperatures without vapor binding and cavitation, are nonoverloading in parallel or individual operation, and operate within 25 percent of midpoint of published maximum efficiency curve.

END OF SECTION

SECTION 22 1313
FACILITY SANITARY SEWERS

PART 1 – GENERAL

1.01 RELATED DOCUMENTS

A. Section includes gravity-flow, outside the building, with the following components:
   1. Cleanouts
   2. Manholes

B. All public work to be performed and materials to be used within the street right-of-way, shall be in accordance with the City of Austin Design Standards.

C. All private work to be performed and materials to be used beyond the street right-of-way shall be in accordance with the Plumbing Code. In the event of a discrepancy between the above-referenced standards, the plans, and/or any portion of this specification section, the order of precedence will be the plans, the City Design Standards, and then these specifications. The Contractor shall contact the engineer in the event of a discrepancy.

1.02 DEFINITIONS

A. PVC: Polyvinyl chloride plastic.

1.03 PERFORMANCE REQUIRMENTS

A. Gravity-Flow, Nonpressure, Drainage-Piping Pressure Rating: 10-food head of water (30 kPa).

1.04 SUBMITTALS

A. Product Data: For the following:
   1. Special pipe fittings.

B. Shop Drawings: For the following:
   1. Manholes: Include plans, elevations, sections, details, and frames and covers.

C. Coordination Drawings: Show pipe sizes, locations, and elevations. Show other piping in same trench and clearances from sewerage system piping. Indicate interface and spatial relationship between manholes, piping, and proximate structures.

D. Field Quality-control test reports.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Do not store plastic manholes, pipe, and fittings in direct sunlight.

B. Protect pipe, pipe fittings, and seals from dirt and damage.

C. Handle manholes according to manufacturer's written rigging instructions.

1.06 PROJECT CONDITIONS

A. Interruption of Existing Sanitary Sewerage Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:
   1. Notify Construction Manager no fewer than two days in advance of proposed interruption of service.
   2. Do not proceed with interruption of service without Construction Manager's written permission.

PART 2 - PRODUCTS

2.01 PVC PIPE AND FITTINGS

A. PVC Pressure Pipe: AWWA C900, Class 150, for gasketed joints and using ASTM F 477, elastomeric seals.

1. Fittings NPS 4 to NPS 8 (DN 100 to DN 200): PVC pressure fittings complying with AWWA C907, for gasketed joints and using ASTM F 477, elastomeric seals.
2. Fittings NPS 10 (DN 250) and Larger: Ductile-iron, compact fittings complying with AWWA C153, for push-on joints and using AWWA C111, rubber gaskets.

B. PVC Sewer Pipe and Fittings, NPS 16 and Smaller: ASTM D 3034, SDR 26, with bell-and-spigot ends for gasketed joints with ASTM F 477, elastomeric seals.

2.02 NONPRESSURE-TYPE PIPE COUPLINGS

A. Comply with ASTM C 1173, elastomeric, sleeve-type, reducing or transition coupling, for joining underground nonpressure piping. Include ends of same sizes as piping to be joined and corrosion-resistant-metal tension band and tightening mechanism on each end.

B. Sleeve Materials:
1. For Concrete Pipes: ASTM C 443 (ASTM C 443M), rubber.
2. For Cast-Iron Soil Pipes: ASTM C 564, rubber.
3. For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.
4. For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.

2.03 MANHOLES

A. Precast Concrete Manholes: ASTM C 478, precast, reinforces concrete, of depth indicated, with provision for rubber gasketed joints, and pipe boots.
1. Inside diameter: 48 inches minimum, unless otherwise indicated.
2. Base section: 8 inches minimum thickness for floor slab and 5-inch minimum thickness for walls and base riser section and having separate base slab or base section with integral floor.
3. Riser sections: 5-inch minimum thickness.
4. Top Section: Eccentric-cone type, unless otherwise indicated.
5. Gaskets: ASTM C 443, rubber (when required by local authority having jurisdiction).
6. Pipe connectors: ASTM C 923, resilient, of size required, for each pipe connecting to base section.
7. Joints of the manhole sections shall be of the tongue and groove type, filled with an approved preformed butyl rubber base, sealing compound, conforming to Federal Specifications SS-S210A, Type 1, Rope form.
8. Inside of the manhole shall have a Thane Coat installed for all sanitary manholes located inside of the property boundary.

B. Standard manhole frames and covers shall conform to the standard detail of the regulatory authorities having jurisdiction for the project (if applicable). Otherwise, manhole frames and covers to be Neenah Foundary Co. No. R-1642 or Vulcan Foundary Inc. No. V-1357, 30” opening.

C. All sanitary sewer manhole covers shall have the word “SANITARY SEWER” cast on the top in letters 2 inches higher.

2.04 CLEANOUTS

A. Gray-Iron Cleanouts: ASME A112.36.2M, round, gray-iron housing with clamping device and round, secured, scoriated, gray-iron cover. Include gray-iron ferrule with inside calk or spigot connection and countersunk, tapered-thread, brass closure plug, with a 2’ x 2’ x 6” thick concrete apron.
1. Available Manufacturers:

a. Refer to City of Austin Utility Standards, latest edition.
2. Top-Loading Classification: Extra-heavy duty.
3. Sewer Pipe Fitting and Riser to Cleanout: ASTM A 74, Service class, cast-iron soil pipe and fittings.

2.05 CONCRETE

A. General: Cast-in-place concrete according to ACI 318/318R, ACI 350R, and the following:
1. Cement: ASTM C 150, Type II.
2. Fine Aggregate: ASTM C 33, sand.
3. Coarse Aggregate: ASTM C 33, crushed gravel.
4. Water: Potable.

B. Portland Cement Design Mix: 4000 psi (27.6 MPa) minimum, with 0.45 maximum water/cementitious materials ratio.
1. Reinforcement Fabric: ASTM A 185, steel, welded wire fabric, plain.
2. Reinforcement Bars: ASTM A 615/A 615M, Grade 60 (420 MPa), deformed steel.

PART 3 - EXECUTION

3.01 EARTHWORK

A. Excavating, trenching, and backfilling are specified in Division 31 Section “Earth Moving.”

3.02 PIPING APPLICATIONS

A. Pipe couplings and special pipe fittings with pressure ratings at least equal to piping rating may be used in applications below, unless otherwise indicated.
1. Use nonpressure-type flexible couplings where required to join gravity-flow, nonpressure sewer piping, unless otherwise indicated.
a. Unshielded flexible couplings for same or minor difference OD pipes.
b. Unshielded, increaser/reducer-pattern, flexible couplings for pipes with different OD.
c. Ring-type flexible couplings for piping of different sizes where annular space between smaller piping's OD and larger piping's ID permits installation.
2. Use pressure-type pipe couplings for force-main joints.

B. Special Pipe Fittings: Use for pipe expansion and deflection. Pipe couplings and special pipe fittings with pressure ratings at least equal to piping rating may be used in applications below, unless otherwise indicated.

C. Gravity-Flow, Nonpressure Sewer Piping:
1. NPS 3 (DN 80): NPS 4 (DN 100) PVC sewer pipe and fittings, gaskets, and gasketed joints.
2. NPS 4 (DN 100): PVC sewer pipe and fittings, gaskets, and gasketed joints.
3. NPS 5 and NPS 6 (DN 125 and DN 150): NPS 6 (DN 150) PVC sewer pipe and fittings, gaskets, and gasketed joints.

3.03 PIPING INSTALLATION

A. General Locations and Arrangements: Drawing plans and details indicate general location and arrangement of underground sanitary sewerage piping. Location and arrangement of piping layout take design considerations into account. Install piping as indicated, to extent practical. Where specific installation is not indicated, follow piping manufacturer's written instructions.

B. Install piping beginning at low point, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves,

and couplings according to manufacturer's written instructions for using lubricants, cements, and other installation requirements.

C. Install manholes for changes in direction unless fittings are indicated. Use fittings for branch connections unless direct tap into existing sewer is indicated.

D. Install proper size increasers, reducers, and couplings where different sizes or materials of pipes and fittings are connected. Reducing size of piping in direction of flow is prohibited.

E. Tunneling: Install pipe under streets or other obstructions that cannot be disturbed by tunneling, jacking, or combination of both.

F. Install gravity-flow, nonpressure, drainage piping according to the following:

1. Install piping pitched down in direction of flow, at minimum slope of 1 percent, unless otherwise indicated.
2. Install piping NPS 6 (DN 150) and larger with restrained joints at tee fittings and at changes in direction. Use corrosion-resistant rods, pipe or fitting manufacturer's proprietary restraint system, or cast-in-place-concrete supports or anchors.
3. Install piping with 36-inch (915-mm) minimum cover.
4. Install piping below frost line.
5. Install hub-and-spigot, cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook."
6. Install hubless cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook."

3.04 PIPE JOINT CONSTRUCTION

A. Basic piping joint construction is specified in Division 22 Section "Common Work Results for Plumbing" Where specific joint construction is not indicated, follow piping manufacturer's written instructions.

B. Join gravity-flow, nonpressure, drainage piping according to the following:

1. Join PVC profile gravity sewer piping according to ASTM D 2321 for elastomeric-seal joints or ASTM F 794 for gasketed joints.
2. Join dissimilar pipe materials with nonpressure-type, flexible [or rigid] couplings.

3.05 MANHOLE INSTALLATION

A. General: Install manholes complete with appurtenances and accessories indicated.

B. Install precast concrete manhole sections with sealants according to ASTM C 923.

C. Construct cast-in-place manholes as indicated.

D. Install PE sheeting on earth where cast-in-place-concrete manholes are to be built.

E. Install FRP manholes according to manufacturer's written instructions.

F. Form continuous concrete channels and benches between inlets and outlet.

G. Set tops of frames and covers flush with finished surface of manholes that occur in pavements. Set tops 3 inches (76 mm)] above finished surface elsewhere, unless otherwise indicated.

H. Install manhole cover inserts in frame and immediately below cover.

3.06 CONCRETE PLACEMENT

A. Place cast-in-place concrete according to ACI 318/318R.

3.07 CLEANOUT INSTALLATION

A. Install cleanouts and riser extensions from sewer pipes to cleanouts at grade. Use cast-iron soil pipe fittings in sewer pipes at branches for cleanouts and cast-iron soil pipe for riser extensions to cleanouts. Install piping so cleanouts open in direction of flow in sewer pipe.

1. Use heavy-duty, top-loading classification cleanouts in vehicle-traffic service areas.

2. Use extra-heavy-duty, top-loading classification cleanouts in roads.

B. Set cleanout frames and covers in earth in cast-in-place-concrete block, 24” by 24” by 6” deep. Set with tops 1 inch (25 mm) above surrounding grade.

C. Set cleanout frames and covers in concrete pavement with tops flush with pavement surface.

3.08 CONNECTIONS

A. Connect nonpressure, gravity-flow drainage piping to building's sanitary building drains specified in Division 22 Section "Sanitary Waste and Vent Piping."

B. Make connections to existing piping and underground manholes.

1. Use commercially manufactured wye fittings for piping branch connections. Remove section of existing pipe; install wye fitting into existing piping; and encase entire wye fitting, plus 6-inch (150-mm) overlap, with not less than 6 inches (150 mm) of concrete with 28-day compressive strength of 3000 psi (20.7 MPa).
2. Make branch connections from side into existing piping, NPS 4 to NPS 20 (DN 100 to DN 500). Remove section of existing pipe; install wye fitting into existing piping; and encase entire wye with not less than 6 inches (150 mm) of concrete with 28-day compressive strength of 3000 psi (20.7 MPa).
3. Make branch connections from side into existing piping, NPS 21 (DN 525) or larger, or to underground manholes by cutting opening into existing unit large enough to allow 3 inches (76 mm) of concrete to be packed around entering connection. Cut end of connection pipe passing through pipe or structure wall to conform to shape of and be flush with inside wall, unless otherwise indicated. On outside of pipe or manhole wall, encase entering connection in 6 inches (150 mm) of concrete for minimum length of 12 inches (300 mm) to provide additional support of collar from connection to undisturbed ground.
    a. Use concrete that will attain minimum 28-day compressive strength of 3000 psi (20.7 MPa), unless otherwise indicated.
    b. Use epoxy-bonding compound as interface between new and existing concrete and piping materials.
4. Protect existing piping and manholes to prevent concrete or debris from entering while making tap connections. Remove debris or other extraneous material that may accumulate.

C. Connect to grease interceptors specified in Division 22 Section "Sanitary Waste Interceptors."

3.09 FIELD QUALITY CONTROL

A. Inspect interior of piping to determine whether line displacement or other damage has occurred. Inspect after approximately 24 inches (600 mm) of backfill is in place, and again at completion of Project.

1. Submit separate report for each system inspection.
2. Defects requiring correction include the following:
    a. Alignment: Less than full diameter of inside of pipe is visible between structures.
    b. Deflection: Flexible piping with deflection that prevents passage of ball or cylinder of size not less than 92.5 percent of piping diameter. Hand pulled no earlier than 30 days after backfill was completed.
    c. Crushed, broken, cracked, or otherwise damaged piping.
    d. Infiltration: Water leakage into piping.
    e. Exfiltration: Water leakage from or around piping.

3. Replace defective piping using new materials, and repeat inspections until defects are within allowances specified.
4. Reinspect and repeat procedure until results are satisfactory.

B. Test new piping systems, and parts of existing systems that have been altered, extended, or repaired, for leaks and defects.
1. Do not enclose, cover, or put into service before inspection and approval.
2. Test completed piping systems according to requirements of authorities having jurisdiction.
3. Schedule tests and inspections by authorities having jurisdiction with at least 24 hours' advance notice.
4. Submit separate report for each test.
5. Hydrostatic Tests: Test sanitary sewerage according to requirements of authorities having jurisdiction and the following:
   a. Allowable leakage is maximum of 50 gal./inch of nominal pipe size per mile (4.6 L/millimeter of nominal pipe size per kilometer) of pipe, during 24-hour period.
   b. Close openings in system and fill with water.
   c. Purge air and refill with water.
   d. Disconnect water supply.
   e. Test and inspect joints for leaks.
   f. Option: Test ductile-iron piping according to AWWA C600, "Hydrostatic Testing" Section. Use test pressure of at least 10 psig (69 kPa).
6. Air Tests: Test sanitary sewerage according to requirements of authorities having jurisdiction, UNI-B-6, and the following:
   a. Option: Test plastic gravity sewer piping according to ASTM F 1417.
   b. Option: Test concrete gravity sewer piping according to ASTM C 924 (ASTM C 924M).
7. Manholes: Perform hydraulic test according to ASTM C 969 (ASTM C 969M).

C. Leaks and loss in test pressure constitute defects that must be repaired.

D. Replace leaking piping using new materials, and repeat testing until leakage is within allowances specified.

3.10 CLEANING

Clean interior of piping of dirt and superfluous material. Flush with potable water.

END OF SECTION

SECTION 22 1323
SANITARY WASTE INTERCEPTORS

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Grease interceptors.

1.02 SUBMITTALS

A. Shop Drawings: For each type and size of precast-concrete interceptor indicated.
   1. Include materials of construction, dimensions, rated capacities, retention capacities, location and size of each pipe connection, furnished specialties, and accessories.

PART 2 PRODUCTS

2.01 GREASE INTERCEPTORS

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. Park.

B. Grease Interceptors: Precast concrete complying with ASTM C 913.
   1. Include rubber-gasketed joints, vent connections, manholes, compartments or baffles, and piping or openings to retain grease and to permit wastewater flow.
   2. Structural Design Loads:
      a. Heavy-Traffic Load: Comply with ASTM C 890, A-16 (ASSHTO HS20-44).
   3. Grade Rings: Reinforced-concrete rings, 6- to 9-inch total thickness, to match diameter of manhole frame and cover.
   4. Manhole Frames and Covers: Ferrous; 24-inch ID by 7- to 9-inch riser with 4-inch-minimum width flange and 26-inch-diameter cover.
      a. Ductile Iron: ASTM A 536, Grade 60-40-18, unless otherwise indicated.
      b. Gray Iron: ASTM A 48, Class 35, unless otherwise indicated.
      c. Include indented top design with lettering cast into cover, using wording equivalent to " GREASE INTERCEPTOR."

C. Capacities and Characteristics: (Refer to drawing schedule)

PART 3 EXECUTION

3.01 EXCAVATION, GENERAL

A. Unclassified Excavation: Excavate to subgrade elevations regardless of the character of surface and subsurface conditions encountered. Unclassified excavated materials may include rock, soil materials, and obstructions. No changes in the Contract Sum or the Contract Time will be authorized for rock excavation or removal of obstructions.
   1. If excavated materials intended for fill and backfill include unsatisfactory soil materials and rock, replace with satisfactory soil materials.
   2. Remove rock to lines and grades indicated to permit installation of permanent construction without exceeding the following dimensions:
      a. 24 inches outside of concrete forms other than at footings.
      b. 12 inches outside of concrete forms at footings.
      c. 6 inches outside of minimum required dimensions of concrete cast against grade.
      d. 6 inches beneath bottom of concrete slabs-on-grade.
      e. 6 inches beneath pipe in trenches, and the greater of 24 inches wider than pipe or 42 inches wide.

3.02 EXCAVATION FOR STRUCTURES

A. Excavate to indicated elevations and dimensions within a tolerance of plus or minus 1 inch. If applicable, extend excavations a sufficient distance from structures for placing and removing concrete formwork, for installing services and other construction, and for inspections.
   1. Excavation for Underground Tanks, Basins, and Mechanical or Electrical Utility Structures: Excavate to elevations and dimensions indicated within a tolerance of plus or minus 1 inch. Do not disturb bottom of excavations intended as bearing surfaces.

3.03 INSTALLATION

A. Install precast-concrete interceptors according to ASTM C 891. Set level and plumb.

B. Install manhole risers from top of underground concrete interceptors to manholes and gratings at finished grade.

C. Set tops of manhole frames and covers flush with finished surface in pavements.

D. Set tops of grating frames and grates flush with finished surface.

3.04 CONNECTIONS

A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Make piping connections between interceptors and piping systems.

3.05 IDENTIFICATION

A. Identification materials and installation are specified in Division 31 Section "Earth Moving." Arrange for installation of green warning tapes directly over piping and at outside edges of underground interceptors.
   1. Use warning tapes or detectable warning tape over ferrous piping.
   2. Use detectable warning tape over nonferrous piping and over edges of underground structures.

END OF SECTION

SECTION 22 1500
GENERAL-SERVICE COMPRESSED-AIR SYSTEMS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Reciprocating air compressors.

B. System filters.

C. Pipe and fittings.

D. Unions and couplings.

E. Pressure reducing stations.

F. Air outlets.

1.02 RELATED REQUIREMENTS

A. Section 03 3000 - Cast-in-Place Concrete.

B. Section 22 0523 - General-Duty Valves for Plumbing Piping.

C. Section 22 0548 - Vibration and Seismic Controls for Plumbing Piping and Equipment.

1.03 REFERENCE STANDARDS

A. ABMA STD 9 - Load Ratings and Fatigue Life for Ball Bearings 2015 (Reaffirmed 2020).

B. ASME B16.3 - Malleable Iron Threaded Fittings: Classes 150 and 300 2021.

C. ASME B31.1 - Power Piping 2022.

D. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless 2022.

E. ASTM A234/A234M - Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service 2023a.

1.04 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements for submittal procedures.

B. Product Data: Provide manufacturers catalog literature with capacity, weight, and electrical characteristics and connection requirements.

C. Shop Drawings: Indicate piping system schematic with electrical characteristics and connection requirements.

D. Manufacturer's Instructions: Indicate manufacturer's installation instructions, hoisting and setting requirements, starting procedures.

E. Operation Data: Submit for air compressor, air receiver, and accessories, aftercooler, refrigerated air dryer, and pressure reducing station.

F. Maintenance Data: Submit for air compressor, air receiver, and accessories, aftercooler, refrigerated air dryer, and pressure reducing station.

G. Warranty: Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer.

H. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
   1. See Section 01 6000 - Product Requirements for additional provisions.
   2. Extra Compressor Oil: One container, quart size.

1.05 QUALITY ASSURANCE

A. Pressure Vessels: Comply with applicable code for installation of pressure vessels.

B. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Accept air compressors, refrigerated air dryer on site in factory-fabricated containers with shipping skids and plastic pipe end protectors in place. Inspect for damage.

B. Protect piping and equipment from weather and construction traffic.

1.07 WARRANTY

A. See Section 01 7800 - Closeout Submittals for additional warranty requirements.

B. Provide five year manufacturer warranty for reciprocating air compressors.

PART 2 PRODUCTS

2.01 RECIPROCATING AIR COMPRESSORS

A. Manufacturers:
   1. Atlas Copco USA: www.atlascopco.com/#sle.
   2. Ingersoll Rand, Inc: www.ingersollrandproducts.com/#sle.
   3. Quincy Compressor, LLC: quincycompressor.com/#sle.

B. Type: Duplex air compressor system with fixed belt-driven mechanism.

C. Electrically-driven, air-cooled compressor unit; factory assembled on surface-mount tank with heat exchangers, air intake filters, gauges, sight glasses, vibration isolators, thermostats, safeties, differential pressure oil pump, thermal overload protections, oil separator, moisture separator with drain trap, oil charging valve, and compressor bearings with ABMA STD 9, L10 life expectancy at 100,000 hours.

D. Receiver Accumulator Tank: 80 gal, mount compressor on horizontal aligned tank.

E. Enclosure: Sound masking enclosure capable of reducing equipment generated noise down to 50 percent of generated loudness.

F. Controls:
   1. Indicators:
      a. Air temperature.
      b. Oil temperature.
      c. Hour meter.
      d. Air discharge pressure.
      e. Sump pressure.
      f. Air intake filter loading.
      g. Anti-recycle timer.
      h. Phase loss/reversal monitor.
   2. Pushbutton or Handswitch: Start/stop and load/unload functions.

G. Electrical:
   1. 7.5 hp at 460-VAC, 50 to 60 hz, TEFC motor, wye-delta starter controlled.
   2. Factory mount disconnect switch with terminal box with each circuit identified and spare spare to accommodate field-installed components. Ground each component to base of assembly.

2.02 SYSTEM FILTERS

A. Cartridge Number 1: Coalescing.

B. Location: Downstream of air compressor.

C. Flow Capacity: Match compressor rate.

2.03 PIPE AND FITTINGS

A. Steel Pipe: ASTM A53/A53M, Grade B, Type E, Schedule 40 black.
   1. Fittings: ASME B16.3, malleable iron, or ASTM A234/A234M, wrought steel welding type.
   2. Joints: Threaded or welded to ASME B31.1.

2.04 UNIONS AND COUPLINGS

A. Unions:
   1. Ferrous Pipe: 150 psi malleable iron threaded unions.

B. Flexible Connector: Neoprene with brass threaded connectors.

2.05 PRESSURE REDUCING STATIONS

A. Pressure Reducing Station: Consisting of automatic reducing valve and bypass and low pressure side relief valve and gauge. Provide oil separator where indicated.

B. Valve Capacity: Reduce pressure from 200 psi to 30 psi, adjustable upwards from reduced pressure.

2.06 AIR OUTLETS

A. Quick Connector: 3/8 inch brass, snap-on connector with self closing valve, Style A.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install equipment in accordance with manufacturer's instructions.

B. Install compressor unit on concrete housekeeping pad. See Section 03 3000.

C. Install compressor unit on vibration isolators. Level and bolt in place. See Section 22 0548.

D. Make air cock and drain connection on horizontal casing.

E. Install line size gate valve and check valve on compressor discharge. See Section 22 0523.

F. Install replaceable cartridge type filter silencer of adequate capacity for each compressor.

G. Connect condensate drains to nearest floor drain.

H. Install valved drip connections at low points of piping system. See Section 22 0523.

I. Install takeoffs to outlets from top of main, with shut off valve after takeoff. Slope takeoff piping to outlets.

J. Install compressed air couplings, female quick connectors, and pressure gauges where outlets are indicated.

K. Install tees instead of elbows at changes in direction of piping. Fit open end of each tee with plug.

END OF SECTION

SECTION 22 3000
PLUMBING EQUIPMENT

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Commercial gas-fired water heaters.

B. Commercial gas-fired water boilers.

C. Packaged water heating systems.

D. Water filters.

E. Water softeners.

F. Point-of-use water filters.

G. In-line circulator pumps.

1.02 REFERENCE STANDARDS

A. ASHRAE Std 90.1 I-P - Energy Standard for Buildings Except Low-Rise Residential Buildings Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

B. NSF 61 - Drinking Water System Components - Health Effects 2022, with Errata.

1.03 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements for submittals procedures.

B. Product Data:
   1. Provide dimension drawings of water heaters indicating components and connections to other equipment and piping.
   2. Indicate pump type, capacity, power requirements.
   3. Provide certified pump curves showing pump performance characteristics with pump and system operating point plotted. Include NPSH curve when applicable.
   4. Provide electrical characteristics and connection requirements.

C. Shop Drawings:

D. Operation and Maintenance Data: Include operation, maintenance, and inspection data, replacement part numbers and availability, and service depot location and telephone number.

E. Warranty Documentation: Submit manufacturer warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.

1.04 QUALITY ASSURANCE

A. Certifications:
   1. Water Heaters: NSF approved.

B. Identification: Provide pumps with manufacturer's name, model number, and rating/capacity identified by permanently attached label.

1.05 WARRANTY

A. See Section 01 7800 - Closeout Submittals for additional warranty requirements.

B. Provide five year manufacturer warranty for domestic water heaters.

PART 2 PRODUCTS

2.01 WATER HEATERS

A. Commercial Gas-Fired Water Heaters:
   1. Manufacturers:

2. Type: Automatic, natural gas-fired, vertical storage.
3. Minimum Efficiency Required: ASHRAE Std 90.1 I-P.
4. Performance:
5. Tank: Antimicrobial-infused, enamel-lined, welded steel,; multiple flue passages, 4-inch diameter inspection port, thermally insulated with minimum 2 inches glass fiber, encased in corrosion-resistant steel jacket; baked-on enamel finish; floor shield and legs.
6. Accessories:
   a. Water Connections: Brass.
   b. Dip Tube: Brass.
   c. Drain valve.
   d. Anode: Magnesium.
   e. Temperature and Pressure Relief Valve: ASME labeled.
7. Applications:
8. Controls: Automatic water thermostat with temperature range adjustable from 120 to 180 degrees F, automatic reset high temperature limiting thermostat factory set at 195 degrees F, gas pressure regulator, multi-ribbon or tubular burner, 100 percent safety shut-off pilot and thermocouple, flue baffle and draft hood.

2.02 BOILERS

A. Commercial Gas-Fired Boilers:
   1. Type: Automatic, natural gas fired.
   2. Minimum Efficiency Required: ASHRAE Std 90.1 I-P.
   3. Tank: Glass-lined, welded steel ASME labeled; multiple flue passages, 4-inch diameter inspection port, thermally insulated with minimum 2 inches glass fiber, encased in corrosion-resistant steel jacket; baked-on enamel finish; floor shield and legs.
   4. Accessories:
      a. Water Connections: Brass.
      b. Dip Tube: Brass.
      c. Drain valve.
      d. Anode: Magnesium.
   5. Controls: Automatic water thermostat with temperature range adjustable from 120 to 180 degrees F, automatic reset high-temperature-limiting thermostat factory set at 195 degrees F, gas pressure regulator, multi-ribbon or tubular burner, 100 percent safety shut-off pilot and thermocouple, flue baffle and draft hood.

2.03 WATER FILTERS

A. Commercial:
   1. Filter Media: Activated carbon.
   2. Glassfiber reinforced plastic tank with valve, 30 gpm.
   3. Provide capped backwash, carbon refill, and sediment removal access.
   4. Potable Water Service: NSF 61 certified.

2.04 WATER SOFTENERS

A. Salt-Based Ion-Exchange Water Softener:
   1. Manufacturers:
      a. Culligan International Company; _____: www.culligan.com/#sle.
      b. US Water Systems, Inc; _____: www.uswatersystems.com//#sle.
      c. Substitutions: See Section 01 6000 - Product Requirements.
   2. Type: Separate ion exchange and feed tanks.
   3. Tank Materials: Epoxy lined steel ion exchange with one-piece resin for feed.

2.05 POINT-OF-USE WATER FILTERS

A. Point-of-Use Application: Provide for ice makers and Drinking fountains.

B. Type: Disposable, side positioned, line or tap installed cartridge, canister, or showerhead filter.

C. Construction: Polymer based material housing with built-in female threaded connections, and internal specific or composite filtering media such as activated carbon, sand, gravel, calcite, limestone, or other mineral media suitable to reduce intended contaminants.

D. Internal Filter Media: Chemical-free, pH-resilient materials proven to reduce bacteria, chlorine, odors, sediment, and trace metals down to the 0.2 micron particle size.

E. Maximum Service Requirements: 100 psi and 130 degrees F.

2.06 IN-LINE CIRCULATOR PUMPS

A. Manufacturers:
   1. Armstrong Fluid Technology; _____: www.armstrongfluidtechnology.com/#sle.
   2. Bell & Gossett, a brand of Xylem, Inc; _____: www.bellgossett.com/#sle.

B. Casing: Bronze, rated for 125 psig working pressure, with stainless steel rotor assembly.

C. Impeller: Bronze.

D. Shaft: Alloy steel with integral thrust collar and two oil lubricated bronze sleeve bearings.

E. Seal: Carbon rotating against a stationary ceramic seat.

F. Drive: Flexible coupling.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install plumbing equipment in accordance with manufacturer's instructions, as required by code, and complying with conditions of certification, if any.

B. Coordinate with plumbing piping and related fuel piping work to achieve operating system.

C. Pumps:
   1. Ensure pumps operate at specified system fluid temperatures without vapor binding and cavitation, are non-overloading in parallel or individual operation, and operate within 25 percent of midpoint of published maximum efficiency curve.
   2. Provide electrical interlocking from cooling condensate pump safety switch to associated HVAC unit(s) furnished under other Sections.

D. Coordinate BAS, BMS, or Integrated Automation linking between unit controller(s) and remote front-end interface; see Section 25 1500.

END OF SECTION

SECTION 22 4000
PLUMBING FIXTURES

PART 1 GENERAL

1.01 RELATED REQUIREMENTS

1.02 REFERENCE STANDARDS

A. ASME A112.6.1M - Floor-Affixed Supports for Off-the-Floor Plumbing Fixtures for Public Use 1997 (Reaffirmed 2017).

B. ASME A112.18.1 - Plumbing Supply Fittings 2018, with Errata.

C. ASME A112.19.2 - Ceramic Plumbing Fixtures 2018, with Errata.

D. NSF 61 - Drinking Water System Components - Health Effects 2022, with Errata.

E. NSF 372 - Drinking Water System Components - Lead Content 2022.

1.03 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements for submittal procedures.

B. Product Data: Provide catalog illustrations of fixtures, sizes, rough-in dimensions, utility sizes, trim, and finishes.

C. Warranty: Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer.

1.04 MOCK-UP

A. Provide mock-up of typical bathroom group.

B. Mock-up may remain as part of the Work.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Accept fixtures on-site in factory packaging. Inspect for damage.

B. Protect installed fixtures from damage by securing areas and by leaving factory packaging in place to protect fixtures and prevent use.

1.06 WARRANTY

A. See Section 01 7800 - Closeout Submittals for additional warranty requirements.

B. Provide five year manufacturer warranty for electric water cooler.

PART 2 PRODUCTS

2.01 GENERAL REQUIREMENTS

A. Potable Water Systems: Provide plumbing fittings and faucets that comply with NSF 61 and NSF 372 for maximum lead content; label pipe and fittings.

2.02 FLUSH VALVE WATER CLOSETS

A. Water Closets: Refer to plumbing schedule for additional details.
   1. Manufacturers:
      a. American Standard, Inc; Baby Devoro, 2-Piece Gravity: www.americanstandard-us.com/#sle.
      b. Kohler Company; _____: www.kohler.com/#sle.
      c. Zurn Industries, LLC; _____: www.zurn.com/#sle.
      d. Toto

B. Flush Valves: Refer to plumbing schedule for additional details.
   1. Manufacturers:
      a. Sloan Valve Company; _____: www.sloanvalve.com/#sle.

b. Zurn Industries, LLC; ZEMS Series: www.zurn.com/#sle.
c. Toto.

C. Toilet Seats: Refer to plumbing schedule for additional details.
1. Manufacturers:
a. Bemis Manufacturing Company; _____: www.bemismfg.com/#sle.
b. Church Seat Company; _____: www.churchseats.com/#sle.
c. Olsonite; _____: www.olsonite.com/#sle.
2. Plastic: Black finish, open front, extended back, self-sustaining hinge, brass bolts, with cover.
3. Plastic: Black finish, open front, extended back, self-sustaining hinge, brass bolts, with cover.

D. Water Closet Carriers:
1. Manufacturers:
a. Jay R. Smith Manufacturing Company; _____: www.jrsmith.com/#sle.
b. JOSAM Company; _____: www.josam.com/#sle.
c. Zurn Industries, LLC; Z1201-N: www.zurn.com/#sle.
2. ASME A112.6.1M; adjustable cast iron frame, integral drain hub and vent, adjustable spud, lugs for floor and wall attachment, threaded fixture studs with nuts and washers.

2.03 WALL HUNG URINALS

A. Manufacturers:
1. American Standard, Inc; _____: www.americanstandard-us.com/#sle.
2. Kohler Company; _____: www.kohler.com/#sle.
3. Zurn Industries, LLC; _____: www.zurn.com/#sle.

B. Vitreous china, ASME A112.19.2, wall hung with side shields and concealed carrier.
1. Consumption Volume: 1.0 gal per flush, maximum.
2. Flush Valve: Exposed (top spud).
3. Flush Operation: Sensor operated.
4. Trapway Outlet: Integral.

C. Flush Valves:
1. Manufacturers:
a. American Standard, Inc; _____: www.americanstandard-us.com/#sle.
b. Sloan Valve Company; _____: www.sloanvalve.com/#sle.
c. Zurn Industries, LLC; ZEMS Series: www.zurn.com/#sle.

D. Urinal Carriers:
1. Manufacturers:
a. Jay R. Smith Manufacturing Company; _____: www.jrsmith.com/#sle.
b. JOSAM Company; _____: www.josam.com/#sle.
c. Zurn Industries, LLC; Z1221: www.zurn.com/#sle.
2. ASME A112.6.1M; cast iron and steel frame with tubular legs, lugs for floor and wall attachment, threaded fixture studs for fixture hanger, bearing studs.

2.04 LAVATORIES

A. Refer to plumbing schedule for additional details.

B. Manufacturers:
1. Kohler Company; _____: www.kohler.com/#sle.
2. Zurn Industries, LLC; _____: www.zurn.com/#sle.

C. Supply Faucet:
1. Deck Mounted Faucet Manufacturers:

a. American Standard, Inc; _____: www.americanstandard-us.com/#sle.
b. Kohler Company; _____: www.kohler.com/#sle.
c. Zurn Industries, LLC; Aqua Sense Series: www.zurn.com/#sle.

2. ASME A112.18.1; chrome plated combination supply fitting with pop-up waste, water economy aerator with maximum flow of 2.2 gpm, indexed handles.

D. Metered Faucet:
1. ASME A112.18.1; chrome plated metered mixing faucet with low voltage operated solenoid operator and infrared sensor, aerator and cover plate, open grid strainer.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that walls and floor finishes are prepared and ready for installation of fixtures.

B. Confirm that millwork is constructed with adequate provision for the installation of counter top lavatories and sinks.

3.02 PREPARATION

A. Rough-in fixture piping connections in accordance with minimum sizes indicated in fixture rough-in schedule for particular fixtures.

3.03 INSTALLATION

A. Install each fixture with trap, easily removable for servicing and cleaning.

B. Provide chrome-plated rigid or flexible supplies to fixtures with loose key stops, reducers, and escutcheons.

C. Install components level and plumb.

D. Install and secure fixtures in place with wall supports and bolts.

E. Solidly attach water closets to floor with lag screws. Lead flashing is not intended to hold fixture in place.

3.04 INTERFACE WITH WORK OF OTHER SECTIONS

A. Review millwork shop drawings. Confirm location and size of fixtures and openings before rough-in and installation.

3.05 ADJUSTING

A. Adjust stops or valves for intended water flow rate to fixtures without splashing, noise, or overflow.

3.06 CLEANING

A. Clean plumbing fixtures and equipment.

3.07 PROTECTION

A. Protect installed products from damage due to subsequent construction operations.

B. Do not permit use of fixtures by construction personnel.

C. Repair or replace damaged products before Date of Substantial Completion.

3.08 SCHEDULES

A. Refer to drawings

END OF SECTION

SECTION 23 0120
MECHANICAL SHOP DRAWINGS AND SUBMITTALS

PART 1 GENERAL

1.01 SHOP DRAWINGS

A. Contractor shall submit for acceptance to the Architect shop drawings specified for the equipment indicated in these specifications. The shop drawings shall include the following minimum information:
   1. The equipment manufacturer's name and address
   2. Catalog designation or model number
   3. Rough-in data & dimensions
   4. Performance curves and rated capacities & operational characteristics.
   5. Equipment specific wiring diagrams.
   6. Electrical characteristics.
   7. Warranty information.

B. All submittals shall be electronic in PDF format, hard copies will not be accepted.

C. The Contractor shall thoroughly review each item for compliance with these Specifications making any necessary corrections prior to submittal. Each shop drawing set shall be stamped, signed, and dated indicating Contractor review.
   1. If the Contractor fails to properly review shop drawings, the Contractor shall reimburse the Engineer for all additional reviews on a time and material basis.

D. Specification Compliance Certification: Where this Section and other Sections of this Division require Specification Compliance Certification to be submitted, comply with the following:
   1. Prepare a line-by-line Specification Compliance Certification by marking up a copy of the Contract Document specification section in the left margin. Accompany the markup with a written report explaining all items that are not marked with "Compliance". Submit line-by-line markup, written report of deviations and alternates and a cover letter certified by Manufacturer or Installer that prepared the Specification Compliance Certification. Use the following key for preparing the line-by-line markup.
      a. "C" for Compliance: By noting the term "compliance" or "C" in the margin, it shall be understood that the manufacturer is in full compliance with the item specified and will provide exactly the same with no deviations.
      b. "D" for Deviation: By noting the term "deviation" or "D" in the margin, it shall be understood that the manufacturer prefers to provide a different component in lieu of that specified.
      c. "A" for Alternate: By noting the term "alternate" or "A" in the margin, it shall be understood that the manufacturer proposes to provide the same operating function but prefers to do it in a different manner.
      d. "N/A" for Not Applicable: By noting the term "not applicable" or "N/A" in the margin, it shall be understood that the specified item is not applicable to the project.

E. Provide samples of materials or equipment proposed to be furnished, if requested. Samples shall become the property of the Architect/Engineer and will be returned only when accompanied by a written request to do so.

F. None of the items listed shall be purchased, delivered to the site, or installed, until the item is reviewed. No substitution will be permitted after review except where such substitution is considered by the Architect to be in the best interest of the Owner.

G. The Engineer will review all Shop Drawings submitted.

H. Approval Stamp: This review is to verify general conformance with the design concept of the Project and substantial compliance with the information provided in the Contract Documents. This review does not in any way relieve the Contractor or their suppliers of their responsibility to provide all materials and equipment as specified, in quantities, quality and dimensions required. Submittals will be reviewed with the following actions:
   1. “Reviewed” indicates that the Submittal appears to conform to the design concept of the Work and that the Contractor, at their discretion, may proceed with fabrication and/or procurement and installation. Shop drawings that are returned "Reviewed" or "Furnished as Corrected" shall not be resubmitted back to the engineer and if submitted will not be reviewed.
   2. “Furnished as Corrected” indicates that the Submittal, after noted corrections are made, appears to conform to the design concept of the Work and that the Contractor, at their discretion, may proceed with fabrication and/or procurement and installation, if the corrections are accepted by the Contractor without any increase in Contract Sum or Time. If the corrections are accepted by the contractor, shop drawings that are returned "Furnished as Corrected" shall not be resubmitted back to the engineer and if submitted will not be reviewed.
   3. “Revised and Resubmit” indicates that the noted revisions are such that a corrected copy of the Submittal is required for review to confirm that the noted revisions have been understood and made. The Contractor, at their discretion, may proceed with fabrication and/or procurement and installation after submitting a corrected copy and verifying with the reviewer that the corrected copy is acceptable, if the corrections are accepted by the Contractor without an increase in the Contract Sum or Time.
   4. “Rejected” indicates that the Submittal does not appear to conform to the specifications, a resubmission is required, and fabrication or procurement is not authorized.

I. If the Engineer rejects (Revised and Resubmit or Rejected) the same section two times the engineer shall be compensated for additional reviews. Any subsequent submittal will require the inclusion of a check made out to the engineer in the amount of $500.00. Contractor is responsible for all delays caused by the resubmittal process.

J. Should the contractor fail to comply with any of the requirements of the preceding sub-paragraphs; then the right is reserved by the Architect to select any or all items in the material schedule, with that selection to be final and binding upon the contractor. The materials selected or reviewed, as the case may be, by the Architect, shall be used in the work at no additional cost to the Owner.

K. Where a contractor chooses to use any reviewed material or item of equipment, other than the one shown on the drawings, or specified in detail, he shall be responsible for coordinating any necessary changes in other work and shall bear the cost of such changes.

1.02 SPECIAL WRENCHES, TOOLS AND KEYS

A. Each Contractor shall provide, along with the equipment provided, any special wrenches or tools necessary to dismantle or service equipment or appliances installed by him. Wrenches shall include necessary keys, handles and operators for valves, switches, breakers, etc. and keys to electrical panels, alarm pull boxes and panels, etc. At least two of any such special wrench, keys, etc. shall be turned over to the Architect prior to completion of the project. Obtain a receipt that this has been accomplished and forward a copy to the Engineer.

1.03 MANUALS

A. In addition to catalog data and shop drawings submitted for review, this contractor shall furnish Systems Manuals (O&M's):
   1. The Contractor Shall provide an electronic copy in PDF format. The PDF shall contain:
      a. Approved Shop Drawings of all major mechanical components.
      b. Parts lists for the same components.

c. Manufacturer's operating, maintenance, and cleaning instructions.
d. List of materials recommended for maintenance.
e. Factory startup reports.
f. Valve tag list.
g. Name and address of authorized service organization and parts depot.
h. Chemical Treatment Analysis Reports for heating & cooling systems.
i. Radiographic Testing Reports of welded pipe with picture of weld & location plan showing physical location of where test was performed.
j. A description of how the components of a given HVAC system interact within the large system. For example, circulating pumps, boilers, unit heaters are part of the "heating system".
k. A description of normal operating conditions for the system and its components.
l. A description of common symptoms of a malfunctioning system and likely causes.
m. Warranty letter from the automatic temperature controls contractor indicating the warranty period for their portion of the work.
n. Signed owner instruction forms for all items specified as requiring owners' instruction.

2. The Systems manual shall have an electronic index and be broken up by individual systems such as "heating", "shop exhaust", "kitchen ventilation and exhaust", "chilled water", "administration ventilation".
3. Include at the front of the manual a complete listing of the Architect, Engineer and contractors and sub-contractors used on the project. Listing shall include names, addresses and phone numbers for each.
4. All major pieces of equipment shall be referenced with the equipment supplier's name, address and phone number shall be provided.
5. Where indicated in the Specifications, the Contractor shall provide the services of a factory trained representative to instruct the Owner's authorized personnel in the operation, control, and maintenance of equipment.

B. Operations and Maintenance Manuals shall be submitted to the Engineer for approval prior to delivery to the Architect.

PART 2 PRODUCTS – NOT USED

PART 3 EXECUTION – NOT USED

END OF SECTION

SECTION 23 0150
MECHANICAL MATERIALS & METHODS

PART 1 GENERAL

1.01 APPLICABILITY

A. This section covers basic materials and methods and applies to and forms a part of each of the sections of Division 23.

B. This work shall be in accordance with this and other applicable sections and/or provisions of these specifications and with the applicable drawings.

1.02 COORDINATION OF OPENINGS

A. This contractor shall coordinate all openings required for new piping, ductwork, equipment, controls, etc. through any structural slabs, beams, or walls. Contractor shall request a copy of the precast concrete shop drawings and verify locations and sizes of all openings required.

B. All costs associated with structural field changes or redesigns of the building systems due to lack of field coordination shall be responsibility of this contractor.

1.03 MATERIALS & MANUFACTURERS

A. All materials and equipment shall be new, free of defects, installed in accordance with manufacturer's current published recommendations in a neat manner and in accordance with standard practice of the industry.

B. Certain materials and/or equipment in this specification are specified by manufacturer and catalog numbers. The design was based on the specified equipment and establishes a degree of quality, performance, physical configuration, etc. If the contractor should elect to use equipment other than the equipment used as a basis for design but listed as "acceptable" in the specifications, he shall be responsible for space requirements, configuration, performance, and changes in bases, supports, vibration isolators, structural members, openings in structure and other apparatus that may be affected by its use.

PART 2 PRODUCTS

2.01 PIPE AND FITTINGS

A. Piping is to be installed as shown on the drawings as much as practical. When a pipe size is not indicated, the subcontractor shall request the pipe size from the Architect through the Mechanical Contractor.

B. Provide sufficient swing joints, expansion loops, and/or devices necessary and install so as to permit free expansion and contraction of piping without causing undue stresses. Make all changes in direction with fittings. Support piping independently at all equipment so that its weight shall not be supported by the equipment.

C. Install piping without springing or forcing and clear all windows, doors, and other openings. Excessive cutting or other weakening of the building structure to facilitate piping installation will not be permitted.

D. All pipes shall be reamed to full pipe diameter before joining.

E. Install vertical risers plumb and straight, horizontal lines parallel with walls and partitions. Conceal piping above ceilings and within furring and/or walls (finished construction).

F. Provide shut-off valves and unions suitably located to isolate each item of equipment, branch circuit or section of piping.

G. Provide solid head plugs on any crosses, tees, etc., located in the piping around the boilers.

H. Provide drain valves at all low points of each system to enable complete drainage. Drain shall consist of a 3/4” ball valve with hose end.

I. Provide a manual air vent consisting of 1/2" ball valve with hose end installed on a "T" at all high points of each system to enable complete venting.

J. All piping shall be adequately supported from the building structure with adjustable hangers to maintain uniform grading where required and to prevent sagging or pocketing.

K. Provide supports between piping and building structure where necessary to prevent swaying.

L. The use of wire or perforated metal to support pipe will not be permitted.

2.02 SUPPORTING STEEL

A. Provide structural steel framework for supporting mechanical equipment as required.

B. All steel work shall be in conformance with the requirements of the AISC Specification for the Design, Fabrication and Erection of Structural Steel for Buildings. Material shall conform to ASTM A36.

PART 3 EXECUTION

3.01 PROTECTION, DELIVERY AND STORAGE OF MATERIALS

A. Make provisions for the delivery and storage of materials and make the required arrangements with other contractors for the introduction into the building of equipment too large to pass through finished openings.

B. Protect materials and equipment stored on site from weather and moisture by maintaining factory covers and/or suitable weather-proof coverings. For extended outdoor storage, motors shall be removed from equipment and stored separately.

C. The open ends of all piping and ductwork shall be covered whenever that system is not being worked on, i.e., end of the workday, completion of a section, etc. Covering shall keep dust, garbage, vermin, and other foreign objects out of the piping or ductwork when the contractor is not on the jobsite.

3.02 CUTTING AND REPAIRING

A. All holes and penetrations required for the installation of the mechanical equipment shall be by the mechanical contractor. This shall include all piping, ductwork, and any other penetration through the wall, floor, or roof.

B. Cutting construction shall be done only with the written permission of the Architect. Cutting shall be done carefully and damage to buildings, pipes, wiring, or equipment as a result of cutting for installation shall be repaired by skilled mechanics of the trade involved at no additional charge to the Owner. This Contractor shall be responsible for all cutting and patching unless such work has been delegated to the General Contractor.

C. All holes cut into concrete shall be cut by means of power saws or core drills. All unsightly spalls or chips shall be repaired.

D. All openings remaining around duct and pipe penetrations shall be filled, caulked, and painted to match wall. Code approved fire caulking shall be used for all rated penetrations.

3.03 SEALING FLOOR, CEILINGS AND WALL OPENINGS

A. Where pipes or ducts pass through walls, ceilings, floors, or partitions, (other than those through fire rated walls or chases) the opening in the construction around the pipe or duct shall not exceed ½ inch average clearance on all sides and shall be sealed to prevent the passage of sound and air. Coordinate wall openings to allow insulation thickness to pass through walls if allowed.

B. The material used to seal space between the wall and the pipe/duct shall be non-combustible caulk type, or wrap type, as conditions require. Provide sheet metal angles or flanges as may be required to contain the stopping material. Use of expanding foam will be allowed if surfaces are cleaned of an excess material and all edges are trimmed smooth. Penetrations through exterior walls shall be sealed weather tight.

C. Special attention shall be given to penetrations of mechanical room walls. Fill gaps around entire exterior area of the pipes or ducts with sound insulation (batt or mineral wool) to within ½" of the wall surface. Use silicone caulking to finish filling the opening smooth with the wall surface or provide sheet metal angles. All sealer shall meet flame spread 25 and smoke developed less than 50.

D. Where pipes or ducts pass through fire-rated walls, ceilings, floors, vertical service shafts walls, or partitions, the opening in the construction around the pipe or duct shall be fire-stopped to prevent the passage of flame and smoke. All assemblies shall be UL or ASTM listed to provide a fire rating equal to that of the construction being penetrated. For the firestop applications that exist for which no UL tested system is available through a manufacturer, an engineering judgment derived from similar UL system designs or other tests shall be submitted from the manufacturer to the local authorities having jurisdiction for their review and approval prior to installation. Individuals installing the firestopping shall be experienced and certified as required by the manufacturer whose product is being applied. Refer to firestopping specification section for more information.

E. Manufacturer's assembly drawings shall be provided in O & M Manuals for each type of penetration. Printed metal or plastic labels shall be permanently applied on the structure within 6" of the edge of the firestop system. Metal labels shall be applied with mechanical fasteners & plastic labels shall be the self-adhering type with adhesive capable of permanently bonding labels to the surfaces on which the labels are placed. The information required on the label include UL/ASTM assembly number, date of installation, fire stopping material manufacture name, Contractor's name, address & phone number & the installer's name.

F. Duct coverings shall not extend through walls or floors required to be fire-stopped or have a fire resistance rating. Insulation shall be taped or sealed to the walls to eliminate sweating at any fire and/or smoke dampers.

G. Acceptable manufacturers shall be Hilti, 3M Brand, or a prior approved product.

3.04 CLEANING AND PAINTING

A. Clear away all debris, surplus materials, etc., resulting from work or operations, leaving the job and equipment furnished under this contract in a clean condition.

B. All exposed ductwork visible behind grilles, registers or air terminals shall be painted flat black.

C. All equipment being furnished with finished paint coat shall be examined upon job completion for scratches and other surface damage. All finished surfaces where necessary shall be touched up with touch-up paint of color to match the factory finish.

D. Paint all exposed bare pipe exterior of the building. Bare pipe shall be painted one coat of No. 7769402 damp-proof red primer as manufactured by Rust-Oleum Corporation, or equal, and one coat of oil paint. Final coat shall be of a color selected by the architect.

E. Paint all exposed iron and steel work, pipe hangers, pipe stands, uninsulated tanks, supporting steel for equipment and exposed bare pipe in mechanical areas. Iron and steel work and bare pipe shall be painted one coat of No. 4769402 damp-proof red primer as manufactured by Rust-Oleum Corporation, or equal, and one coat of oil paint. Iron and steel work shall be painted black.

3.05 ASBESTOS FREE BUILDING

A. There shall be no products or building materials used as a temporary or permanent element in the construction of this building, which has in its make-up any form of asbestos. The contractors shall be responsible to monitor shop drawings and product literature to verify the make-up of materials to be used in the building and remind material suppliers that their products must be asbestos free.

B. Notify the Architect immediately of any existing materials which are suspected of containing asbestos. Do not disturb or attempt to remove any asbestos containing material. The Architect will contact the Owner and inform them of the Contractors observations. The Owner will obtain and provide the services of professionals skilled in asbestos removal.

3.06 SALVAGE:

A. All items removed from existing building shall be salvaged in a workmanlike manner.

B. The handling, storage, and disposition of salvage materials shall be as directed by the Architect. Generally, all salvage material shall remain the property of the Owner. Materials and equipment not wanted by Owner shall be removed from the job site and become the property of the contractor.

END OF SECTION

SECTION 23 0400
ARCHITECTURAL REQUIREMENTS FOR HVAC

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Size, Weight, Fall Protection and Screening Requirements for HVAC Unit Field Modifications

1.02 RELATED REQUIREMENTS

A. Section 01 3000 - Administrative Requirements: Submittal procedures, project meetings, progress schedules and documentation, reports, coordination.

B. Section 01 6000 - Product Requirements: Fundamental product requirements, substitutions and product options, delivery, storage, and handling.

C. Division 23 - Heating, Ventilating and Air Conditioning

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination: Coordinate the installation of all HVAC equipment with size, weight, fall protection and screening requirements for HVAC Units.

B. Preinstallation Meeting: Conduct a preinstallation meeting one week prior to the start of the work of this section; require attendance by all affected installers.

1.04 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements, for submittal procedures.

B. Provide engineered drawings stating compliance with this specification section.

C. Provide sightline study to verify compliance with this specification section.

1.05 QUALITY ASSURANCE

A. Work covered by this section of the specifications shall conform to the contract documents, as well as state and local codes.

B. Designer Qualifications: Perform design under direct supervision of a Professional Engineer experienced in design of this type of work and licensed in Texas.

C. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with not less than three years of documented experience.

D. Installer Qualifications: Company specializing in performing work of the type specified and with minimum three years of documented experience.

E. Copies of Documents at Project Site: Maintain at the project site a copy of each referenced document that prescribes execution requirements.

1.06 ARCHITECTURAL REQUIREMENTS

A. The purpose of these specifications is to define the performance and design standards for modifications of HVAC equipment required for products not listed as "Basis of Design" or relocated due to other coordination parameters.

B. Coordinate the installation of all HVAC equipment with size, weight, fall protection and screening requirements for HVAC Units and make adustments as required to comply with state and local codes and ordinances.

C. Screening:
   1. Contractor shall verify that the unit heights and placement for the provided equipment and curbs do not exceed those detailed in the construction documents.
   2. If the total height and placement differs from the locations or details of the construction documents, the Contractor shall perform a sightline study to verify compliance with the local screening codes and ordinances and make the required modifications to comply. Contractor shall verify compliance before any parapet walls are constructed or screening equipment is ordered.

D. Size:
   1. Contractor shall verify the size of all units, roof curbs and structural openings for equipment that deviate from the units or openings as detailed in the construction documents and make the required adjustments.

E. Weight:
   1. Contractor shall confirm the weights of the provided equipment and verify compliance with the designed loads shown on the construction documents. If the weights exceed those designed, Contractor shall coordinate with the General Contractor and Structural Detailer to adjust the joist or steel design as required.

F. Fall Protection:
   1. Contractor shall provide fall protection for any unit locations that are modified in the field, where the modifications locate them adjacent to any hazzards that require fall protection by state or local codes.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 23 0513
COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 GENERAL

1.01 SECTION INCLUDES

A. General construction and requirements.

B. Applications.

C. Single phase electric motors.

D. Three phase electric motors.

E. Electronically Commutated Motors (ECM).

1.02 REFERENCE STANDARDS

A. ABMA STD 9 - Load Ratings and Fatigue Life for Ball Bearings 2015 (Reaffirmed 2020).

B. IEEE 112 - IEEE Standard Test Procedure for Polyphase Induction Motors and Generators 2017.

C. NEMA MG 1 - Motors and Generators 2021.

D. NFPA 70 - National Electrical Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.03 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements for submittal procedures.

B. Maintenance Data: Include assembly drawings, bearing data including replacement sizes, and lubrication instructions.

1.04 QUALITY ASSURANCE

A. Comply with NFPA 70.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Protect motors stored on site from weather and moisture by maintaining factory covers and suitable weather-proof covering. For extended outdoor storage, remove motors from equipment and store separately.

1.06 WARRANTY

A. See Section 01 7800 - Closeout Submittals for additional warranty requirements.

PART 2 PRODUCTS

2.01 GENERAL CONSTRUCTION AND REQUIREMENTS

A. Electrical Service:
   1. Motors 3/4 HP and Smaller: 115 volts, single phase, 60 Hz.
   2. Motors Larger than 3/4 Horsepower: Three phase, 60 Hz, motor voltage to be coordinated with electrical drawings.

B. Construction:
   1. Open drip-proof type except where specifically noted otherwise.
   2. Design for continuous operation in 104 degrees F environment.
   3. Design for temperature rise in accordance with NEMA MG 1 limits for insulation class, service factor, and motor enclosure type.
   4. All motors shall be premium efficiency type.

C. Visible Nameplate: Indicating motor horsepower, voltage, phase, cycles, RPM, full load amps, locked rotor amps, frame size, manufacturer's name and model number, service factor, power factor, efficiency.

D. Wiring Terminations:
   1. Provide terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated. Enclose terminal lugs in terminal box sized to NFPA 70, threaded for conduit.
   2. For fractional horsepower motors where connection is made directly, provide threaded conduit connection in end frame.

2.02 APPLICATIONS

A. Exception: Motors less than 250 watts, for intermittent service may be the equipment manufacturer's standard and need not comply with these specifications.

B. Motors located in exterior locations: Totally enclosed type.

C. Motors located in outdoors, in wet air streams downstream of sprayed coil dehumidifiers, in draw through cooling towers, and in humidifiers: Totally enclosed weatherproof epoxy-treated type.

D. Motors located in draw through cooling towers: Totally enclosed weatherproof epoxy-sealed type.

2.03 SHAFT GROUNDING

A. All motors over 1 HP on variable frequency drives shall be equipped with shaft grounding system to discharge shaft voltage potential to ground. Motors on variable frequency drives shall be bonded from the motor foot to system ground with high frequency grounding strap consisting on tinned, copper strap with terminations to accommodate the motor foot and system ground.

2.04 SINGLE PHASE POWER - SPLIT PHASE MOTORS

A. Starting Torque: Less than 150 percent of full load torque.

B. Starting Current: Up to seven times full load current.

C. Breakdown Torque: Approximately 200 percent of full load torque.

D. Drip-proof Enclosure: Class A (50 degrees C temperature rise) insulation, NEMA Service Factor, prelubricated sleeve or ball bearings.

E. Enclosed Motors: Class A (50 degrees C temperature rise) insulation, 1.0 Service Factor, prelubricated ball bearings.

2.05 SINGLE PHASE POWER - CAPACITOR START MOTORS

A. Starting Torque: Three times full load torque.

B. Starting Current: Less than five times full load current.

C. Motors: Capacitor in series with starting winding; provide capacitor-start/capacitor-run motors with two capacitors in parallel with run capacitor remaining in circuit at operating speeds.

D. Drip-proof Enclosure: Class A (50 degrees C temperature rise) insulation, NEMA Service Factor, prelubricated sleeve bearings.

E. Enclosed Motors: Class A (50 degrees C temperature rise) insulation, 1.0 Service Factor, prelubricated ball bearings.

2.06 THREE PHASE POWER - SQUIRREL CAGE MOTORS

A. Starting Torque: Between 1 and 1-1/2 times full load torque.

B. Starting Current: Six times full load current.

C. Design, Construction, Testing, and Performance: Comply with NEMA MG 1 for Design B motors.

D. Insulation System: NEMA Class H or better.

E. Testing Procedure: In accordance with IEEE 112. Load test motors to determine free from electrical or mechanical defects in compliance with performance data.

F. Motor Frames: NEMA Standard T-Frames of steel, aluminum, or cast iron with end brackets of cast iron or aluminum with steel inserts.

G. Bearings: Grease lubricated anti-friction ball bearings with housings equipped with plugged provision for relubrication, rated for minimum ABMA STD 9, L-10 life of 20,000 hours. Calculate bearing load with NEMA minimum V-belt pulley with belt center line at end of NEMA standard shaft extension. Stamp bearing sizes on nameplate.

H. Sound Power Levels: To NEMA MG 1.

I. Weatherproof Epoxy Sealed Motors: Epoxy seal windings using vacuum and pressure with rotor and starter surfaces protected with epoxy enamel; bearings double shielded with waterproof non-washing grease.

J. Nominal Efficiency: As indicated at full load and rated voltage when tested in accordance with IEEE 112.

K. Nominal Power Factor: As indicated at full load and rated voltage when tested in accordance with IEEE 112.

2.07 ELECTRONICALLY COMMUTATED MOTORS (ECM)

A. Electronically Commutated Motor
   1. Motor to be a DC electronic commutation type motor (ECM) specifically designed for application.
   2. Motors are permanently lubricated, heavy duty ball bearing type to match with the fan load and pre-wired to the specific voltage and phase.
   3. Internal motor circuitry to convert AC power supplied to the fan to DC power to operate the motor.
   4. Motor shall be speed controllable down to 20% of full speed (80% turndown). Speed shall be controlled by either a potentiometer dial mounted at the motor or by a 0-10 VDC signal.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install securely on firm foundation. Mount ball bearing motors with shaft in any position.

C. Check line voltage and phase and ensure agreement with nameplate.

END OF SECTION

SECTION 23 0519
METERS AND GAUGES FOR HVAC PIPING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Pressure gauges and pressure gauge taps.

B. Thermometers and thermometer wells.

C. Static pressure gauges.

1.02 REFERENCE STANDARDS

A. ASME B40.100 - Pressure Gauges and Gauge Attachments 2022.

B. ASTM E1 - Standard Specification for ASTM Liquid-in-Glass Thermometers 2014 (Reapproved 2020).

C. ASTM E77 - Standard Test Method for Inspection and Verification of Thermometers 2014 (Reapproved 2021).

D. AWWA M6 - Water Meters -- Selection, Installation, Testing, and Maintenance 2012, with Addendum (2018).

E. UL 393 - Indicating Pressure Gauges for Fire-Protection Service Current Edition, Including All Revisions.

1.03 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide list that indicates use, operating range, total range and location for manufactured components.

PART 2 PRODUCTS

2.01 PRESSURE GAUGES

A. Pressure Gauges: ASME B40.100, UL 393 drawn steel case, phosphor bronze bourdon tube, rotary brass movement, brass socket, with front recalibration adjustment, black scale on white background.
   1. Case: Steel with brass bourdon tube.
   2. Size: 4-1/2 inch diameter.
   3. Mid-Scale Accuracy: One percent.
   4. Scale: Psi.

2.02 PRESSURE GAUGE TAPPINGS

A. Gauge Cock: Tee or lever handle, brass for maximum 150 psi.

B. Needle Valve: Brass, 1/4 inch NPT for minimum 150 psi.

C. Pulsation Damper: Pressure snubber, brass with 1/4 inch connections.

D. Syphon: Steel, Schedule 40, 1/4 inch angle or straight pattern.

2.03 STEM TYPE THERMOMETERS

A. Thermometers - Adjustable Angle: Red- or blue-appearing non-toxic liquid in glass; ASTM E1; lens front tube, cast aluminum case with enamel finish, cast aluminum adjustable joint with positive locking device; adjustable 360 degrees in horizontal plane, 180 degrees in vertical plane.
   1. Size: 9 inch scale.
   2. Window: Clear Lexan.
   3. Stem: 3/4 inch NPT brass.

4. Accuracy: 2 percent, per ASTM E77.
5. Calibration: Degrees F.

2.04 THERMOMETER SUPPORTS

A. Socket: Brass separable sockets for thermometer stems with or without extensions as required, and with cap and chain.

B. Flange: 3 inch outside diameter reversible flange, designed to fasten to sheet metal air ducts, with brass perforated stem.

2.05 TEST PLUGS

A. Test Plug: 1/4 inch or 1/2 inch brass fitting and cap for receiving 1/8 inch outside diameter pressure or temperature probe with neoprene core for temperatures up to 200 degrees F.

2.06 STATIC PRESSURE GAUGES

A. 3-1/2 inch diameter dial in metal case, diaphragm actuated, black figures on white background, front recalibration adjustment, 2 percent of full scale accuracy.

B. Accessories: Static pressure tips with compression fittings for bulkhead mounting, 1/4 inch diameter tubing.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install positive displacement meters with isolating valves on inlet and outlet to AWWA M6. Provide full line size valved bypass with globe valve for liquid service meters.

C. Provide one pressure gauge per pump, installing taps before strainers and on suction and discharge of pump. Pipe to gauge.

D. Install pressure gauges with pulsation dampers. Provide gauge cock to isolate each gauge. Extend nipples and siphons to allow clearance from insulation.

E. Install thermometers in piping systems in sockets in short couplings. Enlarge pipes smaller than 2-1/2 inch for installation of thermometer sockets. Ensure sockets allow clearance from insulation.

F. Install thermometers in air duct systems on flanges.

G. Locate duct mounted thermometers minimum 10 feet downstream of mixing dampers, coils, or other devices causing air turbulence.

H. Provide instruments with scale ranges selected according to service with largest appropriate scale.

I. Install gauges and thermometers in locations where they are easily read from normal operating level. Install vertical to 45 degrees off vertical.

J. Adjust gauges and thermometers to final angle, clean windows and lenses, and calibrate to zero.

K. Locate test plugs adjacent thermometers and thermometer sockets.

END OF SECTION

SECTION 23 0523
GENERAL-DUTY VALVES FOR HVAC PIPING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Ball valves.

B. Butterfly valves.

C. Check valves.

D. Gate valves.

E. Chainwheels.

1.02 ABBREVIATIONS AND ACRONYMS

A. CWP: Cold working pressure.

B. EPDM: Ethylene propylene copolymer rubber.

C. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.

D. NRS: Nonrising stem.

E. OS&Y: Outside screw and yoke.

F. PTFE: Polytetrafluoroethylene.

G. RS: Rising stem.

H. TFE: Tetrafluoroethylene.

I. WOG: Water, oil, and gas.

1.03 REFERENCE STANDARDS

A. ASME B1.20.1 - Pipe Threads, General Purpose, Inch 2013 (Reaffirmed 2018).

B. ASME B16.1 - Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250 2020.

C. ASME B16.5 - Pipe Flanges and Flanged Fittings: NPS 1/2 through NPS 24 Metric/Inch Standard 2020.

D. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings 2021.

E. ASME B31.9 - Building Services Piping 2020.

F. ASME BPVC-IX - Boiler and Pressure Vessel Code, Section IX - Qualification Standard for Welding, Brazing, and Fusing Procedures; Welders; Brazers; and Welding, Brazing, and Fusing Operators 2023.

G. ASTM A126 - Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings 2004 (Reapproved 2019).

H. ASTM A536 - Standard Specification for Ductile Iron Castings 1984, with Editorial Revision (2019).

I. ASTM B62 - Standard Specification for Composition Bronze or Ounce Metal Castings 2017.

J. AWWA C606 - Grooved and Shouldered Joints 2022.

K. MSS SP-67 - Butterfly Valves 2022.

L. MSS SP-70 - Gray Iron Gate Valves, Flanged and Threaded Ends 2011.

M. MSS SP-71 - Gray Iron Swing Check Valves, Flanged and Threaded Ends 2018.

N. MSS SP-80 - Bronze Gate, Globe, Angle, and Check Valves 2019.

O. MSS SP-110 - Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends 2010, with Errata .

1.04 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements for submittal procedures.

B. Product Data: Provide data on valves including manufacturers catalog information. Submit performance ratings, rough-in details, weights, support requirements, and piping connections.

1.05 QUALITY ASSURANCE

A. Manufacturer:
   1. Obtain valves for each valve type from single manufacturer.

B. Welding Materials and Procedures: Comply with ASME BPVC-IX.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:
   1. Minimize exposure of operable surfaces by setting plug and ball valves to open position.
   2. Protect valve parts exposed to piped medium against rust and corrosion.
   3. Protect valve piping connections such as grooves, weld ends, threads, and flange faces.
   4. Adjust globe, gate, and angle valves to the closed position to avoid clattering.
   5. Secure check valves in either the closed position or open position.
   6. Adjust butterfly valves to closed or partially closed position.

B. Use the following precautions during storage:
   1. Maintain valve end protection and protect flanges and specialties from dirt.
      a. Provide temporary inlet and outlet caps.
      b. Maintain caps in place until installation.
   2. Store valves in shipping containers and maintain in place until installation.
      a. Store valves indoors in dry environment.
      b. Store valves off the ground in watertight enclosures when indoor storage is not an option.

C. Exercise the following precautions for handling:
   1. Handle large valves with sling, modified to avoid damage to exposed parts.
   2. Avoid the use of operating handles or stems as rigging or lifting points.

PART 2 PRODUCTS

2.01 APPLICATIONS

A. See drawings for specific valve locations.

B. Listed pipe sizes shown using nominal pipe sizes (NPS) and nominal diameter (DN).

C. Provide the following valves for the applications if not indicated on drawings:
   1. Throttling (Hydronic): Butterfly, Ball, and Globe.
   2. Isolation (Shutoff): Butterfly, Gate, and Ball.
   3. Swing Check (Pump Outlet):
      a. Size 2 inch and Smaller: Bronze with bronze disc.
      b. Size 2-1/2 inch and Larger: Iron with lever and weight or lever and spring.
   4. Dead-End: Butterfly, single-flange (lug) type.

D. Substitutions of valves with higher CWP classes or WSP ratings for same valve types are permitted when specified CWP ratings or WSP classes are not available.

E. Required Valve End Connections for Non-Wafer Types:
   1. Steel Pipe:
      a. Size 2 inch and Smaller: Threaded ends.

b. Size 2-1/2 inch and Larger: Grooved or flanged ends.
2. Copper Tube:
a. Size 2 inch and Smaller: Threaded ends, except solder-joint valve-ends.
b. Size 2-1/2 inch and Larger: Grooved ends.

F. Chilled Water Valves:
1. Size 2 inch and Smaller, Bronze Valves:
a. Threaded ends.
b. Ball: Full port, one piece, brass trim.
c. Swing Check: Bronze disc, Class.
2. Size 2-1/2 inch and Larger, Iron Valves:
a. 2-1/2 inch to 4 inch: Flanged ends.
b. Single-Flange Butterfly: 2-1/2 inch to 12 inch, aluminum-bronze disc, EPDM seat, 200 CWP.
c. Single-Flange Butterfly: 14 inch to 24 inch, aluminum-bronze disc, EPDM seat, 150 CWP.
d. Grooved-End Butterfly: 2-1/2 inch to 12 inch, 175 CWP.
e. Swing Check: Metal seats, Class 125.
f. Swing Check with Closure Control: 2-1/2 inch to 12 inch, lever and spring, Class 125.
g. Grooved-End Check: 3 inch to 12 inch, 300 CWP.

G. Condenser Water Valves:
1. Size 2 inch and Smaller, Bronze Valves:
a. Threaded ends.
b. Ball: Full port, one piece, brass trim.
c. Swing Check: Bronze disc, Class 125.
2. Size 2-1/2 inch and Larger, Iron Valves:
a. 2-1/2 inch to 4 inch: Flanged ends.
b. Single-Flange Butterfly: 2-1/2 inch to 12 inch, aluminum-bronze disc, EPDM seat, 200 CWP.
c. Single-Flange Butterfly: 14 inch to 24 inch, 150 CWP, aluminum-bronze disc, EPDM seat, 150 CWP.
d. Grooved-End Butterfly: 2-1/2 inch to 12 inch, 175 CWP.
e. Swing Check: Metal seats, Class 125.
f. Swing Check with Closure Control, 2-1/2 inch to 12 inch: Lever and spring, Class 125.
g. Grooved-End Swing Check: 3 inch to 12 inch, 300 CWP.

H. Heating Hot Water Valves:
1. Size 2 inch and Smaller, Bronze Valves:
a. Threaded ends.
b. Ball: Full port, one piece, brass trim.
c. Swing Check: Bronze disc, Class 125.
2. Size 2-1/2 inch and Larger, Iron Valves:
a. 2-1/2 inch to 4 inch: Threaded ends.
b. Single-Flange Butterfly: 2-1/2 inch to 12 inch, aluminum-bronze disc, EPDM seat, 200 CWP.
c. Single-Flange Butterfly: 14 inch to 24 inch, aluminum-bronze disc, EPDM seat, 150 CWP.
d. Grooved-End Butterfly: 2-1/2 inch to 12 inch, 175 CWP.
e. Swing Check: Metal seats, Class 125.
f. Swing Check: 2-1/2 inch to 12 inch, lever and spring closure control, Class 125.

g. Grooved-End Swing Check: 3 inch to 12 inch, 300 CWP.

2.02 GENERAL REQUIREMENTS

A. Valve Pressure and Temperature Ratings: No less than rating indicated; as required for system pressures and temperatures.

B. Valve Sizes: Match upstream piping unless otherwise indicated.

C. Valve Actuator Types:
1. Gear Actuator: Quarter-turn valves 8 inch and larger.
2. Handwheel: Valves other than quarter-turn types.
3. Hand Lever: Quarter-turn valves 6 inch and smaller.
4. Chainwheel: Device for attachment to valve handwheel, stem, or other actuator, of size and with chain for mounting height, as indicated in the "Valve Installation" Article.

D. Valves in Insulated Piping: Provide 2 inch stem extensions and the following features:
1. Ball Valves: Extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.
2. Butterfly Valves: Extended neck.
3. Memory Stops: Fully adjustable after insulation is installed.

E. Memory Stops: Fully adjustable after insulation is installed.

F. Valve-End Connections:
1. Threaded End Valves: ASME B1.20.1.
2. Flanges on Iron Valves: ASME B16.1 for flanges on iron valves.
3. Pipe Flanges and Flanged Fittings 1/2 inch through 24 inch: ASME B16.5.
4. Solder Joint Connections: ASME B16.18.
5. Grooved End Connections: AWWA C606.

G. General ASME Compliance:
1. Building Services Piping Valves: ASME B31.9.

H. Bronze Valves:
1. Fabricate from dezincification resistant material.
2. Copper alloys containing more than 15 percent zinc are not permitted.

2.03 BRONZE, BALL VALVES

A. General:
1. Fabricate from dezincification resistant material.
2. Copper alloys containing more than 15 percent zinc are not permitted.

B. Two Piece, Full Port with Bronze or Brass Trim:
1. Comply with MSS SP-110.
2. WSP Rating: 150 psi.
3. WOG Rating: 400 psi.
4. Body: Forged bronze or dezincified-brass alloy.
5. End Connections: Pipe thread or solder.
6. Seats: PTFE.
7. Stem: Bronze or brass.
8. Ball: Chrome plated brass.

2.04 IRON, SINGLE FLANGE BUTTERFLY VALVES

A. Lug Style; Bidirectional Dead-End Service without Use of Downstream Flange:
1. Comply with MSS SP-67, Type I.
2. Lug Style, CWP Ratings:

a. Sizes 2 to 12 inch: 150 psi.
b. Vacuum Service: Down to 29.9 in-Hg.
3. Body Material: ASTM A126 cast iron or ASTM A536 ductile iron.
4. Stem: One or two-piece stainless steel.
5. Seat: NBR.
6. Disc: Aluminum-bronze.

2.05 IRON, GROOVED-END BUTTERFLY VALVES

A. CWP Rating: 175 psi.
1. Comply with MSS SP-67, Type I.
2. Body: Coated ductile iron.
3. Stem: Two-piece stainless steel.
4. Disc: Coated ductile iron.
5. Disc Seal: EPDM.

2.06 BRONZE, LIFT CHECK VALVES

A. Class 125:
1. Comply with MSS SP-80, Type 1, Metal Disc to Metal Seat and Type 2, Nonmetallic Disc to Metal Seat.
2. CWP Rating: 200 psi.
3. Design: Vertical flow.
4. Body: Bronze.
5. Ends: Threaded.
6. Disc (Type 1): Bronze.
7. Disc (Type 2): NBR or PTFE.

2.07 BRONZE, SWING CHECK VALVES

A. Class 150:
1. Pressure and Temperature Rating: MSS SP-80, Type 3.
2. Design: Y-pattern, horizontal or vertical flow.
3. CWP Rating: 300 psi.
4. Body: Bronze, ASTM B62.
5. End Connections: Threaded or soldered.
6. Disc: Bronze.

2.08 IRON, FLANGED END SWING CHECK VALVES

A. Class 125:
1. 150 psi with metal seats.
2. 200 psi with metal seats and nonmetallic-to-metal seats.

2.09 IRON, SWING CHECK VALVES WITH CLOSURE CONTROL

A. Class 125:
1. Comply with MSS SP-71, Type I.
2. Body Design: Clear or full waterway.
3. Body Material: ASTM A126, gray iron with bolted bonnet.
4. Ends: Flanged.
5. Trim: Bronze.
6. Gasket: Asbestos free.
7. Closer Control: Factory installed, exterior lever, and spring or weight.

2.10 IRON, GROOVED-END SWING CHECK VALVES

A. Class 300:
1. CWP Rating: 300 psi.

2. Body Material: ASTM A536, Grade 65-45-12 ductile iron.
3. Seal: EPDM or Nitrile.
4. Disc: Ductile iron.
5. Coating: Black, non-lead paint.

2.11 IRON, GATE VALVES

A. OS&Y:
1. Comply with MSS SP-70, Type I.
2. Class 125:
   a. Sizes 2-1/2 to 12 inch, CWP Rating; 200 psi.
   b. Sizes 14 to 24 inch, CWP Rating; 500 psi.
3. Body Material: Gray iron with bolted bonnet.
4. Ends: Flanged.
5. Trim: Bronze.
6. Disc: Solid wedge.
7. Packing and Gasket: Asbestos free.

2.12 CHAINWHEELS

A. Description: Valve actuation assembly with sprocket rim, brackets, and chain.
1. Brackets: Type, number, size, and fasteners required to mount actuator on valve.
2. Attachment: For connection to ball, butterfly, and plug valve stems.
3. Sprocket Rim with Chain Guides: Ductile iron include zinc coating.
4. Chain: Hot-dip galvanized steel. Sized to fit sprocket rim.

PART 3 EXECUTION

3.01 INSTALLATION

A. Provide unions or flanges with valves to facilitate equipment removal and maintenance while maintaining system operation and full accessibility for servicing.

B. Provide separate valve support as required and locate valve with stem at or above center of piping, maintaining unimpeded stem movement.

END OF SECTION

SECTION 23 0529
HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Support and attachment components.

1.02 REFERENCE STANDARDS

A. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products 2017.

B. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware 2023.

C. ASTM A181/A181M - Standard Specification for Carbon Steel Forgings, for General-Purpose Piping 2022.

D. ASTM A36/A36M - Standard Specification for Carbon Structural Steel 2019.

E. ASTM A47/A47M - Standard Specification for Ferritic Malleable Iron Castings 1999, with Editorial Revision (2022).

F. ASTM A283/A283M - Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates 2018.

G. ASTM A395/A395M - Standard Specification for Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures 1999 (Reapproved 2022).

H. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process 2022.

I. ASTM B633 - Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel 2023.

J. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials 2023.

K. FM (AG) - FM Approval Guide Current Edition.

L. MFMA-4 - Metal Framing Standards Publication 2004.

M. MSS SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation 2018, with Amendment (2019).

N. UL (DIR) - Online Certifications Directory Current Edition.

O. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials Current Edition, Including All Revisions.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate sizes and arrangement of supports and bases with the actual equipment and components to be installed.
   2. Coordinate the work with other trades to provide additional framing and materials required for installation.
   3. Coordinate compatibility of support and attachment components with mounting surfaces at the installed locations.
   4. Coordinate the arrangement of supports with ductwork, piping, equipment and other potential conflicts installed under other sections or by others.
   5. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

B. Sequencing:
   1. Do not install products on or provide attachment to concrete surfaces until concrete has fully cured in accordance with Section 03 3000.

1.04 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements for submittal procedures.

B. Product Data: Provide manufacturer's standard catalog pages and data sheets for channel (strut) framing systems, nonpenetrating rooftop supports, post-installed concrete and masonry anchors, and thermal insulated pipe supports.

C. Shop Drawings: Include details for fabricated hangers and supports where materials or methods other than those indicated are proposed for substitution.

PART 2 PRODUCTS

2.01 SUPPORT AND ATTACHMENT COMPONENTS

A. General Requirements:
   1. Provide all required hangers, supports, anchors, fasteners, fittings, accessories, and hardware as necessary for the complete installation of plumbing work.
   2. Provide products listed, classified, and labeled as suitable for the purpose intended, where applicable.
   3. Where support and attachment component types and sizes are not indicated, select in accordance with manufacturer's application criteria as required for the load to be supported. Include consideration for vibration, equipment operation, and shock loads where applicable.
   4. Do not use wire, chain, perforated pipe strap, or wood for permanent supports unless specifically indicated or permitted.
   5. Steel Components: Use corrosion resistant materials suitable for the environment where installed.
      a. Zinc-Plated Steel: Electroplated in accordance with ASTM B633.
      b. Galvanized Steel: Hot-dip galvanized after fabrication in accordance with ASTM A123/A123M or ASTM A153/A153M.

B. Prefabricated Trapeze-Framed Metal Strut Systems:
   1. MFMA-4 compliant, pre-fabricated, MSS SP-58 type 59 continuous-slot metal strut channel with associated tracks, fittings, and related accessories.
   2. Strut Channel or Bracket Material:
      a. Indoor Dry Locations: Use painted steel, zinc-plated steel, or galvanized steel.
      b. Outdoor and Damp or Wet Indoor Locations: Use galvanized steel.
   3. Accessories: Provide bracket covers, cable basket clips, cable tray clips, clamps, conduit clamps, fire-retarding brackets, j-hooks, protectors, and vibration dampeners.

C. Strut Channels:
   1. ASTM A653/A653M galvanized steel bracket with clamps for surface mounting of piping or plumbing equipment support.
   2. Channel or Bracket Kits: Include rods, brackets, end-fixed fittings, covers, clips, and other related hardware required to complete sectional trapeze section for piping or other support.

D. Channel Nuts:
   1. Provide carbon steel channel nut with epoxy copper or zinc finish and long, regular, or short spring.

E. Hanger Rods:
   1. Threaded zinc-plated steel unless otherwise indicated.

2. Minimum Size, Unless Otherwise Indicated or Required:
   a. Equipment Supports: 1/2 inch diameter.
   b. Piping up to 1 inch: 1/4 inch diameter.
   c. Piping larger than 1 inch: 3/8 inch diameter.
   d. Trapeze Support for Multiple Pipes: 3/8 inch diameter.

F. Pipe Supports:
1. Material: ASTM A395/A395M ductile iron, ASTM A36/A36M carbon steel, ASTM A47/A47M malleable iron, ASTM A181/A181M forged steel, or ASTM A283/A283M steel.
2. Liquid Temperatures Up To 122 degrees F:
   a. Overhead Support: MSS SP-58 Types 1, 3 through 12.
   b. Support From Below: MSS SP-58 Types 35 through 38.
3. Operating Temperatures from 122 to 446 degrees F:
   a. Overhead Support: MSS SP-58 Type 1 or 3 through 12, with appropriate saddle of MSS SP-58 Type 40 for insulated pipe.

G. Roller Chairs:
1. MSS SP-58 type 43 based on required load, nonconductive and corrosion resistant.
2. Steel Yoke Type: MSS SP-58 type 44, vertically adjustable, nonconductive, and corrosion resistant.
3. Material: Zinc plated ASTM A36/A36M carbon steel or ASTM A47/A47M malleable iron.

H. Pipe Stanchions:
1. Material: Malleable iron, ASTM A47/A47M; or carbon steel, ASTM A36/A36M.
2. Provide coated or plated saddles to isolate steel hangers from dissimilar metal tube or pipe.
3. For pipe runs, use stanchions of same type and material where vertical adjustment is required for stationary pipe.

I. Beam Clamps:
1. MSS SP-58 types 19 through 23, 25 or 27 through 30 based on required load.
2. Beam C-Clamp: MSS SP-58 type 23, malleable iron and steel with plain, stainless steel, and zinc finish.
3. Small or Junior Beam Clamp: MSS SP-58 type 19, malleable iron with plain finish. For inverted usage provide manufacturer listed size(s).
4. Wide Mouth Beam Clamp: MSS SP-58 type 19, malleable iron with plain finish.
5. Centerload Beam Clamp with Extension Piece: MSS SP-58 type 30, malleable iron with plain finish.
6. FM (AG) and UL (DIR) Approved Beam Clamp: MSS SP-58 type 19, plain finish,
7. Provide clamps with hardened steel cup-point set screws and lock-nuts for anchoring in place.
8. Material: ASTM A395/A395M ductile iron, ASTM A36/A36M carbon steel, ASTM A47/A47M malleable iron, ASTM A181/A181M forged steel, or ASTM A283/A283M steel.

J. Riser Clamps:
1. For insulated pipe runs, provide two bolt-type clamps designed for installation under insulation.
2. MSS SP-58 type 1 or 8, carbon steel or steel with epoxy plated, plain, stainless steel, or zinc plated finish.
3. Medium Split Horizontal Pipe Clamp: MSS SP-58 type 4, carbon steel or stainless steel with epoxy plated, plain, stainless steel, or zinc plated finish.
4. Copper Tube Pipe Clamp: MSS SP-58 type 8, epoxy plated copper.
5. UL (DIR) listed: Pipe sizes 1/2 to 8 inch.

K. U-Bolts:
   1. MSS SP-58 Type 24, carbon steel u-bolt for pipe support or anchoring.

L. Strut Clamps:
   1. Pipe Clamp: Two-piece rigid, universal, or outer diameter type, carbon steel with epoxy copper or zinc finish.

M. Insulation Clamps:
   1. Two bolt-type clamps designed for installation under insulation.
   2. Material: Carbon steel with epoxy copper or zinc finish.

N. Pipe Hangers:
   1. Split Ring Hangers:
      a. Provide hinged split ring and yoke roller hanger with epoxy copper or plain finish.
      b. Material: ASTM A47/A47M malleable iron or ASTM A36/A36M carbon steel.
      c. Provide hanger rod and nuts of the same type and material for a given pipe run.
      d. Provide coated or plated hangers to isolate steel hangers from dissimilar metal tube or pipe.
   2. Swivel Ring Hangers, Adjustable:
      a. MSS SP-58 Type 10, epoxy-painted, zinc-colored.
      b. Material: ASTM A395/A395M ductile iron, ASTM A36/A36M carbon steel, ASTM A47/A47M malleable iron, ASTM A181/A181M forged steel, or ASTM A283/A283M steel.
      c. FM (AG) and UL (DIR) listed for specific pipe size runs and loads.
   3. Clevis Hangers, Adjustable:
      a. Copper Tube: MSS SP-58 Type 1, epoxy-plated copper.
      b. Felt-Lined: MSS SP-58 Type 1, zinc-plated, silicone-free carbon steel.
      c. Light-Duty: MSS SP-58 Type 1, zinc-colored, epoxy plated.

O. Intermediate Pipe Guides:
   1. Pipe Diameter 6 inch and Smaller: Provide minimum clearance of 0.16 inch.
   2. Pipe Sizes 8 inch: 0.625 inch U-bolt with double nuts providing minimum clearance of 0.28 inch.
   3. Pipe Size 10 inch: 0.75 inch U-bolt.
   4. Pipe Sizes 12 to 16 inch: 0.875 inch U-bolt.
   5. Pipe Sizes 18 to 30 inch: 1 inch U-bolt.
   6. Use pipe clamps with oversize pipe sleeve that provides clearance around pipe.

P. Pipe Alignment Guides: Galvanized steel.
   1. Pipe Sizes 8 inch and Smaller: Spider or sleeve type.
   2. Pipe Sizes 10 inch and Larger: Roller type.

Q. Dielectric Barriers: Provide between metallic supports and metallic piping and associated items of dissimilar type; acceptable dielectric barriers include rubber or plastic sheets or coatings attached securely to pipe or item.

R. Nonpenetrating Rooftop Supports for Low-Slope Roofs:
   1. Base Sizes: As required to distribute load sufficiently to prevent indentation of roofing assembly.
   2. Attachment/Support Fixtures: As recommended by manufacturer, same type as indicated for equivalent indoor hangers and supports.
   3. Mounting Height: Provide minimum clearance of 6 inches under supported component to top of roofing.

S. Pipe Shields for Insulated Piping:

1. General Construction and Requirements:
   a. Surface Burning Characteristics: Comply with ASTM E84 or UL 723.
   b. Shields Material: UV-resistant polypropylene with glass fill.
   c. Maximum Insulated Pipe Outer Diameter: 12-5/8 inch.
   d. Minimum Service Temperature: Minus 40 degrees F.
   e. Maximum Service Temperature: 178 degrees F.
   f. Pipe shields to be provided at hanger, support, and guide locations on pipe requiring insulation or additional support.

T. Anchors and Fasteners:
   1. Unless otherwise indicated and where not otherwise restricted, use the anchor and fastener types indicated for the specified applications.
   2. Steel: Use beam-ceiling clamps, beam clamps, machine bolts, or welded threaded studs.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Provide independent support from building structure. Do not provide support from piping, ductwork, conduit, or other systems.

C. Unless specifically indicated or approved by Architect, do not provide support from suspended ceiling support system or ceiling grid.

D. Unless specifically indicated or approved by Architect, do not provide support from roof deck.

E. Do not penetrate or otherwise notch or cut structural members without approval of Structural Engineer.

F. Equipment Support and Attachment:
   1. Use metal fabricated supports or supports assembled from metal channel (strut) to support equipment as required.
   2. Use metal channel (strut) secured to studs to support equipment surface-mounted on hollow stud walls when wall strength is not sufficient to resist pull-out.
   3. Use metal channel (strut) to support surface-mounted equipment in wet or damp locations to provide space between equipment and mounting surface.
   4. Securely fasten floor-mounted equipment. Do not install equipment such that it relies on its own weight for support.

G. Secure fasteners according to manufacturer's recommended torque settings.

H. Remove temporary supports.

END OF SECTION

SECTION 23 0553
IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 GENERAL

1.01 RELATED REQUIREMENTS

A. Section 09 9123 - Interior Painting: Identification painting.

1.02 REFERENCE STANDARDS

A. ASTM D709 - Standard Specification for Laminated Thermosetting Materials 2017.

1.03 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements for submittal procedures.

B. Chart and Schedule: Submit valve chart and schedule, including valve tag number, location, function, and valve manufacturer's name and model number.

C. Product Data: Provide manufacturers catalog literature for each product required.

D. Project Record Documents: Record actual locations of tagged valves.

PART 2 PRODUCTS

2.01 IDENTIFICATION APPLICATIONS

A. Air Handling Units: Nameplates.

B. Air Terminal Units: Tags.

C. Control Panels: Nameplates.

D. Heat Transfer Equipment: Nameplates.

E. Piping: Pipe markers.

F. Pumps: Nameplates.

G. Tanks: Nameplates.

H. Valves: Tags and ceiling tacks where located above lay-in ceiling.

2.02 NAMEPLATES

A. Letter Color: White.

B. Letter Height: 1/4 inch.

C. Background Color: Black.

D. Plastic: Comply with ASTM D709.

2.03 TAGS

A. Plastic Tags: Laminated three-layer plastic with engraved black letters on light contrasting background color. Tag size minimum 1-1/2 inch diameter.

B. Metal Tags: Brass with stamped letters; tag size minimum 1-1/2 inch diameter with smooth edges.

C. Valve Tag Chart: Typewritten letter size list in anodized aluminum frame.

2.04 ADHESIVE-BACKED DUCT MARKERS

A. Material: High gloss acrylic adhesive-backed vinyl film 0.0032 inch; printed with UV and chemical resistant inks.

B. Style: Individual Label.

C. Color: Yellow/Black.

2.05 STENCILS

A. Stencils: With clean cut symbols and letters of following size:
   1. 1-1/2 to 2 inch Outside Diameter of Insulation or Pipe: 8 inch long color field, 3/4 inch high letters.
   2. 2-1/2 to 6 inch Outside Diameter of Insulation or Pipe: 12 inch long color field, 1-1/4 inch high letters.
   3. 8 to 10 inch Outside Diameter of Insulation or Pipe: 24 inch long color field, 2-1/2 inch high letters.
   4. Over 10 inch Outside Diameter of Insulation or Pipe: 32 inch long color field, 3-1/2 inch high letters.
   5. Ductwork and Equipment: 2-1/2 inch high letters.

B. Stencil Paint: As specified in Section 09 9123, semi-gloss enamel, colors complying with ASME A13.1.

2.06 PIPE MARKERS

A. Color: Comply with ASME A13.1.

B. Plastic Pipe Markers: Factory fabricated, flexible, semi- rigid plastic, preformed to fit around pipe or pipe covering; minimum information indicating flow direction arrow and identification of fluid being conveyed.

C. Underground Plastic Pipe Markers: Bright-colored continuously printed plastic ribbon tape, minimum 6 inches wide by 4 mil, 0.004 inch thick, manufactured for direct burial service.

D. Ammonia Pipe Markers: Flexible, vinyl film tape with pressure-sensitive adhesive backing and printed markings.

2.07 CEILING TACKS

A. Description: Steel with 3/4 inch diameter color coded head.

B. Color code as follows:
   1. Fire Dampers and Smoke Dampers: Red.
   2. Heating/Cooling Valves: Blue.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install nameplates with corrosive-resistant mechanical fasteners, or adhesive. Apply with sufficient adhesive to ensure permanent adhesion and seal with clear lacquer.

B. Install tags with corrosion resistant chain.

C. Apply stencil painting in accordance with Section 09 9123.

D. Install plastic pipe markers in accordance with manufacturer's instructions.

E. Install plastic tape pipe markers complete around pipe in accordance with manufacturer's instructions.

F. Install underground plastic pipe markers 6 to 8 inches below finished grade, directly above buried pipe.

G. Locate ceiling tacks to locate valves or dampers above lay-in panel ceilings. Locate in corner of panel closest to equipment.

END OF SECTION

SECTION 23 0593
TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 GENERAL

1.01 RELATED REQUIREMENTS

A. Section 01 9113 - General Commissioning Requirements: Commissioning requirements that apply to all types of work.

B. Section 23 0800 - Commissioning of HVAC.

1.02 REFERENCE STANDARDS

A. AABC (NSTSB) - AABC National Standards for Total System Balance, 7th Edition 2016.

B. ASHRAE Std 111 - Measurement, Testing, Adjusting, and Balancing of Building HVAC Systems 2008, with Errata (2019).

1.03 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements, for submittal procedures.

B. Installer Qualifications: Submit name of adjusting and balancing agency and TAB supervisor for approval within 30 days after award of Contract.

C. TAB Plan: Submit a written plan indicating the testing, adjusting, and balancing standard to be followed and the specific approach for each system and component.
   1. Submit to Architect.
   2. Submit to the Commissioning Authority.
   3. Submit six weeks prior to starting the testing, adjusting, and balancing work.
   4. Include at least the following in the plan:
      a. List of all air flow, water flow, sound level, system capacity and efficiency measurements to be performed and a description of specific test procedures, parameters, formulas to be used.
      b. Copy of field checkout sheets and logs to be used, listing each piece of equipment to be tested, adjusted and balanced with the data cells to be gathered for each.
      c. Discussion of what notations and markings will be made on the duct and piping drawings during the process.
      d. Final test report forms to be used.
      e. Expected problems and solutions, etc.
      f. Details of how TOTAL flow will be determined; for example:
         1) Air: Sum of terminal flows via control system calibrated readings or via hood readings of all terminals, supply (SA) and return air (RA) pitot traverse, SA or RA flow stations.
         2) Water: Pump curves, circuit setter, flow station, ultrasonic, etc.
      g. Procedures for formal deficiency reports, including scope, frequency and distribution.

D. Field Logs: Submit at least twice a week to the Commissioning Authority.

E. Control System Coordination Reports: Communicate in writing to the controls installer all setpoint and parameter changes made or problems and discrepancies identified during TAB that affect, or could affect, the control system setup and operation.

F. Progress Reports.

G. Final Report: Indicate deficiencies in systems that would prevent proper testing, adjusting, and balancing of systems and equipment to achieve specified performance.
   1. Submit to the the Commissioning Authority within two weeks after completion of testing, adjusting, and balancing.
   2. Revise TAB plan to reflect actual procedures and submit as part of final report.

3. Submit draft copies of report for review prior to final acceptance of Project. Provide final copies for Architect and for inclusion in operating and maintenance manuals.
4. Include actual instrument list, with manufacturer name, serial number, and date of calibration.
5. Form of Test Reports: Where the TAB standard being followed recommends a report format use that; otherwise, follow ASHRAE Std 111.
6. Units of Measure: Report data in both I-P (inch-pound) and SI (metric) units.

H. Project Record Documents: Record actual locations of flow measuring stations and balancing valves and rough setting.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 GENERAL REQUIREMENTS

A. Perform total system balance in accordance with one of the following:
1. AABC (NSTSB), AABC National Standards for Total System Balance.

B. Begin work after completion of systems to be tested, adjusted, or balanced and complete work prior to Substantial Completion of the project.

C. TAB Agency Qualifications:
1. Company specializing in the testing, adjusting, and balancing of systems specified in this section.
2. Having minimum of three years documented experience.
3. Certified by one of the following:
a. AABC, Associated Air Balance Council: www.aabc.com/#sle; upon completion submit AABC National Performance Guaranty.
b. NEBB, National Environmental Balancing Bureau: www.nebb.org/#sle.

D. TAB Supervisor and Technician Qualifications: Certified by same organization as TAB agency.

3.02 EXAMINATION

A. Verify that systems are complete and operable before commencing work. Ensure the following conditions:
1. Systems are started and operating in a safe and normal condition.
2. Temperature control systems are installed complete and operable.
3. Proper thermal overload protection is in place for electrical equipment.
4. Final filters are clean and in place. If required, install temporary media in addition to final filters.
5. Duct systems are clean of debris.
6. Fans are rotating correctly.
7. Fire and volume dampers are in place and open.
8. Air coil fins are cleaned and combed.
9. Access doors are closed and duct end caps are in place.
10. Air outlets are installed and connected.
11. Duct system leakage is minimized.
12. Hydronic systems are flushed, filled, and vented.
13. Pumps are rotating correctly.
14. Proper strainer baskets are clean and in place.
15. Service and balance valves are open.

B. Submit field reports. Report defects and deficiencies that will or could prevent proper system balance.

C. Beginning of work means acceptance of existing conditions.

3.03 PREPARATION

A. Hold a pre-balancing meeting at least one week prior to starting TAB work.
   1. Require attendance by all installers whose work will be tested, adjusted, or balanced.

B. Provide instruments required for testing, adjusting, and balancing operations. Make instruments available to Architect to facilitate spot checks during testing.

3.04 ADJUSTMENT TOLERANCES

A. Air Handling Systems: Adjust to within plus or minus 5 percent of design for supply systems and plus or minus 10 percent of design for return and exhaust systems.

B. Air Outlets and Inlets: Adjust total to within plus 10 percent and minus 5 percent of design to space. Adjust outlets and inlets in space to within plus or minus 10 percent of design.

C. Hydronic Systems: Adjust to within plus or minus 10 percent of design.

3.05 RECORDING AND ADJUSTING

A. Field Logs: Maintain written logs including:
   1. Running log of events and issues.
   2. Discrepancies, deficient or uncompleted work by others.
   3. Contract interpretation requests.
   4. Lists of completed tests.

B. Ensure recorded data represents actual measured or observed conditions.

C. Permanently mark settings of valves, dampers, and other adjustment devices allowing settings to be restored. Set and lock memory stops.

D. After adjustment, take measurements to verify balance has not been disrupted or that such disruption has been rectified.

E. Leave systems in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes, and restoring thermostats to specified settings.

3.06 AIR SYSTEM PROCEDURE

A. Adjust air handling and distribution systems to provide required or design supply, return, and exhaust air quantities at site altitude.

B. Make air quantity measurements in ducts by Pitot tube traverse of entire cross sectional area of duct.

C. Measure air quantities at air inlets and outlets.

D. Adjust distribution system to obtain uniform space temperatures free from objectionable drafts and noise.

E. Use volume control devices to regulate air quantities only to extend that adjustments do not create objectionable air motion or sound levels. Effect volume control by duct internal devices such as dampers and splitters.

F. Vary total system air quantities by adjustment of fan speeds. Provide drive changes required. Vary branch air quantities by damper regulation.

G. Provide system schematic with required and actual air quantities recorded at each outlet or inlet.

H. Measure static air pressure conditions on air supply units, including filter and coil pressure drops, and total pressure across the fan. Make allowances for 50 percent loading of filters.

I. Adjust outside air automatic dampers, outside air, return air, and exhaust dampers for design conditions.

J. Measure temperature conditions across outside air, return air, and exhaust dampers to check leakage.

K. Where modulating dampers are provided, take measurements and balance at extreme conditions. Balance variable volume systems at maximum air flow rate, full cooling, and at minimum air flow rate, full heating.

L. Measure building static pressure and adjust supply, return, and exhaust air systems to provide required relationship between each to maintain approximately 0.05 inches positive static pressure near the building entries.

M. Check multi-zone units for motorized damper leakage. Adjust air quantities with mixing dampers set first for cooling, then heating, then modulating.

N. For variable air volume system powered units set volume controller to air flow setting indicated. Confirm connections properly made and confirm proper operation for automatic variable air volume temperature control.

O. On fan powered VAV boxes, adjust air flow switches for proper operation.

3.07 WATER SYSTEM PROCEDURE

A. Adjust water systems to provide required or design quantities.

B. Use calibrated Venturi tubes, orifices, or other metered fittings and pressure gauges to determine flow rates for system balance. Where flow metering devices are not installed, base flow balance on temperature difference across various heat transfer elements in the system.

C. Adjust systems to provide specified pressure drops and flows through heat transfer elements prior to thermal testing. Perform balancing by measurement of temperature differential in conjunction with air balancing.

D. Effect system balance with automatic control valves fully open to heat transfer elements.

E. Effect adjustment of water distribution systems by means of balancing cocks, valves, and fittings. Do not use service or shut-off valves for balancing unless indexed for balance point.

F. Where available pump capacity is less than total flow requirements or individual system parts, full flow in one part may be simulated by temporary restriction of flow to other parts.

3.08 COMMISSIONING

A. See Sections 01 9113 - General Commissioning Requirements and 23 0800 for additional requirements.

B. Perform prerequisites prior to starting commissioning activities.

C. Fill out Prefunctional Checklists for:
   1. Air side systems.
   2. Water side systems.

D. Furnish to the Commissioning Authority, upon request, any data gathered but not shown in the final TAB report.

E. Re-check minimum outdoor air intake flows and maximum and intermediate total airflow rates for ___ percent of the air handlers plus a random sample equivalent to ____ percent of the final TAB report data as directed by Commissioning Authority.
   1. Original TAB agency shall execute the re-checks, witnessed by the Commissioning Authority.
   2. Use the same test instruments as used in the original TAB work.
   3. Failure of more than 10 percent of the re-checked items of a given system shall result in the rejection of the system TAB report; rebalance the system, provide a new system TAB report, and repeat random re-checks.
   4. For purposes of re-check, failure is defined as follows:

a. Air Flow of Supply and Return: Deviation of more than 10 percent of instrument reading.
b. Minimum Outside Air Flow: Deviation of more than 20 percent of instrument reading; for inlet vane or VFD OSA compensation system using linear proportional control, deviation of more than 30 percent at intermediate supply flow.
c. Temperatures: Deviation of more than one degree F.
d. Air and Water Pressures: Deviation of more than 10 percent of full scale of test instrument reading.
e. Sound Pressures: Deviation of more than 3 decibels, with consideration for variations in background noise.

5. For purposes of re-check, a whole system is defined as one in which inaccuracies will have little or no impact on connected systems; for example, the air distribution system served by one air handler or the hydronic chilled water supply system served by a chiller or the condenser water system.

F. In the presence of the Commissioning Authority, verify that:
1. Final settings of all valves, splitters, dampers and other adjustment devices have been permanently marked.
2. The air system is being controlled to the lowest possible static pressure while still meeting design loads, less diversity; this shall include a review of TAB methods, established control setpoints, and physical verification of at least one leg from fan to diffuser having all balancing dampers wide open and that during full cooling of all terminal units taking off downstream of the static pressure sensor, the terminal unit on the critical leg has its damper 90 percent or more open.
3. The water system is being controlled to the lowest possible pressure while still meeting design loads, less diversity; this shall include a review of TAB methods, established control setpoints, and physical verification of at least one leg from the pump to the coil having all balancing valves wide open and that during full cooling the cooling coil valve of that leg is 90 percent or more open.

3.09 SCOPE

A. Test, adjust, and balance the following:
1. Plumbing Pumps.
2. HVAC Pumps.
3. Chillers.
4. Cooling Towers.
5. Packaged Roof Top Heating/Cooling Units.
6. Air Coils.
7. Air Handling Units.
8. Fans.
9. Air Terminal Units.
10. Air Inlets and Outlets.

3.10 MINIMUM DATA TO BE REPORTED

A. Electric Motors:
1. Manufacturer.
2. Model/Frame.
3. HP/BHP.
4. Phase, voltage, amperage; nameplate, actual, no load.
5. RPM.
6. Service factor.
7. Starter size, rating, heater elements.
8. Sheave Make/Size/Bore.

B. V-Belt Drives:
   1. Identification/location.
   2. Required driven RPM.
   3. Driven sheave, diameter and RPM.
   4. Belt, size and quantity.
   5. Motor sheave diameter and RPM.
   6. Center to center distance, maximum, minimum, and actual.

C. Pumps:
   1. Identification/number.
   2. Manufacturer.
   3. Size/model.
   4. Impeller.
   5. Service.
   6. Design flow rate, pressure drop, BHP.
   7. Actual flow rate, pressure drop, BHP.
   8. Discharge pressure.
   9. Suction pressure.
   10. Total operating head pressure.
   11. Shut off, discharge and suction pressures.
   12. Shut off, total head pressure.

D. Chillers:
   1. Identification/number.
   2. Manufacturer.
   3. Capacity.
   4. Model number.
   5. Serial number.
   6. Evaporator entering water temperature, design and actual.
   7. Evaporator leaving water temperature, design and actual.
   8. Evaporator pressure drop, design and actual.
   9. Evaporator water flow rate, design and actual.
   10. Condenser entering water temperature, design and actual.
   11. Condenser pressure drop, design and actual.
   12. Condenser water flow rate, design and actual.

E. Cooling Tower:
   1. Tower identification/number.
   2. Manufacturer.
   3. Model number.
   4. Serial number.
   5. Rated capacity.
   6. Condenser water entering temperature.
   7. Condenser water leaving temperature.
   8. Condenser water flow rate.
   9. Fan RPM.

F. Heat Exchangers:
   1. Identification/number.
   2. Service.
   3. Manufacturer.
   4. Model number.
   5. Serial number.

6. Primary water entering temperature, design and actual.
7. Primary water leaving temperature, design and actual.
8. Primary water flow, design and actual.
9. Primary water pressure drop, design and actual.
10. Secondary water leaving temperature, design and actual.
11. Secondary water flow, design and actual.
12. Secondary water pressure drop, design and actual.

G. Cooling Coils:
1. Identification/number.
2. Service.
3. Air flow, design and actual.
4. Water flow, design and actual.
5. Water pressure drop, design and actual.
6. Entering water temperature, design and actual.
7. Leaving water temperature, design and actual.
8. Air pressure drop, design and actual.

H. Heating Coils:
1. Identification/number.
2. Service.
3. Manufacturer.
4. Air flow, design and actual.
5. Water flow, design and actual.
6. Entering water temperature, design and actual.
7. Air pressure drop, design and actual.

I. Electric Duct Heaters:
1. Identification/number.
2. Model number.
3. Design kW.
4. Number of stages.
5. Phase, voltage, amperage.
6. Test voltage (each phase).
7. Test amperage (each phase).
8. Air flow, specified and actual.

J. Air Moving Equipment:
1. Manufacturer.
2. Model number.
3. Serial number.
4. Arrangement/Class/Discharge.
5. Air flow, specified and actual.
6. Return air flow, specified and actual.
7. Outside air flow, specified and actual.
8. Total static pressure (total external), specified and actual.
9. Inlet pressure.
10. Discharge pressure.
11. Sheave Make/Size/Bore.
12. Number of Belts/Make/Size.
13. Fan RPM.

K. Duct Traverses:
1. System zone/branch.

2. Duct size.
3. Area.
4. Design velocity.
5. Design air flow.
6. Test velocity.
7. Test air flow.
8. Duct static pressure.
9. Air temperature.

L. Duct Leak Tests:
1. Description of ductwork under test.
2. Duct design operating pressure.
3. Duct design test static pressure.
4. Duct capacity, air flow.
5. Maximum allowable leakage duct capacity times leak factor.
6. Test static pressure.
7. Test orifice differential pressure.
8. Leakage.

M. Air Monitoring Stations:
1. Identification/location.
2. System.
3. Size.
4. Area.
5. Design velocity.
6. Design air flow.
7. Test velocity.
8. Test air flow.

N. Flow Measuring Stations:
1. Identification/number.
2. Location.
3. Size.
4. Manufacturer.
5. Model number.
6. Serial number.
7. Design Flow rate.
8. Design pressure drop.
9. Actual/final pressure drop.
10. Actual/final flow rate.
11. Station calibrated setting.

O. Terminal Unit Data:
1. Manufacturer.
2. Type, constant, variable, single, dual duct.
3. Identification/number.
4. Model number.
5. Size.
6. Minimum static pressure.
7. Minimum design air flow.
8. Maximum design air flow.
9. Maximum actual air flow.
10. Inlet static pressure.

P. Air Distribution Tests:
   1. Air terminal number.
   2. Room number/location.
   3. Terminal type.
   4. Terminal size.
   5. Area factor.
   6. Design velocity.
   7. Design air flow.
   8. Test (final) velocity.
   9. Test (final) air flow.
   10. Percent of design air flow.

END OF SECTION

SECTION 23 0713
DUCT INSULATION

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Duct insulation.

B. Duct liner.

C. Weather barrier coatings.

D. Jacketing and accessories.

1.02 REFERENCE STANDARDS

A. ASTM C553 - Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications 2013 (Reapproved 2019).

B. ASTM C612 - Standard Specification for Mineral Fiber Block and Board Thermal Insulation 2014 (Reapproved 2019).

C. ASTM C916 - Standard Specification for Adhesives for Duct Thermal Insulation 2020.

D. ASTM C1071 - Standard Specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material) 2019.

E. ASTM C1338 - Standard Test Method for Determining Fungi Resistance of Insulation Materials and Facings 2019 (Reapproved 2022).

F. ASTM C1371 - Standard Test Method for Determination of Emittance of Materials Near Room Temperature Using Portable Emissometers 2015.

G. ASTM C1423 - Standard Guide for Selecting Jacketing Materials for Thermal Insulation 2021.

H. ASTM D5590 - Standard Test Method for Determining the Resistance of Paint Films and Related Coatings to Fungal Defacement by Accelerated Four-Week Agar Plate Assay 2017 (Reapproved 2021).

I. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials 2023.

J. ASTM E96/E96M - Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials 2022a, with Editorial Revision (2023).

K. ASTM G21 - Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi 2015, with Editorial Revision (2021).

L. SAE AMS3779 - Tape, Adhesive, Pressure-Sensitive Thermal Radiation Resistant, Aluminum Coated Glass Cloth 2016b.

M. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible 2021.

N. UL 181A - Closure Systems for Use with Rigid Air Ducts Current Edition, Including All Revisions.

O. UL 181B - Closure Systems for Use with Flexible Air Ducts and Air Connectors Current Edition, Including All Revisions.

P. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials Current Edition, Including All Revisions.

1.03 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements for submittal procedures.

B. Product Data: Provide product description, thermal characteristics, list of materials and thickness for each service, and locations.

C. Manufacturer's Instructions: Indicate installation procedures necessary to ensure acceptable workmanship and that installation standards will be achieved.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Accept materials on site in original factory packaging, labelled with manufacturer's identification, including product density and thickness.

B. Protect insulation from weather and construction traffic, dirt, water, chemical, and mechanical damage, by storing in original wrapping.

1.05 FIELD CONDITIONS

A. Maintain ambient temperatures and conditions required by manufacturers of adhesives, mastics, and insulation cements.

B. Maintain temperature during and after installation for minimum period of 24 hours.

PART 2 PRODUCTS

2.01 REGULATORY REQUIREMENTS

A. Surface Burning Characteristics: Flame spread index/Smoke developed index of 25/50, maximum, when tested in accordance with ASTM E84 or UL 723.

2.02 GLASS FIBER, FLEXIBLE

A. Manufacturer:
   1. CertainTeed Corporation; _____: www.certainteed.com/#sle.
   2. Johns Manville; _____: www.jm.com/#sle.
   3. JP Lamborn Co; Thermal Sleeve MT: www.jpflex.com/#sle.
   4. Knauf Insulation; Atmosphere Duct Wrap: www.knaufinsulation.com/#sle.

B. Insulation: ASTM C553; flexible, noncombustible blanket.

C. Vapor Barrier Jacket:
   1. Kraft paper with glass fiber yarn and bonded to aluminized film.
   2. Moisture Vapor Permeability: 0.02 perm inch, when tested in accordance with ASTM E96/E96M.
   3. Secure with pressure-sensitive tape.

D. Vapor Barrier Tape:
   1. Kraft paper reinforced with glass fiber yarn and bonded to aluminized film, with pressure-sensitive rubber-based adhesive.

E. Indoor Vapor Barrier Mastic:
   1. Vinyl emulsion type acrylic or mastic, compatible with insulation, black color.

F. Outdoor Vapor Barrier Mastic:
   1. Vinyl emulsion type acrylic or mastic, compatible with insulation, black color.

2.03 GLASS FIBER, RIGID

A. Manufacturer:
   1. CertainTeed Corporation; _____: www.certainteed.com/#sle.
   2. Johns Manville; _____: www.jm.com/#sle.
   3. Knauf Insulation; _____: www.knaufinsulation.com/#sle.
   4. Owens Corning Corporation; 700 Series FIBERGLAS Insulation: www.ocbuildingspec.com/#sle.

B. Insulation: ASTM C612; rigid, noncombustible blanket.

C. Vapor Barrier Jacket:
   1. Kraft paper with glass fiber yarn and bonded to aluminized film.

2. Moisture Vapor Permeability: 0.02 perm inch, when tested in accordance with ASTM E96/E96M.
3. Secure with pressure-sensitive tape.

D. Vapor Barrier Tape:
1. Kraft paper reinforced with glass fiber yarn and bonded to aluminized film, with pressure-sensitive rubber-based adhesive.

2.04 WEATHER BARRIER COATINGS

A. Weather-Resistive Barrier Coating: Fire-resistive, UV resistant, water-based mastic for use over closed cell polyethylene and polyurethane foam insulation; applied with glass fiber or synthetic reinforcing mesh.
1. Surface Burning Characteristics: Flame spread index of 25 or less, smoke developed index of 450 or less, Class A, when tested in accordance with ASTM E84.
2. Water Vapor Permeance: Greater than 1.0 perm in accordance with ASTM E96/E96M.
3. Resistance to Fungal Growth: No growth when tested in accordance with ASTM D5590.
4. Color: As selected by Architect.

2.05 JACKETING AND ACCESSORIES

A. Flexible Weather-Proofing Outdoor Jacket: Self-healing, field-applied outdoor cladding.
1. Material: Aluminum foil/polymer laminate with rubberized asphalt layer and acrylic adhesive.
2. Thickness: 34 mil, 0.034 inch.
3. Finish: Embossed.
4. Color: Silver.
5. Water Vapor Transmission: 0.002 perm inch, maximum, when tested in accordance with ASTM E96/E96M.
6. Mold Resistance: Pass when tested in accordance with ASTM C1338.
7. Emissivity: 0.30 when tested in accordance with ASTM C1371.

B. Reinforced Tape:
1. FSK tape suitable for sealing seams between insulation, insulated elbows, and fittings resulting in a tight, smooth surface without wrinkles.
2. Comply with UL 723 or ASTM E84.
3. Moisture Vapor Permeability: 0.00 perm inch, when tested in accordance with ASTM E96/E96M.

C. Plain Foil Tape:
1. Aluminum foil with pressure-sensitive adhesive on paper release liner.

D. UL181 Tape for Rigid and Flexible Ductwork:
1. Comply with UL 181A for rigid ductwork.
2. Comply with UL 181B for flexible ductwork.
3. Aluminum foil coated with pressure-sensitive adhesive on paper release liner.
4. Foil tape suitable for sealing seams between insulation, insulated elbows, and fittings resulting in a tight, smooth surface without wrinkles.

2.06 DUCT LINER

A. Note: Choose the liner type - Elastomeric Foam or Glass Fiber.

B. Glass Fiber Insulation: Non-corrosive, incombustible glass fiber complying with ASTM C1071; flexible blanket; impregnated surface and edges coated with poly vinyl acetate polymer, acrylic polymer, or black composite.
1. Fungal Resistance: No growth when tested according to ASTM G21.
2. Apparent Thermal Conductivity: Maximum of 0.31 at 75 degrees F.
3. Rated Velocity on Coated Air Side for Air Erosion: 5,000 fpm, minimum.

C. Adhesive: Waterproof, fire-retardant type, ASTM C916.

PART 3 EXECUTION

3.01 EXAMINATION

A. Test ductwork for design pressure prior to applying insulation materials.

B. Verify that surfaces are clean, foreign material removed, and dry.

3.02 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Insulated Ducts Conveying Air Below Ambient Temperature:
   1. Provide insulation with vapor barrier jackets.
   2. Finish with tape and vapor barrier jacket.
   3. Continue insulation through walls, sleeves, hangers, and other duct penetrations.
   4. Insulate entire system, including fittings, joints, flanges, fire dampers, flexible connections, and expansion joints.

C. Exterior Applications: Provide insulation with vapor barrier jacket. Cover with caulked aluminum jacket with seams located on bottom side of horizontal duct section.

D. Slope exterior ductwork to shed water.

E. Duct and Plenum Liner Application:
   1. Adhere insulation with adhesive for 90 percent coverage.
   2. Secure insulation with mechanical liner fasteners. Refer to SMACNA (DCS) for spacing.
   3. Seal and smooth joints. Seal and coat transverse joints.
   4. Seal liner surface penetrations with adhesive.
   5. Duct dimensions indicated are net inside dimensions required for airflow. Increase duct size to allow for insulation thickness.

3.03 SCHEDULES

A. Exhaust Ducts Within 10 ft of Exterior Openings:

B. Outside Air Intake Ducts:

C. Supply Ducts:

D. Supply Ducts From Fans to Vertical Ducts in Shafts (Cooling System):

E. Supply Ducts in Vertical Shafts (Cooling Systems):

F. Ducts Exposed to Outdoors:

END OF SECTION

SECTION 23 0716
HVAC EQUIPMENT INSULATION

PART 1 GENERAL

1.01 REFERENCE STANDARDS

A. ASTM C177 - Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus 2019, with Editorial Revision (2023).

B. ASTM C195 - Standard Specification for Mineral Fiber Thermal Insulating Cement 2007 (Reapproved 2019).

C. ASTM C518 - Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus 2021.

D. ASTM C534/C534M - Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form 2023.

E. ASTM C592 - Standard Specification for Mineral Fiber Blanket Insulation and Blanket-Type Pipe Insulation (Metal-Mesh Covered) (Industrial Type) 2022a.

F. ASTM C612 - Standard Specification for Mineral Fiber Block and Board Thermal Insulation 2014 (Reapproved 2019).

G. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials 2023.

H. ASTM E96/E96M - Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials 2022a, with Editorial Revision (2023).

I. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials Current Edition, Including All Revisions.

1.02 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide product description, thermal characteristics, list of materials and thickness for equipment scheduled.

C. Manufacturer's Instructions: Indicate installation procedures that ensure acceptable workmanship and installation standards will be achieved.

PART 2 PRODUCTS

2.01 REGULATORY REQUIREMENTS

A. Surface Burning Characteristics: Flame spread index/Smoke developed index of 25/50, maximum, when tested in accordance with ASTM E84 or UL 723.

2.02 GLASS FIBER, RIGID

A. Manufacturer:
   1. CertainTeed Corporation; _____: www.certainteed.com/#sle.
   2. Johns Manville Corporation; _____: www.jm.com/#sle.
   3. Knauf Insulation; Earthwool Insulation Board: www.knaufinsulation.com/#sle.
   4. Owens Corning Corporation; _____: www.ocbuildingspec.com/#sle.

B. Insulation: ASTM C612 or ASTM C592; rigid, noncombustible.
   1. K Value: 0.25 at 75 degrees F, when tested in accordance with ASTM C177 or ASTM C518.
   2. Maximum Service Temperature: 1,200 degrees F.
   3. Maximum Water Vapor Absorption: 5.0 percent by weight.
   4. Maximum Density: 8.0 pcf.

C. Aluminum-Foil Laminate Jacket:
   1. Factory-applied, pressure sensitive adhesive jacketing to comply with ASTM C1775.

D. Vapor Barrier Jacket:
   1. Kraft paper reinforced with glass fiber yarn and bonded to aluminized film.
   2. Moisture Vapor Permeability: 0.02 perm inch, when tested in accordance with ASTM E96/E96M.
   3. Secure with self-sealing longitudinal laps and butt strips.
   4. Secure with outward clinch expanding staples and vapor barrier mastic.

E. Facing: 1 inch galvanized steel hexagonal wire mesh stitched on one face of insulation.

F. Vapor Barrier Lap Adhesive: Compatible with insulation.

G. Insulating Cement/Mastic: ASTM C195; hydraulic setting on mineral wool.

2.03 FLEXIBLE ELASTOMERIC CELLULAR INSULATION

A. Manufacturer:
   1. Aeroflex USA, Inc; Aerocel AC Sheet and Roll: www.aeroflexusa.com/#sle.
   2. Armacell LLC; ArmaFlex Ultra with FlameDefense: www.armacell.us/#sle.
   3. K-Flex USA LLC; Insul-Sheet: www.kflexusa.com/#sle.

B. Insulation: Preformed flexible elastomeric cellular rubber insulation complying with ASTM C534/C534M Grade 1, in sheet form.
   1. Minimum Service Temperature: Minus 40 degrees F.
   2. Maximum Service Temperature: 220 degrees F.
   3. Connection: Waterproof vapor barrier adhesive.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Factory Insulated Equipment: Do not insulate.

C. Insulated equipment containing fluids below ambient temperature; insulate entire system.

D. Fiber glass insulated equipment containing fluids below ambient temperature; provide vapor barrier jackets, factory-applied or field-applied. Finish with glass cloth and vapor barrier adhesive.

E. For hot equipment containing fluids 140 degrees F or less, do not insulate flanges and unions, but bevel and seal ends of insulation.

F. For hot equipment containing fluids over 140 degrees F, insulate flanges and unions with removable sections and jackets.

G. Fiber glass insulated equipment containing fluids above ambient temperature; provide standard jackets, with or without vapor barrier, factory-applied or field-applied. Finish with glass cloth and adhesive.

H. Cover glass fiber insulation with metal mesh and finish with heavy coat of insulating cement.

I. Nameplates and ASME Stamps: Bevel and seal insulation around; do not insulate over.

3.02 SCHEDULE

A. Heating Systems:
   1. Heat Exchangers/Converters:
   2. Air Separators:

B. Cooling Systems:
   1. Pump Bodies:

2. Air Separators:
3. Expansion Tanks:
4. Chiller Cold Surfaces (Not Factory Insulated):
5. Cold Thermal Storage Tanks:

END OF SECTION

SECTION 23 0719
HVAC PIPING INSULATION

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Piping insulation.

B. Flexible removable and reusable blanket insulation.

C. Jacketing and accessories.

D. Engineered wall outlet seals and refrigerant piping insulation protection.

1.02 RELATED REQUIREMENTS

A. Section 07 8400 - Firestopping.

1.03 REFERENCE STANDARDS

A. ASTM B209/B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate 2021a.

B. ASTM C177 - Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus 2019, with Editorial Revision (2023).

C. ASTM C195 - Standard Specification for Mineral Fiber Thermal Insulating Cement 2007 (Reapproved 2019).

D. ASTM C449 - Standard Specification for Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement 2007 (Reapproved 2019).

E. ASTM C547 - Standard Specification for Mineral Fiber Pipe Insulation 2022a.

F. ASTM C795 - Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel 2008 (Reapproved 2018).

G. ASTM C1126 - Standard Specification for Faced or Unfaced Rigid Cellular Phenolic Thermal Insulation 2019.

H. ASTM C1136 - Standard Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation 2023.

I. ASTM C1423 - Standard Guide for Selecting Jacketing Materials for Thermal Insulation 2021.

J. ASTM D1621 - Standard Test Method for Compressive Properties of Rigid Cellular Plastics 2016.

K. ASTM D1623 - Standard Test Method for Tensile and Tensile Adhesion Properties of Rigid Cellular Plastics 2017.

L. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials 2023.

M. ASTM E96/E96M - Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials 2022a, with Editorial Revision (2023).

N. ASTM E283 - Standard Test Method for Determining the Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen 2004 (Reapproved 2012).

O. ASTM E331 - Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference 2000 (Reapproved 2023).

P. ASTM E2178 - Standard Test Method for Determining Air Leakage Rate and Calculation of Air Permeance of Building Materials 2021a.

Q. SAE AMS3779 - Tape, Adhesive, Pressure-Sensitive Thermal Radiation Resistant, Aluminum Coated Glass Cloth 2016b.

R. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials Current Edition, Including All Revisions.

1.04 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements for submittal procedures.

B. Product Data: Provide product description, thermal characteristics, list of materials and thickness for each service, and locations.

C. Manufacturer's Instructions: Indicate installation procedures that ensure acceptable workmanship and installation standards will be achieved.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Accept materials on site, labeled with manufacturer's identification, product density, and thickness.

PART 2 PRODUCTS

2.01 REGULATORY REQUIREMENTS

A. Surface Burning Characteristics: Flame spread index/Smoke developed index of 25/50, maximum, when tested in accordance with ASTM E84 or UL 723.

2.02 GLASS FIBER, RIGID

A. Insulation: ASTM C547 and ASTM C795; rigid molded, noncombustible.
   1. K Value: ASTM C177, 0.24 at 75 degrees F.
   2. Maximum Service Temperature: 850 degrees F.
   3. Maximum Moisture Absorption: 0.2 percent by volume.

B. Vapor Barrier Jacket: White kraft paper with glass fiber yarn, bonded to aluminized film; moisture vapor transmission when tested in accordance with ASTM E96/E96M of 0.02 perm-inches.

C. Tie Wire: 0.048 inch stainless steel with twisted ends on maximum 12 inch centers.

D. Vapor Barrier Lap Adhesive: Compatible with insulation.

E. Insulating Cement/Mastic: ASTM C195; hydraulic setting on mineral wool.

F. Insulating Cement: ASTM C449.

2.03 RIGID, CELLULAR PHENOLIC

A. Manufacturers:
   1. Dyplast Products, LLC; _____: www.dyplastproducts.com/#sle.
   2. ITW Insulation Systems; _____: www.itwinsulation.com/#sle.
   3. Polyguard Products; PolyPhen: www.polyguardproducts.com.com/#sle.

B. Insulation: ASTM C1126, Type III, Grade 1.
   1. Nominal Density: 3.75 pcf.
   2. Preliminary Initial Minimum K Value: 0.145 at 50 degrees F based on density of 2.5 pcf.
   3. Maximum Service Temperature: 248 degrees F.
   4. Minimum Service Temperature: Minus 292 degrees F.
   5. Minimum compressive strength as determined by ASTM D1621.
   6. Minimum tensile strength as determined by ASTM D1623.

2.04 JACKETING AND ACCESSORIES

A. ABS Plastic:
   1. Jacket: One piece molded type fitting covers and sheet material, off-white color.

a. Minimum Service Temperature: Minus 40 degrees F.
b. Maximum Service Temperature: 180 degrees F.
c. Moisture Vapor Permeability: 0.012 perm inch, when tested in accordance with ASTM E96/E96M.
d. Thickness: 30 mil, 0.030 inch.
e. Connections: Brush on welding adhesive.

B. Aluminum Jacket:
1. Comply with ASTM B209/B209M, Temper H14, minimum thickness of 0.016 inch with factory-applied polyethylene and kraft paper moisture barrier on the inside surface.
2. Thickness: 0.016 inch sheet.
3. Type: Factory-applied, self-adhesive jacketing.
4. Joining: Longitudinal slip joints and 2 inch laps.
5. Fittings: 0.016 inch thick die-shaped fitting covers with factory-attached protective liner.
6. Metal Jacket Bands: 3/8 inch wide; 0.015 inch thick aluminum.

C. Reinforced Tape:
1. FSK tape suitable for sealing seams between insulation, insulated pipe bends, and fittings resulting in a tight, smooth surface without wrinkles.
2. Comply with UL 723, ASTM E84.
3. Moisture Vapor Permeability: 0.00 perm inch, when tested in accordance with ASTM E96/E96M.

2.05 ENGINEERED WALL OUTLET SEALS AND REFRIGERANT PIPING INSULATION PROTECTION

A. Pipe Penetration Wall Seal: Seals HVAC piping wall penetrations with compression gasket wall mounted rigid plastic outlet cover.
1. Wall Outlet Size, Stucco and Masonry Applications: 7-1/2 inch wide by 10 inch high.
a. Elastomeric Sleeve Diameter: 1-11/16 inch.
2. Outlet Cover Color: Gray.
3. Water Penetration: Comply with ASTM E331.
4. Air Leakage: Comply with ASTM E283.
5. Air Permeance: Comply with ASTM E2178.

B. Insulation Protection System: Refrigerant piping insulation PVC protective cover.
1. PVC Insulation Cover Color: Black with full-length velcro fastener.
2. Flame Spread and Smoke Development Rating of 24/450: Comply with ASTM E84 or UL 723.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Insulated Pipes Conveying Fluids Below Ambient Temperature:
1. Insulate entire system, including fittings, valves, unions, flanges, strainers, flexible connections, pump bodies, and expansion joints.

C. For hot piping conveying fluids over 140 degrees F, insulate flanges and unions at equipment.

D. Glass Fiber Insulated Pipes Conveying Fluids Above Ambient Temperature:
1. Provide standard jackets, with or without vapor barrier, factory-applied, or field-applied. Secure with self-sealing longitudinal laps and butt strips with pressure-sensitive adhesive. Secure with outward clinch expanding staples.
2. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe. Finish with glass cloth and adhesive or PVC fitting covers.

E. Inserts and Shields:
   1. Application: Piping 1-1/2 inches diameter or larger.
   2. Shields: Galvanized steel between pipe hangers or pipe hanger rolls and inserts.

F. Continue insulation through walls, sleeves, pipe hangers, and other pipe penetrations. Finish at supports, protrusions, and interruptions. At fire separations, see Section 07 8400.

G. Exterior Applications: Provide vapor barrier jacket. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe, and finish with glass mesh reinforced vapor barrier cement. Cover with aluminum jacket with seams located on bottom side of horizontal piping. Provide two coats of UV resistant finish for flexible elastomeric cellular insulation without jacketing.

H. Heat Traced Piping: Insulate fittings, joints, and valves with insulation of like material, thickness, and finish as adjoining pipe. Size large enough to enclose pipe and heat tracer. Cover with aluminum jacket with seams located on bottom side of horizontal piping.

3.02 SCHEDULE

A. Heating Systems:
   1. Heating Water Supply and Return: Glass Fiber, Rigid, 2-inch thick.

B. Cooling Systems:
   1. Chilled Water: Rigid, Cellular Phenolic, 2-inch thick

C. Other Systems:
   1. Piping Exposed to Freezing: Class Fiber, Rigid, 2-inch thick with Heat Tracing

END OF SECTION

SECTION 23 0800
COMMISSIONING OF HVAC

PART 1 GENERAL

1.01 RELATED WORK

A. Division 22 - Plumbing

B. Division 26 - Electrical

1.02 REFERENCES

A. Drawings and general provisions of contract, including general and supplementary conditions, general mechanical provisions and Division-1 Specification sections, apply to work of this section.

B. ASHRAE Guideline 1-1996

C. ASHRAE Guideline 0-2005

D. ACG Commissioning Guideline – 2005

1.03 DESCRIPTION OF WORK

A. The purpose of the commissioning process is to provide the owner/operator of the facility with a high level of assurance that the mechanical systems have been installed in the prescribed manner, and operate within the performance guidelines set in the Basis of Design Documents (BOD). The CA shall provide the owner with an unbiased, objective view of the system's installation, operation, and performance. This process is not intended to take away or reduce the responsibility of the design team or installing contractors to provide a finished product. Commissioning is intended to enhance the quality of system start-up and aid in the orderly transfer of systems for beneficial use by the owner. The CA will be a member of the construction team, administrating and coordinating commissioning activities with the design team, construction manager, subcontractors, manufacturers and equipment suppliers.

B. The independent commissioning agent (CA) contracted directly with the owner for this project. This specification has been included for reference only to define contractors' responsibilities. Each contractor should review this procedure and include adequate time in their proposal.

PART 2 PRODUCTS

2.01 NOT USED

PART 3 EXECUTION

3.01 ROLES OF THE COMMISSIONING AGENCY

A. The primary point of responsibility is to inform the construction manager, the owner and design team on the status, integration, and performance of HVAC systems within the facility.

B. The CA shall function as a catalyst and initiator to disseminate information and assist the design and construction teams in implementing completion of the construction process. This shall include system verification, functional performance testing, and conformance with the intended design of each system. Services include documenting construction observations, verification and functional performance testing, and documenting proper distribution of performance and operating information to the owner's O&M staff.

C. Assist the responsible parties to maintain a high quality level of installation by meeting or exceeding prevailing standards and specifications.

D. The CA shall observe and coordinate testing as required to assure system performance meets the design intent.

E. The CA shall document the results of the performance testing directly and/or assure that the appropriate technicians document testing. The CA shall approve standard forms to be used by

all parties for consistency of approach and type of information to be recorded.

F. The CA shall provide technical expertise to oversee and verify the correction of deficiencies found during the commissioning process.

G. The CA is to remain an independent party with specific knowledge of the project. The CA shall investigate the scope and extent of the problem and facilitate communication to determine responsibilities by delineating specifications. The CA shall monitor resolution for conformance with design intent and prevailing industry standards.

H. The CA shall document the date of acceptance as determined by the construction manager, owner and design team. System Verification Checklists and Functional Performance Test results may be used in determining the start of the warranty period for HVAC systems and subsystems.

I. The CA will review operating and maintenance materials for HVAC systems.

J. The CA will review phasing plans as provided by the GC relating to temporary use of HVAC equipment, O&M considerations, warranty issues, impact of construction sequencing on occupied areas, and interruption of services from the existing equipment.

3.02 SYSTEMS INCLUDED IN THE COMMISSIONING PROCESS

A. HVAC System
   1. Chillers
   2. Pumps
   3. Boilers
   4. Cooling Towers
   5. Variable Frequency Drives
   6. Air Handling Units
   7. Energy Recovery Units
   8. VAV boxes
   9. Supply and Exhaust Fans

B. DDC Controls

C. DDC System GUI Compliance

D. Domestic Hot Water System

E. Science Lab Safety Panels

F. Lighting Controls

G. Electric Sub-Metering

3.03 HVAC COMMISSIONING PLAN

A. Commissioning Team
   1. The Commissioning Team (CT) shall consist of key parties involved in design, construction and testing of this facility. It is necessary for each agency to appoint team members that will have long-term commitments to this project. Switching team members during the project will reduce the ability of the CT to provide continuity and acceptable results to the building owner. Team members must maintain an ongoing supervisory position on this project. One team member shall be provided by each of the parties listed below:
      a. Program Manager (PrM)
      b. Facilities Management Division (FMD)
      c. Commissioning Agent (CA)
      d. Design Team (DT)
      e. General Contractor (GC)
      f. GC's Mechanical Contractor (MC)

g. GC's Controls Contractor (CC)
h. Test and Balance Contractor (TABC)
i. GC's Electrical Contractor (EC)

B. Basis of Design Document
1. The Basis of Design Document (BOD) represents a composite of design drawings, project specifications, submittals, change orders and industry standards that describe the systems of this facility. References to design intent will be taken from these contract documents. The BOD is an evolving manuscript maintained by the design professional to track and incorporate design alterations that occur throughout the construction process. Any industry standards used for this project will be specifically noted when referenced.
2. The CA will review the BOD documents for adequate commissioning provisions, functional performance, optimization of performance, accessibility, TAB provisions, and O&M considerations.

C. Commissioning Meetings
1. Commissioning meetings will be held in conjunction with progress meetings as necessary. Commissioning meetings will be used to address any problems that alter the design intent or affect the commissioning process. These meetings provide an open forum for exchange of ideas between contractors, vendors, designers, users and owners.

D. Resolution Tracking Forms (RTF)
1. The use of Resolution Tracking Forms is a method employed by the CA to monitor and record problems, their causes, and solutions. The use of these lists promotes communication between the installing contractors, design team, commissioning agent, and owner, in order to expedite their resolution in a timely manner.
2. The CA will regularly submit RTF's to the CT in order to document and resolve deficiencies as quickly as possible. The frequency of RTF submission will be adjusted as project conditions dictate.

E. System Verification Checklists (SVC) / Manufacturers' Checklists
1. The MC will provide SVC's based on manufacturers start-up procedures. These tests should be provided for all systems and subsystems. See SYSTEMS INCLUDED IN THE COMMISSIONING PROCESS. Draft copies will be submitted to the CT for review and comment prior to placement on the job site. A master copy of the SVC's will be bound in a three-ring binder and placed on the job site for use by the installing contractors. No system will be started until the appropriate SVC's have been completed.
2. The CA will review the SVC for each piece of equipment prior to start-up. Equipment will be released for start-up only after these checklists have been completed by the installing contractor and reviewed by the CA.
3. The equipment manufacturers' checklists must also be reviewed by the CA prior to start-up. These lists must be completed by the installing contractor, and reviewed by the CA before start-up can commence.

F. Start-Up
1. The appropriate contractors and/or manufacturer's representative will be required on site to perform start-up. No system will be started until the appropriate SVC's have been completed. No system will be started until the Manufacturer's checklists have been completed. Start-up will be performed according to the Manufacturer's recommended procedures. The CA will visit the site to review completeness of installation in conjunction with progress meetings prior to starting HVAC equipment.
2. CT members involved in installation, fabrication, manufacture, control, or design of equipment are required to be present at the time of start-up. A factory-authorized technician will be on site to start equipment when required by the specifications. This will minimize delays in bringing equipment on line and expedite acceptable functional performance in accordance with the BoD.

G. Controls Monitoring
   1. Close monitoring of the Control Contractor's progress will promote efficient coordination of the TAB work. The CC will be expected to submit point-to-point checklists verifying that his work has been completed and all systems are ready for TAB work and Functional Performance Testing. Programming and graphics will be surveyed by the CA for completeness and conformance with the BoD and the owner's scheduling requirements.

H. TAB Monitoring
   1. The preliminary TAB report set-up will be reviewed prior to HVAC equipment start-up, in order to assure that the final TAB report format and content is acceptable.
   2. TAB work will be monitored so that any problems that prevent or hinder proper air and water balance can be addressed and corrected with minimal delays. By addressing these problems as quickly as possible, we can assure that functional performance testing and owner training will take place on schedule.
   3. A pencil copy of the TAB report will be reviewed prior to submission of the final TAB report. A written review will be submitted to the TAB contractor and to the DT for their comments. A TAB report approved by the DT will be required before Functional Performance Testing can be carried out. The CA will visit the site during the TAB process in order to assist TABC and CC in the effective completion of their scope of work.

I. Functional Performance Tests (FPT)
   1. The CA will write FPT's based on the respective sequence of operations. These tests will be created for systems and subsystems. See SYSTEMS INCLUDED IN THE COMMISSIONING PROCESS above.
   2. Each major system will be tested. A random sample of each subsystem will be tested. This will be coordinated and witnessed by the CA and the owner's maintenance staff. Witnessing the FPT's will serve as a compliment to the O&M Training. No FPT's will be performed until the system and related subsystems have been started, the TAB report has been submitted and reviewed, and the completion of the control system has been documented through point-to-point checklists and other documentation.
   3. The Functional Performance Tests shall include HVAC and related equipment.
      a. AHU's will be tested in designed operating modes. Proper operation will be verified at minimum OA, maximum OA, automatic control, and other modes, if necessary, to achieve BOD conformance.
      b. Variable Air Volume terminals with and without reheats will be tested at minimum and maximum temperature set points, and under automatic control. Intermediate settings will be tested as necessary.
      c. Chilled water system will be tested in designed operating modes. Proper operation will be verified at minimum loads, maximum loads, waterside economizing mode, Manual control, automatic control, and other modes.
      d. Hot water system will be tested.
      e. EF's will be tested for conformance to BoD.
      f. Hydronic pumps will be tested under relevant operating conditions.
      g. Heat Exchangers will be tested under relevant operating conditions.
      h. DDC control systems will be tested as necessary.
      i. HVAC systems will be tested to assure that the building as an integrated system operates properly.
      j. Trend verification of systems and subsystems shall be completed prior to start of functional performance testing. CA will provide trend format to CC and discuss trend requirements in CX meetings throughout the construction phase of project.
   4. Deferred Testing
      a. If tests cannot be completed because of a deficiency outside the scope of the responsible contractor, the deficiencies shall be documented and reported to the

Owner. Deficiencies shall be resolved and corrected by the appropriate parties and test rescheduled.

b. Off-season mode testing will be implemented as necessary to assure conformance with the BoD. Installing contractors will be expected to participate as required by the project specifications.

5. Rescheduled Functional Performance Test
   a. During Functional Performance Testing period, it is assumed that the contractors will be complete with all checklists when the commissioning agents travel to site. If the work is not ready for commissioning when the commissioning personnel are on site, their time will be billed to the contractor as an additional fee of $1500.00 per day.
   b. If the contractor has deficiencies that cannot be corrected at the time of the test, that part of the sequence will be retested at a later date. If the deficiency does not pass during the retest, the contractor will be billed at a rate of $1500.00 per day for the commissioning personnel's return trip.

J. Building Turn-Over / Owner Orientation / User Training
   1. The CA will oversee contractors prepare, coordinate and review O&M manuals, working closely with each contractor to achieve specificity and completeness.
   2. The CA will review as-built drawings, working closely with each contractor to achieve specificity and completeness.
   3. Owner training will be coordinated with the assistance of the CA. The training will be provided by the installing contractor, or manufacturer's representative, and witnessed by the CA. This training should include both classroom training and hands-on operational training. The owner may choose to videotape this training for future use. The CA will visit the site during the Turn-Over and Training period to assure that any on-going HVAC related problems are being addressed and corrected in a timely and efficient manner.
   4. The CA will assist in the coordination of off-season testing, calibrating, and servicing as specified in the contract documents.

3.04 RESPONSIBILITIES OF TEAM MEMBERS

A. General Contractor (GC)
   1. Include commissioning requirements in the mechanical, electrical, and controls contracts, as well as other subcontracts, to assure full cooperation of all parties in the Plumbing commissioning process.
   2. Assure acceptable representation, with the means and authority to prepare and coordinate execution of the mechanical commissioning program as described in the contract documents.
   3. Assure that the CA shall receive a copy of all construction documents, addenda, change orders and appropriate approved submittals and shop drawings for review and use in development of the commissioning plan.
   4. Coordinate inclusion of commissioning activities in the construction schedule.
   5. Facilitate resolution of deficiencies identified by observation or performance testing.
   6. Assist the CA in monitoring the duct leakage testing.

B. GC's Mechanical Contractor (MC)
   1. Each contractor in this division shall include in their quote the cost of participating in the commissioning process.
   2. Include requirements for submittal data (including partial load data), O&M data, and training in each purchase order or sub-contract.
   3. Assure cooperation and participation of specialty sub-contractors such as sheet metal, piping, refrigeration, water treatment, temperature controls, and TAB in commissioning activities.
   4. Assure participation of major equipment manufacturers in appropriate startup, training, and testing activities.

5. Attend commissioning meetings scheduled by the CA.
6. Assist the CA in system verification and performance testing.
7. Prepare preliminary schedule for HVAC system inspections, O & M manual submission, training sessions, pipe and duct system testing, flushing and cleaning, equipment start-up, system verification, performance testing, and system completion for use by the CA. Update schedule as appropriate throughout the construction period.
8. Complete System Verification Checklists and manufacturer's pre-start checklists prior to scheduling startup of HVAC equipment.
9. Monitor and respond to Resolution Tracking Forms distributed by the CA in order to expedite corrective actions necessary to achieve design intent.
10. Notify the CA a minimum of two weeks in advance of scheduled system start-up.
11. Update drawings to as-built condition and review with the CA throughout the construction process.
12. Schedule vendor and subcontractor provided training sessions as required by project specifications.
13. Provide written notification that the following work has been completed in accordance with the project specifications, and that the equipment, systems and sub-systems are operating in accordance with design intent.
    a. HVAC equipment including fans, air handling units, dehumidification units, ductwork, dampers, terminal devices, etc.
    b. Fire detection and smoke detection devices furnished under other divisions as they affect the operation of the HVAC systems.
    c. That BAS is functioning in accordance with design intent.
14. Participate in the Functional Performance Tests.
15. Participate in the off-season mode testing.
16. Participate in O&M Training as required by project specifications.
17. Provide a complete set of as-built drawings and O & M manuals for review. The CA shall review the as-built drawings and O&M manuals concurrently with the design team.

C. Test and Balance Contractor (TABC)
1. Include cost for commissioning requirements (participation) in the contract price.
2. Attend commissioning meetings scheduled by the CA.
3. Submit the TAB procedures and preliminary TAB report to the CA for review at least two weeks prior to beginning TAB work.
4. Notify the CA a minimum of two weeks in advance of scheduled TAB work.
5. Provide partial, preliminary TAB Reports by phase, by building section, by system, or as required by the CA.
6. Assist the CA in system verification and performance testing.
7. Monitor and respond to Resolution Tracking Forms distributed by the CA in order to expedite corrective actions necessary to achieve design intent.
8. Participate in verification of the TAB report, which will consist of repeating any selected measurement contained in the TAB report where required by the CA for verification or diagnostic purposes.
9. Participate in the Functional Performance Tests as required to achieve design intent.
10. Provide sound and vibration where required to assist in diagnosis of areas exhibiting unacceptable levels of noise or vibration.
11. Participate in the off-season mode testing as required to achieve design intent.
12. Participate in O&M Training as required by project specifications.

D. GC's Temperature Control Contractor (TCC)
1. Include cost for commissioning requirements in the contract price.
2. Review control sequence and component selection for conformance with design intent.

   a. Attend a submittal review meeting with the CA and Engineer to ensure clear understanding of scope of work and expectations.
   b. Verify that specified safeties and interlocks have been selected.
   c. Verify proper selection of control valves and actuators based on design parameters.
   d. Verify proper selection of control dampers and actuators based on design parameters.
   e. Verify that sensor selection conforms to design intent.
3. Attend commissioning meetings scheduled by the CA.
4. Provide the following submittals to the CA:
   a. Hardware and software submittals.
   b. Control panel construction shop drawings.
   c. Narrative description of control sequences for each HVAC system and subsystem.
   d. Schematics showing all control points, sensor locations, point names, actuators, controllers and where necessary, points of access.
   e. A list of all control points, including analog inputs, analog outputs, digital inputs and digital outputs. Include the values of all parameters for each system point. Provide a separate list for each stand-alone control unit.
   f. A complete listing of all software routines employed in operating the control system. Also provide a program narrative that describes the logic flow of the software and the functions of each routine and sub-routine. The narrative should also explain individual math or logic operations that are not clear from reading the software listing.
   g. Hardware operation and maintenance manuals.
   h. Application software and project applications code manuals.
   i. Panel and equipment insert documents.
   j. Assist CA with remote monitoring capabilities. Supply any software and/or hardware needed.
5. Verify that specified interfaces provided by others are compatible with BAS hardware and software.
6. Coordinate installation and programming of BAS with construction and commissioning schedules.
7. Complete System Verification Checklists and manufacturer's pre-start checklists prior to scheduling startup of HVAC equipment.
8. Provide control system technician to assist during equipment startup.
9. Monitor and respond to Resolution Tracking Forms distributed by the CA in order to expedite corrective actions necessary to achieve design intent.
10. Participate in the Functional Performance Tests as required by the project specifications.
11. Provide a control system technician to assist during verification and performance testing.
12. Provide system modifications to achieve system operation as defined by the design intent.
13. Provide support and coordination for TAB contractor. Provide all devices, such as portable operator terminals and all software for the TAB to use in completing TAB procedures.
14. Provide written notification that the TCC scope of work has been completed in accordance with the project specifications, and that the equipment, systems and sub-systems are operating in accordance with design intent, and that BAS is functioning in accordance with design intent.
15. Participate in the Functional Performance Tests as required to achieve design intent.
16. Participate in the off-season mode testing as required to achieve design intent.
17. Participate in O&M Training as required by project specifications. Include training on hardware operations and programming

END OF SECTION

SECTION 23 0900
INSTRUMENTATION AND CONTROL FOR HVAC

PART 1 GENERAL

1.01 SYSTEM PERFORMANCE

A. Comply with the following performance requirements:
   1. Graphic Display: Display graphic with minimum 20 dynamic points with current data within 10 seconds.
   2. Graphic Refresh: Update graphic with minimum 20 dynamic points with current data within 8 seconds.
   3. Object Command: Reaction time of less than two seconds between operator command of a binary object and device reaction.
   4. Object Scan: Transmit change of state and change of analog values to control units or workstation within six seconds.
   5. Alarm Response Time: Annunciate alarm at workstation within 45 seconds. Multiple workstations must receive alarms within five seconds of each other.
   6. Program Execution Frequency: Run capability of applications as often as five seconds, but selected consistent with mechanical process under control.
   7. Performance: Programmable controllers shall execute DDC PID control loops, and scan and update process values and outputs at least once per second.
   8. Reporting Accuracy and Stability of Control: Report values and maintain measured variables within tolerances as follows:
      a. Water Temperature: Plus or minus 1 deg F.
      b. Water Flow: Plus or minus 5 percent of full scale.
      c. Water Pressure: Plus or minus 2 percent of full scale.
      d. Space Temperature: Plus or minus 1 deg F.
      e. Ducted Air Temperature: Plus or minus 1 deg F.
      f. Outside Air Temperature: Plus or minus 2 deg F.
      g. Dew Point Temperature: Plus or minus 3 deg F.
      h. Temperature Differential: Plus or minus 0.25 deg F.
      i. Relative Humidity: Plus or minus 5 percent.
      j. Airflow (Pressurized Spaces): Plus or minus 3 percent of full scale.
      k. Airflow (Measuring Stations): Plus or minus 5 percent of full scale.
      l. Airflow (Terminal): Plus or minus 10 percent of full scale.
      m. Air Pressure (Space): Plus or minus 0.01-inch wg.
      n. Air Pressure (Ducts): Plus or minus 0.1-inch wg.
      o. Carbon Monoxide: Plus or minus 5 percent of reading.
      p. Carbon Dioxide: Plus or minus 50 ppm.
      q. Electrical: Plus or minus 5 percent of reading.

1.02 SUBMITTALS

A. Product Data: Include manufacturer's technical literature for each control device. Indicate dimensions, capacities, performance characteristics, electrical characteristics, finishes for materials, and installation and startup instructions for each type of product indicated.
   1. DDC System Hardware: Bill of materials of equipment indicating quantity, manufacturer, and model number. Include technical data for operator workstation equipment, interface equipment, control units, transducers/transmitters, sensors, actuators, valves, relays/switches, control panels, and operator interface equipment.
   2. Control System Software: Include technical data for operating system software, operator interface, color graphics, and other third-party applications.

3. Controlled Systems: Instrumentation list with element name, type of device, manufacturer, model number, and product data. Include written description of sequence of operation including schematic diagram.

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. Bill of materials of equipment indicating quantity, manufacturer, and model number.
   2. Schematic flow diagrams showing fans, pumps, coils, dampers, valves, and control devices.
   3. Wiring Diagrams: Power, signal, and control wiring.
   4. Details of control panel faces, including controls, instruments, and labeling.
   5. Schedule of dampers including size, leakage, and flow characteristics.
   6. Schedule of valves including flow characteristics.
   7. DDC System Hardware:
      a. Wiring diagrams for control units with termination numbers.
      b. Schematic diagrams for field sensors and control hardware.
      c. Schematic diagrams for control, communication, and power wiring, showing trunk data conductors and wiring between operator workstation and control unit locations.
   8. Control System Software: List of color graphics indicating monitored systems, data (connected and calculated) point addresses, output schedule, and operator notations.
   9. Controlled Systems:
      a. Schematic diagrams of each controlled system with control points labeled and control elements graphically shown, with wiring.
      b. Scaled drawings showing mounting, routing, and wiring of elements including bases and special construction.
      c. Written description of sequence of operation including schematic diagram.
      d. Points list.

C. Data Communications Protocol Certificates: Certify that each proposed DDC system component complies with ASHRAE 135.

D. Software and Firmware Operational Documentation: Include the following:
   1. Software operating and upgrade manuals.
   2. Program Software Backup: On a magnetic media or compact disc, complete with data files.
   3. Device address list.
   4. Printout of software application and graphic screens.
   5. Software license required by and installed for DDC workstations and control systems.

E. Software Upgrade Kit: For Owner to use in modifying software to suit future systems revisions or monitoring and control revisions.

F. Operation and Maintenance Data: For HVAC instrumentation and control system to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
   1. Maintenance instructions and lists of spare parts for each type of control device and compressed-air station.
   2. Interconnection wiring diagrams with identified and numbered system components and devices.
   3. Keyboard illustrations and step-by-step procedures indexed for each operator function.
   4. Inspection period, cleaning methods, cleaning materials recommended, and calibration tolerances.
   5. Calibration records and list of set points.

1.03 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 ASHRAE 135 for DDC system components.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Factory-Mounted Components: Where control devices specified in this Section are indicated to be factory mounted on equipment, arrange for shipping of control devices to equipment manufacturer.

B. System Software: Update to latest version of software at Project completion.

1.05 COORDINATION

A. Coordinate location of thermostats, humidistats, and other exposed control sensors with plans and room details before installation.

B. Coordinate supply of conditioned electrical branch circuits for control units and operator workstation.

C. Coordinate equipment with Division 26 Section "Electrical Power Monitoring and Control" to achieve compatibility of communication interfaces.

D. Coordinate equipment with Division 26 Section "Panelboards" to achieve compatibility with starter coils and annunciation devices.

E. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03 Section "Cast-in-Place Concrete."

PART 2 PRODUCTS

2.01 CONTROL SYSTEM

A. Available Manufacturers:
   1. Reliable Controls as installed by Unified Energy Solutions
   2. Automated Logic Corporation as installed by local factory ALC Branch

B. Control system shall consist of sensors, indicators, actuators, final control elements, interface equipment, other apparatus, accessories, and software connected to distributed controllers operating in multiuser, multitasking environment on token-passing network and programmed to control mechanical systems. An operator workstation permits interface with the network through a standard web broswer via dynamic color graphics with each mechanical system, building floor plan, and control device depicted by point-and-click graphics.

2.02 DDC EQUIPMENT

A. Control Units: Modular, comprising processor board with programmable, nonvolatile, random-access memory; local operator access and display panel; integral interface equipment; and backup power source.
   1. Units monitor or control each I/O point; process information; execute commands from other control units, devices, and operator stations; and download from or upload to operator workstation or diagnostic terminal unit.
   2. Stand-alone mode control functions operate regardless of network status. Functions include the following:
      a. Global communications.
      b. Discrete/digital, analog, and pulse I/O.
      c. Monitoring, controlling, or addressing data points.
      d. Software applications, scheduling, and alarm processing.

e. Testing and developing control algorithms without disrupting field hardware and controlled environment.

3. Standard Application Programs:
   a. Electric Control Programs: Demand limiting, duty cycling, automatic time scheduling, start/stop time optimization, night setback/setup, on-off control with differential sequencing, staggered start, antishort cycling, PID control, DDC with fine tuning, and trend logging.
   b. HVAC Control Programs: Optimal run time, supply-air reset, and enthalpy switchover.
   c. Chiller Control Programs: Control function of condenser-water reset, chilled-water reset, and equipment sequencing.
   d. Programming Application Features: Include trend point; alarm processing and messaging; weekly, monthly, and annual scheduling; energy calculations; run-time totalization; and security access.
   e. Remote communications.
   f. Maintenance management.
   g. Units of Measure: Inch-pound and SI (metric).
4. Local operator interface provides for download from or upload to operator workstation or diagnostic terminal unit.
5. ASHRAE 135 Compliance: Control units shall use ASHRAE 135 protocol and communicate using ISO 8802-3 (Ethernet) datalink/physical layer protocol.

B. Diagnostic Terminal Unit: The control contractor to include $1,000 allowance in the bid for purchase of the diagnostic terminal unit.

C. Local Control Units: Modular, comprising processor board with electronically programmable, nonvolatile, read-only memory; and backup power source.
1. Units monitor or control each I/O point, process information, and download from or upload to operator workstation or diagnostic terminal unit.
2. Stand-alone mode control functions operate regardless of network status. Functions include the following:
   a. Global communications.
   b. Discrete/digital, analog, and pulse I/O.
   c. Monitoring, controlling, or addressing data points.
3. Local operator interface provides for download from or upload to operator workstation or diagnostic terminal unit.
4. ASHRAE 135 Compliance: Control units shall use ASHRAE 135 protocol and communicate using ISO 8802-3 (Ethernet) datalink/physical layer protocol.

D. I/O Interface: Hardwired inputs and outputs may tie into system through controllers. Protect points so that shorting will cause no damage to controllers.
1. Binary Inputs: Allow monitoring of on-off signals without external power.
2. Pulse Accumulation Inputs: Accept up to 10 pulses per second.
3. Analog Inputs: Allow monitoring of low-voltage (0- to 10-V dc), current (4 to 20 mA), or resistance signals.
4. Binary Outputs: Provide on-off or pulsed low-voltage signal, selectable for normally open or normally closed operation Not standard
5. Analog Outputs: Provide modulating signal, either low voltage (0- to 10-V dc) or current (4 to 20 mAnot standard
6. Tri-State Outputs: Provide two coordinated binary outputs for control of three-point, floating-type electronic actuators.
7. Universal I/Os: Provide software selectable binary or analog outputs.

E. Power Supplies: Transformers with Class 2 current-limiting type or overcurrent protection; limit connected loads to 80 percent of rated capacity. DC power supply shall match output current and voltage requirements and be full-wave rectifier type with the following:
   1. Output ripple of 5.0 mV maximum peak to peak.
   2. Combined 1 percent line and load regulation with 100-mic.sec. response time for 50 percent load changes.
   3. Built-in overvoltage and overcurrent protection and be able to withstand 150 percent overload for at least 3 seconds without failure.

F. Power Line Filtering: Internal or external transient voltage and surge suppression for workstations or controllers with the following:
   1. Minimum dielectric strength of 1000 V.
   2. Maximum response time of 10 nanoseconds.
   3. Minimum transverse-mode noise attenuation of 65 dB.
   4. Minimum common-mode noise attenuation of 150 dB at 40 to 100 Hz.

2.03 UNITARY CONTROLLERS

A. Unitized, capable of stand-alone operation with sufficient memory to support its operating system, database, and programming requirements, and with sufficient I/O capacity for the application.
   1. Configuration: Diagnostic LEDs for power, communication, and processor; wiring termination to terminal strip or card connected with ribbon cable; memory with bios; and 4-hour battery backup.
   2. Operating System: Manage I/O communication to allow distributed controllers to share real and virtual object information and allow central monitoring and alarms. Perform scheduling with real-time clock. Perform automatic system diagnostics; monitor system and report failures.
   3. ASHRAE 135 Compliance: Communicate using read (execute and initiate) and write (execute and initiate) property services defined in ASHRAE 135. Reside on network using MS/TP datalink/physical layer protocol and have service communication port for connection to diagnostic terminal unit.
   4. Enclosure: Dustproof rated for operation at 32 to 120 deg F.
   5. Enclosure: Waterproof rated for operation at 40 to 150 deg F.

2.04 ANALOG CONTROLLERS

A. Step Controllers: 6- or 10-stage type, with heavy-duty switching rated to handle loads and operated by electric motor.

B. Electric, Outdoor-Reset Controllers: Remote-bulb or bimetal rod-and-tube type, proportioning action with adjustable throttling range, adjustable set point, scale range minus 10 to plus 70 deg F, and single- or double-pole contacts.

C. Electronic Controllers: Wheatstone-bridge-amplifier type, in steel enclosure with provision for remote-resistance readjustment. Identify adjustments on controllers, including proportional band and authority.

D. Receiver Controllers: Single- or multiple-input models with control-point adjustment, direct or reverse acting with mechanical set-point adjustment with locking device, proportional band adjustment, authority adjustment, and proportional control mode.
   1. Remote-control-point adjustment shall be plus or minus 20 percent of sensor span, input signal of 3 to 13 psig.
   2. Proportional band shall extend from 2 to 20 percent for 5 psig.
   3. Authority shall be 20 to 200 percent.
   4. Gages: 2-1/2 inches in diameter, 2.5 percent wide-scale accuracy, and range to match transmitter input or output pressure.

2.05 ELECTRONIC SENSORS

A. Description: Vibration and corrosion resistant; for wall, immersion, or duct mounting as required.

B. Space Temperature Sensor (Thermostat):
   1. Thermistor with resistance of 10,000 ohms at 77□F.
   2. Accuracy shall be +/-1/2□F.
   3. Range of 55□ to 95□ F.
   4. Provide manufacturers calibration certificate.
   5. Front covers without displays throughout the building.
   6. Temperature Indicator:
      a. Offices: Numeric LED
      b. Classrooms: None
      c. Public Areas: None
   7. Setpoint Adjustment:
      a. Offices: Push Button
      b. Classrooms: None
      c. Public Areas: None
   8. Occupant Override:
      a. Offices: Push Button
      b. Classrooms: None
      c. Public Areas: None
   9. Ventilation ring for fast response
   10. Jack at sensor for communications
   11. Location and height to be approved by Engineer prior to installation
   12. Color to be approved by Engineer/Owner. Submit a sample to reviewed by owner. Acceptance of sample shall be in writing to contractor.
   13. Provide ventilated locking clear plastic guards in the following locations:
      a. Cafeteria
      b. Kitchen/Serving Lines
      c. Gymnasium
      d. Dressing/Locker Rooms/Weight Rooms
      e. Industrial Labs
   14. Provide an insulated sensor wall plate to fully cover wall opening. Back cover plate shall match sensor color.
   15. Where indicated on drawings to provide both space temperature and space humidity, a combination temperature sensor shall be provided.

C. Thermistor Temperature Sensors and Transmitters:
   1. Accuracy: Plus or minus 0.5 deg F at calibration point.
   2. Wire: Twisted, shielded-pair cable.
   3. Insertion Elements in Ducts: Single point, 8 inches long; use where not affected by temperature stratification or where ducts are smaller than 9 sq. ft.
   4. Averaging Elements in Ducts: 36 inches long, flexible; use where prone to temperature stratification or where ducts are larger than 10 sq. ft.
   5. Averaging Elements at coils: Flexible type serpentine across the entire face of the coil, (minimum of 2-passes).
   6. Freeze Stats: Flexible type serpentine across the entire face of the coil every six inches on center.
   7. Insertion Elements for Liquids: Brass or stainless-steel socket with minimum insertion length of 2-1/2 inches.

D. Outside Air Temperature and Humidity Sensor:
   1. Temperature
      a. Range of –40□ to 140□F.
      b. Accuracy shall be +/-0.9□F
      c. Encapsulated into Type 304 stainless steel tubes with low conductivity moisture proofing material and lag extension for thickness of insulation.
   2. Humidity
      a. Capacitance element in the space or duct as required and output a 4 to 20 MA signal proportional to 0 to 100% RH to the DDC.
      b. Accuracy shall be +/-2%
      c. Range from 20 to 95% RH.
      d. Relative humidity sensors shall have the sensing element of inorganic resistance media.
   3. Weatherproof sun shield consisting of multiple white plastic plates to reduce the thermal effects of the sum and increasing air flow between the plates.
   4. Sensor shall be mounted a minimum of 6” from all building structures.
   5. Minimum of 8' long leads.
   6. Provide manufacturers calibration certificate.
   7. Provide with a 5-year warranty

E. Humidity Sensors: Bulk polymer sensor element.
   1. Accuracy: 2 percent full range with linear output.
   2. Room Sensor Range: 20 to 80 percent relative humidity.
   3. Duct Sensor: 20 to 80 percent relative humidity range with element guard and mounting plate.
   4. Outside-Air Sensor: 20 to 80 percent relative humidity range with mounting enclosure, suitable for operation at outdoor temperatures of 32 to 120 deg F
   5. Duct and Sensors: With element guard and mounting plate, range of 0 to 100 percent relative humidity.

F. Electric, Low-Limit Duct Thermostat: Snap-acting, single-pole, single-throw, manual- reset switch that trips if temperature sensed across any 12 inches of bulb length is equal to or below set point.
   1. Bulb Length: Minimum 20 feet.
   2. Quantity: One thermostat for every 20 sq. ft. of coil surface.

G. Electric, High-Limit Duct Thermostat: Snap-acting, single-pole, single-throw, manual- reset switch that trips if temperature sensed across any 12 inches of bulb length is equal to or above set point.
   1. Bulb Length: Minimum 20 feet.
   2. Quantity: One thermostat for every 20 sq. ft. of coil surface.

H. Pressure Transmitters/Transducers:
   1. Static-Pressure Transmitter: Nondirectional sensor with suitable range for expected input, and temperature compensated.
      a. Accuracy: 2 percent of full scale with repeatability of 0.5 percent.
      b. Output: 4 to 20 mA.
      c. Building Static-Pressure Range: 0- to 0.25-inch wg.
      d. Duct Static-Pressure Range: 0- to 5-inch wg.
   2. Water Pressure Transducers: Stainless-steel diaphragm construction, suitable for service; minimum 150-psig operating pressure; linear output 4 to 20 mA.
   3. Water Differential-Pressure Transducers: Stainless-steel diaphragm construction, suitable for service; minimum 150-psig operating pressure and tested to 300-psig; linear output 4 to 20 mA.

4. Differential-Pressure Switch (Air or Water): Snap acting, with pilot-duty rating and with suitable scale range and differential.
5. Pressure Transmitters: Direct acting for gas, liquid, or steam service; range suitable for system; linear output 4 to 20 mA.

2.06 STATUS SENSORS

A. Status Inputs for Fans: Current Switches. See below for requirements. Provide a current switch on each fan motors with a multiple fan AHU.

B. Status Inputs for Pumps: Differential-pressure switch with pilot-duty rating and with adjustable pressure-differential range of 8 to 60 psig, piped across pump.

C. Status Inputs for Electric Motors: Comply with ISA 50.00.01, current-sensing fixed- or split-core transformers with self-powered transmitter, adjustable and suitable for 175 percent of rated motor current.

D. Voltage Transmitter (100- to 600-V ac): Comply with ISA 50.00.01, single-loop, self-powered transmitter, adjustable, with suitable range and 1 percent full-scale accuracy.

E. Power Monitor: 3-phase type with disconnect/shorting switch assembly, listed voltage and current transformers, with pulse kilowatt hour output and 4- to 20-mA kW output, with maximum 2 percent error at 1.0 power factor and 2.5 percent error at 0.5 power factor.

F. Current Switches:
1. Ensure compatibility with VFD applications for variable speed motor status.
2. Provide with adjustable set point.
3. Relays must be mounted and not hung by power wires thru CT.
4. Provide split-core type.
5. Loop powered.
6. LED Status.
7. Relays shall close status contacts in response to current flow in power leads to the equipment being monitored.

G. Current Transducers:
1. Ensure compatibility with VFD and ECM applications for variable speed motor status and current.
2. Provide with adjustable set point capable of reading lowest required amperage.
3. The current sensor shall be a split core type with self-gripping iris that adheres to the electrical conductor.
4. Provide split-core type.
5. Loop powered.
6. The current sensor shall be fixed 0-10A and output of 0-10 VDC.
7. LED Status.
8. Transducer shall provide a current reading to BMCS.

H. Electronic Valve/Damper Position Indicator: Visual scale indicating percent of travel and 2- to 10-V dc, feedback signal.

I. Water-Flow Switches: Bellows-actuated mercury or snap-acting type with pilot-duty rating, stainless-steel or bronze paddle, with appropriate range and differential adjustment, in NEMA 250, Type 1 enclosure.

2.07 FLOW MEASURING STATIONS

A. Electromagnetic Flow Meters:
1. Retractable hot tap flow sensor
2. Accuracy: +/- 1% of full scale
3. Custom thread-o-let 400 psi / 250°F rated
4. Installed into a 1” full port ball valve

5. Provided with an insertion depth gage
6. Line size from 2-1/2 to 72 inches
7. Metering range from 0.1 to 20 f/sec (200:1 turndown).
8. Remote NEMA 4 wall mounted LCD display. Mounted on wall at 5'-6" above finished floor.
9. Field Pro Software & Communicator
10. Warranty two years
11. Approved Manufacturer: Onicon Electromagnetic Flow Meter F-3500 Series

B. Cooling Tower Pulse Water Meters:
   1. General:
      a. Multi-jet principle.
      b. A gear train drives the register totalizer dials.
      c. Changing the pulse rate requires no special tools and can be done in the field.
      d. Solid-state, hall-effect sensor.
   2. Power: 6mA at 12 VdcTemperature: 105F Max.Pressure: 150 psiMaterials:Body: Cast Bronze, Epoxy powder coated inside and out.Internals: Engineered thermoplasticMagnet: AlnicoAccuary +/- 1.5% of readingPulse output:Max Current: 20 mAMax Voltage: 24 Vdc or VacFlow Rates:Make-up water meter: 132 gpm (2" meter)Chemical treatment blowdown: 52 gpm (1" meter)
   3. Temperature: 105F Max.
   4. Pressure: 150 psi
   5. Materials:
      a. Body: Cast Bronze, Epoxy powder coated inside and out.
      b. Internals: Engineered thermoplastic
      c. Magnet: Alnico
   6. Accuary +/- 1.5% of reading
   7. Pulse output:
      a. Max Current: 20 mA
      b. Max Voltage: 24 Vdc or Vac
   8. Flow Rates:
      a. Make-up water meter: XXX gpm
      b. Chemical treatment blowdown: XX gpm

C. Duct Airflow Station: Shall be traverse probe(s) type capable of continuously monitoring the fan or duct capacities served. Probe(s) shall contain multiply total and static pressure sensors located along the exterior surface of the cylindrical probe and internally connected to the respective averaging manifolds. Flow sensors shall not protrude beyond surface of probe(s), and shall be the offset (Fechheimer) type for static pressure and the chamfer impact type for total pressure measurement. The airflow sensing probe's measurement accuracy shall not be affected by the direcitional flow having pitch and/or yaw angles up to 30deg. Each airflow traverse probe shall be of extruded aluminum construction and furnished with mounting plate(s), gasket, and signal fittings suitable for HVAC duct installation. Probes shall be AMCA certified and be capable of measuring the airflow rates within an accuracy of +/- 2% without the use of correction factors. The maximum allowable unrecovered pressure drop caused by the probes shall not exceed 0.025" w.c. at 2000 FPM, or 0.085" w.c. at 4000 FPM.

2.08 ACTUATORS

A. Electric Motors: Size to operate with sufficient reserve power to provide smooth modulating action or two-position action.
   1. Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."

2. Permanent Split-Capacitor or Shaded-Pole Type: Gear trains completely oil immersed and sealed. Equip spring-return motors with integral spiral-spring mechanism in housings designed for easy removal for service or adjustment of limit switches, auxiliary switches, or feedback potentiometer.
3. Nonspring-Return Motors for Valves Larger Than NPS 2-1/2: Size for running torque of 150 in. x lbf and breakaway torque of 300 in. x lbf.
4. Spring-Return Motors for Valves Larger Than NPS 2-1/2: Size for running and breakaway torque of 150 in. x lbf.
5. Nonspring-Return Motors for Dampers Larger Than 25 Sq. Ft.: Size for running torque of 150 in. x lbf and breakaway torque of 300 in. x lbf.
6. Spring-Return Motors for Dampers Larger Than 25 Sq. Ft.: Size for running and breakaway torque of 150 in. x lbf.

B. Electronic Actuators: Direct-coupled type designed for minimum 60,000 full-stroke cycles at rated torque.
1. Valves: Size for torque required for valve close off at maximum pump differential pressure.
2. Dampers: Size for running torque calculated as follows:
a. Parallel-Blade Damper with Edge Seals: 7 inch-lb/sq. ft. of damper.
b. Opposed-Blade Damper with Edge Seals: 5 inch-lb/sq. ft. of damper.
c. Parallel-Blade Damper without Edge Seals: 4 inch-lb/sq. ft of damper.
d. Opposed-Blade Damper without Edge Seals: 3 inch-lb/sq. ft. of damper.
e. Dampers with 2- to 3-Inch wg of Pressure Drop or Face Velocities of 1000 to 2500 fpm: Increase running torque by 1.5.
f. Dampers with 3- to 4-Inch wg of Pressure Drop or Face Velocities of 2500 to 3000 fpm: Increase running torque by 2.0.
3. Coupling: V-bolt and V-shaped, toothed cradle.
4. Overload Protection: Electronic overload or digital rotation-sensing circuitry.
5. Fail-Safe Operation: Mechanical, spring-return mechanism. Provide external, manual gear release on nonspring-return actuators.
6. Power Requirements (Two-Position Spring Return): -V ac.
7. Power Requirements (Modulating): Maximum 10 VA at 24-V ac or 8 W at 24-V dc.
8. Proportional Signal: 2- to 10-V dc or 4 to 20 mA, and 2- to 10-V dc position feedback signal.
9. Temperature Rating: Minus 22 to plus 122 deg F .
10. Temperature Rating (Smoke Dampers): Minus 22 to plus 250 deg F.
11. Run Time: 12 seconds open, 5 seconds closed.

2.09 CONTROL VALVES

A. Ball Valves with Characterized Disk and Threaded Ends.
1. Source Limitations: Obtain two-way ball valves, with characterized disk and threaded ends, from single manufacturer.
2. Performance:
a. Stem Action: Rotary, 0 to 90 degrees.
b. Controllable Flow Range: 75 percent open.
c. Flow Characteristic: Equal percentage.
d. Leakage: Zero percent.
e. Hydronic Pressure:
1) Rating: Nominal 400 psig.
2) Close-off Pressure: 200 psig.
3) Pressure Differential (Maximum): 50 psig.
3. Construction:

a. Size Range: NPS 1/2 to NPS 2.
b. Body: Cast bronze or forged brass with nickel plating.
c. End Connections: Female threaded (NPT) ends.
d. Ball: 300 series stainless steel.
e. Ball Seats: Reinforced PTFE.
f. Characterizing Disk: Stainless steel.
g. Stem and Stem Extension:
    1) Material to match ball.
    2) Blowout-proof design.
    3) For valves installed in insulated piping systems, provide stem extension.
    4) Provide sleeve or other approved means to allow valve to be opened and closed without damaging the insulation and the insulation vapor barrier seal.
h. Stem Seal: Reinforced PTFE packing ring with a threaded packing ring follower to retain the packing ring under design pressure with the linkage removed. Alternative means, such as EPDM O-rings, are acceptable if an equivalent cycle endurance can be demonstrated by testing.

B. Ball Valves with Characterized Disk and Flanged Ends, Two Way:
1. Source Limitations: Obtain two-way ball valves, with characterized disk and flanged ends, from single manufacturer.
2. Performance:
    a. Stem Action: Rotary, 0 to 90 degrees.
    b. Controllable Flow Range: 75 percent open.
    c. Flow Characteristic: Equal percentage.
    d. Leakage: Zero percent.
    e. Hydronic Pressure:
        1) Rating: In accordance with ASME B16.1, Class B.
        2) Close-off Pressure:
            (a) Class 125: 175 psig.
        3) Pressure Differential (Maximum): 50 psig.
3. Construction:
    a. Size Range: NPS 2-1/2 to NPS 6.
    b. Body: Cast iron, Class B in accordance with ASME B16.1.
    c. End Connections: Flanged, Class 125 or 250 in accordance with ASME B16.1.
    d. Ball: Stainless steel.
    e. Ball Seats: Reinforced PTFE.
    f. Characterizing Disk: Stainless steel.
    g. Stem and Stem Extension: Material to match ball; blowout-proof design.
    h. Stem Seal: Reinforced PTFE packing ring with a threaded packing ring follower to retain the packing ring under design pressure with the linkage removed. Alternative means, such as EPDM O-rings, are acceptable if an equivalent cycle endurance can be demonstrated by testing.

C. Ball Valves with Characterized Disk and Threaded Ends, Three Way:
1. Source Limitations: Obtain three-way ball valves, with characterized disk and threaded ends, from single manufacturer.
2. Performance:
    a. Stem Action: Rotary, 0 to 90 degrees.
    b. Controllable Flow Range: 75 percent open.
    c. Flow Characteristics:
        1) A-Port: Equal percentage.
        2) B-Port: Modified for constant common port flow.

d. Leakage: Zero percent for A-port; two percent for B-port.
e. Hydronic Pressure:
1) Rating: Nominal 400 psig.
2) Close-off Pressure: 200 psig.
3) Pressure Differential (Maximum): 50 psig.

3. Construction:
a. Size Range: NPS 1/2 to NPS 2.
b. Body: Cast bronze or forged brass with nickel plating.
c. End Connections: Female threaded (NPT) ends.
d. Ball: 300 series stainless steel.
e. Ball Seats: Reinforced PTFE.
f. Characterizing Disk: Stainless steel.
g. Stem and Stem Extension:
1) Material to match ball.
2) Blowout-proof design.
3) For valves installed in insulated piping systems, provide stem extension.
4) Provide sleeve or other approved means to allow valve to be opened and closed without damaging the insulation and the insulation vapor barrier seal.
h. Stem Seal: Reinforced PTFE packing ring with a threaded packing ring follower to retain the packing ring under design pressure with the linkage removed. Alternative means, such as EPDM O-rings, are acceptable if an equivalent cycle endurance can be demonstrated by testing.

D. Vave Sizing: By Automatic Control System Manufacturer for fully modulating operation.
1. Minimum pressure drop: Equal to pressure drop of coil or exchanger.
2. Maximum pressure drop: 5 psi.
3. Relief and bypass valves: Sized according to pressure available.
4. 2-position valves: Line size.
5. Manual by-pass operator.

2.10 CONTROL DAMPERS

A. Model: Ruskin CD50 or equal.

B. Rating:
1. Leakage Rating: Class 1A.
2. Temperature Rating: Withstand -22 to 122 degrees F.
3. Capacity: Damper shall withstand system operating conditions
4. Closed Position: Maximum pressure of 13 inches w.g. @ a 12 inches blade length.
5. Open Position: Maximum air velocity of 6,000 feet per minute.
6. Pressure Drop: Maximum 0.03-inch w.g. at 1,500 feet per minute across 24 inch x 24 inch damper.

C. Construction:
1. Frame: 5 inches x 1 inch x minimum 0.125 inch 6063-T5 extruded aluminum hat channel with hat mounting flanges on both sides of the frame, reinforced at corners.
2. Blades:
a. Style: Airfoil-shaped, single-piece.
b. Action: Opposed.
c. Material: Heavy duty 6063-T5 extruded aluminum.
d. Width: Maximum 6 inches.
3. Bearings: Molded synthetic sleeve, turning in hole in frame.
4. Seals:

a. Blade: Extruded Ruskiprene type for ultra-low leakage from -22 to 122 degrees F. Mechanically attached to blade edge.
b. Jamb: Flexible metal compression type.

5. Linkage: Concealed in frame.
6. Axles: Minimum ½ inch diameter plated steel, hex-shaped, mechanically attached to blade.

2.11 CONTROL CABLE

A. Electronic and fiber-optic cables for control wiring are specified in Division 27 Section "Communications Horizontal Cabling."Insert your information from the other spec
   1. Acceptable manufacturers:
      a. Belden
      b. West Penn
      c. Alpha
   2. All unitary-to-unitary zone communication cabling shall be a minimum of 18 AWG. All other sizing of cabling shall be according to manufacturer's recommendation.
   3. Wall space temperature sensor cabling (from the sensor to the unitary controller) shall have a minimum of four (4) conductors.
   4. All cabling shall be stranded, Solid conductors are not allowed.
   5. All cabling shall be 100% shielded with appropriate drain wire and insulation.
      a. Terminate shields per manufacturer's recommendation.
   6. Refer to Division 27 Section "Voice/Data Systems" for additional requirements.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that power supply is available to control units and operator workstation.

3.02 INSTALLATION

A. Install software in control units and operator workstation(s). Implement all features of programs to specified requirements and as appropriate to sequence of operation.

B. Connect and configure equipment and software to achieve sequence of operation specified.

C. Verify location of thermostats, humidistats, and other exposed control sensors with Drawings and room details before installation. Install devices 48 inches above the floor.
   1. Install averaging elements in ducts and plenums in crossing or zigzag pattern.

D. Install guards on thermostats in the following locations: (as noted on plans)
   1. Gyms.
   2. Refer to drawings for additional locations.

E. Install automatic dampers according to Division 23 Section "Air Duct Accessories."

F. Install damper motors on outside of duct in warm areas, not in locations exposed to outdoor temperatures.

G. Install labels and nameplates to identify control components according to Division 23 Section "Identification for HVAC Piping and Equipment."

H. Install hydronic instrument wells, valves, and other accessories according to Division 23 Section "Hydronic Piping."

I. Install refrigerant instrument wells, valves, and other accessories according to Division 23 Section "Refrigerant Piping."

J. Install duct volume-control dampers according to Division 23 Sections specifying air ducts.

K. Install electronic and fiber-optic cables according to Division 27 Section "Communications Horizontal Cabling."

3.03 ELECTRICAL WIRING AND CONNECTION INSTALLATION

A. Install raceways, boxes, and cabinets according to Division 26 Section "Raceway and Boxes for Electrical Systems."

B. Install building wire and cable according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

C. Install electrical wiring and cabling according to Division 26 Section "Conductors Identifications, Splicing Devices and Connectors".
   1. Provide all power wiring for temperature controls system including but not limited to the following.
      a. Power for control panels.
         1) Power for controls for controls must be from circuits in electrical panels, (taking power from receptacles, lighting or equipment circuits is not acceptable).
         2) Label control circuits within electrical panels.
      b. Power for unitary controllers,(including all terminal devices).
         1) Power taken from the equipment it's served is acceptable provided that power is not interrupted to the electronics if the terminal unit is off for any reason.
      c. Interlock wiring including on/off control of chillers, boilers, pumps, fan-coil units, zone controls, cooling towers, etc.
      d. Provide 110 VAC duplex receptacle for all temperature control panels.

D. Install signal and communication cable according to Division 27 Section "Voice/Data Systems."
   1. Conceal cable, except in mechanical rooms and areas where other conduit and piping are exposed.
   2. Install exposed cable in raceway.
   3. Install cable from wall mounted device, (i.e. thermostat, temperature sensor, etc.) to above ceiling in raceway.
      a. If installing new devices on existing masonry walls, conceal cabling in raceways.
         1) In finished areas use surface mounted race similar to wiremold (i.e. office, classroom).
         2) In unfinished areas use conduit, (i.e. mechanical rooms).
   4. Bundle and harness multiconductor instrument cable in place of single cables where several cables follow a common path.
   5. Fasten flexible conductors, bridging cabinets and doors, along hinge side; protect against abrasion. Tie and support conductors.
   6. Number-code or color-code conductors for future identification and service of control system, except local individual room control cables.
   7. Install wire and cable with sufficient slack and flexible connections to allow for vibration of piping and equipment.

E. Connect manual-reset limit controls independent of manual-control switch positions. Automatic duct heater resets may be connected in interlock circuit of power controllers.

F. Connect hand-off-auto selector switches to override automatic interlock controls when switch is in hand position.

3.04 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. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation. Remove and replace malfunctioning units and retest.

2. Test and adjust controls and safeties.
3. Test each point through its full operating range to verify that safety and operating control set points are as required.
4. Test each control loop to verify stable mode of operation and compliance with sequence of operation. Adjust PID actions.
5. Test each system for compliance with sequence of operation.
6. Test software and hardware interlocks.

C. DDC Verification:
1. Verify that instruments are installed before calibration, testing, and loop or leak checks.
2. Check instruments for proper location and accessibility.
3. Check instrument installation for direction of flow, elevation, orientation, insertion depth, and other applicable considerations.
4. Check flow instruments. Inspect tag number and line and bore size, and verify that inlet side is identified and that meters are installed correctly.
5. Check pressure instruments, piping slope, installation of valve manifold, and self-contained pressure regulators.
6. Check temperature instruments and material and length of sensing elements.
7. Check control valves. Verify that they are in correct direction.
8. Check DDC system as follows:
   a. Verify that DDC controller power supply is from emergency power supply, if applicable.
   b. Verify that wires at control panels are tagged with their service designation and approved tagging system.
   c. Verify that spare I/O capacity has been provided.
   d. Verify that DDC controllers are protected from power supply surges.

D. Replace damaged or malfunctioning controls and equipment and repeat testing procedures.

3.05 ADJUSTING

A. Calibrating and Adjusting:
1. Calibrate instruments.
2. Make three-point calibration test for both linearity and accuracy for each analog instrument.
3. Calibrate equipment and procedures using manufacturer's written recommendations and instruction manuals. Use test equipment with accuracy at least double that of instrument being calibrated.
4. Control System Inputs and Outputs:
   a. Check analog inputs at 0, 50, and 100 percent of span.
   b. Check analog outputs using milliampere meter at 0, 50, and 100 percent output.
   c. Check digital inputs using jumper wire.
   d. Check digital outputs using ohmmeter to test for contact making or breaking.
   e. Check resistance temperature inputs at 0, 50, and 100 percent of span using a precision-resistant source.
5. Flow:
   a. Set differential pressure flow transmitters for 0 and 100 percent values with 3-point calibration accomplished at 50, 90, and 100 percent of span.
   b. Manually operate flow switches to verify that they make or break contact.
6. Pressure:
   a. Calibrate pressure transmitters at 0, 50, and 100 percent of span.
   b. Calibrate pressure switches to make or break contacts, with adjustable differential set at minimum.
7. Temperature:

a. Calibrate resistance temperature transmitters at 0, 50, and 100 percent of span using a precision-resistance source.
b. Calibrate temperature switches to make or break contacts.

8. Stroke and adjust control valves and dampers without positioners, following the manufacturer's recommended procedure, so that valve or damper is 100 percent open and closed.
9. Stroke and adjust control valves and dampers with positioners, following manufacturer's recommended procedure, so that valve and damper is 0, 50, and 100 percent closed.
10. Provide diagnostic and test instruments for calibration and adjustment of system.
11. Provide written description of procedures and equipment for calibrating each type of instrument. Submit procedures review and approval before initiating startup procedures.

B. Adjust initial temperature and humidity set points.

C. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to three visits to Project during other than normal occupancy hours for this purpose.

3.06 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain HVAC instrumentation and controls. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION

SECTION 23 0934
VARIABLE-FREQUENCY MOTOR CONTROLLERS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Variable-frequency motor controllers for low-voltage (600 V and less) AC motor applications.

B. Overcurrent protective devices for motor controllers, including overload relays.

1.02 RELATED REQUIREMENTS

A. Section 23 0529 - Hangers and Supports for HVAC Piping and Equipment.

B. Section 26 0526 - Grounding and Bonding for Electrical Systems.

1.03 REFERENCE STANDARDS

A. IEC 60529 - Degrees of Protection Provided by Enclosures (IP Code) 1989 (Corrigendum 2019).

B. IEEE C57.13 - IEEE Standard Requirements for Instrument Transformers 2016.

C. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum) 2020.

D. NEMA ICS 6 - Industrial Control and Systems: Enclosures 1993 (Reaffirmed 2016).

E. NEMA ICS 7 - Industrial Control and Systems: Adjustable-Speed Drives 2020.

F. NEMA ICS 7.1 - Safety Standards for Construction and Guide for Selection, Installation, and Operation of Adjustable-Speed Drive Systems 2022.

G. NEMA ICS 7.2 - Application Guide for AC Adjustable Speed Drive Systems 2021.

H. NEMA ICS 61800-2 - Adjustable Speed Electrical Power Drive Systems, Part 2: General Requirements-Rating Specifications for Low Voltage Adjustable Frequency AC Power Drive Systems 2005.

I. NEMA MG 1 - Motors and Generators 2021.

J. NETA ATS - Standard For Acceptance Testing Specifications For Electrical Power Equipment And Systems 2021.

K. NFPA 70 - National Electrical Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

L. UL 489 - Molded-Case Circuit Breakers, Molded-Case Switches and Circuit Breaker Enclosures Current Edition, Including All Revisions.

M. UL 508A - Industrial Control Panels Current Edition, Including All Revisions.

N. UL 61800-5-1 - Standard for Adjustable Speed Electrical Power Drive Systems - Part 5-1: Safety Requirements – Electrical, Thermal, and Energy (Ed. 2) Current Edition, Including All Revisions.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate work to provide motor controllers suitable for use with actual motors to be installed.
   2. Coordinate work to provide controllers and associated wiring suitable for interface with control devices to be installed.
   3. Coordinate arrangement with dimensions and clearance requirements of actual equipment to be installed.
   4. Verify with manufacturer that conductor terminations are suitable for use with conductors to be installed.

5. Notify Architect of conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

1.05 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide manufacturer's standard catalog pages and data sheets for motor controllers, enclosures, overcurrent protective devices, and other installed components and accessories.

C. Shop Drawings: Indicate dimensions, voltage, controller sizes, short circuit current ratings, conduit entry locations, conductor terminal information, and installed features and accessories.
   1. Include wiring diagrams showing factory and field connections.

D. Specimen Warranty: Submit sample of manufacturer's warranty.

E. Manufacturer's equipment seismic qualification certification.

F. Manufacturer's certification that products meet or exceed specified requirements.

G. Field quality control test reports.

H. Operation and Maintenance Data: Include detailed information on system operation, equipment programming and setup, replacement parts, and recommended maintenance procedures and intervals.

I. Executed Warranty: Submit documentation of final executed warranty completed in Owner's name and registered with manufacturer.

1.06 QUALITY ASSURANCE

A. Comply with requirements of NFPA 70.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Store in clean, dry space. Maintain factory wrapping or provide additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.

B. Handle carefully in accordance with manufacturer's written instructions to avoid damage to internal components, enclosure, and finish.

1.08 WARRANTY

A. See Section 01 7800 - Closeout Submittals, for additional warranty requirements.

B. Provide minimum Five year manufacturer warranty covering repair or replacement due to defective materials or workmanship.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. ABB.

B. Yaskawa.

C. Danfoss.

D. Substitutions: See Section 01 6000 - Product Requirements.

E. Source Limitations: Furnish variable-frequency motor controllers and associated components produced by a single manufacturer and obtained from a single supplier.

2.02 VARIABLE-FREQUENCY MOTOR CONTROLLERS

A. Provide variable-frequency motor control system consisting of required controller assemblies, operator interfaces, control power transformers, instrumentation and control wiring, sensors, accessories, system programming, etc. as necessary for complete operating system.

B. Provide products listed, classified, and labeled as suitable for purpose intended.

C. Variable-Frequency Motor Controller:
   1. Configuration: Packaged controller with across-the-line bypass.
   2. Rectifier/Converter: Diode-based, 6-pulse type.
   3. Control Method: Scalar/volts per hertz; open-loop, without feedback.
   4. Filtering: Provide input/line reactor and output/load reactor.

D. Controller Assemblies: Comply with NEMA ICS 7, NEMA ICS 7.1, and NEMA ICS 61800-2; list and label as complying with UL 61800-5-1 or UL 508A as applicable.

E. Provide controllers selected for actual installed motors and coupled mechanical loads in accordance with NEMA ICS 7.2, NEMA MG 1 Part 30, and recommendations of manufacturers of both controller and load, where not in conflict with specified requirements; considerations include, but are not limited to:
   1. Motor type (e.g., induction, reluctance, and permanent magnet); consider NEMA MG 1 design letter or inverter duty rating for induction motors.
   2. Motor load type (e.g., constant torque, variable torque, and constant horsepower); consider duty cycle, impact loads, and high inertia loads.
   3. Motor nameplate data.
   4. Requirements for speed control range, speed regulation, and braking.
   5. Motor suitability for bypass starting method, where applicable.

F. Single Controllers Serving Multiple Motors:
   1. Control Method: Scalar/volts per hertz; do not use vector control method.
   2. Provide separate overload relay for each motor; provide auxiliary contacts and control wiring as required to shut down controller upon trip of any single overload relay.
   3. Consider combined length of motor leads for cable length limits.

G. Devices on Load Side of Controller: Suitable for application across full controller output frequency range.

H. Operating Requirements:
   1. Input Voltage Tolerance: Plus/minus 10 percent of nominal.
   2. Input Frequency Tolerance: Plus/minus 5 percent of nominal.
   3. Efficiency: Minimum of 96 percent at full speed and load.
   4. Input Displacement Power Factor: Minimum of 0.96 throughout speed and load range.
   5. Overload Rating:
      a. Variable Torque Loads: Minimum of 110 percent of nominal for 60 seconds.
      b. Constant Torque Loads: Minimum of 150 percent of nominal for 60 seconds.

I. Power Conversion System: Microprocessor-based, pulse width modulation type consisting of rectifier/converter, DC bus/link, and inverter.
   1. Rectifier/Converter: Diode-based, 6-pulse type with 5 percent reactor unless otherwise indicated.

J. Control System:
   1. Provide microprocessor-based control system for automatic control, monitoring, and protection of motors. Include sensors, wiring, and connections necessary for functions and status/alarm indications specified.
   2. Provide integral operator interface for controller programming, display of status/alarm indications, fault reset, and local control functions including motor run/stop, motor forward/reverse selection, motor speed increase/decrease, and local/remote control selection.
   3. Control Functions:
      a. Control Method: Selectable vector and scalar/volts per hertz unless otherwise indicated.

1) Scalar/Volts per Hertz Control: Provide IR compensation or torque boost for improved low-speed torque.
2) Vector Control: Provide selectable autotuning function.

b. Adjustable acceleration and deceleration time; linear and S-curve ramps; selectable coast to stop.
c. Selectable braking control; DC injection or flux braking.
d. Adjustable minimum/maximum speed limits.
e. Adjustable pulse width modulation switching carrier frequency.
f. Adjustable motor slip compensation.
g. Selectable autorestart after noncritical fault; programmable number of time delay between restart attempts.

4. Status Indications:
   a. Motor run/stop status.
   b. Motor forward/reverse status.
   c. Hand/Auto control status.
   d. Output voltage.
   e. Output current.
   f. Output frequency.
   g. DC bus voltage.
   h. Motor speed.
5. Protective Functions/Alarm Indications:
   a. Overcurrent.
   b. Motor overload.
   c. Undervoltage.
   d. Overvoltage.
   e. Controller overtemperature.
   f. Input/output phase loss.
   g. Output short circuit protection.
   h. Output ground fault protection.
6. Inputs:
   a. Digital Input(s): _____.
   b. Analog Input(s): Two.
7. Outputs:
   a. Analog Output(s): Two.
   b. Relay Output(s): Three.
8. Communications: Compatible with connected systems. Provide accessories necessary for proper interface.
   a. Serial Communications: RS-485; support for BACnet MS/TP protocol.
   b. Ethernet Communications: Support for Modbus TCP and BACnet IP protocol.
   c. Remote Monitoring Capabilities:
      1) Motor run/stop status.
      2) Hand-off-auto status.
      3) Fault information.
      4) Discrete input/output status.
      5) Analog input/output values.
9. Features:
   a. Password-protected security access.
   b. Event log.

K. Power Conditioning/Filtering:

1. Provide 5-percent DC link chokes or 5-percent input/line reactor for each controller unless otherwise indicated or required.
2. Reactor Impedance: 5 percent, unless otherwise indicated or required.

L. Packaged Controllers: Controllers factory-mounted in separate enclosure with externally operable disconnect and specified accessories.
1. Disconnects: Circuit breaker or disconnect switch type.
   a. Disconnect Switches: Fusible type or nonfusible type with separate input fuses.
   b. Provide externally operable handle with means for locking in OFF position. Provide safety interlock to prevent opening cover with disconnect in ON position with capability of overriding interlock for testing purposes.
   c. The drive and bypass packaged shall have a UL listed short circuit current rating of 100 kA, for 240VAC and 480 VAC systems, and this rating shall be indicated on the rating label.
   d. Provide auxiliary interlock for disconnection of external control power sources where applicable.
2. Provide door-mounted remote operator interface.
3. Packaged Controllers with Bypass: Provide contactors and controls to enable removal of variable-frequency controller from circuit.
   a. Bypass Method: Manual, unless otherwise indicated.
   b. Bypass Configuration: Drive isolation fuses shall be provided. Bypass designs which have no such fuses, or that only incorporate fuses common to both the drive and the bypass are not acceptable. Third contactor “isolation contactors” and service switch are not an acceptable alternative to drive isolation fuses.
   c. Bypass Motor Starting Method: Full-voltage (across-the-line) with overload relay, unless otherwise indicated. The bypass shall be able to detect a single-phase input power condition while running in bypass, disengage the motor, and provide a single-phase input power indication.
   d. Overload Relays: Selectable Class 10, 20, or 30 electronic motor overload protection shall be included in both drive and bypass mode..
4. Independent Bypass Keypad Requirements:
   a. The bypass shall include a two-line, 20-character LCD display. The display shall allow the user to access parameters and view:
      1) Bypass input voltage, current (Amps) and power (kW)
      2) Bypass faults, warnings, and fault log
      3) Bypass operating time and energy consumption (resettable)
   b. The bypass control panel shall include the following controls:
      1) Four navigation keys (Up, Down, Enter, Escape)
      2) Bypass Hand-Off-Auto, Drive mode / Bypass mode selectors, Bypass reset
   c. The following indicating lights (LED type) or control panel display indications shall be provided.
      1) Bypass Mode Selector Switch: DRIVE/OFF/BYPASS.
      2) Motor Control Selector Switch: HAND/OFF/AUTO.
      3) Indicating Lights: For drive/bypass mode status, drive/bypass run status, and drive/bypass fault status.
      4) Safety interlock and run permissive status shall be displayed using predetermined application specific nomenclature, such as: Damper end switch, smoke alarm, vibration trip, and overpressure.
      5) The bypass shall be designed for stand-alone operation and be completely functional in both Hand and Automatic modes, even if the drive and/or drive’s control board has failed. Network communications shall remain functional. Bypass systems that do not maintain full functionality in the event of a drive failure, are not acceptable.

M. Service Conditions:
   1. Provide controllers and associated components suitable for operation under following service conditions without derating:
      a. Altitude: Less than 3,300 feet.
      b. Ambient Temperature: Between 32 degrees F and 104 degrees F.
   2. Provide controllers and associated components suitable for operation at indicated ratings under service conditions at installed location.

N. Short Circuit Current Rating:
   1. Provide controllers with listed short circuit current rating not less than available fault current at installed location as indicated on drawings.
   2. Provide line/input reactors where specified by manufacturer for required short circuit current rating.

O. Conductor Terminations: Suitable for use with conductors to be installed.

P. Enclosures:
   1. Comply with NEMA ICS 6.
   2. NEMA 250 Environment Type or Equivalent IEC 60529 Rating: Unless otherwise indicated, as specified for following installation locations:
      a. Indoor Clean, Dry Locations: Type 1 or Type 12.
      b. Outdoor Locations: Type 3R or Type 4.
   3. Finish: Manufacturer's standard unless otherwise indicated.
   4. Cooling: Forced air or natural convection as determined by manufacturer.

Q. Instrument Transformers:
   1. Comply with IEEE C57.13.
   2. Select suitable ratio, burden, and accuracy as required for connected devices.
   3. Current Transformers: Connect secondaries to shorting terminal blocks.
   4. Potential Transformers: Include primary and secondary fuses with disconnecting means.

2.03 OVERCURRENT PROTECTIVE DEVICES

A. Circuit Breakers:
   1. Molded Case Circuit Breakers:
      a. Description: Quick-make, quick-break, over center toggle, trip-free, trip-indicating circuit breakers; listed and labeled as complying with UL 489; ratings, configurations, and features as indicated or as required.
         1) Provide thermal magnetic circuit breakers unless otherwise indicated.
      b. Interrupting Capacity:
         1) Provide circuit breakers with a 100 KAIC interrupting capacity as required to provide short circuit current rating indicated, but not less than specified minimum requirements.
         2) Fully Rated Systems: Provide circuit breakers with interrupting capacity not less than short circuit current rating indicated.
         3) Series Rated Systems: Provide circuit breakers listed in combination with upstream devices to provide interrupting rating not less than short circuit current rating indicated.
      c. Thermal Magnetic Circuit Breakers: For each pole, furnish thermal inverse time tripping element for overload protection and magnetic instantaneous tripping element for short circuit protection.
      d. Provide following features and accessories where indicated or where required to complete installation:
         1) Pad-Lock Provision: For locking circuit breaker handle in OFF position.

2) Auxiliary Switch: SPDT switch suitable for connection to system indicated for indicating when circuit breaker has tripped or been turned off.
3) Undervoltage Release: For tripping circuit breaker upon predetermined drop in coil voltage with field-adjustable time delay to prevent nuisance tripping.
4) Alarm Switch: SPDT switch suitable for connection to system indicated for indicating when circuit breaker has tripped.

2.04 SECURITY FEATURES:

A. The drive manufacture shall clearly define cybersecurity capabilities for their products.

B. The drive shall include password protection against parameter changes.
   1. There shall be multiple levels of password protection including: End User, Service, Advanced, and Override.
   2. The drive shall support a customer generated unique password between 0 and 99,999,999.
   3. The drive shall log an event whenever the drive password has been entered.
   4. The drive shall provide a security selection that prevents any “back door” entry. This selection even prevents the drive manufacturer from being able to bypass the security of that drive.
   5. A security level shall be available that prevents the drive from being flashed with new firmware.

2.05 NETWORK COMMUNICATIONS:

A. The drive shall have an EIA-485 port with removable terminal blocks. The onboard protocols shall be BACnet MS/TP, Modbus, and Johnson Controls N2. Optional communication cards for BACnet/IP, LonWorks, Profibus, Profinet, EtherNet/IP, Modbus TCP, and DeviceNet shall be available. The use of third party gateways are not acceptable.

B. The drive shall have the ability to communicate via two protocols at the same time, one onboard protocol and one option card based protocol. Once installed, the drive shall automatically recognize any optional communication cards without the need for additional programming.

C. The drive shall not require a power cycle after communication parameters have been updated.

D. The embedded BACnet connection shall be a MS/TP interface. The drive shall be BTL Listed to Revision 14 or later. Use of non-BTL Listed drives are not acceptable.

E. The drive shall be classified as an Applications Specific Controller (B-ASC). The interface shall support all BIBBs defined by the BACnet standard profile for a B-ASC including, but not limited to:
   1. Data Sharing: Read Property Multiple-B, Write Property Multiple-B, COV-B
   2. Device Management: Time Synchronization-B
   3. Object Type Support: MSV, Loop

2.06 SOURCE QUALITY CONTROL

A. See Section 01 4000 - Quality Requirements, for additional requirements.

B. Factory test controllers in accordance with NEMA ICS 61800-2.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that ratings of controllers are consistent with indicated requirements.

C. Verify that mounting surfaces are ready to accept controllers.

D. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Install in accordance with NEMA ICS 7.1 and manufacturer's instructions.

C. Do not exceed manufacturer's recommended maximum cable length between controller and motor.

D. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.

E. Provide required support and attachment in accordance with Section 23 0529.

F. Install controllers plumb and level.

G. Provide grounding and bonding in accordance with Section 26 0526.

H. Install field-installed devices, components, and accessories.

I. Where accessories are not self-powered, provide control power source as indicated or as required to complete installation.

J. Set field-adjustable settings of controllers and associated components according to installed motor requirements, in accordance with recommendations of manufacturers of controller and load.

3.03 START-UP

A. Start-up shall be provided for each drive by an authorized local service provider.

3.04 FIELD QUALITY CONTROL

A. Provide services of manufacturer's authorized representative to perform inspection and testing. Include manufacturer's reports with submittals.

B. Inspect and test in accordance with NETA ATS, except Section 4.

C. Perform inspections and tests listed in NETA ATS, Section 7.17. Insulation-resistance test on control wiring listed as optional is not required.

D. Packaged Controllers with Bypass: Test for proper operation in both drive and bypass modes.

E. Correct deficiencies and replace damaged or defective controllers or associated components.

3.05 PRODUCT SUPPORT

A. Factory trained application engineering and service personnel that are thoroughly familiar with the drive products offered shall be locally available at both the specifying and installation locations. A toll free 24/365 technical support line connected to factory support personnel located in the US and Canada shall be available.

B. Training shall include installation, programming and operation of the drive, bypass and network communications. Owner training shall be provided locally upon request.

END OF SECTION

SECTION 23 0993
SEQUENCE OF OPERATIONS FOR HVAC CONTROLS

PART 1 GENERAL

1.01 SUMMARY

A. This Section includes control sequences for HVAC systems, subsystems, and equipment.

B. Related Sections include the following:
   1. Division 23 Section "Instrumentation and Control for HVAC" for control equipment and devices and for submittal requirements.

1.02 DEFINITIONS

A. CHWS: Chilled Water Supply

B. CHWR: Chilled Water Return

C. CWS: Condenser Water Supply (Supply to chiller)

D. CWR: Condenser Water Return

E. DDC: Direct digital control.

F. DPT: DewPoint Temperature

G. HWS: Hot Water Supply

H. HWR: Hot Water Return

I. VAV: Variable air volume.

J. BAS: Building Automation System.

K. VFD: Variable Frequency Drive or Controller.

L. VFC: Variable Frequency Drive or Controller.

M. VFV: Variable Refrigerant Volume.

N. TAB: Test and Balance

O. FMS: Facility Monitoring System.

1.03 TRENDING FOR BUILDING COMMISSIONING

A. All diagnostic trends listed in this document shall be provided to the commissioning agent in excel (.EXE) format during the commissioning process. Coordinate additional requirements with commissioning authority prior to programming.

1.04 DISPLAY GRAPHICS

A. Provide display graphics for review with shop drawing submittals.

1.05 MODE OF OPERATION

A. Occupied:

B. Unoccupied:

C. Morning Start-up:

1.06 VARIABLE PRIMARY CHILLED WATER SYSTEM SEQUENCES

A. General:
   1. The chilled water system consists of three (3) 400-ton variable speed chillers. A primary, variable-flow chilled water pumping system will be utilized with a system bypass valve.
   2. All chiller systems shall be either automatically started/stopped by the DDC controls system or manually started/stopped by the system operator.

a. When in the automatic mode, the chilled water system shall operate in a Lead/Lag1/Lag2 arrangement with the Lead chiller rotating weekly.

3. Various points of control shall be “Hardwired” to/from the chiller. Those points shall include but not be limited to:
   a. Inputs:
      1) Chiller(s) start-stop
      2) Chiller demand limit
   b. Outputs:
      1) Chiller failure alarm
      2) Current output to determine percent of chiller is fully loaded.
4. Interface with chiller manufacture BACNET interface, display relevant data on a separate web page.

B. Chilled Water System Operations: The chilled water system shall be called to operate under the following conditions:
   1. Occupied: When 15% (adjustable from chilled water system web page) of air handling units require cooling. An air handling unit is requiring cooling under the following conditions.
      a. VAV Air Handling Unit (Unit with terminal box for zone control): When 15% of zones are above setpoint.
      b. Single Zone AHU (Fan-coils not included): When the zone is above setpoint.
   2. Un-occupied: When 20% (adjustable from chilled water system web page) of air handling units require cooling. An air handling unit is requiring cooling under the following conditions.
      a. VAV Air Handling Unit (Unit with terminal box for zone control): When 20% of zones are above the un-occupied setpoint.
      b. Single Zone AHU (Fan-coils not included): When the zone is above setpoint.

C. Chilled Water System Start-up Sequence: The following shall occur in sequential order:
   1. Control valves on active air handling units shall open to 50% flow, (refer to AHU and OA sequences for additional info).
   2. Initiate Condenser Water System start sequence for Lead chiller.
   3. The lead chiller(s) evaporator 2-way, 2-position control valve shall open and Primary chilled water pump(s) shall start. The control valve shall be slow acting and be programed to open over a 5-minute period.
      a. The chiller(s) evaporator 2-way, 2-position control valve shall be provided with a position verification switch, a start signal shall not be sent to the chiller until verification that the chiller control valve is 100% open has been proven.
   4. The variable flow chilled water pumping system shall maintain minimum flow for 5-minutes prior to starting the chiller(s).
   5. Enable the lead chiller via hardwired connection.

D. Chiller Staging: Chillers shall be staged on/off based on the actual building tonnage. Building tonnage shall be calculated using the chilled water flow meter and chilled water supply & return temperatures to and from the building.
   1. Building tonnage = (Chilled Water Flow (gpm) X (Tret – Tsup) X 500)/12000
   2. Enabling a Lag Chiller:
      a. Enabling Lag1 Chiller (Option #1): The lag1-chiller shall be enabled when building capacity exceeds 90% of its scheduled capacity.
         1) Provide a 20-minute time delay before enabling the Lag1 chiller, if at anytime during the 20-minute delay building capacity reduces below 90% of rated chiller capacity, the lag1 command shall be cancelled and time delay shall be reset.
      b. Enabling Lag1 Chiller (Option #2): The lag1-chiller shall be enabled when the supply water temperature to the building rises 1.5F above setpoint.

1) Provide a 20-minute time delay before enabling the Lag1 chiller, if at anytime during the 20-minute delay chilled water supply temperature to the building drops below 1.5F from setpoint, the lag1 command shall be cancelled and time delay shall be reset.

c. Enabling Lag2 Chiller (Option #1): The lag2-chiller shall be enabled when building capacity exceeds 90% of the combined scheduled capacity of the two (2) operating chillers.
   1) Provide a 20-minute time delay before enabling the Lag2 chiller, if at anytime during the 20-minute delay building capacity reduces below 90% of the combined chiller capacity, the lag1 command shall be cancelled and time delay shall be reset.

d. Enabling Lag2 Chiller (Option #2): The lag2-chiller shall be enabled when the supply water temperature to the building rise 1.5F above setpoint.
   1) Provide a 20-minute time delay before enabling the Lag2 chiller, if at anytime during the 20-minute delay the chilled water supply temperature drops below 1.5F from setpoint, the lag2 command shall be cancelled and time delay shall be reset.

3. Disabling a Lag Chiller:
   a. Disabling Lag2 Chiller: The lag2 chiller shall be disabled when the building capacity is 55% or less than the combined CP capacity of the 3-operating chillers, i.e. with 3-chillers operating, the central plant capacity is equal to 1,575-ton, the lag2 chiller shall be disabled when building capacity is 866-ton or less.
      1) The lag2 chiller shall be disabled immediately when reaching 55% of combined CP capacity, do not provide a time delay.
   b. Disabling Lag1 Chiller: The lag1 chiller shall be disabled when the building capacity is 40% or less than the combined CP capacity of the 2-operating chillers, i.e. with 2-chillers operating, the central plant capacity is equal to 1,050-ton, the lag1 chiller shall be disabled when building capacity is 420-ton or less.
      1) The lag1 chiller shall be disabled immediately when reaching 40% of combined CP capacity, do not provide a time delay.

E. Sequence for Staging Up (activating a Lag chiller): The following shall occur in sequential order when activating a lag chiller:
   1. Lock chilled water pump(s) speed at current speed.
   2. Lock all air handling units control valves at their current position.
   3. Initiate Lag Condenser Water System start sequence.
   4. The Lag chillers evaporator and condenser 2-way, 2-position control valves shall gradually open over a period of 5 minutes (adj.).
   5. After valve position has been verified by position switch, the lag chiller shall be started. After the chiller has started, a 5-minute delay shall be provided to allow the lag chiller to load, after the delay the following shall occur.
      a. Unlock pump speed. Pump(s) speed shall not be allowed to change more than 5 hz per minute until pump speed setpoint has been achieved.
      b. Unlock chilled water control valves on air handling units. Valve position shall not be allowed to change more than 5% per minute until setpoint has been met.

F. Sequence for Staging down (deactivating a lag chiller): The following shall occur in sequence order when deactivating a lag chiller:
   1. Lock chilled water pump(s) speed at current speed.
   2. Lock chilled water valves on all air-handling units at current position.
   3. Deactivate Lag chiller. After deactivating Lag chiller provide 5-minute delay, after period the following shall occur.
      a. Initiate Lag Condenser Water System stop sequence.

b. Close chilled water isolation valve on deactivated chiller. Valve shall close over a 5-minute period.

4. After the Lag chiller has been disabled and isolation valve has been proven closed the following shall occur.
   a. Unlock pump speed. Pump(s) speed shall not be allowed to change more than 5 hz per minute until pump speed setpoint has been achieved.
   b. Unlock chilled water control valves on air handling units. Valve position shall not be allowed to change more than 5% per minute until setpoint has been met.

G. Primary pumping sequence:
   1. The pumps shall operate on a lead/lag1/lag2 basis. Lead/lag1/lag2 operation shall rotate on a weekly (adjustable) basis. The lead/lag1/lag2/lag3 pumps shall be capable of operating if required by the demand and shall be controlled by multiply system pressure differential sensors.
      a. Provide each pump with a current sensor to verify pump operations. If flow is not proven, the pump shall be deactivated and an alarm shall be displayed at the BAS. In the event chilled water flow fails while the chiller is operating, the back-up chilled water pump shall activate. Once the cause of the alarm has been investigated and repaired, the lead pump shall be placed back into normal operations and the back-up pump shall deactivate. Provide a thirty-second time delay to prevent false alarms.
   2. The system shall be provided with a differential pressure sensor installed in Mechanical Platform **MECH M01**, that shall control pump(s) speed. This sensor shall be “hardwired” to the chiller plant unitary controller.
      a. The contractor shall provide all system components and control wiring necessary for proper system operation.
      b. The chilled water pump controller shall continuously survey the DP sensors. The differential pressure setting shall be set per TAB contractor and be reset per the “Chilled Water Loop Pump Speed Control” sequence.
      c. The system shall start with 1- pumps running. Provide a 15-minute (adj) time delay before a lag pump can be incremented or decremented. Incrementing and decrementing a lag pump shall be as follows.
         1) Incrementing a lag pump:
            (a) A lag pump shall be started when pump(s) speed reaches 95%. Provide a 15-minute delay before allowing a pump to increment.
         2) Decrementing a lag pump: Decrementing a lag pump shall vary depending on the number of pumps operating. Provide a 15-minute (adj) time delay when decrementing a lag pump.
            (a) Decrementing lag2 pump (three (3) pumps operating): On decrease to 95% pump speed, decrement the lag2.
            (b) Decrementing lag1 pump (two (2) pumps operating): On decrease to 70% pump speed, decrement lag1 pump.
         3) Lead pump(s) speed control during the decrement/increment process: The lead pump(s) speed during the incrementing process speed shall be allowed to modulate as required to maintain system DP.
         4) Decremented pump speed control: The decremented pump speed shall not be allowed to decrease by more than 5 hz per minute and shall shut off when pump speed reaches 20% (12 hz).
         5) Pump(s) speed shall not be allowed to change by more than 5 hz per minute during the Increment/Decrement process.
         6) Additional requirements while decrementing or incrementing a pump.
            (a) All AHU chilled water valves shall be locked in position for a minimum of 5 minutes during the Increment/Decrement process.

H. Chiller Minimum Flow Requirements

1. The bypass valve shall be located in the Gym Mechanical platform **MECH EP01** and shall modulate as required to maintain a minimum flow through the chillers as follows.
   a. Lead Chiller Operating = 600 gpm
   b. Lead + Lag1 Operating = 1,200 gpm
   c. Lead + Lag1 + Lag 2 Operating = 1,800 gpm
2. The bypass shall be set to open quickly as pressures reaches minimum operation pressure. The valves closure speed shall be greatly slowed, and shall have a maximum closure speed of 5% per minute.
3. One chilled water bypass valve shall be provided. The valve shall be sized for a 15ft pressure loss at 850 gpm.

I. Chiller Maximum Flow Requirements
1. The chiller shall not be allowed to exceed its maximum flow rate. In the event that a chiller approaches 85% of its maximum flow rate, an additional chiller shall be started. Refer to chiller staging requirements in this section for chiller staging sequencing.

J. Operator Station Display: Indicate the following on operator workstation display terminal:
1. DDC system graphic.
2. DDC system status, on-off.
3. Outdoor-air temperature.
4. System flow to from flow meter installed in Central Plant.
5. Chilled-water pump(s) on-off status.
6. Chilled-water pump(s) speed.
7. Chilled-water supply/return temperature to building.
8. Chilled-water return temperature to chillers (downstream of bypass valve).
9. Bypass valve position.
10. Chiller supply water temperature for each chiller.
11. Chiller(s) status.
12. System capacity in tons (based flow meter reading and supply and return temperatures).
13. Differential pressure for each chiller.
14. Link to each trend required per “1.07 Chilled and Condenser Water Trends” of this section.

K. Chilled Water Loop Pump Speed Control: Pump(s) speed shall modulate as required to maintain the system differential pressure. The system DP shall be reset based on valve position at the AHU’s.
1. DP Settings:
   a. Maximum DP Setting = 15 PSI (adj)
   b. Minimum DP Setting = 8 PSI (adj)
2. DP reset sequence:
   a. Poll valve position of all units on a 5-minute basis with the following exceptions.
      1) Units to be excluded from the polling process are:
         (a) All fan coil units.
         (b) All dedicated OA units (not including lab units)
   b. Pump(s) speed shall modulate as required to maintain an average open position 95% (adj) of the 3 Units with the most open valve position.
3. On system start-up DP shall be set to the at the midpoint between the min. and max. DP settings. The DP setpoint shall remain at the midpoint for a minimum of 15-minutes (adj) before the DP can be reset up or down.

1.07 CONDENSER WATER SYSTEM SEQUENCE

A. General: The system is design to operate all three (3) cooling tower cells when only one (1) chiller is operating. The system contains the following components:
1. Three (3) 525-ton cell cooling towers (CT-1A, 1B & 1C)
2. Three condenser water pumps (CWP-1A, 1B & 1C) piped in a header arrangement.

3. 2-position control valve at tower inlet and outlet.
4. VFD for each cooling tower fan.
5. Tower bypass valves for condenser water loop temperature control.
6. Chiller condenser water isolation valves.
7. Chiller head pressure control valve (Carrier only).
8. The towers shall be either automatically started/stopped by the DDC controls system or manually started/stopped by the system operator through the condenser water web page.
    a. Automatic Mode: When operating in the automatic mode, all three tower cells shall be operational with associated automatic isolation valves open.
    b. Manual Mode: When operating in the manual mode, the user shall select the individual cell(s) to operate, when selected to operate, the automatic isolation valves shall be open.

B. Determining Number of Cooling Towers to Operate:
    1. Automatic Mode: On start-up, the all three cooling towers shall start, (note, the cooling towers are designed and size to allow all three (3) cooling towers to operate when only one (1) chiller and one (1) condenser water pump is operating). When operating in the automatic mode, each towers automatic control valves (inlet and outlet) shall be open.
        a. The automatic control valves at the tower inlet and outlet shall be normally open.
    2. Manual Mode: Provide a manual mode to allow the operator to select the specific tower or combination of towers to operate. When an individual tower is isolated or not operating, it's individual inlet and outlet control valve shall be closed.

C. On chiller start-up, the following shall occur in sequential order:
    1. When starting up a chiller, the following shall occur at the same time. Once the following conditions have been met, the chiller shall be allowed to operate.
        a. The condenser water isolation control valve on the chiller shall gradually open over a 5-minute period.
        b. The condenser water pumps shall start and gradually increase to full speed over a 5-minute period.
    2. After the 5-minute period the chiller shall start and the cooling tower fans shall be allowed to operate as required to maintain discharge temperature setpoint. The chiller and tower fans shall not be allowed to operate unless valves are proved open.

D. Staging up a lag chiller: The following shall occur at the same time.
    1. Activate a lag condenser water pump. The lag condenser pumps VFD shall gradually increase speed from start to design frequence over a 5-minute period.
        a. The condenser water pumps shall operate in a Lead/Lag1/Lag2 arrangement with the lead pump rotating on a weekly basis. The number of condenswer water pumps operating shall match the number of chillers operating.
    2. The condenser water control valve on the lag chiller shall gradually open over a 5-minute period.

E. Staging down chillers:
    1. When staging down a chillers, the following shall occur sequential.
        a. Disable lag chiller, after a period of 5-minutes, proceed to next step.
        b. After the chiller has been disabled, the following shall occur over a 5-minute period at the same time:
            1) Close lag chiller’s condenser water control valve (Over a 5-minute period)
            2) Disable a lag condenser water pump by reducing the speed to 0 HZ (over a 5-minute period).
    2. When shutting down condenser water system.
        a. The condenser water system shall operate for a period of 5-minutes after the chillers have been disabled. After that period, the operating towers and condenser water

pumps shall stop and all valves shall close
b. Disable operating chillers, after a period of 5-minutes, proceed to next step.
1) Decrease speed of lag condenser water pump to its minimum speed over a 5-minute period then disable the pump.

F. Condenser Water Temperature Control: Condenser water temperature control shall be accomplished by modulating the tower fan(s) speed and tower bypass control valves. Provide temperature sensor in common CWS to chillers. When multiple fans are operating, all towers fans shall operate at the same fan speed. Condenser water temperature shall be maintained as follows:
1. Tower Fan Control: Cooling tower fans shall modulate as required to maintain a CWS temp to the chillers that is 5°F above the outdoor wet bulb temperature with a maximum CWS temperature of 86°F and a minimum temperature of 65°F.
2. Cooling Tower Bypass Control: Bypass valves are being provided in the return to the cooling towers. Provide individual modulating control valves in the return and bypass line as indicated on the piping schematic. The bypass valves shall be electronically locked to moduate at the same rate. Modulate bypass valves as requried to maintain a minimum supply water temperature to the cooling tower of 60°F (adj).

G. Pump Speed Control:
1. Pump speed shall be constant, the number of pumps operating shall match the number of chillers operating.

H. Vibration Isolation Cut-out Oil Level Swith:
1. Monitor vibration cut-out switch and alarm when activated.
2. Monitor manufacturer oil-level switch and alarm when low.

I. Cooling Tower Make-up and Blow-down:
1. Provide two (2) electronic water meters to monitor and log cooling tower water consumption and chemical treatment blowdown. Meter will provide total gallons of water used to date. Controls shall store milestone gallon usage, (i.e. Jan 1st, 1st day of month and 1st day of week) and use to calculate water usage as indicated in display points below. Meters shall be installed at the following locations:
a. Tower fill
b. Chemical treatment blow-down.

J. Operator Station Display: Provide graphic web page showing condenser water piping schematic, control valves and equipment. The following information shall be displayed on the web page:
1. Overall system status
2. C-1A, 1B & 1C status (on/off/alarm)
3. CWP-1A, 1B & 1C status (on/off/alarm)
4. CWP-1A, 1B & 1C speeds
5. Cooling tower fan(s) status (on/off/alarm)
6. Cooling tower fan(s) speed
7. Cooling tower control valve status (open/closed/alarm)
8. Chiller control valves status (open/closed/alarm)
9. Condenser water temperature setpoint
10. Condenser water supply temp to chiller(s) (located in common pipe serving chillers)
11. Condenser water return temp from C-1A, 1B & 1C (provide individual return water temperature sensors).
12. C-1A, 1B & 1C individual DP, (note, DP measured will be low, the range of this DP sensor shall be from 0 to 10 psi).
13. Gallons of tower make-up water used displayed as the following:
a. Week to date

b. Month to date
c. Year to date
d. Previous Week
e. Previous Month
f. Pervious Year

14. Gallons of tower blow-down displayed as the following:
    a. Week to date
    b. Month to date
    c. Year to date
    d. Previous Week
    e. Previous Month
    f. Pervious Year
15. Tower make-up water alarm if water use has increased by more than 20% from previous week.
16. Vibration Cut-out Switch Status
17. Oil Level Level.
18. Condenser water trend data as indicated in this specification.
19. Link to required condenser water trends.

1.08 CHILLED AND CONDENSER WATER TREND REQUIREMENTS

A. Provide the following diagnostic trend logs for the chilled and condenser water system.
    1. Chiller DP Trend: Points shall be trended on 5-minute intervals.
        a. C-1A Evaporator DP (FT of Head)
        b. C-1A Condenser DP (FT of Head)
        c. C-1B Evaporator DP (FT of Head)
        d. C-1B Condenser DP (FT of Head)
        e. C-1C Evaporator DP (FT of Head)
        f. C-1C Condenser DP (FT of Head)
        g. Bypass valve position
    2. Individual Chiller Trends: Provide for each individual chiller. The trend points shall be recorded on a 5-minute basis
        a. Chiller Status (on/off/alarm)
        b. Chilled water supply temp
        c. Chilled water return temp (temp in common return manifold)
        d. Condenser water supply temp (temp in common supply manifold)
        e. Condenser water return temp
        f. Condenser water isolation valve position
        g. Chilled water isolation valve position
        h. Head pressure control valve position
        i. Evaporator barrel DP (FT of head)
        j. Condenser DP (FT of head)
    3. Overall Chilled Water Systems Temperature Trend: Points shall be trended on 5-minute intervals.
        a. Chiller Status for each chiller (on/off/alarm)
        b. Return water temperature (down stream of bypass)
        c. C-1A supply water temperature
        d. C-1B supply water temperature
        e. C-1C supply water temperature
    4. Overall Condenser water system temperature trend: Points shall be trended on 5-minute intervals.
        a. Condenser water supply temp (from tower to chillers)

b. Condenser water return temp to tower (combined from three chillers)
c. Cooling Tower Status for each cell.

5. Overall cooling tower trend: Points shall be trended on 5-minute intervals.
   a. Cooling tower fan #1 status (on/off/alarm)
   b. Cooling tower fan #2 status (on/off/alarm)
   c. Cooling tower fan #3 status (on/off/alarm)
   d. Cooling tower fan #1 speed
   e. Cooling tower fan #2 speed
   f. Cooling tower fan #3 speed
   g. Bypass valve positions
6. Chilled Water System Pump Trends: Points shall be trended on 5-minute intervals.
   a. CHWP-1A Status (on/off/alarm)
   b. CHWP-1B Status (on/off/alarm)
   c. CHWP-1C Status (on/off/alarm)
   d. CHWP-1A Speed
   e. CHWP-1B Speed
   f. CHWP-1C Speed
7. Condenser water system pump trends: Points shall be trended on 5-minute intervals.
   a. CWP-1A Status (on/off/alarm)
   b. CWP-1B Status (on/off/alarm)
   c. CWP-1C Status (on/off/alarm)

1.09 HOT WATER HEATING SYSTEM CONTROL

A. General: The hot water heating system shall consist of heating hot water boiler(s), associated primary heating hot water pump(s) with variable speed drives and isolation control valves.
   1. The heating hot water system shall be started and stopped through the BAS system.
   2. The boiler is being provided with a factory controller that will control discharge water temperature and operation of the primary heating hot water pump(s). Refer to specification section 235216 Condensing Boilers for additional information.
   3. Install the following boiler manufacture provided sensors.
      a. Boiler OA temperature sensor(s) provided by boiler manufacture.
      b. Install CO gas sensor provided by boiler manufacture.

B. Hot Water System Operations: The heating hot water system shall operate under the following conditions:
   1. An individual air handling unit is calling for heat or dehumidification.
   2. A minimum of 10% (adj) of terminal boxes with hydronic heating coils are calling for heat.

C. Heating Hot Water System Sequencing:
   1. Activation: When called to operate by the BAS, the following shall occur.
      a. The boilers isolation valve shall open over a 5-minute period. Provide valves with position switches to confrim
      b. The BAS system shall send boiler start signal to boiler manufacture provided control panel.
         1) The boiler control system shall control the operation of the boiler(s) and associated primary hot water pump(s).
   2. Deactivation: When called to deactivate by the BAS, the following shall occur.
      a. The secondary hot water pump(s) shall operate for a minimum of 300 seconds.
   3. Primary Pump Sequencing: The boiler(s) control panel shall determine when to operate a boiler's individual primary hot water pump.
      a. Provide current transducers to determine status of primary hot water pumps.

D. Hot Water Pump Control:

1. The pumps shall operate in a lead/lag sequenece with pump rotations as required to keep equal ware on the pumps.
2. The pump controller shall survey the DP sensor and adjust speed as required to satisfy setpoint. The DP sensor must be connected to the controller that is controlling the hot water pumps.

E. Bypass Valve Control:
1. Install flow meter in the heating hot water pipe. This flow meter shall be used to control system bypass valve and maintain the minimum flow requried for boiler operation.
2. Install bypass where indicated on plans, modulate bypass valve as required to maintain minimum boiler flow.
   a. The bypass valve must be tied directly into the central plant controller, mapping of this point through other controllers is not allowed.

F. Operator Station Display: Provide graphic web page showing hot water piping schematic. The following information shall be displayed on the web page:
1. Overall system status
2. Hot water supply temperature
3. Hot water return temperature
4. HWS flow (gpm)
5. Heating hot water pump(s) status
6. DP Measured
7. Points obtainable from boiler BACnet card.

G. Diagnostic Trend Logs: The following trends shall be set-up and accessible from the hot water system web page.
1. Trend #1: Hot Water Heating General Data
   a. System status
   b. HWS Temp
   c. HWR Temp
   d. HWS Flow (gpm)
   e. Building BTU's (calculated by using flow at flow meter and HWS/R temperature)
2. Trend #2: Pump Trend
   a. Lead pump speed
   b. Primary pump(s) stat
   c. Building DP
   d. HWS GPM
3. Trend #3: Hot Water Control Valve Trend
   a. Trend valve position for all heating hot waver valves as a percentage of full open.

1.10 VAV AIR HANDLING UNITS

A. General: Unit shall consist of supply fan with VFD and chilled water coil with modulating 2-way control valve.

B. Supply Air Fan:
1. Provide differential air pressure sensor to prove fan status.
2. The supply air fan shall be controlled through a variable frequency drive (VFD).
3. Provide and install duct mounted pressure sensor approximately 2/3 way down the supply duct main, (if not indicated on drawings, confirm location with engineer prior to installing sensor). The pressure sensors shall control the operation of the supply fan VFD and shall utilize differential pressure optimization.
4. Differential pressure optimization shall be accomplished by polling all VAV box damper positions on a 5-minute basis (adj) and resetting the DP setpoint so that at minimum of 10% of terminal boxes are 90% open.

a. Program shall be able to exclude an individual terminal box from the polling process.

5. The adjustable reset range will be from 0.5” wg to 1.25” wg, (the range shall be adjustable from the AHU web page).
6. SAF Start-up: Before starting the supply air fan, all terminal boxes associated with the air handling unit shall modulate open to their minimum damper position. Provide a minimum 1-minute delay before starting SAF to ensure all terminal box dampers are at their minimum position.
7. If less than 25% (adj) of associated terminal box air valves are completely closed, the air handling unit shall stop. If more than 25% (adj) of FVAV air valves are open, the air handling unit shall start.

C. Supply Air Temperature Control: Supply air temperature control shall be accomplished by modulating the units chilled water control valve. The specific discharge air temperature as measured in supply air duct shall be dependent on a combination of the average temperature of the individual zones and/or return air dewpoint temperature.
   1. Average Space Temperature: Each terminal box space temperature shall be polled at 5-minute intervals to determine the average difference between space temperature and space temperature setpoint.
   2. Return Air Dewpoint (DPT): Provide dewpoint senor located in RA duct upstream of the units OA connection (if provided with OA). The unit’s initial DPT setpoint shall be 55F (adj).
   3. Discharge Temperature Setpoint:
      a. Discharge temperature setpoint, when return air DPT is at or below setpoint, shall be based on the average space temperature as indicated below.
         1) Average space temperature 1°F above setpoint: Discharge air temperature 55°F (adj).
         2) Average space temperature 1°F below setpoint: Discharge air temperature 62°F (adj).
         3) Space temperature between dead band: Vary linearly.
      b. Discharge temperature setpoint when return air DPT is above set point shall be as follows:
         1) Return Air DPT below or at setpoint: Discharge air temperature programed setpoint based on average space temperature above.
         2) Return Air DPT 1.5°F above setpoint: Discharge air temperature 55°F (adj).
         3) DPT between dead band: Vary linearly.

D. UV Lights: These units are equipped with UV lights. 120V power is being provided by Division 26 contractor, provide relays and contacts as required to control lights so that lights are on only when the supply air fan is operating.

E. Display Points:
   1. DDC system web page
   2. Fan status (on/off/failure to run)
   3. Duct static pressure
   4. Duct static pressure setpoint
   5. Average space temperature setpoint differential
   6. Supply fan speed (% of full speed not HZ)
   7. Discharge air temperature
   8. Discharge air temperature setpoint
   9. Return air DPT.
   10. Return air temperature (mount adjacent to DP sensor in ductwork away from OA connection).
   11. Mixed air temperature.
   12. Coiling-coil control valve % of full open (software point, not actual measured)

13. CHWR water temperature

F. Diagnostic Trends: The following points shall be trended on a common web page accessible by clicking on an icon from the unit's system web page.
   1. VAV AHU Trend #1: To be trended on change of state
      a. AHU Run Command
      b. Fan status
   2. VAV AHU Trend #2: (To be trended on a 5-minute basis)
      a. Fan speed (Percentage of max not HZ)
      b. Duct static pressure
      c. Average position of connected terminal box air valves
      d. Average space temperature setpoint difference
      e. Discharge air temperature
      f. Discharge air temperature setpoint
      g. Return air DP temperature
   3. VAV AHU Trend #3: (To be trended on a 5-minute basis)
      a. Discharge air temperature
      b. Discharge air temperature setpoint
      c. Return air temperature
      d. Return air DP temperature
      e. Control valve % opened
      f. Chilled water coil return water temperature
   4. VAV AHU Trend #3: (To be trended on a 5-minute basis)
      a. Provide trend of damper position for all terminal boxes connected to unit on one common page.

1.11 SINGLE ZONE VARIABLE SPEED AIR HANLDING UNIT

A. General: Unit shall consist of supply fan with VFD, chilled water coil with modulating 2-way control valve and re-heat coil with modulating 2-way control valve. Space temperature setpoint shall be input through the unit's web page, a minimum of 4°F offset shall be provided between the heating and cooling setpoints.

B. Space Temperature Sensor Types: Combination temperature and humidity.

C. Supply Air Fan:
   1. Provide differential air pressure sensor to prove fan status.
   2. The supply air fan shall be controlled through a wall-mounted variable frequency drive (VFD).
   3. A space mounted temperature sensor(s) shall control the speed of the supply air fan. The maximum airflow shall be set by the TAB with minimum airflow being 30% (adj) of the maximum airflow.
      a. When multiple space mounted temperature sensors are indicated on the plans, an average temperature shall be determined from the sensors.

D. Space Temperature Control: A wall mounted temperature sensor(s) shall maintain space temperature by modulating the units SAF and control valves as follows.
   1. Supply Air Fan Control: The supply air fan shall modulate based on space temperature, a 2°F (adjustable) dead band shall be utilized to control the fans speed for both heating and cooling systems as follows
      a. Cooling Mode:
         1) Space temperature 1°F below setpoint: Supply fan shall be at minimum speed.
         2) Space temperature 1°F above setpoint: Supply fan shall be at maximum speed.
         3) Space temperature between 1°F below and 1°F above setpoint: Vary linearly.
      b. Heating Mode:

1) Space temperature 1°F below setpoint: Supply fan shall be at maximum speed.
2) Space temperature 1°F above setpoint: Supply fan shall be at minimum speed.
3) Space temperature between 1°F below and 1°F above setpoint: Vary linearly.

c. When space temperatures are between the cooling and heating dead band range, the supply fans shall be at its minimum setpoint.

2. Chilled Water and Reheat Coil Control: The control valves shall modulate based on space temperature, a 2°F (adjustable) deadband shall be utilized to control to a specific discharge air temperature.
   a. Chilled Water Coil Control Valve:
      1) Space temperature 1°F below setpoint: Discharge air temperature 62°F (adj).
      2) Space temperature 1°F above setpoint: Discharge air temperature 55°F (adj).
      3) Space temperature between limits: Vary linearly.
   b. Hot Water Reheat Coil Control Valve:
      1) Space temperature 1°F below setpoint: Discharge air temperature 85°F (adj).
      2) Space temperature 1°F above setpoint: Discharge air temperature 72°F (adj).
      3) Space temperature between limits: Vary linearly.
   c. When space temperatures are between the cooling and heating dead band range, both cooling and heating control valves shall be closed.
3. Dehumidification Mode:
   a. The unit shall enter dehumidification mode if space humidity levels rise above setpoint of 55% RH (adj). There shall be three (3) different stages of dehumidification.
      1) Stage 1 dehumidification (between setpoint and 2% RH above):
         (a) CWC control valve shall modulate to maintain a maximum discharge air temperature of 57F.
      2) Stage 2 dehumidification (2-4% RH above setpoint):
         (a) CWC control valve shall modulate to maintain a discharge air temperature of 55F.
      3) Stage 3 dehumidification (4% RH above setpoint): Before entering Stage 3 dehumidification, space temperatures must be less than or equal to the space setpoint and the heating hot water system must be proven operational, (i.e. boiler and hot water pump(s) active with HWS temp above 100F). If these conditions are not met, the unit shall remain at Stage 2 dehumidification. If these conditions are met, the following shall occur. The unit shall remain in Stage 3 dehumidification until space humidity levels drop to entering Stage 2 conditions, (2% above setpoint).
         (a) Leaving air temperature from CWC (this is different than the units discharge air temperature) shall be set to 53F (adj).
         (b) The fan speed shall be set to 75% of maximum speed.
         (c) The reheat coil shall modulate as required to maintain space temperature setpoint.

E. UV Lights: These units are equipped with UV lights. 120V power is being provided by Division 26 contractor, provide relay's and contacts as required to control UV lights so that the equipment is on only when the supply air fan is operating.

F. OA Damper and Relief Air Control: Specific units are provided with seperate OA connection to unconditioned air and relief air fan.
   1. Units containing OA dampers and Relief air fans are AHU 10.1, 10.2 (any others?)
   2. Units shall be provided with the following:
      a. Space mounted CO2 sensor (install protective cover in gyms).
      b. Modulating OA damper.
      c. VFD for relief air fan.

d. 2-position relief air damper.

3. OA damper shall modulate based on space CO2 levels as follows all points shall be adjustable from the graphics front-end:
   a. Space CO2 level 550 PPM or less: OA damper shall be closed
   b. Space CO2 level 1100 PPM or greater: OA damper shall be 100% opened
   c. Space CO2 level between 550 & 1100 PPM: Vary Linearly
4. The relief air fan's VFD shall be controlled based on the damper position of the OA damper as follows, all points shall be adjustable from the graphics front-end:
   a. OA damper position less than 15% open: Relief air fan shall be off.
   b. OA damper position 15% open: Relief air fan shall be at minimum speed (assume to be 20 hz) and associated damper shall be open.
   c. OA damper position 100% open: Relief air fan shall be at maximum speed (speed to be set by the TAB contractor).
   d. OA damper position between 15% open and 100% open: Vary lineraly.
   e. When the Relief air fan is on, it's associated 2-position damper shall be open.

G. Display Points:
1. DDC system web page
2. Space temperature (if more than one sensor is present show temperature for each sensor and the average temperature)
3. Space humidity level
4. Fan status (on/off/failure to run)
5. Supply fan speed (% of full speed)
6. Discharge air temperature
7. Discharge air temperature setpoint
8. Return air temperature
9. Coiling-coil control valve % of full open (software point, not actual measured)
10. Heating-coil control valve % of full open (software point, not actual measured)
11. Chilled water coil return water temperature
12. Dehumidification mode status
13. OA Damper & Relief Air Control: Required only on select units
    a. Space CO2 Level
    b. OA damper position
    c. Relief fan status
    d. Relief fan speed
    e. Relief damper position

H. Trend Points: The following points shall be trended on a common web page accessible by clicking on an icon from the unit’s system web page.
1. Trend #1:
   a. Fan status
   b. Fan speed
   c. Average space temperature
   d. Space relative humidity
   e. Space CO2 level (
   f. OA damper position (applicable units only)
   g. Relief fan speed (applicable units only)
2. Trend #2
   a. Discharge air temperature
   b. Discharge air temperature set-point
   c. Return air temperature (between OA damper connection and inlet of unit)
   d. Cooling coil control valve % open

e. Heating coil control valve % open
f. Chilled water coil return water temperature

1.12 DEDICATED OUTSIDE AIR UNIT (DOAU) WITH ENERGY RECOVERY WHEEL

A. General: Units consist of supply fan(s) with VFD, exhaust fan(s) with VFD, enthalpy wheel with bypass damper, face & bypass damper, chilled water coil with 2-way modulating control valve, hot water coil with 2-way modulating control valve, 2-way 2-position damper at connection to OA louver and 2-way 2-position at connection to EA damper.
   1. Occupied Mode: The air handling unit shall be placed into operation by the BAS based upon user defined schedule.
   2. Unoccupied Mode: During the unoccupied mode, the supply air fan shall de-activate, exhaust fan de-activate, energy recovery wheel shall de-activate and outside air/exhaust air dampers close.

B. Supply Fan Speed Control:
   1. Before supply fan start, 2-way 2-position OA damper shall open.
   2. A differential air pressure sensor shall prove fan status.
   3. The supply air fan shall be controlled through a unit-mounted variable frequency drive (VFD).
   4. Provide and install a duct mounted pressure sensors 3/4 of the distance out in the system, (field verify location with engineer). The pressure sensors shall control the operation of the supply fan VFD and shall utilize differential pressure optimization.
   5. Differential pressure optimization shall be accomplished by polling all VAV box damper positions and resetting the DP set-point so that at least one VAV damper is 95% open.
   6. The adjustable reset range will be from 0.3” wg to 1.25” wg.

C. Exhaust Fan Speed Control:
   1. Before exhaust fan start, 2-way 2-position EA damper shall open.
   2. Modulate exhaust fans VFD at same percentages as supply fan.

D. Toilet Room Exhaust Control:
   1. General: Two main exhaust trunks are routed directly back to the OA unit, a constant flow Toilet Room Exhaust trunk and a Variable Flow Exhaust trunk.
      a. Toilet Room Exhaust: Provide DP pressure sensor located at manual balancing damper as indicated on drawings. This sensor shall be used to modulate the control damper in the “Variable Flow Exhaust” trunk.
      b. Variable Flow Exhaust Trunk: Provide modulating control damper at location indicated on drawings. This damper shall modulate as required to maintain a constant static pressure drop over manual balancing damper installed in “Toilet Room Exhaust Trunk”. The pressure loss value shall be field calibrated with T&B contractor.

E. Discharge Air Temperature Controls:
   1. A duct mounted discharge air temperature sensor shall control the units face & bypass (F&B) dampers, 2-way chilled water control valve and 2-way hot water valve.
      a. General requirements:
         1) Provide temperature sensor at chilled water coil serpentine across the entire face of the water coil every six inches on center. This temp sensor shall control the operation of the coils control valve.
         2) Provide duct mounted temperature sensor to control the operation of the units F&B damper.
      b. When outdoor air temperature is above 75F (adj):
         1) The energy recovery wheel shall operate, (wheel bypass damper shall be closed).

2) Chilled water valve control: Control of the chilled water control valve shall be dependant on the poisition of the F&B damper. Provide a 5% deadband as follows:
   (a) F&B damper open more than 10% to the chilled water coil the control valve: Modulate as required to maintain a 55F leaving coil temperature.
   (b) F&B damper less than 10% to the chilled water coil: Chilled water valve shall close and remain close until F&B damper is more than 15% open to the coil.
3) Face and bypass damper shall modulate as required to maintain 65F (adj) discharge air temperature.
4) Dehumidification Mode: In the event that dewpoint (DPT) in the variable flow exhaust duct from the building rises to 55F (adj), the discharge air temperature shall be reset as follows:
   (a) DPT temperature 1.5F above DP setpoint = 57F (adj) Discharge air temp
   (b) DPT temperature at DPT setpoint = 65F (adj) Discharge air temp
   (c) Between 1.5F above & setpoint (55DPT) = Vary linearly between 57F & 65F.

c. When outdoor air temperature is between 75 degrees F (adj.) and 60 degrees F (adj.).
   1) The energy recovery wheel shall not operate and its associated bypass damper shall be open.
   2) Chilled water valve control: Control of the chilled water control valve shall be dependant on the poisition of the F&B damper. Provide a 5% deadband as follows
      (a) F&B damper open more than 10% to the chilled water coil the control valve: Modulate as required to maintain a 55F leaving coil temperature.
      (b) F&B damper less than 10% to the chilled water coil: Chilled water valve shall close and remain close until F&B damper is more than 15% open to the coil.
   3) The face and bypass damper shall modulate as required to maintain discharge air temperature.
   4) Dehumidification Mode: Dehumidification mode shall match sequence for when OA temps are above 75F

d. When the outdoor air temperature is below 60°F.
   1) The energy recovery wheel shall operate and the wheels bypass damper shall be closed.
   2) The face and bypass damper shall be in full face mode, (all airflow through the heating coil).
   3) The 2-way hot water control valve shall modulate as required to maintain 65F (adj) discharge air temperature.

F. System Start-up: When a unit has been called to start-up by the BAS, the following shall occur in sequential order:
   1. The units control valve shall open to a minimum position of 50% (adj) or as required to achieve discharge air temperature (whichever is greater) for a minimum period of 15 minutes (adj).
   2. The supply fan shall activate and operate under its normal sequence.
   3. After the start-up period, the valve shall return to its normal operating mode.
      a. The closing speed of the chilled water control valve shall not be allowed to exceed more than 10% per minute (adj) when switch back from Morning Cool-down Mode to normal operations mode.

G. System Shut-down: When a unit has been called to shut-down by the BAS, the following shall occur in sequential order:
   1. The units 2-way control valve shall lock in its current position while SA & EA fans are deactivated.
   2. The SA and EA fans speed shall be reduced to its minimum setting over a period of 5 minutes (adj).
   3. Once SA & EA fans have reached their minimum set-point, the SA and EA fans shall be deactivated.
   4. After SA & EA fans have been deactivated, the units chilled water control valve shall close.
      a. The closing speed of the chilled water control valve shall not be allowed to exceed more than 10% per minute (adj) during System Shut-down mode.

H. Freeze Protection:
   1. Freeze protection wire shall be serpentine across the entire face of the water coil every six inches on center.
      a. A low limit temperature sensor shall be located on the downstream side of the hot water coil.
      b. If a temperature of 40 degrees F (adj.), or less is detected, then the supply air and exhaust air fans shall stop, outside air and exhaust air dampers shall fully close, the hot water control valve shall go full open and an audio/visual alarm shall activate through the BAS.
      c. Upon correction of the problem, the system shall be reset and shall return to normal operation.

I. Temperature Indication: Provide air temperature indication in the supply and return ducts and entering/leaving air temperature to each water coil.

J. UV Disinfection: The UV Disinfection system shall be on when unit is active, provide relays and contactors as required to control manufactured supplied UV lights.

K. Operator Station Display: Indicate the following on operator workstation display terminal:
   1. DDC system graphic.
   2. DDC system on-off indication.
   3. DDC system occupied/unoccupied mode.
   4. Outdoor-air-temperature indication.
   5. Outdoor humidity indication (measured at inlet OA duct)
   6. Outdoor CO2 ppm level, (obtain from FMS).
   7. Enthalpy wheel status, (on/off/failure to start).
   8. Enthalpy wheel inlet exhaust temperature
   9. Enthalpy wheel outlet exhaust temperature
   10. Enthalpy wheel inlet supply temperature
   11. Enthalpy wheel outlet supply temperature
   12. Enthalpy wheel bypass damper position
   13. Supply-fan on-off indication, (on/off/failure to start).
   14. Supply-fan-discharge static-pressure indication.
   15. Supply-fan-discharge static-pressure set point.
   16. Supply-fan airflow rate.
   17. Supply-fan speed.
   18. Exhaust-fan on-off indication, (on/off/failure to start).
   19. Exhaust-fan-discharge static-pressure indication.
   20. Exhaust-fan-discharge static-pressure set point.
   21. Exhaust-fan airflow rate.
   22. Exhaust-fan speed.

23. Face & bypass damper status.
24. Face & bypass damper position.
25. Relative humidity indication, (EA inlet duct and OA outlet duct).
26. Supply filter air-pressure-drop indication.
27. Supply filter low-air-pressure set point.
28. Supply filter high-air-pressure set point.
29. Exhaust filter air-pressure-drop indication.
30. Exhaust filter low-air-pressure set point.
31. Exhaust filter high-air-pressure set point.
32. OA-discharge air-temperature indication, (from sensor mounted in discharge duct).
33. OA-discharge air-temperature set point, (from sensor mounted in discharge duct).
34. Cooling-coil air-temperature indication.
35. Cooling-coil air-temperature set point.
36. Cooling-coil control-valve position (calculated not measured).
37. Chilled water return temperature.
38. Heating-coil air-temperature indication.
39. Heating-coil air-temperature set point.
40. Heating-coil control-valve position (calculated not measured).
41. Freeze stat status.
42. UV Disinfection Status.

L. Trend Points: The following points shall be trended on a common web page accessible by clicking on an icon from the unit's system web page.
   1. DOAU Trend #1: (To be trended on a 5-minute basis)
      a. SA fan speed
      b. Energy wheel status
      c. DPT
      d. Discharge air temperature setpoint
      e. Discharge air temperature
      f. Face & Bypass Damper Position
      g. CHWR temperature
   2. DOAU Trend #2: (To be trended on a 5-minute basis)
      a. Supply duct static pressure
      b. Toilet exhaust static pressure
      c. General exhaust duct damper position
   3. DOAU Trend #3
      a. Chilled Control valve % opened
      b. Hot Control valve % opened
      c. Face & Bypass Damper Position
      d. Chilled water return water temperature
   4. VAV AHU Trend #3: (To be trended on a 5-minute basis)
      a. Provide trend of damper position for all terminal boxes connected to unit on one common page.

1.13 CONSTANT VOLUME LAB AIR HANDLING UNIT WITH ENERGY RECOVERY WHEEL & HEAT PIPE

A. General: Unit is a constant volume that provides both conditioning and make-up air to lab spaces. Note the lab spaces require 1.0 cfm EA per sqft, the required cooling airflow is signifiantly less than the amount of code required exhausts, therefore the unit layout and configuration is designed to reduce the amount of reheat required to maintain space temperatures. The unit consit of the following components:
   1. Supply & Exhaust Fan(s) with VFD

2. Enthalpy wheel with bypass damper around wheel.
3. Enthalpy wheel bypass damper between EA and OA sections (for morning warm-up/cool down).
4. Chilled water coil with 2-way modulating control valve
5. Hot water coil with 2-way modulating control valve
6. Wrap-around heat pipe for four (4) stages
7. 2-way 2-position damper at connection to OA intake
8. 2-way 2-position at connection to EA duct at discharge.

B. Modes of Operation
   1. Occupied Mode: The air handling unit shall be placed into operation by the BAS based upon user defined schedule.
      a. Energy Recovery Wheel: Energy recovery wheel shall be under normal control
      b. Energy Recovery Wheel Bypass Damper Between OA & EA streams: Damper shall be closed.
   2. Unoccupied Mode: While in morning start-up mode air shall be directly circuilated from the space through the unit and back to the space.
      a. Energy Recovery Wheel: Energy recovery wheel shall be off
      b. Energy Recovery Wheel Bypass Damper Between OA & EA streams: Damper shall be open allowing recirculation of air to and from the space it conditions.
      c. OA and EA Discharge Dampers: Closed.
   3. Morning Start-up: While in morning start-up mode air shall be directly circuilated from the space through the unit and back to the space.
      a. Energy Recovery Wheel: Energy recovery wheel shall be off
      b. Energy Recovery Wheel Bypass Damper Between OA & EA Streams: Bypass damper shall be open allowing recirculation of air to and from the space it conditions.
      c. OA and EA Discharge Dampers: Closed.

C. Supply Fan Speed Control:
   1. Before supply fan start, 2-way 2-position OA damper shall open.
   2. A differential air pressure sensor shall prove fan status.
   3. The supply air fan shall be controlled through a unit-mounted variable frequency drive (VFD).
   4. Provide and install a duct mounted pressure sensors 3/4 of the distance out in the system, (field verify location with engineer). The pressure sensors shall control the operation of the supply fan VFD and shall utilize differential pressure optimization.
   5. Differential pressure optimization shall be accomplished by polling all VAV box damper positions and resetting the DP set-point so that at least one VAV damper is 95% open.
   6. The adjustable reset range will be from 0.3” wg to 1.25” wg.

D. Exhaust Fan Speed Control:
   1. Before exhaust fan start, 2-way 2-position EA damper shall open.
   2. The exhaust speed shall be set by TAB contractor and shall operate at a constant speed.

E. Hot and Chilled Water Control Valve Control: Under normal operating conditions, the hot and chilled water control valves shall not be open at the same time. The only exception to this rule is when a freeze stat is tripped.
   1. Hot Water Coil Control: The control valves shall modulate in response to the average space temperature. The BAS system shall poll each individual space on a 5-minute basis to determine the average space temperature. A 2°F average space temperature deadband shall be used, discharge air temperature shall be determined as follows:
      a. Averge Space temperature 1°F below heating setpoint: Heating coil discharge air temperature 70°F (adj).

b. Average Space temperature 1°F above heating setpoint: Heating coil discharge air temperature 60°F (adj).
c. Space temperature between limits: Vary linearly.

2. Chilled Water Coil Control: The control valves shall modulate in response to the average space temperature. The BAS system shall poll each individual space on a 5-minute basis to determine the average space temperature. A 4°F average space temperature deadband shall be used as follows: Discharge air temperature shall be determined as follows:
   a. Averge Space temperature 2°F below cooling setpoint: Cooling coil discharge air temperature 65°F (adj).
   b. Average Space temperature 2°F above cooling setpoint: Cooling coil discharge air temperature 55°F (adj).
   c. Space temperature between limits: Vary linearly.

F. Wrap-Around-Heat Pipe Coil Control: The heat pipe shall be available for reheat only when the entering air temperature to the inlet side of the upstream heat pipe coil is 5°F (adj) greater than the discharge air temperature from the chilled water coil, if this condition is not met, all solenoid valves shall be closed. The heat pipe is provided with 4 stages of reheat, the 4 stages of reheat shall be controlled based on a 0.5°F dead band. For control of the heat pipe individual solenoid valves, the space mounted temperature sensor shall be polled on a 5-minute basis.
   1. If the space temperature is more than 0.5°F below setpoint when polled, a solenoid valve shall open.
   2. If space temperature is at or above setpoint when polled, a solenoid valve shall be closed.

G. Dehumidification Control:
   1. General: It is assumed that this unit will operate in the Dehumidification mode for a signifiant amount of time.
   2. Provide unit with a duct mounted DPT sensor mounted in the exhaust air stream at the inlet of the unit. The unit shall enter dehumidification mode if exhaust DPT levels rise above setpoint of 55°F DPT (adj). While in dehumidification mode, the leaving chilled water coil air temperature shall be reset down. A 2°F DPT deadband shall be used to determine the leaving chilled water setpoint.
      a. Exhaust DPT level at or below setpoint: Discharge air temp to match programed setpoint as defined under “Chilled Water Coil Control”.
      b. Exhaust DPT level 2°F above setpoint: Discharge air temperature from chilled water coil = 55°F (adj).
      c. Exhaust DPT temperature with-in dead band range: Vary linearly.
   3. While in dehumidification mode, the average space temperature shall not be allowed to drop more than 3°F below the space cooling setpoint. In the event space temperatures drop to this temperature, the Heating Hot Water System shall be activated if currently deactivated allowing the zone reheat coils to modulate to maintain space temperature that 2°F below setpoint.
      a. The heating hot water command shall be canceled when the DPT rises to 1°F above setpoint.

H. Energy Recovery Wheel Control:
   1. When outdoor air temperature is above 75°F (adj):
      a. The energy recovery wheel shall operate, (wheel bypass damper shall be closed).
   2. When outdoor air temperature is between 72°F (adj.) and 60°F (adj.).
      a. The energy recovery wheel shall not operate and its associated bypass damper shall be open.
   3. When the outdoor air temperature is below 60°F.
      a. The energy recovery wheel shall operate and the wheels bypass damper shall be closed.

I. System Start-up: When a unit has been called to start-up by the BAS, the following shall occur in sequential order:
   1. The units control valve shall open to a minimum position of 50% (adj) or as required to achieve discharge air temperature (whichever is greater) for a minimum period of 15 minutes (adj).
   2. The supply fan shall activate and operate under its normal sequence.
   3. After the start-up period, the valve shall return to its normal operating mode.
      a. The closing speed of the chilled water control valve shall not be allowed to exceed more than 10% per minute (adj) when switch back from Morning Cool-down Mode to normal operations mode.

J. System Shut-down: When a unit has been called to shut-down by the BAS, the following shall occur in sequential order:
   1. The units 2-way control valve shall lock in its current position while SA & EA fans are deactivated.
   2. The SA and EA fans speed shall be reduced to its minimum setting over a period of 5 minutes (adj).
   3. Once SA & EA fans have reached their minimum set-point, the SA and EA fans shall be deactivated.
   4. After SA & EA fans have been deactivated, the units hot and chilled water control valves shall close if open.
      a. The closing speed of the chilled water control valve shall not be allowed to exceed more than 10% per minute (adj) during System Shut-down mode.

K. Freeze Protection:
   1. Freeze protection wire shall be serpentine across the entire face of the water coil every six inches on center.
      a. A low limit temperature sensor shall be located on the downstream side of the hot water coil.
      b. If a temperature of 40°F (adj.), or less is detected, then the supply air and exhaust air fans shall stop, outside air and exhaust air dampers shall fully close, the hot water control valve shall go full open and an audio/visual alarm shall activate through the BAS.
      c. Upon correction of the problem, the system shall be reset and shall return to normal operation.

L. Temperature Indication: Provide air temperature indication in the supply and return ducts and entering/leaving air temperature to each water coil.

M. UV Disinfection: The UV Disinfection system shall be on when unit is active, provide relays and contactors as required to control manufactured supplied UV lights.

N. Operator Station Display: Indicate the following on operator workstation display terminal:
   1. DDC system graphic.
   2. DDC system on-off indication.
   3. DDC system occupied/unoccupied mode.
   4. Outdoor-air-temperature indication.
   5. Outdoor humidity indication (measured at inlet OA duct)
   6. Outdoor CO2 ppm level, (obtain from FMS).
   7. Enthalpy wheel status, (on/off/failure to start).
   8. Enthalpy wheel inlet exhaust temperature
   9. Enthalpy wheel outlet exhaust temperature
   10. Enthalpy wheel inlet supply temperature
   11. Enthalpy wheel outlet supply temperature
   12. Enthalpy wheel bypass damper position

13. Supply-fan on-off indication, (on/off/failure to start).
14. Supply-fan-discharge static-pressure indication.
15. Supply-fan-discharge static-pressure set point.
16. Supply-fan airflow rate.
17. Supply-fan speed.
18. Exhaust-fan on-off indication, (on/off/failure to start).
19. Exhaust-fan-discharge static-pressure indication.
20. Exhaust-fan-discharge static-pressure set point.
21. Exhaust-fan airflow rate.
22. Exhaust-fan speed.
23. Face & bypass damper status.
24. Face & bypass damper position.
25. Relative humidity indication, (EA inlet duct and OA outlet duct).
26. Supply filter air-pressure-drop indication.
27. Supply filter low-air-pressure set point.
28. Supply filter high-air-pressure set point.
29. Exhaust filter air-pressure-drop indication.
30. Exhaust filter low-air-pressure set point.
31. Exhaust filter high-air-pressure set point.
32. OA-discharge air-temperature indication, (from sensor mounted in discharge duct).
33. OA-discharge air-temperature set point, (from sensor mounted in discharge duct).
34. Cooling-coil air-temperature indication.
35. Cooling-coil air-temperature set point.
36. Cooling-coil control-valve position (calculated not measured).
37. Chilled water return temperature.
38. Heating-coil air-temperature indication.
39. Heating-coil air-temperature set point.
40. Heating-coil control-valve position (calculated not measured).
41. Freeze stat status.
42. UV Disinfection Status.

O. Trend Points: The following points shall be trended on a common web page accessible by clicking on an icon from the unit's system web page.
    1. DOAU Trend #1: (To be trended on a 5-minute basis)
        a. SA fan speed
        b. Energy wheel status
        c. DPT
        d. Discharge air temperature setpoint
        e. Discharge air temperature
        f. Face & Bypass Damper Position
        g. CHWR temperature
    2. DOAU Trend #2: (To be trended on a 5-minute basis)
        a. Supply duct static pressure
        b. Toilet exhaust static pressure
        c. General exhaust duct damper position
    3. DOAU Trend #3
        a. Chilled Control valve % opened
        b. Hot Control valve % opened
        c. Face & Bypass Damper Position
        d. Chilled water return water temperature
    4. VAV AHU Trend #3: (To be trended on a 5-minute basis)

a. Provide trend of damper position for all terminal boxes connected to unit on one common page.

1.14 KITCHEN AIR HANDLING UNIT (UNIT WITH WRAP AROUND COIL AND MELINK CONTROLS)

A. General: Unit shall consist of the following components:
1. Flat Plate type space temperature sensor.
2. Space mounted humidity sensor.
3. Supply fan with VFD.
4. Provide current switch to prove fan status.
5. Hot water pre-heat coil with modulating 2-way control valve.
6. Chilled water coil with modulating 2-way control.
7. Wrap-around heat pipe reheat coil with 4-stages of control.
8. Hot water reheat coil.
9. OA & RA control dampers.
10. Kitchen exhaust fans (KEF) KEF-1A and KEF-1B.
11. Space temperature setpoint shall be input through the unit's web page, a minimum of 4°F offset shall be provided between the heating and cooling setpoints. At start-up the unit shall have a space cooling setpoint of 73F (adj) and heating setpoint of 68F (adj).

B. Modes of Operation: There shall be two (2) different modes of control for this unit.
1. Mode-1: In general, temperature control with-in the space is accomplished by varying fan speed.
a. The RA damper shall be 100% open and the OA damper shall be 100% closed when operating in Mode-1.
2. Mode-2: Total airflow supplied to the space is determined by the speed of the various operating kitchen exhaust fans (KEFs) with space temperature control by varying supply air temperature.
a. The RA damper shall be 100% closed and the OA damper shall be 100% open when operating in Mode-2.

C. Space Temperature Sensor Types: Flat Plate type.

D. Supply Air Fan Control, Mode-1: The supply air fan shall modulate based on space temperature, a 4°F (adjustable) dead band shall be utilized to control the fans speed for cooling mode and a 2°F dead band for heating. Mode-1 minimum CFM shall be set to 1500 CFM; Mode-1 maximum CFM shall be set to 2000 CFM. Fan speed shall modulate as follows:
a. Cooling Mode:
1) Space temperature 2°F below setpoint: Supply fan shall be at minimum speed.
2) Space temperature 2°F above setpoint: Supply fan shall be at Mode-1 maximum speed.
3) Space temperature between 2°F below and 2°F above setpoint: Vary linearly.
b. Heating Mode:
1) Space temperature 1°F below setpoint: Supply fan shall be at Mode-1 maximum speed.
2) Space temperature 1°F above setpoint: Supply fan shall be at minimum speed.
3) Space temperature between 1°F below and 1°F above setpoint: Vary linearly.
c. When space temperatures are between the cooling and heating dead band range, the supply fans shall be at its minimum setpoint.

E. Supply Air Fan Control, Mode-2: The supply fan speed shall modulate based on the total exhaust from the operating kitchen exhaust fans. The minimum speed shall match that of Mode-1 with max speed matching the AHU's units scheduled value. The total amount of kitchen exhaust shall be determined as follows:

1. Kitchen Hood Control Panel (Melink) will provide a weighted average 0-10V signal via. hardwired connection that represents the total kitchen exhaust. The AHU VFD shall modulate based on the control signal as follows
    a. Weighted average less than 1V: Kitchen AHU supply fan shall operate under Mode-1 sequence.
    b. Weighed average equal to 1V: Kitchen AHU fan speed shall be as required to supply 2,000 cfm (minimum airflow under Mode 2).
2. Chilled Water Coil Control: The control valves shall modulate to maintain discharge air temperature based on a 4°F (adj) cooling space temperature dead band.
    a. Space temperature 2°F below cooling setpoint: Cooling coil discharge air temperature 62°F (adj).
    b. Space temperature 2°F above cooling setpoint: Cooling coil discharge air temperature 55°F (adj).
    c. Space temperature between limits: Vary linearly.

F. Pre-Heat Coil Temperature Control: The control valve shall modulate as required to maintain a leaving air temperature of 50F (adj). The control valve shall be closed when entering air temperatures are above 50F (adj).

G. Chilled Water Coil Control: The control valves shall modulate to maintain discharge air temperature based on a 4°F (adj) cooling space temperature dead band.
1. Space temperature 2°F below cooling setpoint: Cooling coil discharge air temperature 62°F (adj).
2. Space temperature 2°F above cooling setpoint: Cooling coil discharge air temperature 55°F (adj).
3. Space temperature between limits: Vary linearly.

H. Wrap-Around-Heat Pipe Coil Control: The heat pipe shall be available for reheat only when the entering air temperature to the inlet side of the upstream heat pipe coil is 5°F (adj) greater than the discharge air temperature from the chilled water coil, if this condition is not met, all solenoid valves shall be closed. The heat pipe is provided with 4 stages of reheat, the 4 stages of reheat shall be controlled based on a 0.5F dead band. For control of the heat pipe individual solenoid valves, the space mounted temperature sensor shall be polled on a 5-minute basis.
1. If the space temperature is more than 0.5F below setpoint when polled, a solenoid valve shall open.
2. If space temperature is at or above setpoint when polled, a solenoid valve shall be closed.

I. Reheat Coil Control: The control valves shall modulate to maintain a heating space temperature dead band of 1°F with exceptions as noted under the dehumidification sequence.
1. Space temperature 1°F below heating setpoint: Discharge air temperature 80°F (adj).
2. Space temperature 1°F above heating setpoint: Discharge air temperature 72°F (adj).
3. Space temperature between limits: Vary linearly.
4. When space temperatures are between the cooling and heating dead band range the reheat coil control valve shall be closed.

J. Dehumidification Control:
1. Provide unit with a space mounted humidity sensor, coordinate location of sensor with engineer if not indicated on the drawings. The unit shall enter dehumidification mode if space humidity levels rise above setpoint of 55% RH (adj). While in dehumidification mode, the leaving chilled water coil air temperature shall be reset down. A 4% humidity dead band shall be used to determine the leaving chilled water setpoint.
    a. Space humidity level at or below setpoint: Discharge air temp to match programed setpoint as defined under “Chilled Water Coil Control”.
    b. Space humidity level 4% above setpoint: Discharge air temperature from chilled water coil = 53F (adj).

c. Space humidity levels with-in dead band range: Vary linearly.

2. While in dehumidification mode, the space temperature shall not be allowed to drop more than 2F below the space cooling setpoint. In the event space temperatures drop to this temperature, the Heating Hot Water System shall be activated if currently deactivated and the reheat coil shall modulate to maintain space temperature that is 2°F below setpoint.

K. Freeze Protection:
1. Freeze protection wire shall be serpentine across the entire face of the pre-heat coil every six inches on center.
   a. A low limit temperature sensor shall be located on the downstream side of the hot water coil.
   b. If a temperature of 40 degrees F (adj.), or less is detected, the supply air fan shall stop, OA dampers shall fully close, RA damper shall fully open, the pre-heat hot water control valve shall full open and an alarm shall activate through the BAS.
   c. Upon correction of the problem, the system shall be manually reset and shall return to normal operation.

L. UV Lights: These units are equipped with UV lights. 120V power is being provided by Division 26 contractor, provide relays and contacts as required to control UV lights so that the equipment is on only when the supply air fan is operating.

M. Display Points:
1. DDC system web page
2. Space temperature (if more than one sensor is present show temperature for each sensor and the average temperature)
3. Space humidity level
4. Dehumidification mode stage
5. Fan status (on/off/failure to run)
6. Supply fan speed (% of full speed)
7. Supply fan cfm (this is based on the fan speed, not a separate airflow monitor)
8. Exhaust fan cfm for each KEFs, (via hardwired Melink weighted average)
9. Totaled exhaust cfm from all KEFs
10. Return air temperature
11. Pre-heat coil entering air temperature
12. Pre-heat coil discharge air temperature
13. Pre-heat coil freeze stat status
14. Upstream heat pipe coil entering air temperature (this is the coil upstream of the chilled water coil)
15. Chilled water coil entering air temperature
16. Chilled water coil leaving air temperature
17. Heat-pipe reheat coil LAT
18. Heat-pipe coil, number of solenoid valves open
19. How Water Reheat coil discharge air temperature
20. Hot Water pre-heat coil control valve % of full open (software point, not actual measured)
21. Coiling-coil control valve % of full open (software point, not actual measured)
22. Hot water reheat heating-coil control valve % of full open (software point, not actual measured)
23. Chilled water coil return water temperature
24. Airflow monitoring station (inlet air probe preferred).
25. Kitchen Exhaust Fan status via CT
26. Kitchen Hood Control Panel Emergency Contacts

N. Trend Points: The following points shall be trended on a common web page accessible by clicking on an icon from the unit’s system web page.

1. Trend No. 1: Airflow Trends
    a. Supply fan CFM (to be based on SAF VFD speed, coordinate with TAB)
    b. Each individual KEF CFM
    c. Total combined exhaust CFM from KEFs (to be based on KEF's VFD speed, coordinate with TAB).
    d. Average space temperature
    e. Space relative humidity
2. Trend No. 2: Temperature Trends
    a. Average space temperature
    b. Space relative humidity
    c. Chilled water coil discharge set-point
    d. Upstream heat pipe coil entering air temperature
    e. Chilled water coil entering air temperature
    f. Chilled water coil leaving air temperature
    g. Downstream heat pipe coil leaving air temperature
    h. Pre-heat coil discharge air temperature
    i. Cooling coil control valve % open
    j. Pre-heat coil control valve % open
    k. Reheating coil control valve % open
    l. Heat pipe coil, number of solenoid valves open
    m. Chilled water coil return water temperature
3. Trend No. 3: Heat-Pipe Temperature Trends
    a. Number of heat-pipe valves open
    b. Heat-pipe pre-conditioning coil EAT
    c. Heat-pipe pre-conditioning coil LAT (this is the same as chilled water coil EAT)
    d. Heat-pipe reheat coil EAT (this is the same as the chilled water coil LAT)
    e. Heat-pipe reheat coil LAT
    f. Hydronic reheat coil LAT

1.15 FAN-COIL UNIT CONTROL

A. Fan-Coil Unit with Chilled and Hot Water Coil
1. General: Fan-coils consist of ECM supply motor, 2-way chilled water coil control valve, 2-way hot water coil control valve and condensate overflow switch.
    a. Provide and install condensate overflow alarm that will stop unit on alarm
2. Space Temperature Sensor Types: Flat Plate type.
3. Occupancy: Terminal boxes shall be placed into operation based on a time of day schedule through the front-end control system.
4. Space Temperature Control, Cooling: When cooling is required, modulate supply fan and chilled water control valve as required to maintain space temperature setpoint. (Heating valve shall be closed at this time).
5. Space Temperature Control, Heating: When heating is required, modulate supply fan and hot water control valve as required to maintain space temperature setpoint. (Heating valve shall be closed at this time).
6. Central Plant Fan-coil Units:
    a. The central plant FCU's are provided with OA connection and automatic control damper.
    b. The control damper shall open and close based on space occupancy. Two (2) occupancy sensor shall be used to control the central plant general exhaust fan and OA damper. The OA damper shall remain open and exhaust fan on for a period of 5-minutes (adj) after occupancy was last detected.
7. Display:

a. DDC system graphic
b. Room/area served
c. Space temperature
d. Space temperature setpoint
e. Discharge air temperature
f. Chilled water control valve position as a percent of full
g. Hot water control valve position as a percent of full
h. Condensate overflow alarm

8. Trends: The following points shall be trended on a common web page accessible from the unit's web page.
   a. Fan status
   b. Space temperature
   c. Discharge air temperature
   d. Chilled water control valve position
   e. Hot water control valve position

1.16 TERMINAL UNIT OPERATING SEQUENCES

A. General Requirements: When a Terminal box for space cooling and terminal box for OA control are located in the same room and serve the same area, they shall be displayed on the same web page.

B. Space Temperature Sensor Types: Flat Plate type shall be installed through-out with limited exceptions in the Administration Suite.
   1. Refer to detail on drawings for temperature sensors located in:
      a. Principal's Office
      b. Conference Room
      c. Teachers Training Room.

C. Series Fan Powered VAV Box, (FVAV) with Electric Heating
   1. Occupancy: Terminal boxes shall be active when associated AHU is operational.
      a. Unit Shut-down: When the terminal units associated AHU has been shut down, the air valve in the terminal box shall 1st modulate to 100% open, then modulate closed then modulate back to 50% open. The damper shall remain 50% open until after the SAF has started, after unit operation has been proved, the unit shall operate per this sequence.
   2. Space Temperature Control:
      a. The supply fan shall be balanced to connected grille total listed on the drawings.
      b. When cooling is required, the air valve shall modulate between its minimum and maximum setting as required to maintain space temperature, (the maximum setting shall equal the total airflow connected to the terminal box).
      c. In the event that space temperatures drop 2F (adj) below cooling set point, the air valve shall go 100% closed.
      d. If heating is required, the supply air damper shall fully close and the electric heating coil shall modulate as required to satisfy set-point temperature.
   3. Display:
      a. DDC system graphic.
      b. Room/area served.
      c. Maximum set point, (GRD Total).
      d. Room temperature indication.
      e. Room temperature set point.
      f. Air-damper position as percent open.
      g. Airflow.
      h. Electric heating coil status/percent of load.

4. Diagnostic Trends: The following points shall be trended on a common web page accessible from the terminal box's web page.
    a. Space temperature setpoint
    b. Space temperature
    c. Airflow
    d. Air-damper position as percent open.
    e. Discharge air temperature
    f. Percent of full load heating.

D. Single Inlet Terminal Box, (VAV) for cooling only
1. General: This box provides cooling to the MDF room and other similar spaces.
2. Occupancy:
    a. Occupied Mode: The terminal unit shall be placed into operation by the BAS based upon user defined schedule.
    b. Unoccupied Mode: During the unoccupied mode, the terminal box shall stroke 100% closed then modulate back to a 50% open position.
3. Air Valve Control: The air valve shall modulate from 0 – CFM listed on drawings as required to maintain space temperature set-point.
4. Display:
    a. DDC system graphic.
    b. Space Temp Set-point
    c. Space Temperature
    d. Airflow.
    e. Air-damper position as percent open.
5. Diagnostic Trends: The following points shall be trended on a common web page accessible from the terminal box's web page.
    a. Airflow
    b. Air-damper position as percent open.

E. Single Inlet Terminal Box, (VAV) with Electric Heating Coil
1. General:
    a. This box provides cooling and heating to occupied spaces.
    b. The box is provide with air, control valve and electric heater with an SCR controller.
2. Occupancy:
    a. Occupied Mode: The terminal unit shall be placed into operation by the BAS based upon user defined schedule.
    b. Unoccupied Mode: During the unoccupied mode, the terminal box shall stroke 100% closed then modulate back to a 50% open position.
3. Space Temperature Control:
    a. General:
        1) Boxes shall be provided with a minimum and maximum setpoint. On select boxes, the minimum and maximum setpoints are equal.
        2) General: Provide a 4°F (adj) offset between the heating and cooling setpoints.
            (a) The minimum offset between cooling and heating setpoints shall be 3°F.
    b. Air Valve Control: The air valve shall modulate as required to maintain the desired airflow to the space.
        1) Space temperatures 1°F above cooling setpoint: Air valve shall be at its maximum setpoint.
        2) Space temperatures 1°F below below setpoint: Air valve shall be at its minimum setpoint.
        3) Space temperature between 1°F above and 1°F below setpoint: Vary linearly.
    c. Electric Heating Coil SCR Control:

1) Space temperatures 1°F above setpoint: The electric heating coil is off.
2) Space temperatures 1°F below below setpoint: The electric heating coil is at full power.
3) Space temperature between 1°F above and 1°F below setpoint: Vary linearly.

4. Display:
   a. DDC system graphic.
   b. Space Temp Set-point
   c. Space Temperature
   d. Airflow.
   e. Air-damper position as percent open.
   f. Electric heating coil percent of full power.
5. Diagnostic Trends: The following points shall be trended on a common web page accessible from the terminal box's web page.
   a. Airflow
   b. Air-damper position as percent open.
   c. Electric heating coil percent of full power.

F. Single Inlet Terminal Box, (VAV) with hydronic heating coil
1. General:
   a. This box provides cooling and heating to occupied spaces.
   b. The box is provided with air control valve and hydronic coil with modulating control valve.
2. Occupancy:
   a. Occupied Mode: The terminal unit shall be placed into operation by the BAS based upon user defined schedule.
   b. Unoccupied Mode: During the unoccupied mode, the terminal box shall stroke 100% closed then modulate back to a 50% open position.
3. Space Temperature Control:
   a. General:
      1) Boxes shall be provided with a minimum and maximum setpoint. On select boxes, the minimum and maximum setpoints are equal.
      2) General: Provide a 4°F (adj) offset between the heating and cooling setpoints.
         (a) The minimum offset between cooling and heating setpoints shall be 3°F.
   b. Air Valve Control: The air valve shall modulate as required to maintain the desired airflow to the space.
      1) Space temperatures 1°F above cooling setpoint: Air valve shall be at its maximum setpoint.
      2) Space temperatures 1°F below below setpoint: Air valve shall be at its minimum setpoint.
      3) Space temperature between 1°F above and 1°F below setpoint: Vary linearly.
   c. Hot Water Valve Control:
      1) Space temperatures 1°F above setpoint: Hot water control valve shall be closed.
      2) Space temperatures 1°F below below setpoint: Hot water control valve shall be 100% open.
      3) Space temperature between 1°F above and 1°F below setpoint: Vary linearly.
4. Display:
   a. DDC system graphic.
   b. Space Temp Set-point
   c. Space Temperature
   d. Airflow.
   e. Air-damper position as percent open.
   f. Hot-water control valve position as percent open.

5. Diagnostic Trends: The following points shall be trended on a common web page accessible from the terminal box's web page.
    a. Airflow
    b. Air-damper position as percent open.
    c. Hot water control valve position.

G. Single Inlet Terminal Box, (VAV) for Space CO2 Control
1. General: This box is connected to OA Unit and is used to control space CO2 levels. It is a variable volume box.
2. Occupancy:
    a. Occupied Mode: The terminal unit shall be placed into operation by the BAS based upon user defined schedule.
        1) Unit Shutdown: When the terminal units associated AHU has been shut down, the air valve in the terminal box shall 1st modulate to 100% open, then modulate closed then modulate back to its minimum position. The damper shall remain at its minimum position until after the SAF has started, after unit operation has been proved, the unit shall operate per this sequence.
    b. Unoccupied Mode: During the unoccupied mode, the terminal box shall stroke 100% closed then modulate back to a 50% open position.
3. Space CO2 Control:
    a. Obtain space CO2 differential from the Facility Monitoring System.
    b. The variable air inlet damper shall modulate between the minimum and maximum air flow rates as required to maintain a space differential of 500 ppm (adj) between OA and space CO2 levels.
4. Display:
    a. DDC system graphic.
    b. Room/area served.
    c. Minimum set point.
    d. Maximum set point.
    e. CO2 differential, (from FMS)
    f. Room occupied/unoccupied.
    g. Air-damper position as percent open.
    h. Actual airflow.
5. Diagnostic Trends: The following points shall be trended on a common web page accessible from the terminal box's web page.
    a. Airflow
    b. Air-damper position as percent open.
    c. Space CO2 DP

H. Single Inlet Terminal Box, (CAV)
1. General: This box is connected to OA unit and provides code required ventilation to the space. It is a constant volume box and is NOT controlled by space CO2 levels.
2. Occupancy:
    a. Occupied Mode: The terminal unit shall be placed into operation by the BAS based upon user defined schedule.
    b. Unoccupied Mode: During the unoccupied mode, the terminal box shall stroke 100% closed then modulate back to a 50% open position.
3. Air Valve Control: The air valve shall modulate as required to maintain a constant air volume as indicated on drawings.
4. Display:
    a. DDC system graphic.
    b. Room/Area/AHU served.
    c. CFM Set-point, (terminal box is constant volume).

d. Room occupied/unoccupied.
e. Air-damper position as percent open.
f. Actual airflow.

5. Diagnostic Trends: The following points shall be trended on a common web page accessible from the terminal box's web page.
   a. Airflow
   b. Airflow setpoint
   c. Air-damper position as percent open.

1.17 GENERAL EXHAUST FAN CONTROL

A. General: Where exhaust fans are provided for general exhaust purposes, (refer to plans for actual location), interlock exhaust fan with air handling unit servicing general area. Provide and install CT on motor for status check.

B. Display:
   1. DC system graphic.
   2. Exhaust fan status
   3. Occupancy status.

1.18 EXHAUST FAN CONTROL WITH OCCUPANCY SENSOR

A. General: Where occupancy sensor(s) are indicated for fan control, provide sensor and required contractor and relay control wiring as required to start fan when space is occupied.

B. Display:
   1. DC system graphic.
   2. Exhaust fan status
   3. Occupancy status.

1.19 DISHWASHER HOOD EXHAUST SYSTEM

A. General: Interlock dishwasher with exhaust fan. Provide and install CT on motor for status check.

B. Display:
   1. DDC system graphic.
   2. Exhaust fan status.
   3. Dishwasher fan status.

1.20 KITCHEN REFRIGERATOR AND FREEZER

A. General: Provide a wall-mounted temperature sensor in the walk-in refrigerator and freezer units to monitor temperature.
   1. If temperatures exceed a pre-designated set-point (adj) an alarm shall be generated at the BAS

B. Display and Trend Points: Provide display for freezer and cooler and trend points on a 5-minute basis.

1.21 HIGH VOLUME LOW SPEED CEILING FAN

A. General: These fans are being provided with local speed control by the manufacture. Provide start/stop signal via occupancy schedule. Coordinate requirements with fan manufacture

B. Display:
   1. DDC system graphic.
   2. Fan status.

1.22 VENTILATION FANS

A. General: These fans are being provided cooling of IT closets and storage spaces in buildings on the site located at the atheletic fields, refer to drawings and schedules for quantity and

locations. Provide the following devices for these spaces:
1. Provide space mounted line voltage temperature sensor to control fan. Line voltage stat shall be set to maintain 80F space temperature.
2. Fan CT to monitor status.
3. Room temperature sensor for monitoring temperature through BAS system.

B. Display:
1. DDC system graphic.
2. Fan status via CT.
3. Space temperature.

C. Alarms:
1. Alarm in the event that temperatures exceed 88F (adj).

1.23 DUCTLESS SPLIT SYSTEMS, IT CLOSET COOLING

A. General: Ductless split systems shall operate under their own control, install and wire manufacturer provided thermostat. Provide the following additional controls components:
1. Condensate overflow alarm in drain pan.
2. Wall mounted temperature sensor to allow monitoring of space temperature

B. Display:
1. Space temperature.
2. Space temperature alarm (alarm when space temp reaches 78F (adj))
3. Condensate overflow alarm

1.24 DUCTLESS SPLIT SYSTEMS, GENERAL CONDITIONING

A. General: Ductless split systems shall operate under their own control, install and wire manufacturer provided thermostat. Condensing units are provided with dry-contacts for on/off control and scheduling by BAS. Note, many of these units are located in remote buildings such as concession stands and press boxes out on the site.

B. Provide condensate overflow in drain pan.

C. Occupancy Scheduling:
1. The unit shall be scheduled through the BAS system.
2. Timed Override:
a. Where indicated on the plans, install a timed override button. When activated, the unit shall operate for a period of 2-hours (adj).

D. Display:
1. Unit status (programmed not via CT)
2. Condensate overflow alarm

1.25 EXTERIOR LIGHTING CONTROL

A. General: Mechanically held contactor type relay panels are being provided for building site-lighting control. Refer to lighting control detail located on drawing E602 & E701 for additional requirements. Provide connection to all lighting control panels indicated on electrical panels including:
1. Elec 118: Panel LC1E
2. Elec 215: Panels LC1
3. Elec 412: Panels LC4 & LC4E
4. Elec 714: Panels LC7 & LC7E
5. Mech/Elec 1324: Panels LC13 & LC13E
6. Concessions 2200: LCTC & LCTCE: Two (2) seperate lighting control schedules are required as follows
a. Concession stand interior lighting.

b. General athletic exterior site lighting.

7. Concessions 2300: LCBC & LCBCE- Provide control of the two individual lighting zones.
   a. Concession stand interior lighting.
   b. General athletic exterior site lighting.

B. Lighting Control: Provide time of day control via exterior lighting schedule, both lighting controllers shall use a common schedule.

C. Time Out Override: Provide "Time Override Buttons" and locate as follows:
   1. Provide Override Button in Admin Suite to control lighting circuits powered from High School, (LC1, LC1E, LC4, LC4E, LC7, LC7E, LC13 & LC13E). On activation of button, the exterior lighting shall operate for a period of 1-hr (adj).
   2. Provide two (2) Override buttons in the Concession Stand.
      a. Button #1 shall activate all of the exterior athetlic buildings exterior lighting for a period of 1-hr (adj).
      b. Button #2 shall activate the Concession Stand interior lighting.

D. Display:
   1. Status
   2. Lighting schedule

1.26 RELAY LIGHTING PANELS

A. General: Relay type lighting control panels have been provided for control of specific interior lighting. Refer to lighting control details located on electrical drawings for additional information. All interior lighting control panels shall share a common time of day schedule. Provide connection to the following relay lighting control panels:
   1. Elec 412: Panel LR4
   2. Elec 714: Panels LR7
   3. Main Elec 1002.2: Panel LR10
   4. Mech/Elec 1324: LR13
   5. Elec 1624: LR16

B. Lighting Control Schedules: Provide individual time of day schedules for the following areas:
   1. Dinning Room, Main Lobby and Main Corridor.
   2. Gym and Gym Lobby
   3. Auditorium Lobby

C. Display:
   1. Status
   2. Lighting schedule

1.27 SHELTER IN PLACE

A. General: A wall mounted push button in the Admin Suite shall active a "shelter-place" mode. Under this condition, all OA equipment and Exhaust equipment, (with the exception of the kitchen hood system) shall be shut-down. Units that do not have OA connections shall not shut-down when activated.

1.28 DOMESTIC WATER HEATERS

A. General: Provide control of domestic water recirculation pumps. Pumps shall be controlled via a time of day schedule.

B. Display:
   1. Pump status via current sensor (for each pump)
   2. Discharge water temperature from domestic water heaters serving kitchen.
   3. Discharge water temperature from domestic water heaters general building.

1.29 BUILDING HUMIDITY SENSORS

A. General: Provide wall mounted humidity sensors where indicated on the drawings.

B. Display: Floor plan with location of humidity sensors including.
   1. Wall mounted humidity sensors
   2. Humidity sensors mounted in the RA or EA duct of AHU and/or OA units

1.30 ENERGY METER

A. General: Two electrical meters are being provided that will be monitored through the BAS. These include (1) at MSBA Switchboard and (1) at MSBB Switchboard. The BAS shall read information from each meter via control interface (coordinate protocol with meter provider)

B. Display:
   1. KWH Week-to-Date
   2. KWH Month-to-Date
   3. KWH Year-to-Date KWH
   4. KWH for each previous year
   5. Peak Demand (KW) Week-to-Date
   6. Peak Demand (KW) Month-to-Date
   7. Peak Demand (KW) Year-to-Date
   8. Peak Demand (KW) for each previous year

C. Trend Data:
   1. Trend Demand on a 15-minute interval for each switchboard.

1.31 PHASE FAILURE PROTECTION

A. General: Provide and install phase failure detection device at each main switch board (MSBA & MSBB). On detection of phase failure, BAS shall shall command all 3 phase equipment that it is controlling to stop. Equipment shall automatically start 10-minutes (adj) after power to the phase has been restored.

B. Alarm:
   1. Provide alarm with date & time stamp when loss of phase occured.
   2. Log date and time that power that phase power has been restored.

1.32 CTE EQUIPMENT MONITORING

A. General: Proivde current switches to monitor the status of CTE ventilation equipment SCES-01, SCES-02, SCES-03 and DC-1.

B. Display:
   1. Status for each piece of equipment.

C. Alarm:
   1. Provide alarm if equipment is operating outside of normal occupancy mode.

D. Trend Log:
   1. Trend operation equipment on a change of state.

PART 2 PRODUCTS (NOT APPLICABLE)

PART 3 EXECUTION (NOT APPLICABLE)

END OF SECTION

SECTION 23 2113
HYDRONIC PIPING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Hydronic system requirements.
B. Heating water and glycol piping, above grade.
C. Chilled water piping, above grade.
D. Condenser water piping, above grade.
E. Equipment drains and overflows.
F. Pipe hangers and supports.
G. Unions, flanges, mechanical couplings, and dielectric connections.
H. Valves:
    1. Ball valves.
    2. Butterfly valves.
    3. Check valves.

1.02 RELATED REQUIREMENTS

A. Section 08 3100 - Access Doors and Panels.
B. Section 23 0719 - HVAC Piping Insulation.
C. Section 23 2500 - HVAC Water Treatment: Pipe cleaning.

1.03 REFERENCE STANDARDS

A. ASME BPVC-IX - Boiler and Pressure Vessel Code, Section IX - Qualification Standard for Welding, Brazing, and Fusing Procedures; Welders; Brazers; and Welding, Brazing, and Fusing Operators 2023.
B. ASME B16.3 - Malleable Iron Threaded Fittings: Classes 150 and 300 2021.
C. ASME B16.5 - Pipe Flanges and Flanged Fittings: NPS 1/2 through NPS 24 Metric/Inch Standard 2020.
D. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings 2021.
E. ASME B16.22 - Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings 2021.
F. ASME B31.9 - Building Services Piping 2020.
G. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless 2022.
H. ASTM A234/A234M - Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service 2023a.
I. ASTM B32 - Standard Specification for Solder Metal 2020.
J. ASTM B88 - Standard Specification for Seamless Copper Water Tube 2022.
K. ASTM B88M - Standard Specification for Seamless Copper Water Tube (Metric) 2020.
L. ASTM D1785 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120 2021a.
M. ASTM D2241 - Standard Specification for Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series) 2020.
N. ASTM D2466 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40 2021.

O. ASTM D2467 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80 2020.

P. ASTM D2774 - Standard Practice for Underground Installation of Thermoplastic Pressure Piping 2021a.

Q. ASTM D2855 - Standard Practice for the Two-Step (Primer and Solvent Cement) Method of Joining Poly (Vinyl Chloride) (PVC) or Chlorinated Poly (Vinyl Chloride) (CPVC) Pipe and Piping Components with Tapered Sockets 2020.

R. ASTM F1960 - Standard Specification for Cold Expansion Fittings with PEX Reinforcing Rings for Use with Cross-Linked Polyethylene (PEX) and Polyethylene of Raised Temperature (PE-RT) Tubing 2023a.

S. ASTM F708 - Standard Practice for Design and Installation of Rigid Pipe Hangers 1992 (Reapproved 2022).

T. ASTM F1476 - Standard Specification for Performance of Gasketed Mechanical Couplings for Use in Piping Applications 2007 (Reapproved 2019).

U. ASTM F2389 - Standard Specification for Pressure-rated Polypropylene (PP) Piping Systems 2021.

V. AWS A5.8M/A5.8 - Specification for Filler Metals for Brazing and Braze Welding 2019.

W. AWS D1.1/D1.1M - Structural Welding Code - Steel 2020, with Errata (2022).

X. AWWA C606 - Grooved and Shouldered Joints 2022.

Y. MSS SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation 2018, with Amendment (2019).

1.04 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements for submittal procedures.

B. Product Data:
   1. Include data on pipe materials, pipe fittings, valves, and accessories.

1.05 QUALITY ASSURANCE

A. Provide all grooved joint couplings, fittings, valves, specialties, and grooving tools from a single manufacturer.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Provide temporary protective coating on cast iron and steel valves.

PART 2 PRODUCTS

2.01 HYDRONIC SYSTEM REQUIREMENTS

A. Comply with ASME B31.9 and applicable federal, state, and local regulations.

B. Piping: Provide piping, fittings, hangers, and supports as required, as indicated, and as follows:
   1. Where more than one piping system material is specified, provide joining fittings that are compatible with piping materials and ensure that the integrity of the system is not jeopardized.
   2. Use non-conducting dielectric connections whenever jointing dissimilar metals.
   3. Grooved mechanical joints may be used in any location.
      a. Accessible locations include those exposed on interior of building, in pipe chases, and in mechanical rooms, aboveground outdoors, and as approved by Architect.
      b. Grooved mechanical connections and joints comply with AWWA C606.
      c. Use rigid joints unless otherwise indicated.
   4. Provide pipe hangers and supports in accordance with ASME B31.9 or MSS SP-58 unless indicated otherwise.

C. Pipe-to-Valve and Pipe-to-Equipment Connections: Use flanges, unions, or grooved couplings to allow disconnection of components for servicing; do not use direct welded, soldered, or threaded connections.

D. Valves: Provide valves where indicated:
   1. Provide drain valves where indicated, and if not indicated, provide at least at main shut-off, low points of piping, bases of vertical risers, and at equipment. Use 3/4 inch gate valves with cap; pipe to nearest floor drain.
   2. On discharge of condenser water pumps, use spring-loaded check valves.
   3. Isolate equipment using butterfly valves with lug end flanges or grooved mechanical couplings.
   4. For throttling, bypass, or manual flow control services, use ball or butterfly valves.
   5. For throttling and isolation service in chilled and condenser water systems, use only butterfly valves.
   6. For shut-off and to isolate parts of systems or vertical risers, use ball or butterfly valves.

E. Welding Materials and Procedures: Comply with ASME BPVC-IX.

2.02 HEATING WATER PIPING, ABOVE GRADE

A. Steel Pipe: ASTM A53/A53M, Schedule 40, black, using one of the following joint types:
   1. Welded Joints: ASTM A234/A234M, wrought steel welding type fittings; AWS D1.1/D1.1M welded.
   2. Threaded Joints: ASME B16.3, malleable iron fittings.
   3. Grooved Joints: AWWA C606 grooved pipe, fittings of same material, and mechanical couplings.

B. Copper Tube: ASTM B88 (ASTM B88M), Type K (A), drawn, using one of the following joint types:
   1. Solder Joints: ASME B16.18 cast brass/bronze or ASME B16.22 solder wrought copper fittings.
      a. Braze: AWS A5.8M/A5.8 BCuP copper/silver alloy.
   2. Mechanical Press Sealed Fittings: Double pressed type complying with ASME B16.22, utilizing EPDM, nontoxic synthetic rubber sealing elements.

2.03 CHILLED WATER PIPING, ABOVE GRADE

A. Steel Pipe: ASTM A53/A53M, Schedule 40, black; using one of the following joint types:
   1. Welded Joints: ASTM A234/A234M, wrought steel welding type fittings; AWS D1.1/D1.1M welded.
   2. Threaded Joints: ASME B16.3, malleable iron fittings.
   3. Grooved Joints: AWWA C606 grooved pipe, fittings of same material, and mechanical couplings.

B. Copper Tube: ASTM B88 (ASTM B88M), Type K (A), hard drawn; using one of the following joint types:
   1. Solder Joints: ASME B16.18 cast brass/bronze or ASME B16.22, solder wrought copper fittings.
      a. Solder: ASTM B32 lead-free solder, HB alloy (95-5 tin-antimony) or tin and silver.
      b. Braze: AWS A5.8M/A5.8 BCuP copper/silver alloy.
   2. Mechanical Press Sealed Fittings: Double pressed type complying with ASME B16.22, utilizing EPDM, nontoxic synthetic rubber sealing elements.

2.04 CONDENSER WATER PIPING, ABOVE GRADE

A. Steel Pipe: ASTM A53/A53M, Schedule 40, black.
   1. Welded Joints: ASTM A234/A234M, wrought steel welding type fittings with finish matching piping; AWS D1.1/D1.1M welded.

2. Threaded Joints: ASME B16.3, malleable iron fittings with finish matching piping.
3. Grooved Joints: AWWA C606 grooved pipe, fittings of same material, and mechanical couplings.

B. PVC Pipe: ASTM D1785, Schedule 80, or ASTM D2241, SDR 21 or 26.
1. Fittings: ASTM D2466 or ASTM D2467, PVC.
2. Joints: Solvent welded in accordance with ASTM D2855.

C. Pressure-Rated Polypropylene Pipe: ASTM D2774 or ASTM F2389, PP-RCT resin pipe with fiber layer, SDR 17.6 or SDR 11.
1. Fittings: ASTM F2389, butt, socket, or saddle-weld heat fusion. Transitions to comply with ASTM F1960 or ASME B16.5.

2.05 EQUIPMENT DRAINS AND OVERFLOWS

A. Steel Pipe: ASTM A53/A53M, Schedule 40 galvanized; using one of the following joint types:
1. Threaded Joints: Galvanized cast iron, or ASME B16.3 malleable iron fittings.

2.06 PIPE HANGERS AND SUPPORTS

A. Provide hangers and supports that comply with MSS SP-58.
1. If type of hanger or support for a particular situation is not indicated, select appropriate type using MSS SP-58 recommendations.
2. Hangers for Pipe Sizes 1/2 to 1-1/2 Inches: Malleable iron, adjustable swivel, split ring.
3. Hangers for Cold Pipe Sizes 2 Inches and Greater: Carbon steel, adjustable, clevis.
4. Hangers for Hot Pipe Sizes 2 to 4 Inches: Carbon steel, adjustable, clevis.
5. Hangers for Hot Pipe Sizes 6 Inches and Greater: Adjustable steel yoke, cast iron roll, double hanger.
6. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
7. Multiple or Trapeze Hangers for Hot Pipe Sizes 6 Inches and Greater: Steel channels with welded spacers and hanger rods, cast iron roll.
8. Wall Support for Pipe Sizes to 3 Inches: Cast iron hook.
9. Wall Support for Pipe Sizes 4 Inches and Greater: Welded steel bracket and wrought steel clamp.
10. Wall Support for Hot Pipe Sizes 6 Inches and Greater: Welded steel bracket and wrought steel clamp with adjustable steel yoke and cast iron roll.
11. Vertical Support: Steel riser clamp.
12. Floor Support for Cold Pipe: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
13. Floor Support for Hot Pipe Sizes to 4 Inches: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
14. Floor Support for Hot Pipe Sizes 6 Inches and Greater: Adjustable cast iron roll and stand, steel screws, and concrete pier or steel support.
15. Copper Pipe Support: Carbon steel ring, adjustable, copper plated.
16. Hanger Rods: Mild steel threaded both ends, threaded one end, or continuous threaded.
17. Inserts: Malleable iron case of galvanized steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms; size inserts to suit threaded hanger rods.

B. In grooved installations, use rigid couplings with offsetting angle-pattern bolt pads or with wedge-shaped grooves in header piping to permit support and hanging in accordance with ASME B31.9.

2.07 UNIONS, FLANGES, MECHANICAL COUPLINGS, AND DIELECTRIC CONNECTIONS

A. Unions for Pipe of 2 Inches and Less:
1. Ferrous Piping: 150 psi brass or malleable iron, threaded.
2. Copper Pipe: Bronze, soldered joints.

B. Flanges for Pipe 2 Inches and Greater:
   1. Ferrous Piping: 150 psig forged steel, slip-on.
   2. Copper Piping: Bronze.
   3. Gaskets: 1/16 inch thick, preformed neoprene.

C. Mechanical Couplings for Grooved and Shouldered Joints: Two or more curved housing segments with continuous key to engage pipe groove, circular C-profile gasket, and bolts to secure and compress gasket.
   1. Dimensions and Testing: In accordance with AWWA C606.
   2. Mechanical Couplings: Comply with ASTM F1476.
   3. Bolts and Nuts: Hot dipped galvanized or zinc-electroplated steel.
   4. When pipe is field grooved, provide coupling manufacturer's grooving tools.

D. Dielectric Connections:
   1. Waterways:
      a. Water impervious insulation barrier capable of limiting galvanic current to 1 percent of short circuit current in a corresponding bimetallic joint.
      b. Dry insulation barrier able to withstand 600-volt breakdown test.
      c. Construct of galvanized steel with threaded end connections to match connecting piping.
      d. Suitable for the required operating pressures and temperatures.
   2. Flanges:
      a. Dielectric flanges with same pressure ratings as standard flanges.
      b. Water impervious insulation barrier capable of limiting galvanic current to 1 percent of short circuit current in a corresponding bimetallic joint.
      c. Dry insulation barrier able to withstand 600-volt breakdown test.
      d. Construct of galvanized steel with threaded end connections to match connecting piping.
      e. Suitable for the required operating pressures and temperatures.
   3. Unions:
      a. 1/2 to 1 Inches: Brass solder to galvanized FPT.
      b. 1/2 to 2 Inches: Brass solder to galvanized FPT.
      c. 1/2 to 1 Inches: Brass to galvanized FPT or FIP (Female Iron Pipe).
      d. 3/4 to 1/2 Inch Reducer: Brass solder to galvanized FPT.
      e. Service: 250 psi, minus 20 to 180 deg F.

2.08 ACCEPTABLE VALVE MANUFACTURES

A. Manufacturers:
   1. Apollo Valves
   2. Nibco
   3. Victaulic Company
   4. Watts Corporation

2.09 BALL VALVES

A. Up To and Including 2 Inches:
   1. Bronze two piece body, chrome plated brass ball, teflon seats and stuffing box ring, lever handle with balancing stops, solder ends with union.

2.10 BUTTERFLY VALVES

A. Body: Cast or ductile iron with resilient replaceable EPDM seat, wafer, lug, grooved, or _____ ends, extended neck.

B. Disc: Construct of aluminum bronze, chrome plated ductile iron, stainless steel, ductile iron with EPDM encapsulation, Buna-N encapsulation, or _____.

C. Operator: 10 position lever handle.

2.11 SWING CHECK VALVES

A. Up To and Including 2 Inches:
   1. Bronze body, bronze trim, bronze rotating swing disc, with composition disc, solder ends.

B. Over 2 Inches:
   1. Iron body, bronze or _____ trim, stainless steel, bronze, bronze faced rotating, or _____ swing disc, renewable disc and seat, flanged, grooved, or _____ ends.

2.12 SPRING LOADED CHECK VALVES

A. Iron body, bronze trim, split plate, hinged with stainless steel spring, resilient seal bonded to body, wafer, or threaded lug ends.

PART 3 EXECUTION

3.01 PREPARATION

A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.

B. Prepare pipe for grooved mechanical joints as required by coupling manufacturer.

C. Remove scale and dirt on inside and outside before assembly.

D. Prepare piping connections to equipment using jointing system specified.

E. Keep open ends of pipe free from scale and dirt. Protect open ends with temporary plugs or caps.

F. After completion, fill, clean, and treat systems. See Section 23 2500 for additional requirements.

3.02 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. PVC Pipe: Make solvent-welded joints in accordance with ASTM D2855.

C. Route piping in orderly manner, parallel to building structure, and maintain gradient.

D. Install piping to conserve building space and to avoid interference with use of space.

E. Group piping whenever practical at common elevations.

F. Sleeve pipe passing through partitions, walls, and floors.

G. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified _____.

H. Slope piping and arrange to drain at low points.

I. Grooved Joints:
   1. Install in accordance with the manufacturer's latest published installation instructions.

J. Pipe Hangers and Supports:
   1. Install in accordance with ASME B31.9, ASTM F708, or MSS SP-58.

K. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings. See Section 23 0719.

L. Provide access where valves and fittings are not exposed. Coordinate size and location of access doors with Section 08 3100 .

M. Install valves with stems upright or horizontal, not inverted.

3.03 SCHEDULES

A. Pipe Application:

1. Chilled Water Piping, Interior or Exterior Above Ground:
   a. Piping 2-inch and less: Copper pipe with brazed or press-fit joints or Steel pipe with screwed fittings.
   b. Piping 2.5-inch and greater: Steel pipe with welded, flanged, or grooved fittings.
2. Hot Water Piping, Interior or Exterior Above Ground:
   a. Piping 2-inch and less: Copper pipe with brazed or press-fit joints or Steel pipe with screwed fittings.
   b. Piping 2.5-inch and greater: Steel pipe with welded, flanged, or grooved fittings.
3. Condenser Water Piping, Interior Above Grade:
   a. All pipe sizes: Steel pipe with welded fittings.
4. Condenser Water Piping, Exterior Above Ground:
   a. Piping 2-inch and less: Steel pipe with welded fittings.
   b. Piping 2.5-inch and greater: Steel pipe with welded fittings.
5. Makeup-water Piping, Above Ground:
   a. Piping 2-inch and less: Copper pipe with brazed or press-fit joints.

B. Hanger Spacing for Copper Tubing.
1. 1/2 Inch and 3/4 inch: Maximum span, 5 feet; minimum rod size, 1/4 inch.
2. 1 Inch: Maximum span, 6 feet; minimum rod size, 1/4 inch.
3. 1-1/2 Inches and 2 Inches: Maximum span, 8 feet; minimum rod size, 3/8 inch.

C. Hanger Spacing for Steel Piping.
1. 1/2 Inch, 3/4 Inch, and 1 Inch: Maximum span, 7 feet; minimum rod size, 1/4 inch.
2. 1-1/4 Inches: Maximum span, 8 feet; minimum rod size, 3/8 inch.
3. 1-1/2 Inches: Maximum span, 9 feet; minimum rod size, 3/8 inch.
4. 2 Inches: Maximum span, 10 feet; minimum rod size, 3/8 inch.
5. 2-1/2 Inches: Maximum span, 11 feet; minimum rod size, 3/8 inch.
6. 3 Inches: Maximum span, 12 feet; minimum rod size, 3/8 inch.
7. 4 Inches: Maximum span, 14 feet; minimum rod size, 1/2 inch.
8. 6 Inches: Maximum span, 17 feet; minimum rod size, 1/2 inch.
9. 8 Inches: Maximum span, 19 feet; minimum rod size, 5/8 inch.
10. 10 Inches: Maximum span, 20 feet; minimum rod size, 3/4 inch.
11. 12 Inches: Maximum span, 23 feet; minimum rod size, 7/8 inch.

D. Hanger Spacing for Plastic Piping.
1. 1/2 Inch: Maximum span, 42 inches; minimum rod size, 1/4 inch.
2. 3/4 Inch: Maximum span, 45 inches; minimum rod size, 1/4 inch.
3. 1 Inch: Maximum span, 51 inches; minimum rod size, 1/4 inch.
4. 1-1/4 Inches: Maximum span, 57 inches; minimum rod size, 3/8 inch.
5. 1-1/2 Inches: Maximum span, 63 inches; minimum rod size, 3/8 inch.
6. 2 Inches: Maximum span, 69 inches; minimum rod size, 3/8 inch.
7. 3 Inches: Maximum span, 7 feet; minimum rod size, 3/8 inch.
8. 4 Inches: Maximum span, 8 feet; minimum rod size, 1/2 inch.
9. 6 Inches: Maximum span, 10 feet; minimum rod size, 1/2 inch.
10. 8 Inches: Maximum span, 11 feet; minimum rod size, 5/8 inch.
11. 10 Inches: Maximum span, 13 feet; minimum rod size, 3/4 inch.
12. 12 Inches: Maximum span, 14 feet; minimum rod size, 7/8 inch.

END OF SECTION

SECTION 23 2114
HYDRONIC SPECIALTIES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Expansion tanks.
B. Air vents.
C. Air separators.
D. Strainers.
E. Suction diffusers.
F. Pressure-temperature test plugs.
G. Balancing valves.
H. Relief valves.
I. Pressure reducing valves.

1.02 RELATED REQUIREMENTS

A. Section 23 2113 - Hydronic Piping.

1.03 REFERENCE STANDARDS

A. ASME BPVC-VIII-1 - Boiler and Pressure Vessel Code, Section VIII, Division 1: Rules for Construction of Pressure Vessels 2021.

1.04 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements for submittal procedures.
B. Product Data: Provide product data for manufactured products and assemblies required for this project. Include component sizes, rough-in requirements, service sizes, and finishes. Include product description and model.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Accept valves on site in shipping containers with labeling in place. Inspect for damage.
B. Provide temporary protective coating on cast iron and steel valves.
C. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.
D. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

PART 2 PRODUCTS

2.01 EXPANSION TANKS

A. Manufacturers:
   1. American Wheatley, a company of Global Flow Products, LLC: www.wheatleyhvac.com/#sle.
   2. Amtrol Inc: www.amtrol.com/#sle.
   3. Bell & Gossett, a brand of Xylem, Inc: www.bellgossett.com/#sle.
   4. Taco, Inc: www.taco-hvac.com/#sle.
   5. Thrush Company.
   6. Substitutions: See Section 01 6000 - Product Requirements.
B. Acceptance Volume Capacity: As indicated on drawings.
C. Maximum Rated Working Pressure: 125 psi.

D. Maximum Allowable Service Temperature: 240 degrees F.

E. Construction: Welded steel, tested and stamped in accordance with ASME BPVC-VIII-1; supplied with National Board Form U-1, adjustable flexible EPDM diaphragm or bladder seal factory precharged to 12 psi, and steel support stand.

F. Automatic Cold Water Fill Assembly: Pressure reducing valve, reduced pressure double check backflow preventer, test cocks, strainer, vacuum breaker, and valved by-pass.

G. Accessories: Provide air-charging fitting, pressure gauge, and tank drain ball valve.

2.02 AIR VENTS

A. Manual Air Vent: Short vertical sections of 2-inch diameter pipe to form air chamber, with 1/8 inch brass needle valve at top of chamber.

B. Maximum Fluid Pressure: 150 psi.

C. Maximum Fluid Temperature: 250 degrees F.

2.03 AIR SEPARATORS

A. Centrifugal Air Separators/Strainers:
   1. Manufacturers:
      a. American Wheatley, a company of Global Flow Products, LLC: www.wheatleyhvac.com/#sle.
      b. Armstrong International, Inc: www.armstronginternational.com/#sle.
      c. Bell & Gossett, a brand of Xylem, Inc: www.bellgossett.com/#sle.
      d. Taco, Inc: www.taco-hvac.com/#sle.
      e. Thrush Company.
      f. Substitutions: See Section 01 6000 - Product Requirements.
   2. Primed steel body, tested and stamped in accordance with ASME BPVC-VIII-1 with integral bronze strainer, tangential flanged inlet and outlet connections, and internal stainless steel air collector tube.
   3. Maximum Service Flow and Pressure: 4,500 gpm at 125 psi.
   4. Accessories: Provide epoxy coating finish and tank-bottom magnets.

2.04 STRAINERS

A. Size 2 inch and Under:
   1. Provide threaded or grooved brass or iron body for up to 175 psi working pressure, Y-pattern strainer with 1/32 inch stainless steel perforated screen.

B. Size 2-1/2 inch to 4 inch:
   1. Provide flanged or grooved iron body for up to 175 psi working pressure, up to 250 degrees F working temperature, Y-pattern strainer with 1/16 inch or 3/64 inch stainless steel perforated screen.

C. Size 5 inch and Larger:
   1. Provide flanged or grooved iron body for up to 175 psi working pressure, basket pattern with 1/8 inch stainless steel perforated screen.

2.05 SUCTION DIFFUSERS

A. Fitting: Angle pattern, cast-iron body, threaded for 2 inch and smaller, flanged for 2-1/2 inch and larger, rated for 175 psi working pressure, with inlet vanes, cylinder strainer with 3/16 inch diameter openings, disposable 5/32 inch mesh strainer to fit over cylinder strainer, 20 mesh startup screen, and permanent magnet located in flow stream and removable for cleaning.

B. Class 125:
   1. Horizontally or vertically mounted angle-pattern fitting with integral-cast vanes, fine particle mesh screen and magnetic drain plugs for particle removal without disassembly.

2. Maximum Operating Service: 175 psi and 300 degrees F.
3. Sizes, Material, and Connection:
   a. 2 inch and Smaller: Cast iron body, threaded.
   b. 2-1/2 to 12 inch: Ductile iron body, flanged.

C. Accessories: Adjustable foot support, blowdown tapping in bottom, gauge tapping in side.

2.06 PUMP CONNECTORS

A. Flexible Connectors: Flanged, EPDM rubber sphere type with wetted components of stainless steel, sized to match piping.
   1. Maximum Operating Service: 150 psi at 120 degrees F.
   2. End Connections: Same as specified for pipe jointing.
   3. Provide necessary accessories including, but not limited to, swivel joints.

2.07 PRESSURE-TEMPERATURE TEST PLUGS

A. Construction: Brass body designed to receive temperature or pressure probe with removable protective cap, and Neoprene rated for minimum 200 degrees F.

B. Application: Use extended length plugs to clear insulated piping.

2.08 BALANCING VALVES

A. Manufacturers:
   1. American Wheatley, a company of Global Flow Products, LLC: www.wheatleyhvac.com/#sle.
   2. Armstrong International, Inc: www.armstronginternational.com/#sle.
   3. Bell & Gossett, a brand of Xylem, Inc: www.bellgossett.com/#sle.
   4. Hays Fluid Controls: www.haysfluidcontrols.com/#sle.
   5. Taco, Inc: www.taco-hvac.com/#sle.
   6. Substitutions: See Section 01 6000 - Product Requirements.

B. Size 2 inch and Smaller:
   1. Provide ball or globe style with flow balancing, shut-off capabilities, memory stops, and minimum of two metering ports and NPT threaded connections.
   2. Metal construction materials consist of bronze or brass.
   3. Non-metal construction materials consist of Teflon, EPDM, or engineered resin.

C. Size 2-1/2 inch and Larger:
   1. Provide ball or globe style with flow balancing, shut-off capabilities, memory stops, and minimum of two metering ports and flanged or grooved connections.
   2. Valve body construction materials consist of cast iron, carbon steel, or ductile iron.
   3. Internal components construction materials consist of brass, aluminum bronze, bronze, Teflon, EPDM, NORYL, or engineered resin.

2.09 RELIEF VALVES

A. Bronze body, teflon seat, stainless steel stem and springs, automatic, direct pressure actuated, capacities ASME certified and labelled.

2.10 PRESSURE REDUCING VALVES

A. Operation: Automatically feeds make-up water to the hydronic system whenever pressure in the system drops below the pressure setting of the valve. Refer to Section 23 2113.

B. Materials of Construction:
   1. Valve Body: Constructed of bronze, cast iron, brass, or iron.
   2. Internal Components: Construct of stainless steel or brass and engineered plastics or composition material.

C. Connections:

1. NPT threaded: 1/2 inch or 3/4inch.
2. Soldered: 1/2 inch.

D. Provide integral check valve and strainer.

E. Maximum Inlet Pressure: 400 psi.

F. Maximum Fluid Temperature: 180 degrees F.

G. Adjustable Pressure Range: From 10 to 45 psi, set to 25 psi.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install specialties in accordance with manufacturer's instructions.

B. Provide manual air vents at system high points and as indicated.

C. Provide air separator on suction side of system circulation pump and connect to expansion tank.

D. Provide pump suction fitting on suction side of base-mounted centrifugal pumps where indicated. Remove temporary strainers after cleaning systems.

E. Provide relief valves on pressure tanks, low-pressure side of reducing valves, heat exchangers, and expansion tanks.

F. Select system relief valve capacity so that it is greater than make-up pressure reducing valve capacity. Select equipment relief valve capacity to exceed rating of connected equipment.

G. Pipe relief valve outlet to nearest floor drain.

END OF SECTION

SECTION 23 2123
HYDRONIC PUMPS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. End-suction pumps.

1.02 RELATED REQUIREMENTS

A. Section 23 0513 - Common Motor Requirements for HVAC Equipment.

B. Section 23 0934 - Variable-Frequency Motor Controllers.

C. Section 25 3500 - Integrated Automation Instrumentation and Terminal Devices for HVAC.

1.03 REFERENCE STANDARDS

A. NFPA 70 - National Electrical Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

B. UL 778 - Standard for Motor-Operated Water Pumps Current Edition, Including All Revisions.

1.04 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements for submittal procedures.

B. Product Data: Provide certified pump curves showing performance characteristics with pump and system operating point plotted. Include NPSH curve when applicable. Include electrical characteristics and connection requirements.

C. Manufacturer's Installation Instructions: Indicate hanging and support requirements and recommendations.

D. Operation and Maintenance Data: Include installation instructions, assembly views, lubrication instructions, and replacement parts list.

E. Certification of Pump Alignment: Manufacturer representative shall certifiy that the pump alignment meets all manufacture requirements.

F. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
   1. See Section 01 6000 - Product Requirements, for additional provisions.
   2. Pump rebuild kit for each size pump. Rebuild kit to include complete seal/gasket kit and bearing kit.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Armstrong Fluid Technology, Inc: www.armstrongfluidtechnology.com/#sle.

B. Bell & Gossett, a Xylem Inc. brand: www.bellgossett.com/#sle.

C. Aurora Pump.

D. Peerless.

E. Paco.

2.02 GENERAL

A. Provide pumps that operate at specified system fluid temperatures without vapor binding and cavitation, are non-overloading in parallel or individual operation, and operate within 25 percent of midpoint of published maximum efficiency curve.

B. Electrical Requirements:
   1. Listed and classified by UL or testing agency acceptable to authority having jurisdiction as suitable for the purpose specified and indicated.

2. Variable Frequency Drives (VFDs): Provide in accordance with Section 23 0934, except for integral-VFDs.
3. Enclosures: Provide unspecified product(s) required to fit motor:

2.03 END-SUCTION PUMPS

A. Split-Coupled Pump: Base-mounted, single-stage pump with horizontal shaft and radially- or horizontally-split casing rated for discharge pressures up to 175 psi.

B. Casing: Cast iron or ductile iron with renewable bronze casing wearing rings, seal flush connection, drain plug, flanged suction, and discharge flanged connections with gauge ports.

C. Impeller: Stainless steel, balanced, fully enclosed, keyed to shaft.

D. Bearings: Grease lubricated roller or ball bearings.

E. Shaft: Alloy steel with copper, bronze, or stainless steel shaft sleeve.

F. Seal: Mechanical, 225 degrees F maximum continuous duty temperature.

G. Drive: Flexible coupling with coupling guard.

H. Baseplate: Cast iron or fabricated steel with integral drain rim.

I. Electrical:
1. Motor: 1,750 rpm, open drip-proof (ODP); see Section 23 0513.
2. Wiring Terminations: Provide terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated. Enclose terminal lugs in terminal box sized to NFPA 70.

PART 3 EXECUTION

3.01 PREPARATION

A. Verify that electric power is available and of the correct characteristics.

3.02 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Manufacturer shall certified field alignment after pump installation is complete.

C. Provide access space around pumps for service. Provide no less than minimum space recommended by manufacturer.

D. Provide line sized shut-off valve and strainer on pump suction, and line sized soft seat check valve and balancing valve on pump discharge.

E. Provide air cock and drain connection on horizontal pump casings.

F. Controls Human-Machine Interface (HMI): HVAC operator terminal; see Section 25 3500.

END OF SECTION

SECTION 23 2300
REFRIGERANT PIPING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Piping.

B. Refrigerant.

C. Moisture and liquid indicators.

D. Valves.

E. Strainers.

F. Filter-driers.

1.02 RELATED REQUIREMENTS

A. Section 23 0716 - HVAC Equipment Insulation.

B. Section 26 0583 - Wiring Connections: Electrical characteristics and wiring connections.

1.03 REFERENCE STANDARDS

A. AHRI 710 (I-P) - Performance Rating of Liquid-Line Driers 2009.

B. AHRI 711 (SI) - Performance Rating of Liquid-Line Driers 2009.

C. ASHRAE Std 15 - Safety Standard for Refrigeration Systems 2019, with All Amendments and Errata.

D. ASME BPVC-IX - Boiler and Pressure Vessel Code, Section IX - Qualification Standard for Welding, Brazing, and Fusing Procedures; Welders; Brazers; and Welding, Brazing, and Fusing Operators 2023.

E. ASME B16.22 - Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings 2021.

F. ASME B16.26 - Cast Copper Alloy Fittings for Flared Copper Tubes 2018.

G. ASME B31.5 - Refrigeration Piping and Heat Transfer Components 2022.

H. ASME B31.9 - Building Services Piping 2020.

I. ASTM B88 - Standard Specification for Seamless Copper Water Tube 2022.

J. ASTM B88M - Standard Specification for Seamless Copper Water Tube (Metric) 2020.

K. ASTM B280 - Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service 2020.

L. AWS A5.8M/A5.8 - Specification for Filler Metals for Brazing and Braze Welding 2019.

M. MSS SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation 2018, with Amendment (2019).

1.04 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements for submittal procedures.

B. Product Data: Provide general assembly of specialties, including manufacturer's catalogue information. Provide manufacturer's catalog data including load capacity.

C. Shop Drawings: Indicate schematic layout of system, including equipment, critical dimensions, and sizes.

D. Project Record Documents: Record exact locations of equipment and refrigeration accessories on record drawings.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Deliver and store piping and specialties in shipping containers with labeling in place.

B. Protect piping and specialties from entry of contaminating material by leaving end caps and plugs in place until installation.

C. Dehydrate and charge components such as piping and receivers, seal prior to shipment, until connected into system.

PART 2 PRODUCTS

2.01 SYSTEM DESCRIPTION

A. Provide pipe hangers and supports in accordance with ASME B31.5 unless indicated otherwise.

B. Liquid Indicators:
   1. Use line size liquid indicators in main liquid line leaving condenser.
   2. If receiver is provided, install in liquid line leaving receiver.
   3. Use line size on leaving side of liquid solenoid valves.

C. Valves:
   1. Use service valves on suction and discharge of compressors.

D. Filter-Driers:
   1. Use a filter-drier immediately ahead of liquid-line controls, such as thermostatic expansion valves, solenoid valves, and moisture indicators.

E. Flexible Connectors: Utilize at or near compressors where piping configuration does not absorb vibration.

2.02 REGULATORY REQUIREMENTS

A. Comply with ASME B31.9 for installation of piping system.

B. Welding Materials and Procedures: Comply with ASME BPVC-IX and applicable state labor regulations.

2.03 PIPING

A. Copper Tube: ASTM B280, H58 hard drawn.
   1. Fittings: ASME B16.22 wrought copper.
   2. Joints: Braze, AWS A5.8M/A5.8 BCuP silver/phosphorus/copper alloy.

B. Copper Tube to 7/8-inch OD: ASTM B88 (ASTM B88M), Type K (A), annealed.
   1. Fittings: ASME B16.26 cast copper.
   2. Joints: Flared.

C. Pipe Supports and Anchors:
   1. Provide hangers and supports that comply with MSS SP-58.
      a. If type of hanger or support for a particular situation is not indicated, select appropriate type using MSS SP-58 recommendations.
   2. Hangers for Pipe Sizes 2 Inches and Over: Carbon steel, adjustable, clevis.
   3. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
   4. Wall Support for Pipe Sizes to 3 Inches: Cast iron hook.
   5. Vertical Support: Steel riser clamp.
   6. Copper Pipe Support: Carbon steel ring, adjustable, copper plated.
   7. Hanger Rods: Mild steel threaded both ends, threaded one end, or continuous threaded.
   8. Inserts: Malleable iron case of galvanized steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms; size inserts to suit threaded hanger rods.

2.04 REFRIGERANT

A. Refrigerant: Use only refrigerants that have ozone depletion potential (ODP) of zero and global warming potential (GWP) of less than 50.

2.05 MOISTURE AND LIQUID INDICATORS

2.06 MOISTURE AND LIQUID INDICATORS

A. Indicators: Single port type, UL listed, with copper or brass body, flared or soldered ends, sight glass, color coded paper moisture indicator with removable element cartridge and plastic cap; for maximum temperature of 200 degrees F and maximum working pressure of 500 psi.

2.07 VALVES

2.08 VALVES

A. Ball Valves:
   1. Two piece bolted forged brass body with teflon ball seals and copper tube extensions, brass bonnet and seal cap, chrome plated ball, stem with neoprene ring stem seals; for maximum working pressure of 500 psi and maximum temperature of 300 degrees F.

B. Service Valves:
   1. Forged brass body with copper stubs, brass caps, removable valve core, integral ball check valve, flared or soldered ends, for maximum pressure of 500 psi.

2.09 STRAINERS

2.10 STRAINERS

A. Straight Line or Angle Line Type:
   1. Brass or steel shell, steel cap and flange, and replaceable cartridge, with screen of stainless steel wire or monel reinforced with brass; for maximum working pressure of 430 psi.

2.11 FILTER-DRIERS

2.12 FILTER-DRIERS

A. Performance:
   1. Flow Capacity - Liquid Line: ____ ton, minimum, rated in accordance with AHRI 710 (I-P) (AHRI 711 (SI)).
   2. Pressure Drop: 2 psi, maximum, when operating at full connected evaporator capacity.
   3. Design Working Pressure: 350 psi, minimum.

B. Cores: Molded or loose-fill molecular sieve desiccant compatible with refrigerant, activated alumina, activated charcoal, and filtration to 40 microns, with secondary filtration to 20 microns; of construction that will not pass into refrigerant lines.

C. Construction: UL listed.
   1. Connections: As specified for applicable pipe type.

PART 3 EXECUTION

3.01 PREPARATION

A. Ream pipe and tube ends. Remove burrs. Bevel plain-end ferrous pipe.

B. Remove scale and dirt on inside and outside before assembly.

C. Prepare piping connections to equipment with flanges or unions.

3.02 INSTALLATION

A. Install refrigeration specialties in accordance with manufacturer's instructions.

B. Route piping in orderly manner, with plumbing parallel to building structure, and maintain gradient.

C. Install piping to conserve building space and avoid interference with use of space.

D. Group piping whenever practical at common elevations and locations. Slope piping one percent in direction of oil return.

E. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.

F. Pipe Hangers and Supports:
   1. Install in accordance with ASME B31.5.
   2. Place hangers within 12 inches of each horizontal elbow.
   3. Support vertical piping at every other floor. Support riser piping independently of connected horizontal piping.
   4. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
   5. Provide copper plated hangers and supports for copper piping.

G. Flood piping system with nitrogen when brazing.

H. Insulate piping and equipment.

I. Follow ASHRAE Std 15 procedures for charging and purging of systems and for disposal of refrigerant.

J. Provide replaceable cartridge filter-driers, with isolation valves and valved bypass.

K. Locate expansion valve sensing bulb immediately downstream of evaporator on suction line.

L. Fully charge completed system with refrigerant after testing.

M. Provide electrical connection to solenoid valves. See Section 26 0583.

3.03 FIELD QUALITY CONTROL

A. See Section 01 4000 - Quality Requirements, for additional requirements.

B. Test refrigeration system in accordance with ASME B31.5.

C. Pressure test system with dry nitrogen to 200 psi. Perform final tests at 27 inches vacuum and 200 psi using halide torch. Test and repair piping until no leakage.

3.04 SCHEDULES

A. Hanger Spacing for Copper Tubing.
   1. 1/2 inch, 5/8 inch, and 7/8 inch OD: Maximum span, 5 feet; minimum rod size, 1/4 inch.
   2. 1-1/8 inch OD: Maximum span, 6 feet; minimum rod size, 1/4 inch.
   3. 1-3/8 inch OD: Maximum span, 7 feet; minimum rod size, 3/8 inch.
   4. 1-5/8 inch OD: Maximum span, 8 feet; minimum rod size, 3/8 inch.

END OF SECTION

SECTION 23 2500
HVAC WATER TREATMENT

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Materials.
   1. System cleaner.
   2. Closed system treatment (water).

B. By-pass (pot) feeder.

C. Solution metering pump.

D. Conductivity controller.

E. Water meter.

F. Side-stream filtration equipment.

1.02 RELATED REQUIREMENTS

A. Section 01 6000 - Product Requirements: Owner furnished treatment equipment.

1.03 REFERENCE STANDARDS

A. UL (DIR) - Online Certifications Directory Current Edition.

1.04 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide chemical treatment materials, chemicals, and equipment including electrical characteristics and connection requirements.

C. Shop Drawings: Indicate system schematic, equipment locations, and controls schematics, electrical characteristics and connection requirements.

D. Manufacturer's Installation Instructions: Indicate placement of equipment in systems, piping configuration, and connection requirements.

E. Manufacturer's Field Reports: Indicate start-up of treatment systems when completed and operating properly. Indicate analysis of system water after cleaning and after treatment.

F. Project Record Documents: Record actual locations of equipment and piping, including sampling points and location of chemical injectors.

G. Operation and Maintenance Data: Include data on chemical feed pumps, agitators, and other equipment including spare parts lists, procedures, and treatment programs. Include step by step instructions on test procedures including target concentrations.

H. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
   1. See Section 01 6000 - Product Requirements, for additional provisions.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Nalco, an Ecolab Company; _____: www.nalco.com/#sle.

B. Earthwise.

C. Substitutions: See Section 01 6000 - Product Requirements.

2.02 REGULATORY REQUIREMENTS

A. Comply with applicable codes for addition of non-potable chemicals to building mechanical systems and to public sewage systems.

B. Comply with UL (DIR) requirements.

C. Perform work in accordance with local health department regulations.

2.03 MATERIALS

A. System Cleaner:
   1. Liquid alkaline compound with emulsifying agents and detergents to remove grease and petroleum products; sodiumtripoly phosphate and sodium molybdate.
   2. Biocide chlorine release agents such as sodium hypochlorite or calcium hypochlorite or microbiocides such as quarternary ammonia compounds, tributyltin oxide, methylene bis (thiocyanate).

B. Closed System Treatment (Water):
   1. Sequestering agent to reduce deposits and adjust pH; polyphosphate.
   2. Corrosion inhibitors; boron-nitrite, sodium nitrite and borax, sodium totyltriazole, low molecular weight polymers, phosphonates, sodium molybdate, or sulphites.

2.04 BY-PASS (POT) FEEDER

A. 6.0 gal quick opening cap for working pressure of 175 psi.

2.05 SOLUTION METERING PUMP

A. Positive displacement, diaphragm pump with adjustable flow rate, thermoplastic construction, continuous-duty fully enclosed electric motor and drive, and built-in relief valve.

2.06 CONDUCTIVITY CONTROLLER

A. Packaged monitor controller with solid state circuiting, five percent accuracy, linear dial adjustment, built-in calibration switch, on-off switch and light, control function light, output to control circuit and recorder.

2.07 WATER METER

2.08 SIDE-STREAM FILTRATION SYSTEM

A. System: Flow indicator, filter housing with cartridge filter, shut-off valves, and flow control valve.

B. Hot Water and Glycol Filter Housing: Glass reinforced nylon plastic suitable for 220 degrees F and 200 psi operating conditions.

C. Chilled Water Filter Housing: Reinforced polypropylene plastic housing suitable for 125 degrees F and 125 psi operating conditions.

D. Cartridges: 30 micron for start-up and 5 micron for system operation.

PART 3 EXECUTION

3.01 PREPARATION

A. Systems shall be operational, filled, started, and vented prior to cleaning. Use water meter to record capacity in each system.

B. Place terminal control valves in open position during cleaning.

C. Verify that electric power is available and of the correct characteristics.

3.02 CLEANING SEQUENCE

3.03 INSTALLATION

A. Install in accordance with manufacturer's instructions.

3.04 CLOSED SYSTEM TREATMENT

A. Provide one bypass feeder on each system. Install isolating and drain valves and necessary piping. Install around balancing valve downstream of circulating pumps unless indicated otherwise.

B. Introduce closed system treatment through bypass feeder when required or indicated by test.

C. Provide 3/4 inch water coupon rack around circulating pumps with space for 4 test specimens.

3.05 CONDENSER WATER SYSTEMS (COOLING TOWERS)

A. Provide automatic condenser water control systems for inhibitor feed, blowdown and biocide feeds. Inhibitor application shall be meter activated, blowdown shall be conductivity activated, and biocide shall be meter fed with blowdown locked out to ensure biocide retention time.

B. Control system shall incorporate solid state integrated circuits and digital LED displays, in NEMA-12 steel enclosure. Provide gasketed and lockable door.

C. Base dissolved solids control on conductivity and include:
   1. LED digital readout display (micro-ohm/cm).
   2. Temperature compensated sensor probe adaptable to sample stream manifold.
   3. High, low, normal conductance indicator lights (LED).
   4. High or low conductance alarm light (flash or steady switch), trip points field adjustable. Flash or steady switch shall have silence position.
   5. Illuminated legend shall indicate "ALARM" whenever alarm condition exists.
   6. Hand-off-automatic switch for solenoid bleed valve.
   7. Illuminated legend shall indicate "BLEED" when valve is operated.

D. Base inhibitor feed control on make-up volume and include:
   1. Solid state counter (1-15 field selectable).
   2. Solid state timer (adjustable 1/4 to 5 minutes).
   3. Test switch.
   4. Hand-off-automatic switch for chemical pump.
   5. Illuminated legend shall indicate "FEED" when pump is activated.
   6. Solid state lock-out timer (adjustable 1/4 to 3 hours) and indicator light. Lock-out timer shall deactivate the pump and activate alarm circuits.
   7. Panel totalizer (amount of makeup), electro-mechanical type.

E. Biocide programmer to include:
   1. 24 hour timer with 14 day skip feature to permit activation any hour of the day.
   2. Precision solid state bleed lock-out timer (0-9 hours) and biocide pump timer (0 - 2-1/4 hours), clock controlled.
   3. Solid state alternator to enable the use of two different formulations.
   4. Digital display of the time of day (24 hours).
   5. LED display of day of week (14 days).
   6. Battery back-up so clock is not disturbed by power outages, quartz timekeeping accuracy.
   7. Hand-off-automatic switches for biocide pumps.
   8. Illuminated legend shall indicate "BIOCIDE A" or "BIOCIDE B" when pump is activated.

F. Provide water meter on system make-up, wired to control system.

G. Provide solution pumps to feed sequestering agent and corrosion inhibitor from solution tank into condenser water supply to tower. Provide agitator as required.

H. Provide conductivity controller to sample condenser water and operate 1 inch solenoid bleed valve and piping to blowdown controller sampler wired to open when condensing water pump is operating.

I. Introduce biocide to tower by intermittent slug feed.

J. Provide liquid level switch in each solution tank to deactivate solution pump and agitator and sound local alarm bell.

K. Provide 3/4 inch water coupon rack around circulating pumps with space for 4 test specimens.

3.06 CLOSEOUT ACTIVITIES

A. Training: Train Owner's personnel on operation and maintenance of chemical treatment system.
   1. Provide minimum of two hours of instruction for two people.
   2. Have operation and maintenance data prepared and available for review during training.
   3. Conduct training using actual equipment after treated system has been put into full operation.

3.07 MAINTENANCE

A. Perform maintenance work using competent and qualified personnel under the supervision and in the direct employ of the equipment manufacturer or original installer.

B. Provide service and maintenance of treatment systems for one year from Date of Substantial Completion.

C. Provide monthly technical service visits to perform field inspections and make water analysis on-site. Detail findings in writing on proper practices, chemical treating requirements, and corrective actions needed. Submit two copies of field service report after each visit.

D. Provide laboratory and technical assistance services during this maintenance period.

E. Provide on-site inspections of equipment during scheduled or emergency shutdown to properly evaluate success of water treatment program, and make recommendations in writing based upon these inspections.

END OF SECTION

SECTION 23 3100
HVAC DUCTS AND CASINGS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Metal ducts.

B. Flexible ducts.

C. Air plenums and casings.

D. Ducts for kitchen exhaust applications.

1.02 RELATED REQUIREMENTS

A. Section 07 8400 - Firestopping.

B. Section 11 4000 - Foodservice Equipment: Kitchen range hoods.

C. Section 23 0713 - Duct Insulation: External insulation and duct liner.

D. Section 23 3300 - Air Duct Accessories.

E. Section 23 3319 - Duct Silencers.

F. Section 23 3600 - Air Terminal Units.

G. Section 23 3700 - Air Outlets and Inlets: Fabric air distribution devices.

1.03 REFERENCE STANDARDS

A. ASTM A36/A36M - Standard Specification for Carbon Structural Steel 2019.

B. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process 2022.

C. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials 2023.

D. ASTM E814 - Standard Test Method for Fire Tests of Penetration Firestop Systems 2013a (Reapproved 2017).

E. ASTM E2336 - Standard Test Methods for Fire Resistive Grease Duct Enclosure Systems 2020.

F. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems 2024.

G. NFPA 90B - Standard for the Installation of Warm Air Heating and Air-Conditioning Systems 2021.

H. NFPA 96 - Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations 2021.

I. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible 2021.

J. SMACNA (KVS) - Kitchen Ventilation Systems and Food Service Equipment Fabrication and Installation Guidelines 2001.

K. SMACNA (LEAK) - HVAC Air Duct Leakage Test Manual 2012.

L. UL 181 - Standard for Factory-Made Air Ducts and Air Connectors current edition, including all revisions.

M. UL 1479 - Standard for Fire Tests of Penetration Firestops Current Edition, Including All Revisions.

N. UL 1978 - Grease Ducts Current Edition, Including All Revisions.

O. UL 2221 - Tests of Fire Resistive Grease Duct Enclosure Assemblies Current Edition, Including All Revisions.

1.04 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements for submittal procedures.

B. Product Data: Provide data for duct materials.

C. Shop Drawings: Indicate duct fitting types, gauges, sizes, welds, and configuration.

D. Test Reports: Indicate pressure tests performed. Include date, section tested, test pressure, and leakage rate per appropriate seal class, following SMACNA (LEAK).

E. Project Record Documents: Record actual locations of ducts and duct fittings. Record changes in fitting location and type. Show additional fittings used.

1.05 FIELD CONDITIONS

A. Do not install duct sealants when temperatures are less than those recommended by sealant manufacturers.

B. Maintain temperatures within acceptable range during and after installation of duct sealants.

1.06 WARRANTY

A. See Section 01 7800 - Closeout Submittals for additional warranty requirements.

PART 2 PRODUCTS

2.01 GENERAL REQUIREMENTS

A. Provide UL Class 1 ductwork, fittings, hangers, supports, and appurtenances in accordance with NFPA 90A and SMACNA (DCS) guidelines unless stated otherwise.

B. Provide metal duct unless otherwise indicated.

C. Acoustical Treatment: Provide sound-absorbing liners and sectional silencers for metal-based ducts in compliance with Section 23 3319.

D. Duct Shape and Material in accordance with Allowed Static Pressure Range:

E. Duct Sealing and Leakage in accordance with Static Pressure Class:
   1. Low Pressure Service: Up to 2 in-wc:
      a. Seal: Class C, apply to seal off transverse joints.
      b. Leakage:
         1) Rectangular: Class 24 or 24 cfm/100 sq ft.
         2) Round: Class 12 or 12 cfm/100 sq ft.
   2. Low Pressure Service: From 2 in-wc to 3 in-wc:
      a. Seal: Class B, apply sealing of transverse joints and longitudinal seams.
      b. Leakage:
         1) Rectangular: Class 12 or 12 cfm/100 sq ft.
         2) Round: Class 6 or 6 cfm/100 sq ft.
   3. Medium and High Pressure Service: Above 3 in-wc:
      a. Seal: Class A, apply sealing of transverse joints, longitudinal seams, and duct wall penetrations.
      b. Leakage:
         1) Rectangular: Class 6 or 6 cfm/100 sq ft.
         2) Round: Class 3 or 3 cfm/100 sq ft.

F. Duct Fabrication Requirements:
   1. Duct and Fitting Fabrication and Support: SMACNA (DCS) including specifics for continuously welded round and oval duct fittings.
   2. Use reinforced and sealed sheet-metal materials at recommended gauges for indicated operating pressures or pressure class.

3. Construct tees, bends, and elbows with radius of not less than 1-1/2 times width of duct on centerline. Where not possible and where rectangular elbows must be used, provide airfoil turning vanes of perforated metal with glass fiber insulation.
4. Provide turning vanes of perforated metal with glass fiber insulation when acoustical lining is indicated.
5. Increase duct sizes gradually, not exceeding 15 degrees divergence wherever possible; maximum 30 degrees divergence upstream of equipment and 45 degrees convergence downstream.
6. Provide turning vanes of perforated metal with glass fiber insulation when an acoustical lining is required.
7. Where ducts are connected to exterior wall louvers and duct outlet is smaller than louver frame, provide blank-out panels sealing louver area around duct. Use same material as duct, painted black on exterior side; seal to louver frame and duct.

2.02 METAL DUCTS

2.03 METAL DUCTS

A. Material Requirements:
   1. Galvanized Steel: Hot-dipped galvanized steel sheet, ASTM A653/A653M FS Type B, with G60/Z180 coating.

B. Flat-Oval Metal Ducts:
   1. Flat-Oval Single Wall Duct: Machine made from a round spiral lock seam duct.
      a. Fittings: Manufacture at least two gauges heavier metal than the duct.
      b. Provide duct material, gauges, reinforcing, and sealing for operating pressures indicated.
   2. Flat-Oval Double Wall Insulated Duct: Machine made from round spiral lock seam duct.
      a. Fittings: Manufacture with solid inner wall.
      b. Inner Wall: Perforated galvanized steel.
      c. Insulation:
         1) Thickness: 1 inch fiberglass.

C. Round Metal Ducts:
   1. Round Single Wall Duct: Round lock seam duct with galvanized steel outer wall.
   2. Round Double Wall Insulated Duct: Round spiral lock seam duct with galvanized steel outer wall, perforated galvanized steel inner wall; fitting with the solid inner wall.
      a. Insulation:
         1) Thickness: 1 inch.
         2) Material: Air.
   3. Round Connection System: Interlocking duct connection system per SMACNA (DCS).

D. Round Spiral Duct:
   1. Round spiral lock seam duct with galvanized steel outer wall.

E. Connectors, Fittings, Sealants, and Miscellaneous:
   1. Fittings: Manufacture with solid inner wall of perforated galvanized steel.
   2. Transverse Duct Connection System: SMACNA "E" rated rigid class connection, interlocking angle and duct edge connection system with sealant, gasket, cleats, and corner clips in accordance with SMACNA (DCS).
   3. Joint Sealers and Sealants: Non-hardening, water resistant, mildew and mold resistant.
      a. Type: Heavy mastic or liquid used alone or with tape, suitable for joint configuration and compatible with substrates, and recommended by manufacturer for pressure class of ducts.
      b. VOC Content: Not more than 250 g/L, excluding water.

c. Surface Burning Characteristics: Flame spread index of zero and smoke developed index of zero, when tested in accordance with ASTM E84.

4. Hanger Rod: ASTM A36/A36M; steel, galvanized; threaded both ends, threaded one end, or continuously threaded.

2.04 FLEXIBLE DUCTS

A. Vapor Barrier Insulated Flexible Air Ducts:
   1. UL 181, Class 1, two-ply polyester or vinyl film supported by helically wound spring steel wire.
   2. Pressure Rating: From 10 in-wc positive to 1 in-wc negative.
   3. Temperature Range: Minus 10 to 160 degrees F.

B. Uninsulated Flexible Air Ducts:
   1. UL 181, Class 1, aluminum laminate and polyester film with latex adhesive supported by helically wound spring steel wire.
   2. Pressure Rating: From 10 in-wc to 1 in-wc negative.
   3. Temperature Range: Minus 20 to 210 degrees F.

2.05 AIR PLENUMS AND CASINGS

A. Fabricate in accordance with SMACNA (DCS) for indicated operating pressures indicated.

B. Minimum Fabrication Requirements:
   1. Fabricate acoustic plenum or casing with reinforcing turned inward.
   2. Provide 16-gauge, 0.059-inch sheet steel back facing and 22-gauge, 0.029-inch perforated sheet steel front facing with 3/32 inch diameter holes on 5/32 inch centers.
   3. Construct panels 3 inches thick, packed with 4.5 pcf minimum glass fiber insulation media, on inverted channel of 16-gauge, 0.059-inch sheet steel.
   4. Mount floor-mounted plenum or casings on 4-inch high concrete curbs. At floor, rivet panels on 8-inch centers to angles. Where floors are acoustically insulated, provide liner of galvanized 18-gauge, 0.052-inch expanded metal mesh supported at 12-inch centers, turned up 12 inches at sides with sheet metal shields.

C. Access Doors:
   1. Install hinged access doors where indicated or required for access to equipment for cleaning and inspection.
   2. Reinforce door frames with steel angles tied to horizontal and vertical plenum supporting angles.
   3. Provide clear wire glass observation ports, minimum 6 by 6 inch size.

2.06 DUCTS FOR KITCHEN EXHAUST APPLICATIONS

A. Provide ductwork, fittings, and appurtenances per NFPA 96, SMACNA (KVS), UL 1978, and UL 2221 requirements and guidelines.

B. Class 1 duct for air with gas and grease particle exhaust at an air velocity of 1,500 to 2,500 fpm.

C. Where ducts are not self-draining back to equipment, provide low-point drain pocket with the copper drain pipe to a sanitary sewer.

D. Design, fabricate, and install liquidtight preventing exhaust leakage into building.

E. Dishwasher Exhaust Duct:
   1. Duct Size: 1/2 in-wc pressure class stainless steel.
   2. Fabricate using single wall, 20-gauge, 0.035-inch Type 304 stainless steel with external welded joints.
   3. Seal joints during installation with factory-supplied overlapping V-bands and sealant.

F. Kitchen Hood and Grease Exhaust Duct:

1. Fabricate in accordance with ductwork manufacturer's instructions, SMACNA (DCS), SMACNA (KVS), and NFPA 96.
2. Rectangular, Single-Wall, Premanufactured Grease Exhaust Duct:
   a. UL Listed and labeled to UL 1978.
   b. Construct of 16-gauge, 0.059-inch sheet steel using continuous external welded joints in rectangular sections.
3. Zero Clearance, 2-Hour Fire-Rated, Rectangular, Double-Wall, Premanufactured Grease Duct:
   a. Listed when tested in accordance with UL 1978 and ASTM E2336.
   b. Construct of 16-gauge, 0.059-inch sheet steel using continuous external welded joints in rectangular sections.
   c. Liquidtight with continuous external weld for seams and joints.
   d. Where ducts are not self-draining back to equipment, provide low-point drain pocket with copper drain pipe to sanitary sewer.
   e. Through-penetration firestop listed to UL 1479 or ASTM E814.
4. Grease Exhaust Duct Access Doors:
   a. Listed when tested in accordance with UL 1978.
   b. Install hinged access doors where indicated or required for access for cleaning and inspection of duct.
   c. Reinforce door frames with steel angles tied to horizontal and vertical plenum supporting angles.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install, support, and seal ducts in accordance with SMACNA (DCS).

B. Install products following the manufacturer's instructions.

C. Comply with safety standards NFPA 90A and NFPA 90B.

D. During construction, provide temporary closures of metal or taped polyethylene on open ductwork to prevent construction dust from entering the ductwork system.

E. Increase duct sizes gradually, not exceeding 15 degrees divergence wherever possible; maximum 30 degrees divergence upstream of equipment and 45 degrees convergence downstream.

F. Kitchen Range Hoods: Install when provided by Section 11 4000 then fit-out with respective ductwork and accessories to interconnect exhaust system.

G. Kitchen Hood Exhaust: Provide residue traps at the base of vertical risers with provisions for the cleanout.

H. Duct sizes indicated are precise inside dimensions. For lined ducts, maintain sizes inside lining.

I. Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities.

J. Use double nuts and lock washers on threaded rod supports.

K. At exterior wall louvers, seal duct to louver frame and install blank-out panels.

L. Louver Fit-out:
   1. Provide blank-out panels sealing available area of wall-mounted exterior-faced louver when connected ductwork is smaller than actual louver free area, and duct outlet is smaller than the louver frame.
   2. Use the same duct material painted black on the exterior side, then seal louver frame and duct.

M. Fire Partitions: Provide firestopping sealing. See Section 07 8400.

N. Duct Accessories, Terminal Units, Inlets, and Outlets: Interconnect as indicated in Sections 23 3300, 23 3600, and 23 3700.

O. Duct Insulation: Provide duct insulation. See Section 23 0713.

END OF SECTION

SECTION 23 3300
AIR DUCT ACCESSORIES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Combination fire and smoke dampers.

B. Duct access doors.

C. Duct test holes.

D. Fire dampers.

E. Flexible duct connectors.

F. Smoke dampers.

G. Volume control dampers.

H. Low leakage (Class 1A) control dampers.

1.02 RELATED REQUIREMENTS

A. Section 23 3100 - HVAC Ducts and Casings.

1.03 REFERENCE STANDARDS

A. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems 2024.

B. NFPA 92 - Standard for Smoke Control Systems 2021.

C. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible 2021.

D. UL 33 - Safety Heat Responsive Links for Fire-Protection Service Current Edition, Including All Revisions.

E. UL 555 - Standard for Fire Dampers Current Edition, Including All Revisions.

F. UL 555C - Standard for Safety Ceiling Dampers Current Edition, Including All Revisions.

G. UL 555S - Standard for Smoke Dampers Current Edition, Including All Revisions.

1.04 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements for submittal procedures.

B. Product Data: Provide for shop-fabricated assemblies including volume control dampers, duct access doors, duct test holes, and hardware used. Include electrical characteristics and connection requirements.

C. Shop Drawings: Indicate for shop fabricated assemblies including volume control dampers.

D. Manufacturer's Installation Instructions: Provide instructions for fire dampers.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Protect dampers from damage to operating linkages and blades.

PART 2 PRODUCTS

2.01 COMBINATION FIRE AND SMOKE DAMPERS

A. Manufacturers:
   1. Arrow United Industries, www.arrowunited.com.
   2. Greenheck, www.greenheck.com.
   3. Louvers & Dampers, Inc, a brand of Mestek, Inc: www.louvers-dampers.com/#sle.
   4. Nailor Industries, Inc: www.nailor.com/#sle.
   5. Pottorff: www.pottorff.com/#sle.
   6. Ruskin Company: www.ruskin.com/#sle.

7. United Enertech: www.unitedenertech.com/#sle.
8. Substitutions: See Section 01 6000 - Product Requirements.

B. Fabricate in accordance with NFPA 90A, UL 555, UL 555S, and as indicated.

C. Ratings:
1. Fire Resistance: Damper shall match wall ratings (1.5-hrs or 3-hrs), refer to architectural plans for wall ratings.
2. Fire Closure Temperature: 165 degree F.Each combination fire-smoke damper shall be equipped with a factory installed heat responsive device rated to close the damper when the temperature at the damper reaches 165 degree F.
3. Elevated Operational Temperature: Dampers shall have a UL 555S elevated temperature rating of 250°F.

D. Construction:
1. Frame: Damper frame shall be 16 ga. galvanized steel formed into a 5 in. x 1 in. structural hat channel. Dampers less than 17 in. high shall utilize low profile geometry and 20 ga. galvanized steel for the top and bottom frame members to maximize free area. Frame shall be 4-piece construction with 1 ½ in. (minimum) integral overlapping gusset reinforcements in each corner to assure square corners and provide maximum resistance to racking. No welding of damper frames shall be permitted.
2. Seals:
   a. Blade Edge: Blade seals shall be extruded silicone rubber mechanically secured to the appropriate blade edges
   b. Jamb: Flexible stainless steel compression type.
3. Linkage: Blade linkages shall be non-adjustable and concealed within the jamb of the damper.
4. Axles: Minimum ½ inch dia. zinc plated steel.
5. Sleeves: Damper shall be supplied as a single assembly with a factory installed sleeve made of material matching that of the damper.
6. Fire Closure Device: Reusable Resettable Link.Mounting: Horizontal or Vertical, refer to plans for requirements.
7. Finish: Galvanized steel.
8. Actuators:
   a. Electric, 120V, 2-position.
   b. Mounting Location: External (outside of duct).
9. Retaining Angles: 1 ½" x 1 ¼" or 2 ½" x 1 ½".

E. Differential Pressure: Dampers shall have a UL 555S differential pressure rating of 4 in. wg.

F. Requirements for Fire and Smoke Dampers installed in Medium Pressure Systems:
1. Performance:
   a. Pressure Drop: The Damper manufacturer's submittal data shall certify that all pressure drop data is licensed in accordance with the AMCA Certified Ratings Program for Test Figures 5.2, 5.3, and 5.5. Damper air performance data shall be developed in accordance with the latest edition of AMCA Standard 500-D. Dampers shall be labeled with the AMCA Air Performance Seal. AMCA certified pressure drop for a 24 in. wide x 24 in. high damper shall not exceed 0.06 in. wg when subjected to an airflow velocity of 1500 fpm according to AMCA Test Figure 5.3.
   b. Leakage: Dampers shall have a UL555S leakage rating of Leakage Class I. (8 cfm/ft2 (0.04 m3/ s/m2) at 4 in. wg (1.0 kPa).

2. Blades: Damper blades shall be of 14 ga. equivalent, galvanized steel with full length structural reinforcement and a double skin true airfoil shape. Each blade shall be symmetrical relative to its axle pivot point, presenting identical performance characteristics with air flowing in either direction through the damper. Provide symmetrical blades of varying size as required to completely fill the damper opening.
3. Velocity: Dampers shall have a UL 555S velocity rating of 4000 fpm.

G. Requirements for Fire and Smoke Dampers installed in Low Velocity Systems:
1. Performance:
a. Pressure Drop: The damper manufacturer's submittal data shall certify that all pressure drop data is licensed in accordance with the AMCA Certified Ratings Program for Test Figures 5.2, 5.3, and 5.5. Damper air performance data shall be developed in accordance with the latest edition of AMCA Standard 500-D. Dampers shall be labeled with the AMCA Air Performance Seal. AMCA certified pressure drop for a 24 in. wide x 24 in. high damper shall not exceed 0.09 in. wg when subjected to an airflow velocity of 1500 fpm according to AMCA Test Figure 5.3.
b. Leakage: Dampers shall have a UL555S leakage rating of Leakage Class II. (20 cfm/ft2 at 4 in. wg).
2. Blades: Damper blades shall be 16 ga. galvanized steel strengthened by three longitudinal 1 in. deep V-grooves running the entire length of each blade. Each blade shall be symmetrical relative to its axle pivot point, presenting identical performance characteristics with air flowing in either direction through the damper. Provide symmetrical blades of varying size as required to completely fill the damper opening.
3. Velocity: Dampers shall have a UL 555S velocity rating of 2000 fpm.

2.02 DUCT ACCESS DOORS

A. Fabricate in accordance with SMACNA (DCS) and as indicated.

B. Fabrication: Rigid and close fitting of galvanized steel with sealing gaskets and quick-fastening locking devices. For insulated ducts, install minimum 1-inch thick insulation with sheet metal cover.
1. Less Than 12 inches Square: Secure with sash locks.
2. Up to 18 inches Square: Provide two hinges and two sash locks.
3. Larger Sizes: Provide an additional hinge.

C. Access doors with sheet metal screw fasteners are not acceptable.

2.03 DUCT TEST HOLES

A. Temporary Test Holes: Cut or drill in ducts as required. Cap with neat patches, neoprene plugs, threaded plugs, or threaded or twist-on metal caps.

2.04 FIRE DAMPERS

A. Fabricate in accordance with NFPA 90A and UL 555, and as indicated.

B. Ceiling (Radiation) Dampers: Galvanized steel, 22-gauge, 0.0299-inch frame and 16-gauge, 0.0598-inch flap, two layers of 0.125-inch thick ceramic fiber on top side and one layer on bottom side for round flaps, with locking clip.
1. Boot Fitting: Factory-provided el type (90 degree). Include field-provided collar.
2. Rated for one hour service in compliance with UL 555C.

C. Horizontal Dampers: Galvanized steel, 22-gauge, 0.0299-inch frame, stainless steel closure spring, and lightweight, heat-retardant, non-asbestos fabric blanket.

D. Curtain Type Dampers: Galvanized steel with interlocking blades. Provide stainless steel closure springs and latches for horizontal installations. Configure with blades out of air stream except for 1-inch pressure-class ducts up to 12 inches in height.

E. Multiple Blade Dampers: 16-gauge, 0.0598-inch galvanized steel frame and blades, oil-impregnated bronze or stainless steel sleeve bearings and plated steel axles, 1/8 by 1/2 inch plated steel concealed linkage, stainless steel closure spring, blade stops, and lock.

F. Fusible Links: UL 33, separate at 160 degrees F with adjustable link straps for combination fire/balancing dampers.

2.05 FLEXIBLE DUCT CONNECTORS

A. Fabricate in accordance with SMACNA (DCS) and as indicated.

B. Flexible Duct Connections: Fabric crimped into metal edging strip.

2.06 SMOKE DAMPERS

A. Fabricate in accordance with NFPA 90A and UL 555S, and as indicated.

B. Dampers: UL Class 1 airfoil blade type smoke damper, normally open automatically operated by electric actuator.

C. Electro Thermal Link: Fusible link melting at 165 degrees F; 120 volts, single phase, 60 Hz; UL listed and labeled.

2.07 VOLUME CONTROL DAMPERS

A. Fabricate in accordance with SMACNA (DCS) and as indicated.

B. Single Blade Dampers:
   1. Fabricate for duct sizes up to 6 by 30 inch.
   2. Blade: 24 gauge, 0.0239 inch, minimum.

C. Multi-Blade Damper: Fabricate consisting of opposed blades with maximum blade sizes 8 by 72 inches. Assemble center- and edge-crimped blades in prime-coated or galvanized-channel frame with suitable hardware.
   1. Blade: 18 gauge, 0.0478 inch, minimum.

D. End Bearings: Except in round ducts 12 inches and smaller, provide end bearings. On multiple blade dampers, provide oil-impregnated nylon, thermoplastic elastomer, or sintered bronze bearings.

E. Quadrants:
   1. Provide locking, indicating quadrant regulators on single and multi-blade dampers.
   2. Where rod lengths exceed 30 inches provide regulator at both ends.

2.08 LOW LEAKAGE (CLASS 1A) CONTROL DAMPERS

A. Manufacturers:
   1. Ruskin Company; CD50: www.ruskin.com/#sle.
   2. United Enertech; _____: www.unitedenertech.com/#sle.

B. Maximum Leakage Allowed: 3 cfm/sq ft at 1 in-wc.

C. Frame:
   1. Material: 20-gauge galvanized steel.

D. Blade:
   1. Type: Multi-blade extruded airfoil for high pressure.
   2. Operation: Opposed type.

E. Other Requirements:
   1. Paint Finish: Standard.
   2. Sleeve or Flange: Factory-mounted standard.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install accessories in accordance with manufacturer's instructions, NFPA 90A, and follow SMACNA (DCS). See Section 23 3100 for duct construction and pressure class.

B. Provide duct test holes where indicated and required for testing and balancing purposes.

C. Provide fire dampers, combination fire and smoke dampers, and smoke dampers at locations indicated, where ducts and outlets pass through fire-rated components, and where required by authorities having jurisdiction. Install with required perimeter mounting angles, sleeves, breakaway duct connections, corrosion resistant springs, bearings, bushings and hinges.

D. Install smoke dampers and combination smoke and fire dampers in accordance with NFPA 92.

E. Demonstrate re-setting of fire dampers to Owner's representative.

F. At fans and motorized equipment associated with ducts, provide flexible duct connections immediately adjacent to the equipment.

G. Provide balancing dampers at points on supply, return, and exhaust systems where branches are taken from larger ducts as required for air balancing. Install minimum two duct widths from duct take-off.

H. Provide balancing dampers on duct take-off to diffusers, grilles, and registers, regardless of whether dampers are specified as part of the diffuser, grille, or register assembly.

END OF SECTION

SECTION 23 3416
CENTRIFUGAL HVAC FANS

PART 1 GENERAL

1.01 REFERENCE STANDARDS

A. ABMA STD 11 - Load Ratings and Fatigue Life for Roller Bearings 2014 (Reaffirmed 2020).

B. AMCA (DIR) - (Directory of) Products Licensed Under AMCA International Certified Ratings Program 2015.

C. AMCA 99 - Standards Handbook 2016.

D. AMCA 210 - Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating 2016.

E. AMCA 300 - Reverberant Room Method for Sound Testing of Fans 2014.

F. AMCA 301 - Methods for Calculating Fan Sound Ratings from Laboratory Test Data 2022.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. ACME Engineering and Manufacturing Corporation; _____: www.acmefan.com/#sle.

B. Carnes, a division of Carnes Company Inc; VIBK: www.carnes.com/#sle.

C. Loren Cook Company; _____: www.lorencook.com/#sle.

D. PennBarry, Division of Air System Components; _____: www.pennbarry.com/#sle.

E. Rosenberg USA, Inc; _____: www.rosenbergusa.com/#sle.

F. Twin City Fan & Blower; _____: www.tcf.com/#sle.

2.02 PERFORMANCE REQUIREMENTS

A. Performance Ratings: Determined in accordance with AMCA 210 and bearing the AMCA Certified Rating Seal.

B. Sound Ratings: AMCA 301, tested to AMCA 300, and bear AMCA Certified Sound Rating Seal.

C. Fabrication: Comply with AMCA 99.

D. Static and Dynamic Balance: Eliminate vibration or noise transmission to occupied areas.

2.03 WHEEL AND INLET

A. Backward Inclined: Steel or aluminum construction with smooth curved inlet flange, heavy back plate, backwardly curved blades welded or riveted to flange and backplate; cast iron hub riveted to back plate and keyed to shaft with set screws.

B. Forward Curved: Black enameled steel construction with inlet flange, backplate, shallow blades with inlet and tip curved forward in direction of airflow, mechanically secured to flange and back plate; steel hub swaged to backplate and keyed to shaft with set screw.

C. Airfoil Wheel: Steel construction with smooth curved inlet flange, heavy backplate die-formed hollow airfoil shaped blades continuously welded at tip flange, and backplate; cast iron or cast steel hub riveted to backplate and keyed to shaft with set screws.

2.04 HOUSING

A. Heavy gauge steel, spot welded for AMCA 99 Class I and II fans, and continuously welded for Class III, adequately braced, designed to minimize turbulence with spun inlet bell and shaped cut.

B. Factory finish before assembly to manufacturer's standard. For fans handling air downstream of humidifiers, provide two additional coats of paint. Prime coating on aluminum parts is not required.

2.05 BEARINGS AND DRIVES

A. Bearings: Heavy duty pillow block type, selfgreasing roller bearings, or ABMA STD 11 life at 120,000 hours.

B. Shafts: Hot rolled steel, ground and polished, with keyway, protectively coated with lubricating oil, and shaft guard.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install flexible connections between fan inlet and discharge ductwork; see Section 23 3300. Ensure metal bands of connectors are parallel with minimum one inch flex between ductwork and fan while running.

END OF SECTION

SECTION 23 3423
HVAC POWER VENTILATORS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Roof exhausters.

B. Cabinet exhaust fans.

C. Inline centrifugal fans and blowers.

D. Kitchen hood upblast roof exhausters.

E. Utility vent blower sets.

F. Laboratory-fume exhaust fans.

1.02 RELATED REQUIREMENTS

A. Section 26 0583 - Wiring Connections: Electrical characteristics and wiring connections.

1.03 REFERENCE STANDARDS

A. AMCA (DIR) - (Directory of) Products Licensed Under AMCA International Certified Ratings Program 2015.

B. AMCA 99 - Standards Handbook 2016.

C. AMCA 204 - Balance Quality and Vibration Levels for Fans 2020.

D. AMCA 210 - Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating 2016.

E. AMCA 211 - Certified Ratings Program Product Rating Manual for Fan Air Performance 2022.

F. AMCA 260 - Laboratory Methods of Testing Induced Flow Fans for Rating 2020.

G. AMCA 300 - Reverberant Room Method for Sound Testing of Fans 2014.

H. AMCA 301 - Methods for Calculating Fan Sound Ratings from Laboratory Test Data 2022.

I. AMCA 311 - Certified Ratings Program Product Rating Manual for Fan Sound Performance 2016.

J. ANSI Z9.5 - Laboratory Ventilation 2022.

K. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum) 2020.

L. NFPA 96 - Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations 2021.

M. UL 762 - Outline of Investigation for Power Roof Ventilators for Restaurant Exhaust Appliances Current Edition, Including All Revisions.

1.04 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements for submittal procedures.

B. Product Data: Provide data on fans and accessories, including fan curves with specified operating point plotted, power, rpm, sound power levels at rated capacity, and electrical characteristics and connection requirements.

C. Manufacturer's Instructions: Indicate installation instructions.

1.05 FIELD CONDITIONS

A. Permanent ventilators may be used for ventilation during construction only after ductwork is clean, filters are in place, bearings have been lubricated, and fan has been test run under observation.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Carnes, a division of Carnes Company Inc; _____: www.carnes.com/#sle.

B. Greenheck Fan Corporation; _____: www.greenheck.com/#sle.

C. Loren Cook Company; _____: www.lorencook.com/#sle.

D. PennBarry, Division of Air System Components; _____: www.pennbarry.com/#sle.

E. Twin City Fan & Blower; _____: www.tcf.com/#sle.

2.02 POWER VENTILATORS - GENERAL

A. Static and Dynamically Balanced: Comply with AMCA 204.

B. Performance Ratings: Comply with AMCA 210, bearing certified rating seal.

C. Sound Ratings: Comply with AMCA 301, tested to AMCA 300, bearing certified sound ratings seal.

D. Fabrication: Comply with AMCA 99.

E. Electrical Components: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

F. Kitchen Hood Exhaust Fans: Comply with requirements of NFPA 96 and UL 762.

2.03 ROOF EXHAUSTERS

A. Fan Unit: Direct driven unless otherwise noted, with spun aluminum housing; resilient mounted motor; 1/2 inch mesh, 0.62 inch thick aluminum wire birdscreen; square base to suit roof curb with continuous curb gaskets.

B. Roof Curb: 8 inch high self-flashing of galvanized steel with continuously welded seams, built-in cant strips.

C. Disconnect Switch: Factory wired, nonfusible, in housing for thermal overload protected motor and wall mounted multiple speed switch.

D. Backdraft Damper: Aluminum multiple blade construction, felt edged with offset hinge pin, nylon bearings, blades linked, and line voltage motor drive, power open, spring return.

E. Sheaves: When required, cast iron or steel, dynamically balanced, bored to fit shafts and keyed; variable and adjustable pitch motor sheave selected so required rpm gets attained with sheaves set at mid-position; fan shaft with self-aligning pre-lubricated ball bearings.

F. Performance Ratings: As indicated on drawings.

2.04 CABINET EXHAUST FANS

A. Centrifugal Fan Unit: Direct driven with galvanized steel housing lined with acoustic insulation, resiliently mounted motor, gravity backdraft damper in discharge.

B. Grille: Molded white plastic.

C. Sheaves: Cast iron or steel, dynamically balanced, bored to fit shafts and keyed; variable and adjustable pitch motor sheaves selected so required rpm is reached with sheaves set at mid-position; fan shaft with self-aligning pre-lubricated ball bearings.

D. Performance Ratings: As indicated on drawings.

2.05 INLINE CENTRIFUGAL FANS AND BLOWERS

A. Centrifugal Fan Unit: V-belt or direct driven, with galvanized steel housing lined with acoustic insulation, resiliently-mounted motor, gravity backdraft damper in discharge.

B. Backward Inclined Blower:

1. Direct-driven, resiliently mounted motor, heavy-duty ball bearings, powder-coated steel housing for outdoor service, and removable service panels.
2. Accessories: Provide external vibration isolator spring.

C. Sheaves: Cast iron or steel, dynamically balanced, bored to fit shafts and keyed; variable and adjustable pitch motor sheaves selected so required rpm gets reached with sheaves set at mid-position; fan shaft with self-aligning prelubricated ball bearings.

D. Performance Ratings: As indicated on drawings.

2.06 KITCHEN HOOD UPBLAST ROOF EXHAUSTERS

A. Direct Drive Fan:
1. Fan Wheel:
a. Type: Non-overloading, backward inclined centrifugal.
b. Material: Aluminum, statically and dynamically balanced.
2. Housing:
a. Construct of heavy gauge aluminum including curb cap, windband, and motor compartment.
b. Rigid internal support structure.
c. One-piece fabricated or fully welded curb-cap base to windband for leak proof construction.
d. Construct drive frame assembly of heavy gauge steel, mounted on vibration isolators.
e. Provide breather tube for fresh air motor cooling and wiring.

B. Shafts and Bearings:
1. Fan Shaft:
a. Ground and polished steel with anti-corrosive coating.
b. First critical speed at least 25 percent over maximum cataloged operating speed.
2. Bearings:
a. Permanently sealed or pillow block type.
b. Minimum L10 life in excess of 100,000 hours (equivalent to L50 average life of 500,000 hours), at maximum cataloged operating speed.
c. 100 percent factory tested.

C. Drive Assembly:
1. Belts, pulleys, and keys oversized for a minimum of 150 percent of driven horsepower.
2. Belts: Static free and oil resistant.
3. Fully machined cast iron type, keyed and securely attached to the wheel and motor shafts.
4. Motor pulley adjustable for final system balancing.
5. Readily accessible for maintenance.

D. Disconnect Switches:
1. Factory mounted and wired in NEMA 3R Encloseure.
2. Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
3. Finish for Painted Steel Enclosures: Provide manufacturer's standard or factory-applied gray unless otherwise indicated.
4. Positive electrical shutoff.
5. Wired from fan motor to junction box installed within motor compartment.

E. Roof Curb: 8 inch high self-flashing of galvanized steel with continuously welded seams, built-in cant strips, insulation and curb bottom, curb bottom, ventilated double wall, and factory installed nailer strip.

F. Drain Trough: Allows for single-point drainage of water, grease, and other residues.

G. Options/Accessories:

1. Birdscreen:
2. Roof Curb Extension: Vented curb extension where required for compliance with minimum clearances required by NFPA 96.
3. Grease Trap:
    a. Container system to collect grease residue.
    b. Maintain 40" height from roof surface to discharge of fan.
4. Hinge Kit:
    a. Hinges and restraint cables mounted to base sleeve.
5. Tie-down Points: Four brackets located on windband secures fan in heavy wind applications.

H. Performance Ratings: As indicated on drawings.

2.07 UTILITY VENT BLOWER SETS

A. Manufacturers:
1. Greenheck Fan Corporation: www.greenheck.com/#sle.
2. Loren Cook Company: www.lorencook.com/#sle.
3. PennBarry, Division of Air System Components: www.pennbarry.com/#sle.
4. Twin City Fan & Blower; BCV: www.tcf.com/#sle.

B. Direct Drive Fan:
1. Fan Wheel:
    a. Type: Non-overloading, backward inclined centrifugal.
    b. Material: Aluminum, statically and dynamically balanced.
2. Housing:
    a. Construct of heavy gauge aluminum including curb cap, windband, and motor compartment.
    b. Rigid internal support structure.
    c. One-piece fabricated or fully welded curb-cap base to windband for leak proof construction.
    d. Construct drive frame assembly of heavy gauge steel, mounted on vibration isolators.
    e. Provide breather tube for fresh air motor cooling and wiring.

C. Shafts and Bearings:
1. Fan Shaft:
    a. Ground and polished steel with anti-corrosive coating.
    b. First critical speed at least 25 percent over maximum cataloged operating speed.
2. Bearings:
    a. Permanently sealed or pillow block type.
    b. Minimum L10 life in excess of 100,000 hours (equivalent to L50 average life of 500,000 hours), at maximum cataloged operating speed.
    c. 100 percent factory tested.

D. Drive Assembly:
1. Belts, pulleys, and keys oversized for a minimum of 150 percent of driven horsepower.
2. Belts: Static free and oil resistant.
3. Fully machined cast iron type, keyed and securely attached to the wheel and motor shafts.
4. Motor pulley adjustable for final system balancing.
5. Readily accessible for maintenance.

E. Disconnect Switches:
1. Factory mounted and wired in NEMA 3R enclosurer.
2. Finish for Painted Steel Enclosures: Provide manufacturer's standard or factory-applied gray unless otherwise indicated.
3. Positive electrical shutoff.

4. Wired from fan motor to junction box installed within motor compartment.

F. Drain Trough: Allows for single-point drainage of water, grease, and other residues.

G. Options/Accessories:
1. Dampers: Provide motorized type.

H. Performance Ratings: As indicated on drawings.

2.08 LABORATORY FUME-EXHAUST FANS

A. Manufacturers:
1. Greenheck Fan Corporation: www.greenheck.com/#sle.
2. Loren Cook Company: www.lorencook.com/#sle.
3. Twin City Fan & Blower: www.tcf.com/#sle.

B. General Requirements:
1. Fan Type: Roof-curb mounted, constant stack-velocity discharge laboratory exhaust.
2. Minimum air discharge velocity of 3,000 fpm in compliance with ANSI Z9.5.
3. Provide fan-assembly manufactured to sustain structural integrity without external guy-wires or supplemental supports at wind speeds up to 125 mph.
4. Fan performance tested in accordance with AMCA 210, AMCA 260, and AMCA 300.
5. Fan performance ratings certified in accordance with AMCA 211 and AMCA 311.

C. Application:
1. Dedicated Fume Hood Exhaust:
a. Fan Type: Direct-driven, single-speed motor with epoxy-based protective coating.
b. Exhaust Capacity: Select fan to handle full exhaust airflow rate, system static pressure loss with 15 percent load-capacity factor, and minimum discharge plume height of 10 feet above roof level.

D. Fan Section Requirements:
1. Impeller:
a. Non-overloading, backward-inclined centrifugal.
b. Material: Aluminum.
2. Fan Shaft:
a. Ground and polished steel with anticorrosive coating.
b. First critical speed at least 25 percent over maximum cataloged operating speed.
c. Enclosed over OSHA recommended safety-yellow painted guards.
3. Bearings:
a. 100 percent factory tested surface-mounted bearings outside of the airstream.
b. Operate during a minimum L10 service life in excess of 100,000 hours at maximum cataloged operating speed.
4. Housing:
a. Construct of heavy gauge aluminum with standard factory finish.
b. Mounting Base:
1) External mounting base with lifting lugs.
c. Construct drive frame assembly of heavy gauge steel, mounted on vibration isolators.
d. Provide breather tube for fresh air motor cooling and wiring.
e. Minimum Assembly Height: 120 inches above the roof surface.
5. Isolation Damper:
a. With parallel blade damper, constructed of matching materials and finish.
b. Provided by manufacturer, bolted to access drawer or panel for easy removal from contaminated airstream.
c. With two-position damper actuator:
1) Provided by manufacturer.

2) Operate interlocked with fan starter.
3) With integral auxiliary switches to monitor blade position status.
4) Rated for NEMA 250, Type 4 (IP66) environment within protective weather-housing out of contaminated airstream, connected through linkages.

6. Fan Discharge Outlet-Nozzle:
   a. High Plume: Conical shaped nozzle manufactured to facilitate attaining a required air-discharge velocity of constantly to lightly reduced exhaust flows.
7. Fan Inlet Flow Sensor: Provide factory-mounted pitot tube-based differential pressure sensor probe ready for use by TAB to balance fan.

E. Fan Bypass Air Plenum:
   1. Constant Volume Systems: For constant volume systems, the fan shall be connected directly to the exhaust duct without the need of a bypass air plenum. Fans mounted directly to roof curbs shall be provided with a damper tray located in the roof curb for mounting of the gravity isolation damper.
   2. Variable Volume Systems: For variable volume systems, a bypass air plenum shall be provided as shown on drawings. The plenum shall be equipped with a bypass air damper and intake air hood with bird screen for introducing outside air at roof level upstream of the fan.

F. Disconnect Switch:
   1. Factory-mounted in NEMA 250, Type 3R box wired in compliance with Section 26 0583.
   2. Switchbox Finish: Manufacturer's standard unless otherwise indicated.

G. Roof Curbs:
   1. 12 inch high, self-flashing of matching material and finish with continuously welded seams.
   2. Provide integral formed steel support framework with curb cap guides.

H. Performance Ratings: As indicated on drawings.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Secure roof exhausters with cadmium plated steel lag screws to roof curb.

C. Extend ducts to roof exhausters into roof curb. Counterflash duct to roof opening.

END OF SECTION

SECTION 23 3439
HIGH-VOLUME, LOW-SPEED PROPELLER FANS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. High-volume, low-speed propeller fans.

1.02 REFERENCE STANDARDS

A. UL 507 - Electric Fans Current Edition, Including All Revisions.

1.03 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements for submittal procedures.

B. Product Data: Provide data on fans and accessories including fan curves with specified operating point clearly plotted, power, RPM, sound power levels at rated capacity, and electrical characteristics and connection requirements.

C. Manufacturer's Instructions: Indicate installation instructions.

1.04 WARRANTY

A. See Section 01 7800 - Closeout Submittals, for additional warranty requirements.

B. Correct defective Work within a five year period after Date of Substantial Completion.

PART 2 PRODUCTS

2.01 GENERAL REQUIREMENTS

A. UL Compliance: UL listed and labeled, designed, manufactured, and tested in accordance with UL 507.

B. Electrical Components: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

2.02 HIGH-VOLUME, LOW-SPEED PROPELLER FANS

A. Manufacturers:
   1. Big Ass Fans; Essence: www.bigassfans.com/#sle.

B. Performance Ratings: Refer to drawing schedule.

C. Shafts and Bearings:
   1. Fan Shaft:
      a. Ground and polished steel with anti-corrosive coating.
      b. First critical speed at least 25 percent over maximum cataloged operating speed.
   2. Bearings:
      a. Permanently sealed or pillow block type.
      b. Minimum L10 life in excess of 100,000 hours (equivalent to L50 average life of 500,000 hours), at maximum cataloged operating speed.
      c. 100 percent factory tested.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Secure fan with stainless steel lag screws to structure.

END OF SECTION

SECTION 23 3513
DUST COLLECTION SYSTEMS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Dust Collection System

B. Ductwork and duct fittings.

C. Inlet fittings.

D. Accessories.

1.02 REFERENCE STANDARDS

A. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process 2022.

B. AWS D9.1/D9.1M - Sheet Metal Welding Code 2018.

C. SMACNA (ROUND) - Round Industrial Duct Construction Standards 2013.

1.03 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements for submittal procedures.

B. Shop Drawings: Indicate dimensions, sizes, weights and point loadings, material thickness, and locations and sizes of field connections. Submit construction layout and details for inlet fittings.

C. Product Data: Provide manufacturers literature and data indicating rated capacities, dimensions, weights and point loadings, accessories, electrical characteristics and connection requirements, wiring diagrams, and location and sizes of field connections.

D. Provide fan curves with specified operating point clearly plotted.

E. Submit sound power levels for both fan inlet and outlet at rated capacity.

F. Manufacturer's Installation Instructions: Indicate assembly and installation instructions.

G. Operation and Maintenance Data: Include instructions for lubrication, motor and drive replacement, spare parts list, and wiring diagrams.

H. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
   1. See Section 01 6000 - Product Requirements, for additional provisions.
   2. Extra Filters: One

PART 2 PRODUCTS

2.01 DUST COLLECTION SYSTEM

A. Manufacturers:
   1. Donaldson Filtration Solutions.
   2. Sternvent

B. General:
   1. Intermittent duty, shaker fabric filter dust collection as shown on the plans and/or listed on the equipment schedule. The collector will include a fan section, filter section and hopper(s) with legs and quick release seal mechanism for connection to integral dust bin.

C. Construction:
   1. The collector housing, hopper(s) and supports shall be constructed of carbon steel and the housing reinforced for maximum pressure of the integral fan.
   2. Exterior surfaces shall have a durable, textured multi-coat urethane finish which passes a 2000-hour salt spray test. Interior surfaces shall be primed only.

3. The collector will be supplied with lift-off hinged doors for access to the fan and filter chamber. No tools shall be required for filter removal and replacement.
4. The collector will have mechanism designed to accept two (2) 55-gallon drum (no fasteners or clamps are required).
5. The fan shall discharge into a special fan chamber designed for noise reduction.

D. Hopper:
1. The hopper(s) shall have a deflector plate at the dirty air inlet to direct large particles directly into the dust bin and distribute the air.
2. The hopper shall be supplied with covered openings so air inlets may be located on either side or the rear.
3. Dust laden air will flow upward into the filter section which shall contain a single, multi-envelope filter with spring steel wire mesh inserts fitted with wear liners.

E. Filters:
1. Slide out filter assembly shall be supported on runners retained by a quick release lever.
2. Filtered air shall flow into the fan section.
3. Filter cleaning occurs after each fan shut down.
4. Filter shaking is via an eccentric mounted on TENV motor located on the side of the housing.

F. Controller:
1. A controller shall be furnished, consisting of start/clean pushbuttons, timer and motor contactors with overloads for the fan and shaker motors, all in a NEMA 12 enclosure. The controller shall automatically activate the filter shaker motor for 35 seconds each time the fan is shut off.

G. Capacity: Refer to drawing schedules for additional requirements.

2.02 DUCTWORK AND DUCT ACCESSORIES

A. Materials:
1. Galvanized Steel Ducts: Hot-dipped galvanized steel sheet, ASTM A653/A653M, FS Type B, with G90/Z275 coating.
a. Thickness: Base sheet steel, 24 gauge, 0.0239 inch minimum.

B. Ductwork:
1. Construct T's, bends, and elbows with radius of not less than 1-1/2 times width of duct on centerline.
2. Increase duct sizes gradually, not exceeding 15 degrees divergence wherever possible; maximum 30 degrees divergence upstream of equipment and 45 degrees convergence downstream.
3. Fabricate continuously welded round and oval duct fittings two gauges heavier than duct gauges indicated in SMACNA (ROUND). Prime coat welded joints.
4. Use crimp joints with or without bead for joining round duct sizes 8 inch and smaller with crimp in direction of air flow, with liquid adhesive plus sheet metal screws.
5. Joints: Minimum 4 inch cemented slip type, brazed, or electric welded to comply with AWS D9.1/D9.1M.
6. Provide standard 45-degree lateral wye branch fittings unless otherwise indicated.
7. Use double nuts and lock washers on threaded rod supports.

C. Flexible Connectors: UL listed, fire-retardant chloroprene or chlorosulfonated polyethylene impregnated fabric, minimum density 20 oz per sq yd, approximately 2 inches wide, crimped into metal edging strip.

D. Angle Rings: Carbon steel, unpainted, leg out, drilled with bolt holes.

E. Blast Gates: Half collar of cast aluminum, with galvanized steel slide, set screw.

F. Flat Back Elbows: Long radius rectangular elbow at duct material with heavy gauge, removable, stainless steel back strip.

G. Ball Joints: Cast iron with tubular studs for connecting ducts, allowing 25 degree angle off center.

H. Floor Sweeps: Galvanized Steel with 4" drop, 12x3 inch opening at floor level with spring load cover.

2.03 INLET FITTINGS

A. Fabricate from 16 gauge, 0.0598 inch galvanized steel, minimum base sheet thickness.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install equipment in accordance with manufacturer's instructions.

B. Install flexible connections at fan inlet and discharge. Ensure metal bands of connectors are parallel with minimum 1-inch flex between ductwork and fan while running.

END OF SECTION

SECTION 23 3600
AIR TERMINAL UNITS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Single-duct terminal units.
   1. Constant-volume units.
   2. Variable-volume units.

B. Fan-powered units.

1.02 RELATED REQUIREMENTS

A. Section 23 0548 - Vibration and Seismic Controls for HVAC.

B. Section 23 3100 - HVAC Ducts and Casings.

1.03 REFERENCE STANDARDS

A. AHRI 410 - Forced-Circulation Air-Cooling and Air-Heating Coils 2001, with Addenda (2011).

B. AHRI 880 (I-P) - Performance Rating of Air Terminals 2017.

C. ASHRAE Std 130 - Laboratory Methods of Testing Air Terminal Units 2016.

D. ASTM A492 - Standard Specification for Stainless Steel Rope Wire 1995 (Reapproved 2019).

E. ASTM A603 - Standard Specification for Metallic-Coated Steel Structural Wire Rope 2019.

F. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials 2023.

G. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum) 2020.

H. NFPA 70 - National Electrical Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

I. SMACNA (SRM) - Seismic Restraint Manual Guidelines for Mechanical Systems 2008.

J. UL 181 - Standard for Factory-Made Air Ducts and Air Connectors current edition, including all revisions.

1.04 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements for submittal procedures.

B. Product Data: Provide data indicating configuration, general assembly, and materials used in fabrication. Include catalog performance ratings that indicate airflow, static pressure, and NC designation. Include electrical characteristics and connection requirements.

C. Shop Drawings: Indicate configuration, general assembly, and materials used in fabrication, and electrical characteristics and connection requirements.
   1. Include schedules listing discharge and radiated sound power level for each of the second through sixth-octave bands at inlet static pressures of 1 to 4 in-wc.

D. Manufacturer's Installation Instructions: Indicate support and hanging details, installation instructions, recommendations, and service clearances required.

E. Project Record Documents: Record actual locations of units and locations of access doors required for access of valving.

F. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
   1. See Section 01 6000 - Product Requirements for additional provisions.
   2. Extra Motors: Two of each type and size.

PART 2 PRODUCTS

2.01 SINGLE-DUCT, VARIABLE-VOLUME AND CONSTANT-VOLUME UNITS

A. Manufacturers:
   1. Krueger-HVAC
   2. Nailor Industries.
   3. Metalaire, a brand of Metal Industries Inc
   4. Price Industries, Inc.
   5. Titus.
   6. Substitutions: See Section 01 6000 - Product Requirements.

B. Basis of Design: Price Industries, Inc: www.priceindustries.com/#sle.
   1. Single-Duct Terminal Unit: SDV, (direct digital controls).
   2. Single-Duct Terminal Units for Electric Coils: SDV-EC, (electric heating coil with direct digital controls).

C. General:
   1. Factory-assembled, AHRI 880 (I-P) rated and bearing the AHRI seal, air volume control terminal with damper assembly, flow sensor, externally mounted volume controller, duct collars, and all required features.
   2. Control box bearing identification, including but not necessarily limited to nominal cfm, maximum and minimum factory-set airflow limits, coil type and coil (right or left hand) connection, where applicable.

D. Unit Casing:
   1. Minimum 22 gauge, 0.0299 inch galvanized steel.
      a. Casing leakage to meet ASHRAE Std 130.
   2. Air Inlet Collar: Provide round, suitable for standard flexible duct sizes.
   3. Unit Discharge: Rectangular, with slip-and-drive connections.
   4. Acceptable Liners:
      a. 3/4 inch thick polyurethane foam adhesive complying with UL 181 erosion requirements in accordance with ASHRAE Std 62.1, and having a maximum smoke developed index of 50 for both insulation and adhesive, when tested in accordance with ASTM E84.
      b. Liner not to contain pentabrominated diphenyl ether (CAS #32534-81-9) or octabrominated diphenyl ether.

E. Damper Assembly:
   1. Heavy-gauge, galvanized steel, or extruded aluminum construction with solid steel, nickel-plated shaft pivoting on HDPE, self-lubricating bearings.
   2. Provide integral position indicator or alternative method for indicating damper position over full range of 90 degrees.
   3. Incorporate low leak damper blades for tight airflow shutoff.

F. Hot Water Heating Coil:
   1. Coil Casing: Minimum 22 gauge, 0.0299 inch galvanized steel, factory-installed on terminal discharge with rectangular outlet, duct connection type.
   2. Coil Fins: Aluminum or aluminum plated fins, mechanically-bonded to seamless copper tubes.
   3. Coil leak tested to minimum 350 psig.
   4. Base performance data on tests run in accordance with AHRI 410 and units to bear AHRI 410 label.

G. Electric Heating Coil:
   1. Listed and provided by the terminal unit manufacturer.

2. Coil Casing: 20 gauge, 0.0359 inch galvanized steel.
3. Heating Elements: Nickel chrome, supported by ceramic insulators.
4. Integral Control Panel: NEMA 250, Type 2 enclosure with hinged access door for access to all controls and safety devices.
5. Furnish a primary automatic reset thermal cutout and differential pressure airflow switch for proof of airflow.
6. Provide the following additional components, mounted and/or wired within the control enclosure:
   a. Fused or non-fused door interlocking disconnect switch.
   b. Mercury contactors.
   c. Fuse block.
7. Factory wired, including all limit switches and steps of control as indicated on the equipment schedule, with the SSR (solid-state relay) proportional heat control.
8. Provide SCR (Silicon Controlled Rectifier) controller.

H. Electrical Requirements:
1. Single-point power connection.
2. Equipment wiring to comply with requirements of NFPA 70.

I. Factory Mounted and Wired Controls:
1. Control Transformers: Factory supplied and mounted for electric and electronic control applications.
2. Wiring Terminations: Fan controls to terminal strip. Terminal lugs to match quantites, sizes, and materials of branch-circuit conductors. Enclose terminal lugs in terminal box that is sized according to NFPA 70.
3. Disconnect Switch: Factory-mounted, fuse type.

J. Factory-Mounted and -Wired Controls: Electrical components mounted in control box with removable cover. Incorporate single-point electrical connection to power source.
1. Control Transformer: Factory mounted for control voltage on electric and electronic control units with terminal strip in control box for field wiring of thermostat and power source.
2. Wiring Terminations: Fan and controls to terminal strip. Terminal lugs to match quantities, sizes, and materials of branch-circuit conductors. Enclose terminal lugs in terminal box that is sized according to NFPA 70.
3. Disconnect Switch: Factory-mounted, fuse type.

K. Control Panel Enclosure: NEMA 250, Type 1, with access panel sealed from airflow and mounted on side of unit.

2.02 FAN-POWERED SERIES UNITS

A. Manufacturers:
1. Krueger-HVAC.
2. Metalaire, a brand of Metal Industries Inc.
3. Nailor Industries.
4. Price Industries, Inc.
5. Trane, a brand of Ingersoll Rand.
6. Titus.
7. Substitutions: See Section 01 6000 - Product Requirements.

B. Basis of Design: Price Industries, Inc: www.priceindustries.com/#sle.
1. Constant-Volume Series Fan-Powered Unit: FDC, (direct digital controls).

C. General:
1. Factory-assembled and wired, AHRI 880 (I-P) rated, horizontal fan-powered terminal unit with blower, blower motor, mixing plenum, and primary air damper contained in a single

unit housing.

D. Unit Casing:
   1. Minimum 22 gauge, 0.0299 inch galvanized steel.
   2. Primary Air Inlet Collar: Suitable for standard flexible duct sizes.
   3. Unit Discharge: Rectangular, suitable for flanged duct connection.
   4. Acceptable Liners:
      a. 3/4 inch thick polyurethane foam adhesive complying with UL 181 erosion requirements in accordance with ASHRAE Std 62.1, and having a maximum smoke developed index of 50 for both insulation and adhesive, when tested in accordance with ASTM E84.

E. Primary Air Damper Assembly:
   1. Heavy-gauge, galvanized steel, or extruded aluminum construction with solid shaft rotating in bearings.
   2. Provide indicator on damper shaft or alternative method for indicating damper position over full range of 90 degrees.
   3. Incorporate low leak (2 percent) damper blades for tight airflow shutoff.
   4. Fan(s): Forward curved, centrifugal type.
   5. Fan Motor:
      a. ECM (Electrically Commutated Motor):
         1) Brushless DC controlled by an integrated controller/inverter that operates the wound stator and senses rotor position to electrically commutate the stator.
      b. Fan motor shaft directly connected to fan and isolated from unit casing to prevent transmission of vibration.

F. Electric Heating Coil:
   1. Listed and provided by the terminal unit manufacturer.
   2. Coil Casing: Minimum 20 gauge, 0.0359 inch galvanized steel.
   3. Heating Elements: Open wire, nickel chrome, supported by ceramic insulators.
   4. Integral Control Panel: NEMA 250, Type 2 enclosure, with hinged access door for access to all controls and safety devices.
   5. Provide a primary automatic reset thermal cutout and differential pressure airflow switch for proof of airflow or electrical interlock to prevent heater operation when fan is not running.
   6. Provide the following additional components, mounted and/or wired within the control enclosure:
      a. Fused or non-fused door interlocking disconnect switch.
      b. Mercury contactors.
      c. Fuse block.
   7. Provide SCR (Silicon Controlled Rectifier) controller.

G. Hot Water Heating Coil:
   1. Coil Casing: Minimum 22 gauge, 0.0299 inch galvanized steel, factory-installed on terminal unit with flanged discharge for attachment to downstream ductwork.
   2. Heavy-gauge aluminum fins, mechanically bonded to tubes.
   3. Copper Tubes: 0.016 inch minimum wall thickness with male solder header connections.
   4. Coil leak tested to minimum 305 psig.
   5. Base performance data on tests run in accordance with AHRI 410.

H. Electrical Requirements:
   1. Single-point power connection.
   2. Equipment wiring to comply with requirements of NFPA 70.

I. Factory-Mounted and -Wired Controls: Electrical components mounted in control box with removable cover. Incorporate single-point electrical connection to power source.
   1. Control Transformer: Factory mounted for control voltage on electric and electronic control units with terminal strip in control box for field wiring of thermostat and power source.
   2. Wiring Terminations: Fan and controls to terminal strip. Terminal lugs to match quantities, sizes, and materials of branch-circuit conductors. Enclose terminal lugs in terminal box that is sized according to NFPA 70.
   3. Disconnect Switch: Factory-mounted, fuse type.

J. Control Panel Enclosure: NEMA 250, Type 1, with access panel sealed from airflow and mounted on side of unit.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install the inlets of air terminal units and air flow sensors a minimum of four duct diameters from elbows, transitions, and duct takeoffs.

C. Provide ceiling access doors or locate units above easily removable ceiling components.

D. Support units individually from structure with wire rope complying with ASTM A492 and ASTM A603 in accordance with SMACNA (SRM). See Section 23 0548.

E. Do not support from ductwork.

F. Connect to ductwork in accordance with Section 23 3100.

END OF SECTION

SECTION 23 3700
AIR OUTLETS AND INLETS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Diffusers:

B. Rectangular ceiling diffusers.

C. Round ceiling diffusers.

D. Fabric air distribution devices.

E. Louvers:

F. Roof hoods.

1.02 RELATED REQUIREMENTS

A. Section 09 9123 - Interior Painting: Painting of ducts visible behind outlets and inlets.

1.03 REFERENCE STANDARDS

A. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials 2023.

B. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems 2024.

C. NFPA 90B - Standard for the Installation of Warm Air Heating and Air-Conditioning Systems 2021.

D. SMACNA (ASMM) - Architectural Sheet Metal Manual 2012.

E. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible 2021.

F. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials Current Edition, Including All Revisions.

G. UL 2518 - Standard for Safety Air Dispersion Systems Current Edition, Including All Revisions.

1.04 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements for submittal procedures.

B. Product Data: Provide data for equipment required for this project. Review outlets and inlets as to size, finish, and type of mounting prior to submission. Submit schedule of outlets and inlets showing type, size, location, application, and noise level.

PART 2 PRODUCTS

2.01 ROUND CEILING DIFFUSERS

A. Type: Round, adjustable pattern, stamped or spun, multicore diffuser to discharge air in 360-degree pattern, with sectorizing baffles where indicated. Project diffuser collar not more than 1 inch above ceiling. In plaster ceilings, provide plaster ring and ceiling plaque.

B. Color: As selected by Architect from manufacturer's standard range.

2.02 RECTANGULAR CEILING DIFFUSERS

A. Type: Provide square formed adjustable, backpan stamped, core removable, and multi-louvered ceiling diffusers constructed to maintain 360 degree discharge air pattern with sectorizing baffles where indicated.

B. Connections: Round.

C. Frame: Provide inverted T-bar type. In plaster ceilings, provide plaster frame and ceiling frame.

D. Fabrication: Aluminum with baked enamel finish.

E. Color: As selected by Architect from manufacturer's standard range.

2.03 FABRIC AIR DISTRIBUTION DEVICES

A. General Requirements:
   1. Diffuser material to comply with ASTM E84, UL 723, UL 2518, NFPA 90A, and NFPA 90B.
   2. Air Dispersion Method:
   3. Hanger Supports:

2.04 LOUVERS

A. Type: 6 inch deep frame with drainable brades, heavy channel frame, 1/2 inch square mesh screen over intake or exhaust end.

2.05 ROOF HOODS

A. Fabricate air inlet or exhaust hoods in accordance with SMACNA (DCS).

B. Fabricate of galvanized steel, minimum 16 gauge, 0.0598 inch base and 20 gauge, 0.0359 inch hood, or aluminum, minimum 16 gauge, 0.0598 inch base and 18 gauge, 0.0598 inch hood; suitably reinforced; with removable hood; birdscreen with 1/2 inch square mesh for exhaust and 3/4 inch for intake, and factory prime coat finish.

C. Fabricate louver penthouses with mitered corners and reinforce with structural angles.

D. Mount unit on minimum 12 inch high curb base with insulation between duct and curb.

E. Make hood outlet area minimum of twice throat area.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Comply with SMACNA (ASMM) for flashing/counter-flashing of roof penetrations and supports for roof curbs and roof mounted equipment.

C. Check location of outlets and inlets and make necessary adjustments in position to comply with architectural features, symmetry, and lighting arrangement.

D. Install diffusers to ductwork with air tight connection.

E. Paint ductwork visible behind air outlets and inlets matte black, see Section 09 9123.

END OF SECTION

SECTION 23 4000
HVAC AIR CLEANING DEVICES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Disposable, extended area panel filters.

B. Filter frames and housings.

C. Ultraviolet lights.

1.02 REFERENCE STANDARDS

A. ACGIH - Ultraviolet Radiation: TLV(R) Physical Agents 7th Edition Documentation 2010.

B. ASHRAE Std 52.2 - Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size 2017, with Addendum (2022).

C. UL 153 - Portable Electric Luminaries Current Edition, Including All Revisions.

D. UL 508A - Industrial Control Panels Current Edition, Including All Revisions.

E. UL 900 - Standard for Air Filter Units Current Edition, Including All Revisions.

F. UL 1598 - Luminaires Current Edition, Including All Revisions.

G. UL 1995 - Heating and Cooling Equipment Current Edition, Including All Revisions.

1.03 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements for submittal procedures.

B. Product Data: Provide data on filter media, filter performance data, filter assembly and filter frames, dimensions, motor locations and electrical characteristics and connection requirements.

C. Shop Drawings: Indicate filter assembly and filter frames, dimensions, motor locations, and electrical characteristics and connection requirements.

D. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
   1. See Section 01 6000 - Product Requirements for additional provisions.
   2. Extra Filters: Two sets of each type and size.

1.04 QUALITY ASSURANCE

PART 2 PRODUCTS

2.01 FILTER MANUFACTURERS

A. American Air Filter Company, Inc; _____: www.aafintl.com/#sle.

B. Camfil, a company of the The Camfil Group; _____: www.camfil.us/#sle.

C. Substitutions: See Section 01 6000 - Product Requirements.

2.02 DISPOSABLE, EXTENDED AREA PANEL FILTERS

A. Media: UL 900 Class 1, pleated, lofted, non-woven, reinforced cotton fabric; supported and bonded to welded wire grid by corrugated aluminum separators.
   1. Frame: Non-flammable.
   2. Nominal size: 24 by 24 inches.
   3. Nominal thickness: 2 inches.

B. Minimum Efficiency Reporting Value (MERV): 8, when tested in accordance with ASHRAE Std 52.2.

C. Rating, per ASHRAE Std 52.2:
   1. Weight Arrestance: 85 percent.
   2. Initial resistance at 500 fpm face velocity: 0.20 in-wc.

3. Recommended final resistance: 0.9 in-wc.

2.03 FILTER FRAMES AND HOUSINGS

A. General: Fabricate filter frames and supporting structures of 16 gauge, 0.0598 inch galvanized steel or extruded aluminum T-section construction with necessary gasketing between frames and walls.

B. Standard Sizes: Provide for interchangeability of filter media of other manufacturers; for panel filters, size for 24 by 24 inches filter media, minimum 2 inches thick; for extended surface and high efficiency particulate air filters, provide for upstream mounting of panel filters.

C. Side Servicing Housings: Flanged for insertion into ductwork, of reinforced 16 gauge, 0.0598 inch galvanized steel; access doors with continuous gasketing and positive locking devices on both sides; extruded aluminum tracks or channels for primary secondary filters with positive sealing gaskets.

2.04 ULTRAVIOLET LIGHTS

A. Manufacturers:
1. Sanuvox Technologies Inc; Biowall: www.sanuvox.com/#sle.
2. Steri-Aire, Inc; _____: www.steril-aire.com/#sle.
3. UV Resources; RLM Xtreme: www.uvresources.com/#sle.
4. Substitutions: See Section 01 6000 - Product Requirements.

B. Tested and recognized by UL 153, UL 1598, and UL 1995 for luminaries, heating, and cooling equipment.

C. UV-C Short Wave Light Array Performance: Provide not less than 190 microwatts/sq in.

D. Materials:
1. Provide UV-C resistant polymeric materials or shield from direct or indirect UV-C light with UV-C tolerant material.
2. UV-C Fixtures: Stainless steel to resist corrosion.

E. Lamp Life: 9000 hours minimum with no more than 20 percent loss of output after two years of continuous use.

F. Control Panel: Provide control panel for each UV-C light array.
1. Comply with UL 508A.
2. Use components marked with minimum SCCR (Short Circuit Current Rating).
3. Provide enclosure with NEMA 4X rating for prevention of corrosion and water ingress.
4. Provide control panel with current sensor to indicate status of UV-C array.

G. Safety Features:
1. Treat view port and other windows to assure UV-C energy emitted is below threshold limit specified by American Conference of Governmental Industrial Hygienists (ACGIH).
2. Provide mechanical interlock switch to disconnect power to UV-C fixtures when opening access door.
3. Provide externally mounted, on-off, disconnect, shutoff, and _____ switch with lockout/tagout that disconnects UV-C power and prevents unwanted operation of UV-C lights.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install air cleaning devices in accordance with manufacturer's instructions.

B. Prevent passage of unfiltered air around filters with felt, rubber, or neoprene gaskets.

C. Do not operate fan system until filters (temporary or permanent) are in place. Replace temporary filters used during construction and testing, with clean set.

D. UV-C system to be commissioned by manufacturer field representative.

END OF SECTION

SECTION 23 5100
BREECHINGS, CHIMNEYS, AND STACKS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Type B double wall gas vents.

B. Double wall metal stacks.

C. Special gas venting.

1.02 REFERENCE STANDARDS

A. ANSI Z21.66 - American National Standard for Automatic Damper Devices for Use with Gas-Fired Appliances 2015 (Reaffirmed 2020).

B. NFPA 54 - National Fuel Gas Code 2021.

C. NFPA 82 - Standard on Incinerators and Waste and Linen Handling Systems and Equipment 2019.

D. UL 441 - Standard for Gas Vents Current Edition, Including All Revisions.

E. UL 1738 - Standard for Venting Systems for Gas-Burning Appliances, Categories II, III, and IV Current Edition.

1.03 DEFINITIONS

A. Breeching: Vent connector.

B. Chimney: Primarily vertical shaft enclosing at least one vent for conducting flue gases outdoors.

C. Vent: That portion of a venting system designed to convey flue gases directly outdoors from a vent connector or from an appliance when a vent connector is not used.

D. Vent Connector: That part of a venting system that conducts the flue gases from the flue collar of an appliance to a chimney or vent, and may include a draft control device.

1.04 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements for submittal procedures.

B. Product Data: Provide data indicating factory built chimneys, including dimensional details of components and flue caps, dimensions and weights, electrical characteristics and connection requirements.

C. Shop Drawings: Indicate general construction, dimensions, weights, support and layout of breechings. Submit layout drawings indicating plan view and elevations where factory-built units are used.

D. Manufacturer's Instructions: Include installation instructions, and indicate assembly, support details, and connection requirements.

E. Manufacturer's Certificate: Certify that refractory lined metal stacks meet or exceed specified requirements.

PART 2 PRODUCTS

2.01 TYPE B DOUBLE WALL GAS VENTS

A. Manufacturers:
   1. Amerivent: www.ameri-vent.com/#sle.
   2. Hart & Cooley, LLC: www.hartandcooley.com/#sle.
   3. Selkirk Corporation: www.selkirkcommercial.com/#sle.
   4. Substitutions: See Section 01 6000 - Product Requirements.

B. Fabrication: Inner pipe of sheet aluminum, and outer pipe of galvanized sheet steel, tested in compliance with UL 441.

C. Electrically Actuated Vent Dampers: Same size as draft hood collar, constructed of stainless steel or galvanized steel, with corrosion-resistant components, in compliance with ANSI Z21.66.

2.02 SPECIAL GAS VENTING (CATEGORY II, III, AND IV)

A. Double-Wall Special Gas Venting:
   1. Manufacturers:
      a. Heatfab Saf-T Vent; Model CI Plus: www.heatfab.com/#sle.
      b. DuraVent.
      c. Hart & Cooley.
   2. Provide double-wall metal stacks, tested to UL 1738 and UL listed with positive pressure rating for use with building heating equipment; comply with NFPA 54.
   3. Fabricate with 1-inch minimum air space between walls and construct inner liner of 28-gauge, 0.015-inch 29-4C stainless steel minimum and outer jacket of 24 gauge, 0.025-inch stainless steel minimum.
      a. Protect aluminized steel surfaces exposed to elements with minimum of one base coat of primer and one finish coat of corrosion-resistant paint suitable for outer jacket skin temperatures of application.
   4. Design, fabricate, and install gastight to prevent products of combustion from leaking into building. Securely connect inner joints and seal in accordance with manufacturer's instructions.
   5. Accessories, UL Labeled:
      a. Ventilated Roof Thimble: Consists of roof penetration, vent flashing with spacers, and storm collar.
      b. Exit Cone: Consists of inner cone and outer jacket to increase stack exit velocity 1.5 times.
      c. Rain/Stack Cap: Consists of conical rainshield with inverted cone for partial rain protection with low flow resistance.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. For Type B, double-wall gas vents, maintain UL-listed minimum clearances from combustibles. Assemble pipe and accessories as required for complete installation.

C. Assemble and install stack sections in accordance with NFPA 82, UL Listings, and industry practices. Join sections with acid-resistant joint cement. Connect base section to foundation using anchor lugs.

D. Level and plumb chimney and stacks.

3.02 SCHEDULES

A. Breechings, Chimneys and Stacks.
   1. Boiler: Category II, III, or IV in accordance with applicable appliance and intallation.

END OF SECTION

SECTION 23 5216
CONDENSING BOILERS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Manufactured units.

B. Boiler construction.

C. Boiler trim.

D. Fuel burning system.

E. Factory installed controls.

1.02 RELATED REQUIREMENTS

A. Section 03 3000 - Cast-in-Place Concrete.

1.03 REFERENCE STANDARDS

A. ASHRAE Std 90.1 I-P - Energy Standard for Buildings Except Low-Rise Residential Buildings Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

B. ASME CSD-1 - Gas-Fired Water Heaters - Volume III - Storage Water Heaters with Input Ratings Above 75,000 Btu per Hour, Circulating and Instantaneous 2015.

C. NFPA 54 - National Fuel Gas Code 2021.

1.04 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements for submittals procedures.

B. Product Data: Provide data indicating general assembly, components, controls, safety controls, and wiring diagrams with electrical characteristics and connection requirements, and service connections.

C. Verification that Contract Documents are in accordance with manufacturer recommendations:
   1. Include with submittal copy of contract documents Hot Water Piping Schematic. Note any modifications required to operate boiler per manufacturer recommendations.
   2. Include with submittal copy of Section 230993 - Sequence of Operations for HVAC. Confirm Sequence of Operations are acceptable to manufacturer, note any required modifications to ensure boiler(s) operate in a manor acceptable to the manufacturer.

D. Manufacturer's Field Reports: Burner manifold gas pressure, percent carbon monoxide (CO), percent oxygen (O), percent excess air, flue gas temperature at outlet, ambient temperature, net stack temperature, percent stack loss, percent combustion efficiency, and heat output.

E. Operation and Maintenance Data: Include manufacturer's descriptive literature, operating instructions, cleaning procedures, replacement parts list, and maintenance and repair data.

F. Warranty: Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer.

1.05 WARRANTY

A. See Section 01 7800 - Closeout Submittals for additional warranty requirements.

B. Provide warranty as follows:
   1. Heat Exchanger: 10-year
   2. Burner: 5-year
   3. All other Components: 1-year

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Modular Condensing Hot Water Boiler for Indoor Applications:
   1. Camus Hydronics.
   2. Raypak.
   3. RBI.

2.02 MANUFACTURED UNITS

A. Comply with the minimum requirements of ASME BPVC-IV and ANSI Z21.13 for construction of boilers.

B. Assembly to bear the ASME "H" stamp and comply with the efficiency requirements of the latest edition of ASHRAE Std 90.1 I-P.

C. Description: Factory-fabricated, -assembled, and -tested, fire-tube condensing boiler with heat exchanger sealed pressure tight, built on a steel base; including insulated jacket; flue-gas vent; combustion-air intake connections; water supply, return, and condensate drain connections; and controls. Water heating service only.

D. Heat Exchanger: Configuration shall be a cylindrical, vertical, two-pass, counter-flow, fire tube design and consist of an integral combustion chamber with an inner tube bundle for primary heat transfer and an outer tube bundle for extracting latent heat from flue gases. The combustion chamber, fire tubes, and tube sheets shall be constructed of 316L stainless steel. The remainder of the heat exchanger shall be constructed of 304L stainless steel. The fire tubes shall be of an oval design with a minimum wall thickness of 0.061”. The upper and lower tube sheets shall have a thickness of no less than 0.25”. The heat exchanger design shall be capable of 40^{o}F constant system return temperatures and be fully condensing complete with condensate trap and drains.

E. Combustion Chamber: The combustion chamber shall be an all welded stainless-steel construction and an integral part of the heat exchanger. The combustion chamber shall incorporate an easily removable radial fired knitted fiber stainless steel burner to access the internal combustion chamber for inspection, service, and cleaning. A window view port shall be provided for visual inspection of the boiler combustion during firing.

F. Burner: The burner shall be a 100% stainless steel vertical mounted radial fired type with stainless knitted metal fiber construction. The burner shall combust a precise amount of premixed combustion air and gas to provide equal distribution of heat for heat transfer throughout the entire heat exchanger. Combustion products are exhausted under minimum back pressure Combustion operates with a minimum 22:1 turn down ratio while sustaining combustion characteristics throughout the entire modulating range. Operation of up to 99% thermal efficiency and shall be certified for Oxides of Nitrogen (NOx) of 9 ppm corrected to 3% oxygen.

G. Blower: Centrifugal fan to operate during each burner firing sequence and to pre-purge and post-purge the combustion chamber.

H. Motors: Comply with requirements specified in Division 23 Section "Common Motor Requirements for HVAC Equipment."

I. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

J. Gas Train: The gas train shall consist of a pressure regulating electro-hydraulic proportional air/gas main gas actuator providing a slow opening, fast closing shutoff valve and proportional 1:1 air/gas ratio control, a fast closing safety shutoff gas pressure regulator with 1/2 PSI allowable static pressure, a low gas pressure switch, and a high gas pressure switch. A factory pre-set combination metering valve and orifice shall be provided for setting combustion

parameters.

K. Ignition: The ignition module shall employ a direct igniter with 3 tries for ignition followed by lockout. Ignition control shall include times for pre-purge, pre-ignition, ignition, and post purge.

L. Casing:

M. Jacket: External Jacket shall be 430 stainless steel mirror finish panels and a power coated access top cover.

N. Control Compartment Enclosures: NEMA 250, Type 1A.

O. Finish: 430 stainless steel mirror finish.

P. Insulation: Minimum 2-inch- thick, mineral-fiber insulation surrounding the heat exchanger.

Q. Combustion-Air Connections: Inlet and vent duct collars.

R. Mounting base to secure boiler.

S. Characteristics and Capacities: Refer to drawing schedules.

2.03 BOILER TRIM

A. Include devices sized to comply with ANSI B31.1, "Power Piping."

B. Aquastat Controllers: Operating and high limit.

C. Safety Relief Valve: ASME rated.

D. Pressure and Temperature Gage: Minimum 3-1/2-inch- diameter, combination water-pressure and -temperature gage. Gages shall have operating-pressure and -temperature ranges so normal operating range is about 50 percent of full range.

E. Boiler Air Vent: Manual.

F. Drain Valve: Minimum NPS 3/4 hose-end gate valve.

2.04 CONTROLS

A. Boilers shall be provided with controls package that will operate all boilers as a common system. BAS contractor will provide boiler control system with a start and stop signal only, the boilers own controls shall preform the following functions:
   1. Determine discharge water temperature based on OA temp and inverse reset schedule. The reset schedule shall be adjustable from a common boiler control panel.
      a. Boiler manufacture shall provide and install exterior temperature sensor. Temperature sensor shall be located in adjacent exterior area way. Control wiring from sensor to boiler shall be installed in conduit.
   2. Determine individual boiler operation dependent on building load and flow.
   3. Rotate boilers on a lead/lag basis to equalize run time among boilers.
   4. Start/stop boilers individual primary water pumps based on building load and operations.
   5. Boiler manufacture shall provide all hydronic temperature sensor required for proper operation of boiler. Coordinate required installation locations with contractor. Control wiring shall be installed in conduit.

B. BAS Interface: Factory installed hardware and software to enable building automation system to monitor and display boiler status and alarm.

C. Burner Operating Controls: To maintain safe operating conditions, burner safety controls limit burner operation.
   1. High Cutoff: Manual reset stops burner if operating conditions rise above maximum boiler design temperature.
   2. Low-Water Cutoff Switch: Electronic probe shall prevent burner operation on low water. Cutoff switch shall be manual -reset type.

3. Blocked Inlet Safety Switch: Manual-reset pressure switch field mounted on boiler combustion-air inlet.

D. ASME CSD-1 Control Requirements: Provide all control accessories as required to meet ASME CSD-1 requirements including but not limited to the following.
   1. Low Water Cutoff Swtich. Low water cut-off switch shall be 120V, provide power from the boiler circuit.
   2. Flow Switch.
   3. High Pressure Gas Switch
   4. Low Pressure Gas Switch

E. Isolation Control Valve: Provide motorized butterfly isolation control valve for each boiler.
   1. Valve shall be controlled by boilers own logic. Provide control wiring as required between valve and boiler controller.
   2. Valve shall be 24V, powered open, spring closed. 24V power for control valve shall be from boiler, if boiler manufacture can not provide 24V power, provide 120V power accordingly.
   3. Valve shall be lined size and shall be control by the boilers own logic. 24V to be powered from the boiler, Power-Open, Spring-Closed.

2.05 GAS VENTING

A. The boiler manufacture shall provide and size the appropriate UL listed boiler breaching system including all required accessories including but not limited to roof thimble, exit conde, rain/stack cap, etc.. Construction to be AL29-4C inner wall, stainless steel outer wall.

2.06 ELECTRICAL POWER

A. Controllers, Electrical Devices, and Wiring: Electrical devices and connections are specified in Division 26 Sections.

B. Single-Point Field Power Connection: Factory-installed and -wired switches, motor controllers, transformers, and other electrical devices necessary shall provide a single-point field power connection to boiler.
   1. House in NEMA 250, Type 1 enclosure.
   2. Wiring shall be numbered and color-coded to match wiring diagram.
   3. Install factory wiring outside of an enclosure in a metal raceway.
   4. Field power interface shall be to fused disconnect switch.
   5. Provide branch power circuit to each motor and to controls with a disconnect switch or circuit breaker.
   6. Provide each motor with overcurrent protection.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install boiler and provide connection of natural gas service in accordance with requirements of NFPA 54 and applicable codes.

C. Install boiler isolation control valve and associated power and control wiring. Control and power wiring between boiler and valve shall be in conduit, lose wires is not acceptable.

D. Install boiler outdoor air sensor and associated control wiring between sensor and boiler controller.

E. Intstall boiler CO sensor and associated control wiring.

F. Install boiler on concrete housekeeping base, sized minimum of 4 inches larger than boiler base in accordance with Section 03 3000.

G. Pipe relief valves to nearest floor drain.

H. Pipe cooled condensate produced by the combustion process from the boiler condensate connection and/or flue stack with suitable piping material to neutralizer prior to discharging into nearest floor drain.

I. Coordinate BAS, BMS, or Integrated Automation linking between unit controller(s) and remote front-end interface, see Section 23 0900 & 23 0993.

3.02 CLOSEOUT ACTIVITIES

A. See Section 01 7800 - Closeout Submittals for closeout submittals.

B. See Section 01 7900 - Demonstration and Training for additional requirements.

C. Demonstrate proper operation of equipment to Owner's designated representative.

D. Training: Train Owner's personnel on operation and maintenance of system.
   1. Use operation and maintenance manual as training reference, supplemented with additional training materials as required.
   2. Provide minimum of two hours of training.

END OF SECTION

SECTION 23 6416
CENTRIFUGAL WATER CHILLERS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Centrifugal water chiller.

1.02 RELATED REQUIREMENTS

A. Section 23 0513 - Common Motor Requirements for HVAC Equipment.

B. Section 25 1500 - Integrated Automation Software.

C. Section 25 3519 - Integrated Automation Control Valves.

D. Section 26 0583 - Wiring Connections.

1.03 REFERENCE STANDARDS

A. AHRI 550/590 (I-P) - Performance Rating of Water-Chilling and Heat Pump Water-Heating Packages Using the Vapor Compression Cycle 2020, with Addendum (2022).

B. ASHRAE Std 15 - Safety Standard for Refrigeration Systems 2019, with All Amendments and Errata.

C. ASHRAE Std 90.1 I-P - Energy Standard for Buildings Except Low-Rise Residential Buildings Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

D. ASHRAE Std 135 - A Data Communication Protocol for Building Automation and Control Networks 2020, with Errata and Amendments (2022).

E. ASME BPVC-VIII-1 - Boiler and Pressure Vessel Code, Section VIII, Division 1: Rules for Construction of Pressure Vessels 2021.

F. IEEE 519 - IEEE Standard for Harmonic Control in Electric Power Systems 2022.

G. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum) 2020.

H. UL 508 - Industrial Control Equipment Current Edition, Including All Revisions.

I. UL 1995 - Heating and Cooling Equipment Current Edition, Including All Revisions.

1.04 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements for submittal procedures.

B. Product Data: Provide rated capacities, weights, specialties and accessories, electrical requirements and wiring diagrams.

C. Shop Drawings: Indicate components, assembly, dimensions, weights and loadings, required clearances, and location and size of field connections. Indicate equipment, piping and connections, valves, strainers, and thermostatic valves required for complete system.

D. Manufacturer's Certificate: Certify that components of package not furnished by manufacturer have been selected in accordance with manufacturer's requirements.

E. Manufacturer's Instructions: Submit manufacturer's complete installation instructions.

F. Operation and Maintenance Data: Include start-up instructions, maintenance data, parts lists, controls, and accessories. Include trouble- shooting guide.

G. Warranty: Submit manufacturer's warranty and ensure forms have been filled out in Owner's name and registered with manufacturer.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Comply with manufacturer's installation instructions for rigging, unloading, and transporting units.

1.06 WARRANTY

A. See Section 01 7800 - Closeout Submittals for additional warranty requirements.

B. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of chillers that fail in materials or workmanship within specified warranty period. Warranty indicated shall be independent of acceptance of any Maintenance Agreement accepted.
   1. Extended warranties include, but are not limited to, the following:
      a. The manufacturer shall provide a five year parts warranty for the entire compressor assembly. Include coverage for compressor casting, compressor motor, impellers, speed increasing gears, inlet guide vanes, bearings, shafts, motor alignment, gaskets and O-rings, suction elbow and discharge volute. Any refrigerant or at the shaft seal shall be repaired at no cost to the owner. The warranty shall commence at date of substantial completion.
      b. The manufacturer shall provide a five year parts and labor warranty for the complete chiller assembly including structural frame, compressor motor starter and/or variable speed drive, compressor, compressor motor, speed increasing gears, purge (low pressure chillers), condenser and evaporator tube bundles and tubes, control panel, chiller controls and safeties, microprocessor boards, gauges, water boxes, refrigerant relief valves (medium and high pressure chillers), and rupture disks (low pressure chillers). The warranty shall commence at date of substantial completion.
   2. The manufacturer shall provide 5-year replacement refrigerant charge warranty.

C. Warranty Period: Five years from date of Substantial Completion. Manufacturers and/or their vendors are requried to cover the added warranty cost between the time of delivery/start-up and substaintial completion, chillers manufacturer and or their vendors not covering this cost will not be accepted.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Carrier Corporation

B. Daikin McQuay

C. York, a brand of Johnson Controls International

D. Substitutions: See Section 01 6000 - Product Requirements.
   1. The chilled water system has been designed based on specific capacities and characteristics of equipment specified in this section and other sections.
   2. When substitution of a different manufacturer or model number is desired, submit sufficient information to demonstrate to Architect that the substitute will have the same or better performance as that specified AND that the related equipment in the system will perform acceptably with the substitute.
   3. If the related equipment must be modified to perform acceptably with the substitute, the entity proposing the substitution is responsible for all additional costs due to re-design and provision of different related equipment.

2.02 CENTRIFUGAL WATER CHILLER

A. Refer to drawing schedule for capacity requirements.

B. Factory assembled and tested, packaged, water cooled chillers consisting of centrifugal compressors, compressor motor, condenser, evaporator, refrigeration accessories, instrument and control panel including gauges and indicating lights, auxiliary components and accessories, and motor starters.
   1. Rating: Comply with AHRI 550/590 (I-P).
   2. Safety: Comply with UL 1995.
   3. Comply with ASME BPVC-VIII-1 for construction and testing of centrifugal chillers.
   4. Comply with ASHRAE Std 15 for safe construction and operation of centrifugal chillers.

C. Refrigeration:
   1. Refrigerant:
      a. Type: R-134a or R1233zd; ASHRAE 34, Class A1.
      b. Compatibility: Chiller parts exposed to refrigerants shall be fully compatible with refrigerants, and pressure components shall be rated for refrigerant pressures.
   2. Refrigerant Flow Control: Manufacturer's standard refrigerant flow-control device satisfying performance requirements indicated.
   3. Pressure Relief Device:
      a. Comply with requirements in ASHRAE 15 and in applicable portions of ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
      b. For Chillers Using R-134a or R-1233zd: ASME-rated, spring-loaded, pressure relief valve; single- or multiple-reseating type. Pressure relief valve(s) shall be provided for each heat exchanger. Condenser shall have dual valves with one being redundant and configured to allow either valve to be replaced without loss of refrigerant.
   4. Refrigeration Transfer: Provide service valves and other factory-installed accessories required to facilitate transfer of refrigerant from chiller to a remote refrigerant storage and recycling system. Comply with requirements in ASHRAE 15 and ASHRAE 147.
   5. Purge System: (Applicable to negative pressure refrigerant machines only)
      a. System shall be a thermal purge design, refrigerant or air cooled, equipped with a carbon filter that includes an automatic regeneration cycle.
      b. Factory wire to chiller's main power supply and system complete with controls, piping, and refrigerant valves to isolate the purge system from the chiller.
      c. Construct components of noncorrodible materials.
      d. Controls shall interface with chiller control panel to indicate modes of operation, set points, data reports, diagnostics, and alarms.
      e. Efficiency of not more than 1 lb of refrigerant per pound of air when rated according to ARI 580.
      f. Operation independent of chiller per ASHRAE 147.

D. Energy Efficiency: ASHRAE Std 90.1.
   1. Refer to drawings for minimum efficiency requirements.

E. Evaporator Side:
   1. Provide evaporator of shell and tube type, seamless or welded steel construction with cast iron or fabricated steel heads, seamless copper tubes or red brass tubes with integral fins, rolled or silver brazed into tube sheets. Position intermediate tube support sheets along length of shell to avoid contact and relative motion between adjacent tubes.
   2. Test and, where applicable, stamp refrigerant side for 45 psi working pressure and water side for 150 psi working pressure, in accordance with ASME BPVC-VIII-1.
   3. Insulate evaporator and cold surfaces with 0.75 inch minimum thick flexible expanded polyvinyl chloride insulation with maximum K factor of 0.28.
   4. Provide thermometer wells or thermistors for temperature controller and low temperature cutout.

5. Design and construct evaporator to prevent liquid refrigerant from entering the compressor.
6. Provide carbon rupture disc or relief valve on shell in accordance with ASHRAE Std 15.
7. Construction and materials to comply with ASME BPVC-VIII-1 or ASHRAE Std 15 as applicable to chiller manufacturer and chiller model.
8. Minimum Wall Thickness: 0.028" at intermediate tube supports.

F. Condenser Side:
1. Provide condensers of shell and tube type, seamless or welded steel construction with cast iron or fabricated steel heads, seamless copper tubes or red brass tubes with integral fins, rolled or silver brazed into tube sheets. Position intermediate tube support sheets along shell length to avoid contact and relative motion between adjacent tubes.
2. Test and, where applicable, stamp refrigerant side for 45 psi working pressure and water side for 150 psi working pressure, in accordance with ASME BPVC-VIII-1.
3. Provide carbon rupture disc or relief valve on shell in accordance with ASHRAE Std 15.
4. Provide baffles to ensure even distribution of incoming gas and to concentrate noncondensible gases.
5. Construction and materials to comply with ASME BPVC-VIII-1.
6. Minimum Wall Thickness: 0.035" at intermediate tube supports.

G. Purge System:
1. Provide purge system on positive pressure units, incorporating a low temperature refrigeration system to automatically remove noncondensibles, water and air.
2. Limit system discharge to maximum of 0.60 pound of refrigerant per pound of air discharged.

H. Centrifugal Compressor:
1. Compressors (Requiring Oil): Single-stage or multistage, variable-displacement, integral variable frequency controller, and digital electronic controls.
2. Compressors (Maginet/Oil Less Type): Single-stage or multistage, variable-displacement, magnetic bearing centrifugal-type compressor driven by an electric motor(s) using oil-free compressor technology using, magnetic bearings, integral variable frequency controller, and digital electronic controls.
3. Compressor Casing: Cast iron, horizontally or vertically split with machined passages and leak tested to 45 psi. Provide refrigerant sight glass.
4. Impellers: Single or multi-stage, in-line design, fully shrouded, statically and dynamically balanced, tested to 20 percent over operating speed, mounted on heat treated forged or rolled steel shaft, nonferrous, labyrinth seals between stages.
5. Bearings: Steel or aluminum journal bearings, pressure lubricated.
6. Gear Box: Double helical design, symmetrical and center supported by spherically seated, self-aligning bearing, arranged for inspection without disassembly.
7. Motor: Hermetically sealed, single speed, low slip induction type; see Section 23 0513.
8. Lubrication: Oil pump, with oil cooler, pressure regulator, oil filters, thermostatically controlled oil heater, and motor controls. Interlock to start before chiller motor and run after motor is shut down. Provide sight glass or electronic sensors for monitoring oil level.
9. Lubrication System:
   a. Force-feed oil to all bearings, gears and rotating surfaces
   b. Oil reservoir: designed in accordance with ASME; contains oil pump and oil heater
   c. Oil pump: positive-displacement type, submerged in oil reservoir.
   d. Oil filter: single filter or dual filter, externally mounted, ½ micron, replaceable cartridge, with service valves
   e. Oil return system: oil eductor to recover and return oil in the evaporator to the main oil sump.
   f. Oil cooler: refrigerant cooled, factory mounted, factory piped and pressure tested

g. Oil heater: immersion type or belly band type, thermostatically controlled
h. Oil temperature: sense via thermocouple located between bearing pads
i. Pump operation: automatically operate oil pump for 50 seconds (minimum) prior to startup. Prevent start¬up until operating oil pressure is established via an interlock with the control panel. Maintain pressure during compressor coastdown, and for 2 minutes (minimum) after coastdown.
j. Means of lubrication after power failure during coast down of driveline. A gravity-fed oil reservoir or a UPS / battery backup to oil pump or a shaft-driven oil pump are acceptable.

10. Refrigerant: Factory precharge unit with refrigerant specified above.

I. Electrical Starters and Drives, Low Voltage (208 to 600 VAC):
1. Water-Cooled, Unit-Mounted Variable Frequency Drive (VFD):
a. Specifically design VFD to interface with the centrifugal water chiller controls and allow for the operating ranges and specific characteristics of the chiller. VFD-control logic is to optimize chiller efficiency by coordinating compressor motor speed and compressor inlet guide vane position to maintain the chilled water setpoint while avoiding surge. If surge is detected, VFD is to move away from and avoid surge at similar conditions in the future.
b. Efficiency: 97 percent or better at full speed and full load.
c. Fundamental Displacement Power Factor: Minimum of 0.97.
d. Provide voltage and current regulated, solid state, microprocessor-based pulse-width modulated (PWM). Output power devices to be IGBT transistors.
e. Provide liquid- or air-cooled heatsink to cool power semiconductor and capacitor.
f. House VFD in NEMA Type 1 metal enclosure having a minimum short circuit withstand rating of 65,000 amps per UL 508. Include three phase input lugs plus a grounding lug for electrical connections, output motor connection via factory installed bus bars and components properly segregated and completely enclosed in a single metal enclosure.
1) Enclosure to include padlockable, door-mounted circuit breaker with minimum AIC rating of 65,000 amps.
2) Entire chiller package to be listed by Underwriter's Laboratories Inc.
g. Test VFD according to UL 508 and listed by a National Recognized Testing Laboratory (NRTL) as designated by OSHA.
h. Active Harmonic Distortion Filter: Factory mounted and wired, IEEE 519 compliant. Maximum of 5% total harmonic distortion. All losses associated with the harmonic filter shall be incorporated into the chiller’s efficiency. Passive filters are not acceptable.
i. Line Frequency: 38 to 60 Hertz with plus or minus 10 percent tolerance.
j. VFD is to include the following features:
1) Control circuit voltages physically and electrically isolated from power circuit voltage.
2) 150 percent instantaneous torque available for improved surge control.
3) Soft start, adjustable linear acceleration, coast-to-stop.
4) Adjustable current limiting and UL-approved electronic motor overload protection.
5) Insensitivity to incoming power phase sequence.
6) VFD and motor protection from the following faults:
(a) Output line-to-line short circuit.
(b) Line-to-ground short circuit.
(c) Phase loss at AFD input.
(d) Phase reversal/imbalance.

(e) Over-voltage.
(f) Under-voltage.
(g) Over-temperature.

k. VFD Status Indicators:
1) Output speed in hertz and rpm.
2) Input line voltage.
3) Input line kW.
4) Output/load amps.
5) Average current in percent RLA.
6) Load power factor.
7) Fault.
8) VFD transistor temperature.

l. Service Conditions:
1) Operating Ambient Temperature: 14 to 104 degrees F.
2) Room Ambient Relative Humidity: Up to 95 percent.
3) Elevation: Up to 3,300 feet. For every 3,300 feet above 3,300 feet, decrease the rated output current by 4 percent up to 9,900 feet.

J. Controls Package:
1. Unit Controls: Factory-supplied DDC:
a. Control-panel mounted with required input-output expansions, power supply, fused disconnect, hand switches, knobs, and accessories required to control chiller unit to manufacturer required sequences to meet intended use with listed performance.
b. Factory configured to interface prewired sensors, switches, and safeties with allowance to add up to four chiller valves and flow sensors.
c. Graphic-based touchscreen to include unit operation controls and user filter based interface for faults, alarms, performance, unit diagnostics, and data recording up to 12 months.
d. BAS, SCADA, or other Integrated Automation Link: ASHRAE Std 135 BACnet MS/TP.
e. External Point Mapping: Provide mapping table for each parameter included in the local visual interface with software-toggle flag to allow reduced mapping of available points.
f. Isolation Valves: Field-installed, 2-position, butterfly type with position tracking; see Section 25 3519.
2. Disconnect Switch: Factory mount disconnect switch in starter control panel.
3. On or near chiller, provide microprocessor based control panel containing solid state, fully automatic operating and safety controls.
4. Provide the following manufacturer's standard safety controls, including the following minimum functions, so that operating any one will shut down machine and require manual reset:
a. Low evaporator refrigerant temperature.
b. High condenser refrigerant pressure.
c. Low oil pressure.
d. Low refrigerant evaporator pressure.
5. Provide the manufacturer's standard safety controls arranged so that operating any one will shut down machine and automatically reset.
6. Provide the following devices on control panel:
a. Manual Switches:
1) Machine off-auto switch.
2) Oil pump switch, manual or automatic.
3) Purge pump switch, manual-off-auto.

4) Machine selector switch to allow load, unload, hold or automatic operation.

b. Manual Setpoint Adjustments:
1) Leaving chilled water temperature.
2) Current demand limit.

c. Status Lights:
1) Chilled water flow proven.
2) Cooling required.
3) Unit running.
4) Unit loading.
5) Unit unloading.
6) Manual reset required.
7) Remote chilled water setpoint active.
8) Remote current water setpoint active.

d. Setpoint and Temperature Display:
1) Chilled water setpoint.
2) Current limit setpoint.
3) Entering evaporator water temperature.
4) Leaving evaporator water temperature.
5) Entering condenser water temperature.
6) Leaving condenser water temperature.

7. Provide the following operating controls:
a. Solid state, chilled water temperature controller that controls electronic guide vane operator and hot gas bypass. Locate temperature sensor in entering chilled water.
b. Adjustable thirty minute off timer prevents compressor from short cycling.
c. Demand limit device to manually set maximum current infinitely between 40 percent and 100 percent of full load amperes.
d. Automatic start that determines demand for chilled water from proof of chilled water flow and temperature differential between chilled water setpoint and supply temperature.

K. Electrical:
1. Compliance: NEMA 250 or UL 1995 as applicable.

L. Accessories:
1. Flow Switches: Chiller manufacturer shall furnish a factory mounted and wired thermal dispersion flow switch for each evaporator and condenser water nozzle and verify field-mounting location before installation.
2. Vibration Isolation:
a. Chiller manufacturer shall furnish vibration isolation for each chiller.
b. Neoprene Pad:
1) Two layers of 0.375-inch-thick, ribbed- or waffle-pattern neoprene pads separated by a 16-gage, stainless-steel plate.
c. Fabricate pads from 40- to 50-durometer neoprene.
d. Provide stainless-steel square bearing plate to load the pad uniformly between 20 and 40 psig with a 0.12- to 0.16-inch deflection.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Provide for connection to electrical service.

C. Provide for connection of electrical wiring between starter and chiller control panel, oil pump, and purge unit.

D. Install units on vibration isolation.

E. Provide evaporator connections to chilled water piping. Refer to piping diagrams for all requirements.

F. Furnish and install necessary auxiliary water piping for oil cooling units and purge condensers.

G. Insulate evaporator and cold surfaces.

H. Provide condenser connection to condenser water piping.

I. Arrange piping for easy dismantling to permit tube cleaning.

J. Provide piping from chiller rupture disc to outdoors. Size as recommended by manufacturer.

K. Coordinate BAS, BMS, or Integrated Automation linking between unit controller(s) and remote front-end interface; see Section 25 1500.

3.02 SYSTEM STARTUP

A. See Section 01 7800 - Closeout Submittals for closeout submittals.

B. See Section 01 7900 - Demonstration and Training for additional requirements.

C. Provide services of factory trained representative for minimum of as required to leak test, refrigerant pressure test, evacuate, dehydrate, charge, start-up, and calibrate controls.

D. Supply initial charge of refrigerant and oil.

3.03 CLOSEOUT ACTIVITIES

A. See Section 01 7800 - Closeout Submittals for closeout submittals.

B. See Section 01 7900 - Demonstration and Training for additional requirements.

C. Train operating personnel in operation and maintenance of units.

D. Provide the services of the manufacturer's field representative to conduct training.

END OF SECTION

SECTION 23 6514
INDUCED-DRAFT COOLING TOWERS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Induced-draft , cross flow type cooling towers.

1.02 RELATED REQUIREMENTS

A. Section 22 1005 - Plumbing Piping.

B. Section 23 2113 - Hydronic Piping.

1.03 REFERENCE STANDARDS

A. ASME PTC 23 - Atmospheric Water Cooling Equipment 2003 (Reaffirmed 2014).

1.04 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements for submittal procedures.

B. Product Data: Provide rated capacities, dimensions, weights and point loadings, accessories, required clearances, electrical requirements and wiring diagrams, and location and size of field connections. Submit schematic indicating capacity controls.

C. Shop Drawings: Indicate suggested structural steel supports including dimensions, sizes, and locations for mounting bolt holes.

D. Manufacturer's Certificate: Certify that cooling tower performance, based on ASME PTC 23, meets or exceeds specified requirements and submit performance curve plotting leaving water temperature against wet bulb temperature.

E. Manufacturer's Instructions: Submit manufacturer's complete installation instructions.

F. Operation and Maintenance Data: Include start-up instructions, maintenance data, parts lists, controls, and accessories.

G. Warranty: Submit manufacturer's warranty and ensure forms have been filled out in Owner's name and registered with manufacturer.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Factory assemble unit. For shipping, disassemble into as large as practical sub-assemblies so that minimum amount of field work is required for re-assembly.

B. Comply with manufacturer's installation instructions for rigging, unloading, and transporting units.

1.06 WARRANTY

A. See Section 01 7800 - Closeout Submittals for additional warranty requirements.

B. The entire tower, including structure, casing, basins, decking, fan(s), motor(s), and all mechanical drive components (including belts, if used) shall be warranted against failure due to defects in materials and workmanship for a period of five (5) years from the date of substantial completion. Manufacturers and/or their vendors are required to cover the warranty cost between the time of delivery/start-up and substantial completion, towers not covered by a warranty of this scope will not be accepted.

PART 2 PRODUCTS

2.01 INDUCED DRAFT CROSSFLOW COOLING TOWER

A. Tower Base:

1. Provide an induced draft, crossflow type, factory assembled, film fill, industrial duty, stainless steel cooling tower situated as shown on the plans. Refer to plans for the limiting overall dimensions of the tower. Total operating power of all fans shall not exceed scheduled HP on drawings. Tower shall be similar and equal in all respects to Marley NC Series.
2. The cooling tower shall be designed for quiet operation, refer to drawing schedule for maximum sound levels. Sound levels shall be independently verified by a CTI-licensed sound test agency to ensure validity and reliability of the manufacturers published values. Measurement and analysis of the sound levels shall be conducted by a certified Professional Engineer in Acoustical Engineering. Sound pressure levels shall be measured and recorded in the acoustic near-field and far-field locations using ANSI S1.4 Type 1 precision instrumentation and in full conformance with CTI ATC-128 test code published by the Cooling Technology Institute (CTI). All low sound options shall be CTI certified for thermal performance.

B. Thermal Performance:
1. Refer to drawing schedule for minimum Thermal Performance requrements. The tower's thermal rating shall be Certified by the Cooling Technology Institute.
2. The tower shall be capable of a minimum 56.332 gpm/Hp efficiency per ASHRAE Standard 90.1.
3. CTI Certification notwithstanding, the cooling tower manufacturer shall guarantee that the tower supplied will meet the specified performance conditions when the tower is installed according to plan. If, because of a suspected thermal performance deficiency, the owner chooses to conduct an on-site thermal performance test under the supervision of a qualified, disinterested third party in accordance with CTI or ASME standards during the first year of operation; and if the tower fails to perform within the limits of test tolerance; then the cooling tower manufacturer will pay for the cost of the test and will make such corrections as are appropriate and agreeable to the owner to compensate for the performance deficiency.

C. Design Loading:
1. The tower structure, anchorage and all its components shall be designed by licensed professional engineers, employed by the manufacturer, per the International Building Code to withstand a wind load of 30 psf, as well as a 0.3g seismic load. The fan deck, hot-water basin covers and, where specified, maintenance platforms shall be designed for 60 psf live load or a 200 lb concentrated load. Guardrails, where specified, shall be capable of withstanding a 200 lb concentrated live load in any direction, and shall be designed in accordance with OSHA guidelines.
2. The tower shall be structurally capable of being supported at the four outer corners of the tower cell. Alternatively, the tower manufacturer shall provide supporting steel to adapt tower to be supported at four outer corners.

D. Construction:
1. Except where otherwise specified, all components of the cooling tower shall be fabricated of series 301L stainless steel. The tower shall be capable of withstanding water having a chloride content (NaCl) up to 750 ppm; a sulfate content (SO4) up to 1200 ppm; a calcium content (CaCO3) up to 800 ppm; and silica (SiO2) up to 150 ppm. The circulating water shall contain no oil, grease, fatty acids, or organic solvents.
2. Fiberglass casing, polyurethane barriers, and thermosetting hybrids and the components they are adhered to shall be considered non-recyclable and not allowed.

3. The specifications, as written, are intended to indicate those materials that will be capable of withstanding the above water quality in continuing service, as well as the loads described in paragraph 4.1. They are to be regarded as minimum requirements. Where component materials peculiar to individual tower designs are not specified, the manufacturers shall take the above water quality and load carrying capabilities into account in the selection of their materials of manufacture.
4. The tower shall be listed in the current FM Approval Guide (approvalguide.com) and conform to the FM Approval Standard for Cooling Towers, Class Number 4930 that is approved for use without sprinkler systems. The tower shall have successfully passed full scale fire testing, static and cyclic wind pressure testing, large missile impact testing (for Zone HM), and structural design evaluation as administered by FM-Approvals. The tower shall be capable of +70/-140 psf for Zone H as defined by FM Global. A copy of the FM Approval Certificate of Compliance, dated November 2013 or later shall be available upon request.

E. Mechanical Equipment:
1. Fan(s) shall be propeller-type, incorporating aluminum alloy blades attached to galvanized hubs with U-bolts. Blades shall be individually adjustable. Maximum fan tip speed shall be 13,000 ft/min. Fan(s) shall be driven through a right angle, industrial duty, oil lubricated, geared speed reducer that requires no oil changes for the first five (5) years of operation. All gearbox bearings shall be rated at an L10A service life of 100,000 hours or greater and the gear sets shall have AGMA Quality Class of 9 or greater. The gearbox shall include any modifications to enable operation down to 10% of full speed.
2. An external oil level dipstick shall be located adjacent to the motor at the fan deck surface and shall be accessible from a portable maintenance ladder.
3. Single-speed motor(s) shall be sized per the drawing schedule, NEMA Premium Efficiency, TEFC, 1.15 service factor, inverter duty, variable torque, and specially insulated for cooling tower duty (Class F). Speed and electrical characteristics shall be 1800 rpm, single-winding, 3-phase, 60 Hz, 460/208 volts. Motor shall operate in the shaft-horizontal position for geardrive towers and shaft-down position for belt drive towers. Nameplate horsepower shall not be exceeded at design operation.
4. The motor to gearbox close coupling shall be a tire-type, single piece, flexible element design to accommodate frequent speed changes that are inherent with VFD applications.
5. The complete mechanical equipment assembly for each cell shall be supported by two horizontal steel beams that resist misalignment between the motor and the gear reducer/ belt drive system.
6. A vibration limit switch in a NEMA 4X housing shall be installed on the mechanical equipment support and wired to the shutdown circuit of the fan motor starter or VFD. The purpose of this switch will be to interrupt control power voltage to a safety circuit in the event of excessive vibration causing the starter or VFD equipment to de-energize the motor. It shall be adjustable for sensitivity, and include a means to reset the switch.

F. Fill, Louvers & Drift Eliminators:
1. Fill shall be film type, thermoformed of PVC, with louvers and eliminators formed as part of each fill sheet. Fill shall be suspended from stainless steel structural tubing supported from the tower structure, and shall be elevated above the floor of the cold-water basin to facilitate cleaning. Air inlet faces of the tower shall be free of water splash out.

G. Drift eliminators shall be PVC, triple-pass, and shall limit drift losses to 0.005% or less of the design water flow rate.

H. Hot Water Distribution System:

1. Two open stainless steel basins (one above each bank of fill) shall receive hot water piped to each cell of the tower. These basin components shall be installed and sealed at the factory and assembled with bolted connections. Tap screws shall not be allowed due to their potential to develop leaks. The basins shall be equipped with removable, stainless steel covers capable of withstanding the loads described in Designed Loading paragraph. The water distribution system shall be accessible and maintainable during tower fan and water operation.
2. Each cell of the tower shall include a single hot-water inlet connection located as shown on the plans. An internal system of PVC piping shall deliver water equally to the distribution basins without the need for balancing valves. This internal piping system shall require no scheduled maintenance, and shall be located such that it does not interfere with normal maintenance access. The internal piping shall extend to the exterior surface of the tower.
3. The water distribution system shall be accessible and maintainable while tower is operating.

I. Casing, Fan Deck and Fan Cylinder:
1. The casing and fan deck shall be stainless steel, and shall be capable of withstanding the loads described in design loading paragraph. The top of the fan shall be equipped with a conical, non-sagging, removable fan guard, fabricated of welded 5/16" and 7 gauge rods, and hot dip galvanized after fabrication. Fan cylinders 5'-0" in height and over shall not be required to have a fan guard.

J. Cold Water Collection Basin:
1. The collection basin shall be welded 301L stainless steel construction. Only low-carbon stainless steel alloys will be accepted in order to minimize the risk of intergranular corrosion in the weld zones. The basin shall include the number and type of suction connections required to accommodate the outflow piping system shown on the plans. Suction connections shall be equipped with stainless steel debris screens. An overflow and drain connection shall be provided in each cell of the cooling tower. The basin floor shall slope toward the drain to allow complete flush out of debris and silt that may accumulate. Towers of more than one cell shall include a method for flow and equalization between cells. The basin shall be accessible and maintainable while water is circulating. All steel items that project into the basin shall also be made of stainless steel.
2. A hole and bolt circle shall be provided in the depressed section of the basin for equalizer piping between cells. A full-face, .25" thick, 50 durometer gasket shall be provided at each equalizer location.

K. Access:
1. Provide a ladder extension for connection to the foot of the ladder attached to the tower casing. This extension shall be long enough to rise from the roof (grade) level to the base of the tower. The installing contractor shall be responsible for cutting the ladder to length; attaching it to the foot of the tower ladder; and anchoring it at its base.
2. 10.1 A large stainless steel, rectangular access door shall be located on both cased faces for entry into the cold-water basin. Doors shall provide convenient access to the fan plenum area to facilitate inspection and allow maintenance to the fan drive system. The access doors shall be at least 30" wide by 48" high.
3. The top of the tower shall be equipped with a guardrail complete with kneerail and toeboard, designed according to OSHA guidelines and factory welded into subassemblies for ease of field installation. Posts, toprails and kneerails shall be 1.5" square tubing. The guardrail assembly shall be hot dipped galvanized after welding and capable of withstanding a 200 pound concentrated live load in any direction. Posts shall be spaced on centers of 8'-0" or less. A 1'-6" wide aluminum ladder with 3" I-beam side rails and 1.25" diameter rungs shall be permanently attached to the endwall casing of the tower, rising from the base of the tower to the top of the guardrail.

4. A heavy gauge aluminum safety cage, welded into subassemblies for ease of field installation, shall surround the ladder, extending from a point approximately 7'-0" above the foot of the ladder to the top of the guardrail. Maximum weight of welded subassemblies shall not exceed 20 lb for ease of installation.
5. There shall be an access platform at the base of the tower extending from the vertical ladder to the access door. The platform shall be surrounded by an OSHA compliant guardrail system welded into subassemblies for ease of installation. The walking surface of the platform shall be perforated to provide a non-slip surface for personnel safety.
6. Provide a factory-installed, walkway extending from one cased-face access door to the other cased face. A steel framework shall support the walkway and the top of the walkway shall be at or above the cold-water basin overflow level. The walkway and framework to be equivalent material as the tower basin and have a minimum width of 36".
7. A factory-installed, elevated platform convenient for the care and maintenance of the tower's mechanical equipment shall be provided. The walkway and framework to be equivalent material as the tower basin.
8. Provide basin equalizer connections, refer to drawings for sizing.

L. Electric Immersion Heaters
1. In pan, suitable to maintain temperature of water in pan at 42 degrees F when outside temperature is 15 degrees F and wind velocity is 15 mph; immersion thermostat and float control operate heaters on low temperature when pan is filled.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install tower on structural steel beams as instructed by manufacturer.

C. Connect condenser water piping with flanged connections to tower. Pitch condenser water supply to tower and condenser water suction away from tower. See Section 23 2113.

D. Connect make-up water piping with flanged or union connections to tower. Pitch to tower. See Section 22 1005.

E. Connect overflow, bleed, and drain, to floor drain.

3.02 FIELD QUALITY CONTROL

A. See Section 01 4000 - Quality Requirements for additional requirements.

B. Provide the services of the manufacturer's field representative to inspect tower after installation and submit report prior to start-up, verifying installation is in accordance with specifications and manufacturer's recommendations.

END OF SECTION

SECTION 23 7313
MODULAR INDOOR CENTRAL-STATION AIR-HANDLING UNITS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Casing construction.
B. Fan section.
C. Coil section.
D. U-Frame Dehumidifer Heat Pipes.
E. Filter and air cleaner section.
F. Damper section.
G. Total energy recovery wheel section.
H. Ultraviolet lights.
I. Access section.

1.02 RELATED REQUIREMENTS

A. Section 23 3416 - Centrifugal HVAC Fans.

1.03 REFERENCE STANDARDS

A. ACGIH - Ultraviolet Radiation: TLV(R) Physical Agents 7th Edition Documentation 2010.
B. AHRI 410 - Forced-Circulation Air-Cooling and Air-Heating Coils 2001, with Addenda (2011).
C. AHRI 1060 (I-P) - Performance Rating of Air-to-Air Exchangers for Energy Recovery Ventilation Equipment 2018.
D. AMCA (DIR) - (Directory of) Products Licensed Under AMCA International Certified Ratings Program 2015.
E. AMCA 99 - Standards Handbook 2016.
F. AMCA 210 - Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating 2016.
G. AMCA 300 - Reverberant Room Method for Sound Testing of Fans 2014.
H. AMCA 301 - Methods for Calculating Fan Sound Ratings from Laboratory Test Data 2022.
I. ASHRAE Std 52.2 - Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size 2017, with Addendum (2022).
J. ASTM B177/B177M - Standard Guide for Engineering Chromium Electroplating 2011 (Reapproved 2021).
K. NFPA 70 - National Electrical Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
L. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems 2024.
M. UL (DIR) - Online Certifications Directory Current Edition.
N. UL 153 - Portable Electric Luminaries Current Edition, Including All Revisions.
O. UL 508A - Industrial Control Panels Current Edition, Including All Revisions.
P. UL 1598 - Luminaires Current Edition, Including All Revisions.
Q. UL 1812 - Ducted Heat Recovery Ventilators Current Edition, Including All Revisions.
R. UL 1995 - Heating and Cooling Equipment Current Edition, Including All Revisions.

1.04 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements for submittal procedures.

B. Product Data:
   1. Published Literature: Indicate dimensions, weights, capacities, ratings, gauges and finishes of materials, and electrical characteristics and connection requirements.
   2. Filters: Data for filter media, filter performance data, filter assembly, and filter frames.
   3. Fans: Performance and fan curves with specified operating point clearly plotted, power, RPM.
   4. Sound Power Level Data: Fan outlet and casing radiation at rated capacity.
   5. Electrical Requirements: Power supply wiring including wiring diagrams for interlock and control wiring, clearly indicating factory-installed and field-installed wiring.

C. Shop Drawings: Indicate assembly, unit dimensions, weight loading, required clearances, construction details, field connection details, and electrical characteristics and connection requirements.

D. Manufacturer's Instructions: Include installation instructions.

E. Maintenance Data: Include instructions for lubrication, filter replacement, motor and drive replacement, spare parts lists, and wiring diagrams.

F. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
   1. See Section 01 6000 - Product Requirements for additional provisions.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Accept products on site in factory-fabricated protective containers, with factory-installed shipping skids and lifting lugs. Inspect for damage.

B. Store in clean dry place and protect from weather and construction traffic. Handle carefully to avoid damage to components, enclosures, and finish.

C. Do not operate units until ductwork is clean, filters are in place, bearings lubricated, and fan has been test run under observation.

1.06 WARRANTY

A. See Section 01 7800 - Closeout Submittals for additional warranty requirements.

B. Provide minimum one year manufacturer warranty covering repair or replacement due to defective materials or workmanship.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Carrier Global Corporation; _____: www.carrier.com/#sle.

B. Daikin Applied; _____: www.daikinapplied.com/#sle.

C. Trane Technologies, PLC; _____: www.trane.com/#sle.

D. York, a brand of Johnson Controls International, PLC; _____: www.york.com/#sle.

E. Temptrol, Nortek Air Solutions.

2.02 REGULATORY REQUIREMENTS

A. Comply with NFPA 70.

B. Products Requiring Electrical Connection: Listed and classified by UL (DIR) as suitable for the purpose specified and indicated.

2.03 CASING CONSTRUCTION

A. Full Perimeter Base Rail:

1. Construct of galvanized steel.
2. Provide base rail of sufficient height to raise unit for external trapping of condensate drain pans.

B. Casing:
1. Forming: Form walls, roofs, and floors with at least two breaks at each joint. Provide 2" double wall construction on all walls, doors, roofs and floors. Provide 20 gauge exterior and 20 gauge interior foam filled panels. Provide minimum 16 gauge interior and 20 gauge foam filled exterior galvanized steel floor. Units shall be designed and constructed such that all exterior panels are non-load bearing.
2. Provide mid-span, no through metal, internal thermal break.
3. Construct outer panels of galvanized steel and inner panels of galvanized steel.
4. Casing Air Pressure Performance Requirements:
   a. Able to withstand up to 8 in-wc positive or negative static pressure.
   b. Not to exceed 0.0042 inches per inch deflection at 8 in-wc in positive pressure sections and minus 8 in-wc in negative pressure sections.
5. Apply manufacturer's standard coating immediately after cleaning and pretreating, un-coated galvanized steel is not acceptable.
6. Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1

C. Casing Insulation and Adhesive:
1. Insulation: ASTM C 1071, Type II, 2" thick 3 pound or 2" foam filled R-12.
2. Location and Application: Encased between outside and inside casing.

D. Access Doors:
1. Construction, thermal and air pressure performance same as casing.
2. Doss shall be provided with neoprene gaskets, applied around entire perimeter of the panel frames.
3. Provide surface mounted handles on hinged, swing doors.
4. Hinges: A minimum of two ball-bearing hinges or stainless-steel piano hinge and two wedge-lever-type latches, operable from inside and outside. Arrange doors to be opened against air-pressure differential.
5. Provide Access Doors in the Following Locations:
   a. Fan section.
   b. Access sections.
   c. Coil sections.
   d. Filter sections.
   e. Mixing sections.

E. Casing Leakage: Seal joints and provide airtight access doors so that air leakage does not exceed one percent of design flow at 8 in-wc positive or negative static pressure.

F. Insulation:
1. Foam filled, provide minimum thermal thickness of 12 R throughout.
2. Completely fill panel cavities in each direction to prevent voids and settling.
3. Comply with NFPA 90A.

G. Drain Pan Construction:
1. Provide cooling coil and humidifier sections with an insulated, double wall, stainless steel drain pan complying with ASHRAE Std 62.1 for indoor air quality and sufficiently sized to collect all condensate.
2. Slope in two planes to promote positive drainage and eliminate stagnate water conditions.
3. Locate outlet of sufficient diameter at lowest point of pan to prevent overflow at normal operating conditions.

4. Provide threaded drain connections constructed of drain pan material, extended sufficient distance beyond the base to accommodate field installed, condensate drain trapping.

H. Finish:
1. Indoor Units:
a. Provide exterior, galvanized steel panels with painted surface complying with ASTM B177/B177M.
b. Color: Manufacturer's standard color.

2.04 FAN SECTION

A. Type: Air foil, single width, single inlet, centrifugal plug fan, in accordance with AMCA 99. See Section 23 3416

B. Performance Ratings: Determined in accordance with AMCA 210 and labeled with AMCA Certified Rating Seal.

C. Sound Ratings: AMCA 301; tested to AMCA 300 and label with AMCA Certified Sound Rating Seal.

D. Bearings: Self-aligning, grease lubricated, with lubrication fittings extended to exterior of casing with plastic tube and grease fitting rigidly attached to casing.

E. Mounting:
1. Locate fan and motor internally on welded steel base coated with corrosion resistant paint.
2. Factory mount motor on slide rails.
3. Provide access to motor, drive, and bearings through removable casing panels or hinged access doors.
4. Internal Vibration Isolation: Fans shall be factory mounted with manufacturer's standard restrained vibration isolation mounting devices having a minimum static deflection of 2-inches.

F. External Motor Junction Box: Factory mount NEMA 4 external junction box and connect to extended motor leads from internally mounted motors.
1. All fan motors shall be factory-wired to individual manual motor protection [MMP] device which shall consist of a motor overload relay with adjustable current rating and an on-off disconnect switch for power isolation. Field wiring of MMP’s to fan motors shall not be permitted.
2. MMP’s shall be contained in a single control panel [MMP panel] and shall be mounted on the exterior wall panel of the fan array section.
3. MMP panel shall have a single point of connection for input power wiring and shall feed power individual MMP’s through a common busbar. Independent wiring of input power to individual MMP’s shall not be permitted.

G. Motor Wiring Conduit: Factory wire fan motor wiring to the unit mounted external motor junction box.

H. Fan Accessories:
1. See Section 23 3416

I. Flexible Duct Connections:
1. For separating fan, coil, and adjacent sections.

2.05 COIL SECTION

A. Casing: Provide access to both sides of coils. Enclose coils with headers and return bends exposed outside casing. Slide coils into casing through removable end panel with blank off sheets and sealing collars at connection penetrations.

B. Drain Pans: 24 inch downstream of coil and down spouts for cooling coil banks more than one coil high.

C. Eliminators: Three break of galvanized steel, mounted over drain pan.

D. Air Coils:
   1. Certify capacities, pressure drops, and selection procedures in accordance with AHRI 410.

E. Fabrication:
   1. Tubes: 5/8 inch OD seamless copper expanded into fins, brazed joints.
   2. Fins: Aluminum.
   3. Casing:
      a. Chilled Water Coils: Die formed channel frame of stainless steel.
      b. Hot Water Coils: Die formed channel frame of galvanized steel.

F. Water Heating Coils:
   1. Headers: Cast iron, seamless copper tube, or prime coated steel pipe with brazed joints.
   2. Configuration: Drainable, with threaded plugs for drain and vent; serpentine type with return bends on smaller sizes and return headers on larger sizes.

G. Water Cooling Coils:
   1. Headers: Cast iron, seamless copper tube, or prime coated steel pipe with brazed joints.
   2. Configuration: Drainable, with threaded plugs for drain and vent; threaded plugs in return bends and in headers opposite each tube.

2.06 U-FRAME DEHUMIDIFER HEAT PIPES

A. General:
   1. Air Handler(s) shall be equipped with Standard Tilted Enhanced Dehumidifier Heat Pipes supplied by Heat Pipe Technology, Inc. to precool the return/outside air and reheat the supply air in a wrap-around configuration. The Dehumidifier Heat Pipes shall be pre-fabricated in a U-Frame arrangement comprised of precool Heat Pipe and reheat Heat Pipe heat exchangers together in one assembly such that the assembly may be inserted into an air conditioning unit with the legs of the U-Frame unit on either side of the cooling coil of the air conditioning unit. The U-Frame assembly shall be configured such that the precool Heat Pipe shall be located immediately before the cooling coil and the reheat Heat Pipe shall be located immediately after the cooling coil. Heat Pipe circuits comprise multiple tubes connected in series, end-to-end to form a closed, continuous loop. Both vapor and liquid will travel in the same direction around the circuit in a single convectional path, making wicking and capillary action unnecessary for continuous heat transfer. The interconnecting piping between the Heat Pipe modules shall be located within the U-Frame unit. Any deviation from the specifications must be approved by the engineer no less than 10 days prior to the project bid date. No consideration of alternates will be given after that time. Heat pipes shall be completely manufactured and fully assembled at the manufacturer’s facility or on site by factory personnel. Conversion of third party coils is not acceptable.

B. Control Valves:

1. The Dehumidifier Heat Pipe circuits shall be equipped with solenoid operated control valves to control the operation of the Heat Pipe circuits, four (4) stages of control each with an individual solenoid valve is required. The electrical power required by the solenoid valves shall be 24 VAC. The solenoid valves shall be wired to a terminal block within a NEMA enclosure located on the exterior surface of the equipment cabinet. All additional wiring, relays, transformers, and power supply etc. necessary to interface with the equipment control system, shall be provided and installed by others. Closing of a valve shall inactivate the Heat Pipe circuit in which it is installed. The valves shall be normally open. The control valves shall be grouped such that each group of valves shall control a designated fraction of the Heat Pipe circuits. With all control valves open, the Dehumidifier Heat Pipe assembly will operate at full capacity. If all the circuits are equipped with control valves, then closing all the valves will stop all Heat Pipe operation. Manufacturer shall provide at least three (3) references for successful controllable wraparound heat pipe installations for at least three (3) years.

C. Heat Pipes:
   1. The Heat Pipe supplier shall have a minimum of 5 years of experience designing and installing Heat Pipes specifically for dehumidification applications.
   2. The tubes shall be ½" OD copper, of specific design for Heat Pipe application, permanently expanded onto the fin collar to form a firm, rigid, and complete pressure contact at all operating conditions. Aluminum tubes will not be allowed.
   3. The fin surface shall be continuous plate type q aluminum q copper fins of specific design to produce maximum heat transfer efficiency for Heat Pipe applications. Airside pressure loss shall be as given on the schedule, or otherwise specified. Fin density and the number of rows of tubes shall be as specified.
   4. Heat transfer fluid shall be classified as Safety Group A1 in ASHRAE Standard 34-2013.
   5. Heat Pipe capacities, entering and leaving dry and wet bulb temperatures, and face velocity shall be as specified.
   6. The frame shall be minimum 16 gauge galvanized steel.
   7. Heat Pipe interconnecting piping and circuitry shall be as specified by Heat Pipe Technology design. Each circuit shall be individually processed, charged, hermetically sealed, and tested. Interconnecting piping shall be fully enclosed to provide complete protection.
   8. Scheduled effectiveness or heat recovery shall be met at a minimum and total pressure drop shall not be exceeded. The resulting Recovery Efficiency Ratio, or RER, shall therefore be met at a minimum.
   9. The Heat Pipes shall be ETL listed to UL standard 207 and CSA C22.2.140.3.
   10. The Heat Pipe heat exchanger shall have a five (5) year limited warranty. All components such as valves and dampers shall carry a 12-month warranty.

2.07 FILTER AND AIR CLEANER SECTION

A. General: Provide filter sections with filter racks, minimum of one access door for filter removal, and filter block-offs to prevent air bypass.

B. Pleated Media Filters:
   1. Media: 2 inch, 100 percent synthetic fibers, continuously laminated to a grid with water repellent adhesive, and capable of operating up to a maximum of 625 fpm without loss of efficiency and holding capacity.
   2. Frame: Galvanized steel, with metal grid on outlet side, steel rod grid on inlet side, hinged, and with pull and retaining handles..
   3. Minimum Efficiency Reporting Value: 8 MERV when tested in accordance with ASHRAE Std 52.2.

C. Differential Pressure Gauge:

1. Provide factory installed dial type differential pressure gauge, flush mounted with casing outer wall, and fully piped to both sides of each filter to indicate status.
2. Maintain plus/minus 5 percent accuracy within operating limits of 20 degrees F to 120 degrees F.

2.08 DAMPER SECTION

A. Control Dampers: Low leakage (Class 1A) Control dampers. See Section 23 3300 - Air Duct Accessories.

B. Mixing Section: Provide a functional section to support the damper assembly for modulating the volume of outdoor, return, and exhaust air.

C. Internal Face Damper Section: Provide as indicated within the air handling unit. Dampers shall be low leakage (Class 1A) Control dampers.

2.09 TOTAL ENERGY RECOVERY WHEEL SECTION

A. Manufacturers:
1. Airxchange.
2. American Energy Exchange, inc.
3. Loren cook Company.
4. SEMCO Incorporated.
5. Greenheck.

B. Certified in accordance with AHRI 1060 (I-P) and UL 1812 for mechanical, electrical, and fire safety.

C. Wheel Construction: Polymer segmented wheel, (for wheels greater than 26-inch in diameter), strengthened with radial spokes.
1. Enthalpy type for both sensible and latent heat recovery.
2. Must insure laminar flow through at design conditions.
3. Energy transfer ratings must be ARI Certified to Standard 1060 and bear the ARI certification symbol for ARI Air-to-Air Energy Recovery Ventilation Equipment Certification Program based on ARI 1060.
4. Desiccant shall be silica gel for maximum latent energy transfer, permanently bonded to wheel media, (sprayed on desiccant coatings or desiccant applied after wheel formation are not acceptable).
5. Wheel shall transfer moisture entirely in the vapor phase.
6. Polymer media shall be mounted in a stainless steel rotor.
7. Maximum Solid Size for Media to Pass: 800 micrometer.

D. Motor:
1. Thermally protected.
2. Factory mounted.

E. Maintenance and Access Features:
1. Access doors upstream and downstream of the wheel cassette.
2. Removable wheel segments to facilitate maintenance and cleaning.
3. Adequate space for cleaning, service, and maintenance.

2.10 ULTRAVIOLET LIGHTS

A. Manufacturers:
1. Sanuvox Technologies Inc; Biowall: www.sanuvox.com/#sle.
2. Steril-Aire, Inc; Rapid Install Kit: www.steril-aire.com/#sle.
3. UV Resources; RLM Xtreme: www.uvresources.com/#sle.

B. Tested and recognized by UL 153, UL 1598, and UL 1995 for luminaries, heating, and cooling equipment.

C. UV-C Short Wave Light Array Performance: Provide not less than 190 microwatts/sq in.

D. Materials:
   1. Provide UV-C resistant polymeric materials or shield from direct or indirect UV-C light with UV-C tolerant material.
   2. UV-C Fixtures: Stainless steel to resist corrosion.

E. Lamp Life: 9000 hours minimum with no more than 20 percent loss of output after two years of continuous use.

F. Control Panel: Provide control panel for each UV-C light array.
   1. Comply with UL 508A.
   2. Use components marked with minimum SCCR (Short Circuit Current Rating).
   3. Provide enclosure with NEMA 4X rating for prevention of corrosion and water ingress.
   4. Provide control panel with current sensor to indicate status of UV-C array.

G. Safety Features:
   1. Treat view port and other windows to assure UV-C energy emitted is below threshold limit specified by American Conference of Governmental Industrial Hygienists (ACGIH).
   2. Provide mechanical interlock switch to disconnect power to UV-C fixtures when opening access door.
   3. Provide externally mounted, on-off, disconnect, and shutoff switch with lockout/tagout that disconnects UV-C power and prevents unwanted operation of UV-C lights.

2.11 ACCESS SECTION

A. Provide where indicated on drawings to allow for inspection, cleaning, and maintenance of field-installed components.

B. Construct access doors same as previously specified within this Section.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Bolt sections together with gaskets.

C. Install flexible duct connections between fan inlet and discharge ductwork and air handling unit sections. Ensure that metal bands of connectors are parallel with minimum 1 inch flex between ductwork and fan while running.

D. Provide fixed sheaves required for final air balance.

E. Make connections to coils with unions or flanges.

F. Hydronic Coils:
   1. Hydronic Coils: Connect water supply to leaving air side of coil (counterflow arrangement).
   2. Provide shut-off valve on supply line and lockshield balancing valve with memory stop on return line.
   3. Locate water supply at bottom of supply header and return water connection at top.
   4. Provide manual air vents at high points complete with stop valve.
   5. Ensure water coils are drainable and provide drain connection at low points.

G. Cooling Coils:
   1. Pipe drain and overflow to nearest floor drain.

3.02 SYSTEM STARTUP

A. Prepare and start equipment and systems in accordance with manufacturers' instructions and recommendations.

B. UV-C system to be commissioned by manufacturer field representative.

3.03 CLOSEOUT ACTIVITIES

A. See Section 01 7800 - Closeout Submittals for closeout submittals.

B. Demonstration: Demonstrate operation of system to Owner's personnel.
   1. Use operation and maintenance data as reference during demonstration.
   2. Briefly describe function, operation, and maintenance of each component.

END OF SECTION

SECTION 23 8126.13
SMALL-CAPACITY SPLIT-SYSTEM AIR CONDITIONERS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Air-source heat pumps.

B. Air cooled condensing units.

C. Indoor air handling (fan and coil) units for ductless systems.

D. Controls.

1.02 RELATED REQUIREMENTS

A. Section 26 0583 - Wiring Connections: Electrical characteristics and wiring connections and installation and wiring of thermostats and other controls components.

1.03 REFERENCE STANDARDS

A. AHRI 210/240 - Performance Rating of Unitary Air-Conditioning and Air-Source Heat Pump Equipment 2023.

B. AHRI 520 - Performance Rating of Positive Displacement Condensing Units 2004.

C. ASHRAE Std 23 - Methods for Performance Testing Positive Displacement Refrigerant Compressors and Compressor Units 2022.

D. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems 2024.

E. NFPA 90B - Standard for the Installation of Warm Air Heating and Air-Conditioning Systems 2024.

F. UL 207 - Standard for Refrigerant-Containing Components and Accessories, Nonelectrical Current Edition, Including All Revisions.

1.04 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide rated capacities, weights, accessories, electrical nameplate data, and wiring diagrams.

C. Shop Drawings: Indicate assembly, required clearances, and location and size of field connections.

D. Manufacturer's Instructions: Indicate rigging, assembly, and installation instructions.

E. Operation and Maintenance Data: Include manufacturer's descriptive literature, operating instructions, installation instructions, maintenance and repair data, and parts listing.

F. Warranty: Submit manufacturers warranty and ensure forms have been filled out in Owner's name and registered with manufacturer.

1.05 WARRANTY

A. See Section 01 7800 - Closeout Submittals, for additional warranty requirements.

PART 2 PRODUCTS

2.01 SYSTEM DESIGN

A. Split-System Heating and Cooling Units: Self-contained, packaged, matched factory-engineered and assembled, pre-wired indoor and outdoor units; UL listed.
   1. Heating and Cooling: Air-source electric heat pump located in outdoor unit with evaporator.
   2. Heating: None.

3. Provide refrigerant lines internal to units and between indoor and outdoor units, factory cleaned, dried, pressurized and sealed, with insulated suction line.

B. Performance Requirements: See Drawings for additional requirements.

C. Electrical Characteristics:
1. Refer to drawings for electrical load requirements.
2. Disconnect Switch: Factory mount disconnect switch on equipment under provisions of Section 26 0583.

2.02 INDOOR AIR HANDLING UNITS FOR DUCTLESS SYSTEMS

A. Indoor Units: Self-contained, packaged, factory assembled, pre-wired unit consisting of cabinet, supply fan, evaporator coil, and controls; wired for single power connection with control transformer.

B. Evaporator Coils: Copper tube aluminum fin assembly, galvanized or polymer drain pan sloped in all directions to drain, drain connection, refrigerant piping connections, restricted distributor or thermostatic expansion valve.
1. Construction and Ratings: In accordance with AHRI 210/240 and UL 207.
2. Manufacturer: System manufacturer.

2.03 OUTDOOR UNITS

A. Outdoor Units: Self-contained, packaged, pre-wired unit consisting of cabinet, with compressor and condenser.
1. Comply with AHRI 210/240.
2. Construction and Ratings: In accordance with AHRI 210/240 with testing in accordance with ASHRAE Std 23 and UL 207.

B. Air Cooled Condenser: Aluminum fin and copper tube coil, AHRI 520 with direct drive axial propeller fan resiliently mounted, galvanized fan guard.

C. Accessories: Filter drier, high-pressure switch (manual reset), low pressure switch (automatic reset), service valves and gauge ports, thermometer well (in liquid line).
1. Provide thermostatic expansion valves.
2. Provide heat pump reversing valves.

D. Operating Controls:
1. Control by room thermostat to maintain room temperature setting.
2. Provide with dry-contacts for scheduling by BAS.

2.04 ACCESSORY EQUIPMENT

A. Room Thermostat: Wall-mounted, electric solid state microcomputer based room thermostat with remote sensor to maintain temperature setting; low-voltage; with following features:
1. Automatic switching from heating to cooling.
2. Preferential rate control to minimize overshoot and deviation from setpoint.
3. Thermostat Display:
a. Actual room temperature.
b. System Mode Indication: Heating, Cooling, Fan Auto, Off, and On, Auto or On, Off.

B. Condenser Wall Mounting Brackets:
1. Provide wall mounting brackets with neoprene vibration isolators and all required mounting hardware for units indicated to be wall mounted.

C. Condenser Dry Contacts:
1. Condensing units shall be provide with dry-contacts to allow scheduling of unit by BAS.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with NFPA 90A and NFPA 90B.

END OF SECTION

SECTION 26 0000

COMMON ELECTRICAL REQUIREMENTS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Section includes common requirements for the entire project.

1.03 GENERAL

A. The Instructions to Bidders, General and Special Conditions, and all other contract documents shall apply to the Contractor's work as well as to each of his Sub-Contractor's work. Each Contractor is directed to familiarize himself in detail with all documents pertinent to this Contract. In case of conflict between these General Provisions and the General and/or Special Conditions, the affected Contractor shall contact the Engineer for clarification and final determination.

B. Each Contractor shall be governed by any alternates, unit prices and addenda or other contract documents insofar as may affect the work or services.

C. The work included in this division consists of the furnishing of all labor, equipment, transportation, excavation, backfill, supplies, material and appurtenances and performing all operations necessary for the satisfactory installation of the complete and operating Electrical System(s) indicated and/or specified in the Contract Documents.

D. Any materials, labor, equipment or services not mentioned specifically herein which may be necessary to complete or perfect any part of the Electrical Systems in a substantial manner, in compliance with the requirements stated, implied or intended in the drawings and/or specifications, shall be included as part of this Contract.

E. The Contractor shall give written notice of any materials or apparatus believed inadequate or unsuitable; in violation of laws, ordinances, rules or regulations of authorities having jurisdiction; and any necessary items of work omitted a minimum of ten days prior to bid. In the absence of such written notice and by the act of submitting his bid, it shall be understood that the Contractor has included the cost of all required items in his bid, and that he will be responsible for the approved satisfactory functioning of the entire system without extra compensation.

F. It is not the intent of this section of the specifications (or the remainder of the contract documents) to make any specific Contractor, other than the Contractor holding the prime agreement, responsible to the Owner, Architect and Engineer. All transactions such as submittal of shop drawings, claims for extra costs, requests for equipment or materials substitution, shall be routed through the Contractor to the Architect (if applicable), then to the Engineer.

G. This section of the Specifications or the arrangement of the Contract Documents shall not be construed as an attempt to arbitrarily assign responsibility of work, material, equipment or services to a particular Contractor or Sub-Contractor. Unless stated otherwise, the subdivision and assignment of work under the various sections shall be the responsibility of the Contractor holding the prime contract.

H. It is the intent of this Contract to deliver to the Owner a new and complete project once work is complete. Although plans and specifications are complete to the extent possible, it shall be the responsibility of the Contractors involved to remove and/or relocate or re-attach any existing or new systems which interfere with new equipment or materials required for the complete installation without additional cost to the Owner.

I. In general, and to the extent possible, all work shall be accomplished without interruption of facility operations. The Contractor shall advise the Architect, Owner and Engineer in writing at least one week prior to the deliberate interruption of any services. The Owner shall be advised

of the exact time that interruption will occur and the length of time the interruption will last. Failure to comply with this requirement may result in complete work stoppage by the Contractors involved until a complete schedule of interruptions can be developed.

J. Whenever utilities are interrupted, either deliberately or accidentally, the Contractor shall work continuously to restore said service. The Contractor shall provide tools, materials, skilled journeymen of his own and other trades as necessary, premium time as needed and coordination with all applicable utilities, including payment of utility company charges (if any), all without requests for extra compensation to the Owner, except where otherwise provided for in the contract for the work.

1.04 DEFINITIONS

A. Architect: The Architect of Record for the project, if any.

B. Contract Documents: All documents pertinent to the quality and quantity of all work to be performed on the project. Includes, but not limited to, plans, specifications, addenda, instructions to bidders (both General and Sub-Contractors), unit prices, shop drawings, field orders, change orders, cost breakdowns, construction manager's assignments, architect's supplemental instructions, periodical payment requests, etc.

1. Note: Any reference within these specifications to a specific entity, i.e. "Electrical Contractor" is not to be construed as an attempt to limit or define the scope of work for that entity or assign work to a specific trade or contracting entity. Such assignments of responsibility are the responsibility of the Contractor or Construction Manager holding the prime contract, unless otherwise provided herein.

C. Contractor: Any Contractor whether proposing or working independently or under the supervision of a General Contractor and/or Construction Manager and who installs any type of mechanical work (Electrical, Low Voltage, Fire Alarm, etc.) or, the General Contractor.

D. Engineer: The Consulting Mechanical-Electrical Engineers either consulting to the Owner, Architect, other Engineers, etc.

E. Furnish: Deliver to the site in good condition.

F. Install: Install equipment furnished by others in complete working order.

G. Provide: Furnish and install in complete working order.

1.05 INTENT

A. It is the intention of the Contract Documents to provide finished work, tested and ready for operation.

B. Minor details not usually shown or specified, but necessary for the proper installation and operation of systems, equipment, materials, etc., shall be included in the work, the same as if herein specified or indicated.

1.06 DRAWINGS AND SPECIFICATIONS

A. The drawings are diagrammatic only and indicate the general arrangement of the systems and are to be followed insofar as possible. If deviations from the layouts are necessitated by field conditions, detailed layouts of the proposed departures shall be submitted to the Engineer for approval before proceeding with the work. The Contract Drawings are not intended to show every vertical or horizontal offset which may be necessary to complete the systems. Contractor shall anticipate that additional offsets may be required without additional cost to the Owner and submit their bid accordingly.

B. The drawings and specifications are intended to supplement each other. No Contractor shall take advantage of conflict between them, or between parts of either. This also includes potential conflicts with regards to equipment and material model numbers, part numbers, etc. and respective description and/or performance. Should this condition exist, the Contractor shall request a clarification not less than 10 days prior to the submission of the proposal so that the condition may be clarified by Addendum. In the event that such a condition arises after work is started, the interpretation of the Engineer shall be the determining factor. In all instances,

unless modified in writing and agreed upon by all parties thereto, the Contract to accomplish the work shall be binding on the affected Contractor.

C. The drawings and specifications shall be considered to be cooperative and complimentary and anything appearing in the specifications which may not be indicated on the drawings or conversely, shall be considered as part of the Contract and must be executed the same as though indicated by both.

D. Contractor shall make all necessary and required measurements in the field and shall be responsible for correct fitting. The work shall be coordinated with all other branches of work in such a manner as to cause a minimum of conflict or delay.

E. The Engineer shall reserve the right to make adjustments in location of conduit, fixtures, outlets, switches, etc. where such adjustments are in the interest of concealing work or presenting a better appearance. Unless a formal proposal request is issued, this work shall be performed without additional cost to the Owner.

F. Each Contractor shall evaluate ceiling heights called for on Architectural Plans. Where the location of Electrical equipment may interfere with ceiling heights, the Contractor shall call this to the attention of the Engineer in writing prior to making the installation. Any such changes shall be anticipated and requested sufficiently in advance so as to not cause extra work on the part of the Contractor or unduly delay the work.

G. Should conflict or overlap (duplication) of work between the various trades become evident, this shall be called to the attention of the Engineer. In such event neither trade shall assume to be relieved of the work which is specified under his branch until instructions in writing are received from the Engineer.

H. The Electrical drawings are intended to show the approximate locations of equipment, materials, conduit, etc. Dimensions given in figures on the drawings shall take precedence over scaled dimensions and all dimensions, whether given in figures or scaled, shall be verified in the field to ensure no conflict with other work. In case of conflict between small and large scale drawings, the larger scale drawings shall take precedence.

I. The Electrical Contractor and his Sub-Contractors shall review all construction documents in detail as they may relate to his work (structural, architectural, site survey, mechanical, etc.). Review all drawings for general coordination of work, responsibilities, ceiling clearances, wall penetrations points, chase access, fixture elevations, etc. Make any pertinent coordination or apparent conflict comments to the Engineer at least ten days prior to bids, for issuance of clarification by written addendum.

J. The Electrical Contractor and his Sub-Contractors shall ensure there is adequate space to install the equipment and materials. Failure to do so shall result in the correction of such encroachment conflict or effect of any work awarded the proposer and shall be accomplished fully without additional expense to the Owner and that they are reasonably accessible for maintenance. Check closely all mechanical and electrical closets, chases, ceiling voids, wall voids, crawl spaces, etc., to ensure adequate spaces.

K. Where on the drawings a portion of the work is drawn out and the remainder is indicated in outline, or not indicated at all, the parts drawn out shall apply to all other like portions of the work. Where ornamentation or other detail is indicated by starting only, such detail shall be continued throughout the courses or parts in which it occurs and shall also apply to all other similar parts of the work, unless otherwise indicated.

L. Details not usually shown or specified, but necessary for the proper installation and operation of systems, equipment, materials, etc., shall be included in the work without additional cost to the Owner, the same as if herein specified or indicated.

M. Where on the Drawings or Addenda the word typical is used, it shall mean that the work method or means indicated as typical shall be repeated in and each time it occurs whether indicated or not.

N. Always check ceiling heights indicated on Architectural Documents and ensure they can be installed appropriately and that they may be maintained after all mechanical and electrical

equipment is installed. If a conflict is apparent, notify the Engineer in writing for instructions. Do not install equipment in the affected area until the conflict is resolved.

1.07 EQUIPMENT AND MATERIALS SUBSTITUTIONS OR DEVIATIONS

A. When any Contractor requests approval of materials and/or equipment of different physical size, weight, capacity, function, color, access, it shall be understood that such substitution, if approved, will be made without additional cost to anyone other than the Contractor requesting the change regardless of changes in connections, space requirements, electrical characteristics, etc.

B. In all cases where substitutions affect other trades, the Contractor requesting such substitutions shall advise all such Contractors of the change and shall compensate them for all necessary changes in their work. Any drawings, specifications, diagram, etc., required to describe and coordinate such substitutions or deviations shall be professionally prepared at the responsible Contractor's expense.

C. Review of shop drawings, submittals, etc. by the Engineer does not in any way absolve the Contractor of the responsibilities of equipment and materials substitutions or deviations.

D. Even with any reference in the specifications to any article, device, product, material, fixture, form, or type of construction by name, make or catalog number, such reference shall be interpreted as establishing a standard of quality and shall not be construed as limiting competition; any devices, products, materials, fixtures, forms, or types of construction which, in the judgment of the Engineer, are equivalent to those specified are acceptable, provided the preceding provisions are met.

E. Wherever any equipment and material is specified exclusively only such items shall be used unless substitution is accepted in writing by the Engineer.

F. Each Contractor shall furnish along with the proposal a list of requested equipment and materials which is to be provided. Where several makes are mentioned in the specifications and the Contractor fails to state which they propose to furnish, the Engineer shall choose any of the makes mentioned without change in price. Inclusion in this list shall not ensure that the Engineers will approve shop drawings unless the equipment, materials, etc., submitted in shop drawings are satisfactorily comparable to the items specified and/or indicated.

G. Each Contractor shall give written notice to the Architect/Engineer 5 days prior to the submission of a proposal of any materials or apparatus believed inadequate or unsuitable; in violation of codes, laws, ordinances, rules or regulations of authorities having jurisdiction; and any necessary items of work omitted. In the absence of such written notice, Proposers signify that they have included the cost of all required items in the proposal and that the Proposer will be responsible for the safe and satisfactory operation of the entire system without additional cost to the Owner.

1.08 COST BREAKDOWNS

A. Within thirty days after acceptance of the Contract, each Contractor is required to furnish to the Engineer one copy of a detailed cost breakdown on each respective area of work. These cost breakdowns shall be made on forms provided or approved by the Engineer or Architect. Payments will not be made until satisfactory cost breakdowns are submitted.

1.09 GUARANTEES AND WARRANTIES

A. Items of equipment which have longer guarantees, as called for in these specifications or as otherwise offered by the manufacturer, such as generators, engines, batteries, transformers, etc., shall have warranties and guarantees completed in order, and shall be in effect at the time of final acceptance of the work by the Engineer. The Contractor shall present the Engineer with such warranties and guarantees at the time of final acceptance of the work. The Owner reserves the right to use equipment installed by the Contractor prior to date of final acceptance. Such use of equipment shall in no way invalidate the guarantee except that Owner shall be liable for any damage to equipment during this period due to negligence of his operator or other employee.

1.10 RECORD DRAWINGS

A. The Contractor shall ensure that any deviations from the design are being recorded daily or as necessary on record drawings being maintained by the Contractor. Dimensions from fixed, visible permanent lines or landmarks shown in vertical and horizontal ways shall be utilized. Compliance shall be a requirement for final payment. Pay particular attention to the location of underfloor or underground exterior in-contract or utility-owned or leased service lines, main switches and other appurtenances important to the maintenance and safety of the Electrical System. Deliver these record drawings to the Engineer as a system is completed, within ten days of the mark-up and/or while the accuracy of the mark-ups can be verified visually. Monthly payment may be withheld if the requirement is not complied with.

1.11 EXAMINATION OF SITE AND CONDITIONS

A. Each Contractor shall be responsible for the conditions under which the work is to be performed, the site of the work, the structure of the ground, above and below grade, the obstacles that may be encountered, the availability and location of necessary facilities and all relevant matters concerning the work.

B. Each Contractor shall carefully examine all Drawings and Specifications and inform themselves of the kind and type of materials to be used throughout the project and which may, in any way, affect the execution of his work

C. Each Contractor shall fully acquaint himself with all existing conditions as to ingress and egress, distance of haul from supply points, routes for transportation of materials, facilities and services, availability of temporary or permanent utilities, etc. The Contractor shall include in his work all expenses or disbursements in connection with such matters and conditions. Each Contractor shall verify all work shown on the drawings and conditions at the site, and shall report in writing to the Engineer ten days prior to bid, any apparent omissions or discrepancies in order that clarifications may be issued by written addendum. No allowance is to be made for lack of knowledge concerning such conditions after bids are accepted.

1.12 SURVEYS, MEASUREMENTS AND GRADES

A. Contractor shall lay out his work and be responsible for all necessary lines, levels, elevations and measurements. He must verify the figures shown on the drawings before laying out the work and will be held responsible for any error resulting from his failure to do so.

B. Contractor shall base all measurements, both horizontal and vertical from established benchmarks. All work shall agree with these established lines and levels. Verify all measurements at site and check the correctness of same as related to the work.

C. Should the Contractor discover any discrepancy between actual measurements and those indicated, which prevents following good practice or the intent of the drawings and specifications, he shall notify the Engineer thru normal channels of job communication and shall not proceed with his work until he has received instructions from the Engineer.

1.13 QUALIFICATIONS OF WORKMEN

A. The installation of all Electrical Work shall be performed by licensed electricians and in accordance with current State Law. All Electrical Contractors bidding this project must have been a licensed company for a minimum of three years to qualify to bid this project. Individual employee experience does not supersede this requirement.

B. All subcontractors bidding the electrical work must have completed one project of 70% this subcontract cost size and two projects of 50% this subcontract cost size.

C. All electrical work shall be accomplished by qualified workmen competent in the area of work for which they are responsible. Untrained and incompetent workmen as evidenced by their workmanship shall be relieved of their responsibilities in those areas. The Engineer shall reserve the right to determine the quality of workmanship of any workman and unqualified or incompetent workmen shall refrain from work in areas not satisfactory to him. Requests for relief of a workman shall be made through the normal channels of responsibility established by the Architect or the contract document provisions.

D. All electrical work shall be accomplished by Journeymen electricians under the direct supervision of a licensed Electrician. All applicable codes, utility company regulations, laws and permitting authority of the locality shall be fully complied with by the Contractor.

E. Special electrical systems, such as Fire Detection and Alarm Systems, Intercom or Sound Reinforcement Systems, Telecommunications or Data Systems, Lightning Protection Systems, Video Systems, Special Electronic Systems, Control Systems, etc., shall be installed by workmen normally engaged or employed in these respective trades. As an exception to this, where small amounts of such work are required and are, in the opinion of the Engineer, within the competency of workmen directly employed by the Contractor involved, they may be provided by this Contractor.

1.14 CONDUCT OF WORKMEN

A. The Contractor shall be responsible for the conduct of all workmen under his supervision. Misconduct on the part of any workmen to the extent of creating a safety hazard, or endangering the lives and property of others, shall result in the prompt permanent dismissal of that workman from the project. The possession, consumption or influence of alcoholic beverages, narcotics or illegally used controlled substances on the jobsite is strictly forbidden. Possession of a fire-arm is prohibited and may result in prosecution. Foul or bad language, graffiti is strictly prohibited. Display of nude tattoos is prohibited.

1.15 SUPERVISION OF WORK

A. The Contractor shall personally supervise the work for which they are responsible or have a competent superintendent, approved by the Engineers, on the work at all times during progress with full authority to act on behalf of the Contractor.

1.16 MATERIALS AND WORKMANSHIP

A. All electrical equipment, materials and articles incorporated in the work shall be new and of comparable quality to that specified. All workmanship shall be first-class and shall be performed by electricians skilled and regularly employed in their respective trades. The Contractor shall determine that the equipment he proposes to furnish can be brought into the building(s) and installed within the space available. All equipment shall be installed so that all parts are readily accessible for inspection, maintenance, replacement, etc. Extra compensation will not be allowed for relocation of equipment for accessibility or for dismantling equipment to obtain entrance into the building(s).

B. All conduit and/or conductors shall be concealed underground, within crawl space in or below walls, floors or above ceilings unless otherwise noted. All fixtures, devices and wiring required shall be installed to make up complete systems as indicated on the drawings and specified herein. Raceways shall not be placed within foundation walls and footings. See notes on plans about the limitation on work allowed to be installed within the crawl space.

C. All materials, where applicable, shall bear Underwriters' Laboratories label or that of another Engineer-approved testing agency, where such a standard has been established.

D. Each length of conduit, wireway, duct, conductor, cable, fitting, fixture and device used in the electrical systems shall be stamped or indelibly marked with the maker’s mark or name.

E. All electrical equipment shall bear the manufacturer's name and address and shall indicate its electrical capacity and characteristics.

F. All electrical materials, equipment and appliances shall conform to the latest standards of the National Electric Manufacturers Association (NEMA) and the National Board of Fire Underwriters (NBFU) and shall be approved by the Owner's insuring agency if so required.

1.17 COOPERATION AND COORDINATION WITH OTHER TRADES

A. The Contractor is expressly directed to read the General Conditions and all sections of these specifications for all other trades and to study all drawings applicable to his work, including Architectural, Plumbing, Fire Protection, Mechanical and Structural drawings, to the end that complete coordination between trades will be affected. Each Contractor shall make known to all other contractors the intended positioning of materials, raceways, supports, equipment and the

intended order of his work. Coordinate all work with other trades and proceed with the installation in a manner that will not create delays for other trades or affect the Owner's operations.

B. Special attention to coordination shall be given to points where raceways, fixtures, etc., must cross other ducts or conduit, where lighting fixtures must be recessed in ceilings, and where fixtures, conduit and devices must recess into walls, soffits, columns, etc. It shall be the responsibility of each Contractor to leave the necessary room for other trades. No extra compensation or time will be allowed to cover the cost of removing fixtures, devices, conduit, ducts, etc. or equipment found encroaching on space required by others.

C. The Contractor shall be responsible for coordination with all trades to ensure they have made provisions for connections, operational switches, disconnect switches, fused disconnects, etc., for electrically operated equipment provided under this or any other division of the specifications, or as called for on the drawings. Any connection, circuiting, disconnects, fuses, etc., that are required for equipment operation shall be provided as a part of this contract.

D. If any discrepancies occur between accompanying drawings and these specifications and drawings and specifications covering other trade's work, each trade shall report such discrepancies to the Engineer far enough in advance so that a workable solution can be presented. No extra payment will be allowed for relocation of fixtures, devices, conduit, and equipment not installed or connected in accordance with the above instructions.

E. In all areas where air diffusers, devices, luminaires and other ceiling-mounted devices are to be installed, the Mechanical Trade(s) and the Electrical Trade and the General Trades shall coordinate their respective construction and installations so as to provide a combined symmetrical arrangement that is acceptable to the Engineer. Where applicable, refer to reflected ceiling plans. Request layouts from the Engineer where in doubt about the potential acceptability of an installation.

1.18 INTERFACING

A. Each Electrical Trade, Specialty Controls Trade, Mechanical Trade and the General Trades, etc., shall ensure that coordination is effected relative to interfacing of all systems. Some typical interface points are (but not necessarily all):

1. Connection of Telecommunications (voice, video, data) lines to Owner's existing or new services.
2. Connection of Power lines to Owner's existing or new services.
3. Connection of all controls to equipment.
4. Electrical power connections to electrically operated (or controlled) equipment.
5. Electrical provisions for all equipment provided by other trades or suppliers within this contract.

1.19 CONNECTION TO EQUIPMENT FURNISHED BY OTHERS

A. Each Contractor shall make all connections to equipment furnished by others, whenever such equipment is shown on any part of the drawings or mentioned in any part of the Specifications, unless otherwise specifically specified hereinafter.

B. All drawings are complementary, one trade of the other. It is the Contractor's responsibility to examine all drawings and specifications to determine the full scope of his work. The project Engineers have arranged the specifications and drawings in their given order solely as a convenience in organizing the project, and in no way shall they imply the assignment of work to specific trades, contractors, subcontractors or suppliers.

C. Supervision to assure proper installation, functioning and operation shall be provided by the Contractor furnishing the equipment or apparatus to be connected.

D. Items indicated on the drawings as rough-in only (RIO) will be connected by the equipment supplier or Owner, as indicated. The Contractor shall be responsible for rough-in provisions

only as indicated. These rough-ins shall be in accord with the manufacturer's or supplier's requirements.

E. For items furnished by others, relocated, or RIO, the Contractor shall obtain from the supplier or shall field determine as appropriate, the exact rough-in locations and connection sizes for the referenced equipment.

F. The Contractor shall be responsible for coordinating with the General and all other trades, as necessary, to determine any and all final connections that he is to make to equipment furnished by others.

1.20 CODES, RULES, PERMITS, FEES, INSPECTIONS, REGULATIONS, ETC.

A. The Contractor shall give all necessary notices, obtain and pay for all permits, government sales taxes, fees, inspections and other costs, including all utility connections, meters, meter settings, extensions, etc. in connection with his work.

B. The Contractor shall file all necessary plans, utility easement requests and drawings, survey information on line locations, load calculations, etc. prepare all documents and obtain all necessary approvals of all utility and governmental departments having jurisdiction; obtain all certificates of inspection for his work and deliver same to the Engineer before request for acceptance and final payment for the work.

C. Ignorance of Codes, Rules, Regulations, Laws, etc. shall not render the Contractor irresponsible for compliance. The Contractor shall be versed in all Codes, Rules and Regulations pertinent to the work prior to submission of a proposal.

D. The Contractor shall include in the work, without extra cost, any labor, materials, services, apparatus and drawings in order to comply with all applicable laws, ordinances, rules and regulations, whether or not indicated or specified.

E. All materials furnished and all work installed shall comply with the National Fire Codes of the National Fire Protection Association, with the requirements of local utility companies, or municipalities and with the requirements of all governmental agencies having jurisdiction.

F. All materials and equipment shall bear the approval label of, or shall be listed by the Underwriters' Laboratories (UL), Incorporated. Each packaged assembly shall be approved as a package. Approval of components of a package shall not be acceptable.

G. Where minimum code requirements are exceeded in the Design, the Design shall govern.

H. The Contractor shall ensure that the work is accomplished in accordance with the OSHA Standards and any other applicable government requirements.

I. All work relating to the handicapped shall be in accord with regulations currently enforced by the Authority Having Jurisdiction.

J. Where conflict arises between any code and the plans and/or specifications, the code shall apply except in the instance where the plans and specifications exceed the requirements of the code. Any changes required as a result of these conflicts shall be brought to the attention of the Engineer at least ten working days prior to bid date, otherwise the Contractor shall make the required changes at his own expense. The provisions of the codes constitute minimum standards for wiring methods, materials, equipment and construction and compliance therewith will be required for all electrical work, except where the drawings and specifications require better materials, equipment, and construction than these minimum standards, in which case the drawings and specifications shall be the minimum standards.

1.21 TEMPORARY SERVICES

A. The Contractor shall arrange with the General Contractor or Construction Manager for temporary electrical and other services which he may require to accomplish his work. In the absence of other provisions in the contract, the Contractor shall provide for his own temporary services of all types, including the cost of connections, utility company fees, construction, removal, etc., in his bid.

B. All temporary services shall be removed by Contractor prior to acceptance of work.

1.22 TEMPORARY USE OF EQUIPMENT

A. The permanent electrical equipment, when installed, may be used for temporary services, subject to an agreement between the Contractors involved, the Owner, and with the consent of the Engineer. Should the permanent systems be used for this purpose, each Contractor shall pay for all temporary connections required and any replacements required due to damage without cost, leaving the equipment and installation in "as new" condition.

B. Permission to use the permanent equipment does not relieve the Contractors who utilize this equipment from the responsibility for any damages to the building construction and/or equipment which might result because of its use.

1.23 PROTECTION OF MATERIALS AND EQUIPMENT

A. The Contractor shall be entirely responsible for all material and equipment furnished in connection with the work and special care shall be taken to properly protect all parts thereof from damage during the construction period. Such protection shall be by a means acceptable to the Engineer. All rough-in conduit shall be properly plugged or capped during construction in a manner approved by the Engineer.

B. Equipment damaged, stolen or vandalized while stored on site, either before or after installation, shall be repaired or replaced (as determined by the Engineer) by the responsible Contractor. Electrical equipment exposed to the weather shall be replaced by the Contractor at the Contractor’s expense.

1.24 EQUIPMENT SUPPORT

A. Each piece of equipment, apparatus, or conduit suspended from the ceiling or mounted above the floor level shall be provided with suitable structural support, conduit rack, or platform in accordance with the best recognized practice. Such supporting or mounting means shall be provided by the Contractor for all equipment and conduit. Exercise extreme care that structural members of building are not overloaded by such equipment. Provide any required additional bracing, cross members, angles, support, etc.

1.25 REQUIRED CLEARANCE FOR ELECTRICAL EQUIPMENT

A. The NEC has specific required clearances above, in front, and around electrical gear, panels etc.

B. Contractor shall ensure that no piping, ductwork, etc., is installed in the required clearance. If any appurtenance is located in the NEC required clearance, it shall be relocated without additional cost to the Owner.

1.26 ACCESSIBILITY

A. The Contractor shall be responsible for the sufficiency of the size of shafts and chases, the adequate clearance in partitions and above suspended ceilings for the proper installation of his work. He shall cooperate with the General Contractor (or Construction Manager) and all other Contractors whose work is in the same space, and shall advise each Contractor of his requirements. Such spaces and clearances shall be kept to the minimum size required to ensure adequate clearance and access.

B. The Contractor shall locate all equipment which must be serviced, operated, or maintained in fully accessible positions. Equipment shall include but not be limited to junction boxes, pull boxes, contactors, panels, disconnects, controllers, switchgear, etc. Minor deviations from drawings may be made to allow for better accessibility, and any change shall be approved where the equipment is concealed.

C. Each Contractor shall provide (or arrange for the provision by other trades) the access panels for each concealed junction box, pull box, fixtures or electrical device requiring access or service as shown on Engineer's plans or as required. Locations of these panels shall be identified in sufficient time to be installed in the normal course of work. All access panels shall be installed in accord with the Architect's standards for such work.

D. Access Doors; in Ceilings or Walls:

1. In mechanical, electrical, or service spaces:
   a. 14-gauge aluminum, 1" border, refer to architectural specifications for finishes
2. In finished areas:
   a. 14-gauge primed steel with 1" border to accept the architectural finishes specified for the space. Confirm these provisions with the Architect prior to obtaining materials or installing any such work.
3. In fire or smoke rated partitions, access doors shall be provided that equal or exceed the required rating of the construction they are mounted in.
4. All access doors shall have continuous hinge and screw type cover. Openings shall be sized to allow personal to pass through.

E. Sides of cable trays cannot be obstructed by pipes, ductwork, cables, etc.

1.27 MAINTENANCE OF EXISTING UTILITIES AND LINES

A. The locations of all piping, conduits, cables, utilities and manholes existing, or otherwise, that come within the contract construction site, shall be subject to continuous uninterrupted maintenance with no exception unless the Owner of the utilities grants permission to interrupt same temporarily, if need be. Provide one week's written notice to Engineer, Architect and Owner prior to interrupting any utility service or line. Also, see Article 1. - General, this section.

B. Known utilities and lines as available to the Engineer are shown on the drawings. However, it is additionally required that, prior to any excavation being performed, each Contractor ascertain and mark all utilities or lines that would be endangered by the excavation. Contractor shall bear costs of repairing damaged utilities.

C. If the above-mentioned utilities or lines occur in the earth within the construction site, the Contractor shall first probe and make every effort to locate the lines prior to excavating in the respective area.

D. Cutting into existing utilities and services shall be done in coordination with and as designated by the Owner of the utility. The Contractor shall work continuously to restore service(s) upon deliberate or accidental interruption, providing premium time and materials as needed without extra claim to the Owner.

E. The Contractor shall repair to the satisfaction of the Engineer any surface or subsurface improvements damaged during the course of the work, unless such improvement is shown to be abandoned or removed.

F. Machine excavation shall not be permitted within ten feet of existing gas or fuel lines. Hand excavate only in these areas, in accord with utility company, agency or other applicable laws, standards or regulations.

G. Protect all new or existing lines from damage by traffic, etc. during construction.

H. Protect existing trees, indicated to remain with fencing or other approved method. Hold all new subsurface lines outside the drip line of trees, offsetting as necessary to protect root structures. Refer to planting or landscaping plans, or in their absence, consult with the Architect.

1.28 RESTORATION OF NEW OR EXISTING SHRUBS, PAVING, ETC.

A. The Contractor shall replace to their original condition all paving, curbing surfaces, drainage ditches, structures, fences, shrubs, existing or new building surfaces and appurtenances, and any other items damaged or removed by his operations. Replacement and repairs shall be in accordance with good construction practice and shall match materials employed in the original construction of the item to be replaced. All repairs shall be to the satisfaction of the Engineer, and in accord with the Architect's standards for such work, as applicable. Patchwork on new construction will not be accepted.

1.29 CONCRETE WORK

A. The Contractor shall be responsible for the provision of all concrete work required for the installation of any of his systems or equipment. If this work is provided by another trade, it will

not relieve the Electrical Contractor of his responsibilities relative to dimensions, quality of workmanship, locations, etc. In the absence of other concrete specifications, all concrete related to Electrical work shall be 3000 PSI minimum compression strength at 28 days curing and shall conform to the standards of the American Concrete Institute Publication ACI-318. Heavy equipment shall not be set on pads for at least seven days after pour.

B. All concrete pads shall be complete with all pipe sleeves, embeds, anchor bolts, reinforcing steel, concrete, etc., as required. Pads larger than l8" in width shall be reinforced with minimum #4 round bars on 6" centers both ways. All reinforcing steel shall be per ASTM requirements, tied properly, lapped 18 bar diameters and supported appropriately up off form, slab or underlayment. Bars shall be approximately 3" above the bottom of the pad with a minimum 2" cover. All parts of pads and foundations shall be properly rodded or vibrated. If exposed parts of the pads and foundations are rough or show honeycomb after removing forms properly adhered repairs shall be made. If structural integrity is violated, the concrete shall be replaced. All surfaces shall be rubbed to a smooth finish and chamfered edges.

C. All pads and concrete lighting standard bases shall be crowned slightly in center to avoid water ponding beneath equipment.

D. In general, concrete pads for small equipment shall extend 6" beyond the equipment's base dimensions. For large equipment with service access panels, extend pads l8" beyond base or overall dimensions to allow walking and servicing space at locations requiring service access.

E. Exterior concrete pads shall be 4" minimum above grade and 4" below grade on a tamped 4" dense grade rock base unless otherwise noted or required by utility company. Surfaces of all foundations and bases shall have a smooth finish with three-quarter inch radius or chamfer on exposed edges, troweled or rubbed smooth. All exterior pads shall be crowned approximately 1/8" per foot, sloping from center for drainage.

1.30 FINAL CONNECTIONS TO EQUIPMENT

A. The roughing-in and final connections to all electrically operated equipment furnished under this and all other sections of the contract documents or by others, shall be included in the Contract and shall consist of furnishing all labor and materials for connection and proper testing. The Contractor shall carefully coordinate with equipment suppliers, manufacturer’s representatives, the vendor or other trades to provide complete electrical and dimensional interface to all such equipment (kitchen, hoods, mechanical equipment, panels, refrigeration equipment, etc.).

1.31 ELECTRICAL CONNECTIONS

A. The Contractor shall furnish and install all power wiring and fusing complete from power source to motor or equipment junction box, including power wiring through starters. The Contractor shall install all starters not factory mounted on equipment. Unless otherwise noted, the supplier of equipment shall furnish starters with the equipment. Also, refer to Division 25 of Specifications, shop drawings and equipment schedules for additional information.

B. All control, interlock, sensor, thermocouple and other wiring required for equipment operation shall be provided by the Contractor. All such installations shall be fully compliant with all requirements of Division 26 regardless of which trade actually installs such wiring. Motors and equipment shall be provided for current and voltage characteristics as indicated or required. All wiring shall be enclosed in raceways unless otherwise noted.

C. Each Contractor or sub-contractor, prior to bidding the work, shall coordinate power, control, sensor, interlock and all other wiring requirements for equipment or motors with all other contractors or sub-contractors, to ensure all needed wiring is provided in the Contract. Failure to make such coordination shall not be justification for claims of extra cost or a time extension to the Contract.

1.32 MOTORS

A. Each motor shall be provided by the equipment supplier or manufacturer with conduit terminal box, adequate starting and internal thermal overload protective equipment as specified or required. The capacity shall be sufficient to operate associated driven devices under all conditions of operation and load and without overload, and at least of the horsepower indicated

or specified. Each motor shall be selected for quiet operation, maximum efficiency and lowest starting KVA per horsepower as applicable. Also, see mechanical specification for further requirements and scheduled sizes.

1.33 QUIET OPERATION, SUPPORTS, VIBRATION AND OSCILLATION

A. All work shall operate under all conditions of load without any objectionable sound or vibration, the performance of which shall be determined by the Engineer. Noise from moving machinery or vibration noticeable outside of room in which it is installed, or annoyingly noticeable noise or vibration inside such room, will be considered objectionable. Sound or vibration conditions considered objectionable by the Engineer shall be corrected in an approved manner by the Contractor (or Contractors responsible) at his expense.

B. All equipment subject to vibration and/or oscillation shall be mounted on vibration supports suitable for the purpose of minimizing noise and vibration transmission, and shall be isolated from external connections such as piping, ducts, etc., by means of flexible connectors, vibration absorbers or other approved means. Surface mounted equipment such as panels, switches, etc., shall be affixed tightly to their mounting surface.

C. The Contractor shall provide supports for all equipment furnished by him using an approved vibration isolating type as needed. Supports shall be liberally sized and adequate to carry the load of the equipment and the loads of attached equipment, piping, etc. All equipment shall be securely fastened to the structure either directly or indirectly through supporting members by means of bolts or equally effective means. No work shall depend on the supports or work of unrelated trades unless specifically authorized in writing by the Architect or Engineer.

1.34 CUTTING AND PATCHING

A. Unless otherwise indicated or specified, each Contractor shall provide his own cutting and patching necessary to install the work specified in this Division. Patching shall match adjacent surfaces to the satisfaction of the Engineer and shall be in accord with the Architect's standards for such work, as applicable.

B. Each Electrical Contractor shall be responsible for all openings, sleeves, trenches, etc. that he may require in floors, roofs, ceilings, walls, etc. and shall coordinate all such work with the General Contractor and all other trades. He shall coordinate with the General Contractor any openings which he is to provide before submitting a bid proposal in order to avoid conflict and disagreement during construction. Improperly located openings shall be reworked at the expense of the responsible Contractor.

C. Each Electrical Contractor shall plan his work ahead and shall place sleeves, frames or forms through all walls, floors and ceilings during the initial construction, where it is necessary for conduit, conductors, wireways, etc. to go through; however, when this is not done, this Contractor shall do all cutting and patching as well as reinforcement required for the installation of his work, or he shall pay other trades for doing this work when so directed by the Engineer. Any damage caused to the buildings by the workmen of the responsible Contractor must be corrected or rectified by him at his own expense.

D. Each Electrical Contractor shall cut holes in casework, equipment panels, etc. (if any), as required to pass pipes in and out.

E. Each Electrical Contractor shall notify other trades in due time where he will require openings of chases in new concrete or masonry. He shall set all concrete inserts and sleeves for his work. Failing to do this, he shall cut openings for his work and patch same as required at his own expense.

F. Openings in slabs and walls shall be cut with core drill. Hammer devices will not be permitted. Edges of trenches and large openings shall be scribe cut with a masonry saw.

G. No structural members shall be cut without the approval of the Structural Engineer and all such cutting shall be done in a manner directed by him.

H. Each Electrical Contractor shall be responsible for properly shoring, bracing, supporting, etc. any existing and/or new construction to guard against cracking, settling, collapsing, displacing

or weakening while openings are being made. Any damage occurring to the existing and/or new structures, due to failure to exercise proper precautions or due to action of the elements, shall be promptly and properly made good to the satisfaction of the Engineer.

I. All work improperly done or not done at all as required by the Electrical trades in this section will be performed by the General Contractor at the direction of the Contractor whose work is affected. The cost of this work shall be paid for by the Contractor responsible.

1.35 SLEEVES AND PLATES

A. Each Contractor shall provide and locate all sleeves and inserts required for his work before the floors and walls are built, or shall be responsible for the cost of cutting and patching required where sleeves and inserts were not installed, or where incorrectly located. Each Contractor shall do all drilling required for the installation of his hangers. Drilling of anchor holes may be prohibited in post-tensioned concrete construction, in which case the Contractor shall request approved methods from the Architect and shall carefully coordinate setting of inserts, etc., with the Structural Engineer and/or Architect.

B. Galvanized steel sleeves shall be provided for all electrical conduit passing thru concrete floor slabs and concrete, masonry, tile and gypsum wall construction.

C. Cast iron sleeves shall be installed through all walls where pipe enters the building below grade. Sleeves shall be flush with each face of the wall and shall be sufficiently larger than the entering pipe to permit thorough caulking with lead and oakum between pipe and sleeve for waterproofing.

D. In all cases, sleeves shall be at least two pipe sizes larger than nominal pipe diameter.

E. Where conduit motion due to expansion and contraction will occur, make sleeves of sufficient diameter to permit free movement of pipe. Check floor and wall construction finishes to determine proper length of sleeves for various locations; make actual lengths to suit the following:

1. Terminate sleeves flush with walls, partitions and ceiling.
2. In areas where pipes are concealed, as in chases, terminate sleeves flush with floor.
3. In all areas where pipes are exposed, extend sleeves ½ inch above finished floor, except in rooms having floor drains, where sleeves shall be extended 3/4 inches above floor.

F. Sleeves shall be constructed of 24-gauge galvanized sheet steel with lock seam joints for all sleeves set in concrete floor slabs terminating flush with the floor. All other sleeves shall be constructed of galvanized steel pipe unless otherwise indicated on the drawings.

G. Fasten sleeves securely in floors, walls, so that they will not become displaced when concrete is poured or when other construction occurs around them. Take precautions to prevent concrete, plaster or other materials being forced into the space between pipe and sleeve during construction. Fire and smoke stop all sleeves in a manner approved by the local authority having jurisdiction or per prevailing codes.

H. Sleeves passing through exterior wall (none are permitted thru roof) or where there is a possibility of water leakage and damage shall be caulked water tight for horizontal sleeves and flashed and counter-flashed with lead (4 lb.) or copper and soldered to the piping, lapped over sleeve and properly weather sealed. All roof penetrations shall be made inside mechanical equipment curbs.

I. All rectangular or special shaped openings in plaster, stucco or similar materials including gypsum board shall be framed by means of plaster frames, casing beads, wood or metal angle members as required. The intent of this requirements is to provide smooth even termination of wall, floor and ceiling finishes as well as to provide a fastening means for lighting fixtures, panels, etc. Lintels shall be provided where indicated over all openings in bearing walls, etc.

1.36 WEATHERPROOFING

A. Where any work pierces waterproofing, including waterproof concrete, the method of installation shall be as approved by the Architect and/or Engineer before work is done. The Contractor

shall furnish all necessary sleeves, caulking and flashing required to make openings absolutely watertight.

B. Wherever work penetrates roofing, it shall be done in a manner that will not diminish or void the roofing guarantee or warranty in any way. Coordinate all such work with the roofing installer.

1.37 SMOKE AND FIRE PROOFING

A. The Contractor shall not penetrate rated fire walls, ceilings or floors with conduit, cable, bus duct, wireway or other raceway system unless all penetrations are protected in a code compliant manner which maintains the rating of the assembly. Smoke and fire stop all openings made in walls, chases, ceiling and floors. Patch all openings around conduit, wireway, bus duct, etc., with appropriate type material to smoke stop walls and provide needed fire rating at fire walls, ceilings and floors. Smoke and fire proofing materials and method of application shall be approved by the local authority having jurisdiction. Submit means to be used.

1.38 WELDING

A. The Contractor shall be responsible for quality of welding done by his organization and shall repair or replace any work not done in accordance with the Architect's or structural Engineer's specifications for such work. If required by the Engineer, the responsible Contractor shall cut at least three welds during the job for X-raying and testing. These welds are to be selected at random and shall be tested as a part of the responsible Contractor's work. Certification of these tests and X-rays shall be submitted, in triplicate, to the Engineer. In case a faulty weld is discovered, the Contractor shall be required to furnish additional tests and corrective measures until satisfactory results are obtained. All welding to be accomplished by certified welder.

1.39 SCAFFOLDING, RIGGING AND HOISTING

A. Each Contractor shall furnish all scaffolding, rigging, hoisting, and services necessary for erection and delivery into the premises of any equipment and apparatus furnished. Remove same from premises when no longer required in strict accordance with OSHA Guidelines.

1.40 INSPECTION, APPROVALS AND TESTS

A. Before requesting a final review of the installation from the Architect and/or Engineer, each Contractor shall thoroughly inspect his installation to assure that the work is complete in every detail and that all requirements of the Contract Documents have been fulfilled. Failure to accomplish this may result in charges from the Architect and/or Engineers for unnecessary and undue work on their part.

B. Owner's and Engineer's inspections: Two inspections will be held to generate and then review punchlist items. All site visits thereafter shall be billed to the Contractor at the Engineer's standard hourly rates.

C. The Contractor shall provide as a part of this contract electrical inspection an inspector, licensed to provide such services. All costs incidental to the provision of electrical inspections shall be borne by the Contractor.

D. The Contractor shall advise each Inspection Agency in writing (with an information copy of the correspondence to the Architect and/or Engineer) when he anticipates commencing work. Failure of the Inspection Agency to inspect the work in the stage following and submit the related reports may result in the Contractor's having to expose concealed work not so inspected. Such exposure will be at the expense of the responsible Contractor.

E. Inspections shall be scheduled for rough-in as well as finished work. The rough-in inspections shall be divided into as many inspections as may be necessary to cover all roughing-in without fail. Report of each such inspection visit shall be submitted to the Architect, Engineer and the Contractor within three days of the inspection.

F. Approval by an Inspector does not relieve the Contractor from the responsibilities of furnishing equipment having a quality of performance equivalent to the requirements set forth in these plans and specifications. All work under this contract is subject to the review of the Architect and/or Engineer, whose decision is binding.

G. Before final acceptance, the Contractor shall furnish the original and three copies of the certificates of final approval by the Electrical Inspector (as well as all other inspection certificates) to the Engineer with one copy of each to the appropriate government agencies, as applicable. Final payment for the work shall be contingent upon completion of this requirement.

H. The Contractor shall test all wiring and connections for continuity and grounds before equipment and fixtures are connected, and when indicated or required, demonstrate by Megger Test the insulation resistance of any circuit or group of circuits. Where such tests indicate the possibility of faulty insulation, locate the point of such fault, pull out the defective conductor, replacing same with new and demonstrate by further test the elimination of such defect.

1.41 OPERATING INSTRUCTIONS

A. Upon completion of all work and all tests, each Contractor shall furnish the necessary skilled labor and helpers for operating his systems and equipment for a period of three days of eight hours each, or as otherwise specified. During this period, instruct the Owner or his representative fully in the operations, adjustment, and maintenance of all equipment furnished. Give at least one week's written notice to the Owner, Architect and Engineer in advance of this period. Contractor shall prepare an agenda for approval by Owner. The Engineer may attend any such training sessions or operational demonstrations. The Contractor shall certify in writing to the Engineer with copy to the Owner and Architect that such demonstrations have taken place, noting the date, time and names of the Owner's representative that were present.

B. Each Contractor shall furnish three complete bound sets for approval to the Engineer of typewritten and/or blueprinted instructions for operating and maintaining all systems and equipment included in this contract. All instructions shall be submitted in draft, for approval, prior to final issue. Manufacturer's advertising literature or catalogs will not be acceptable for operating and maintenance instructions. Each section shall be properly tabbed, indexed and labeled, with a table of contents. Minimum 3-ring hard cover binder. Include specific part, catalog, model, serial, and shop order numbers; statement of warranties – indexed by section; manufacturer names, P.O.C. for warranties, etc.

C. Each Contractor, in the above-mentioned instructions, shall include the maintenance schedule for the principal items of equipment furnished under this contract and a detailed, easy to read parts list and the name and address of the nearest source of supply.

1.42 CLEANING

A. Contractor shall, at all times, keep the area of their work presentable to the public and clean of rubbish and debris caused by operations; and at the completion of the work, shall remove all rubbish, debris, all of his tools, equipment, temporary work and surplus materials from and about the premises, and shall leave the area clean and ready for use.

B. If the Contractor does not attend to cleaning upon request, the Engineer may cause cleaning to be done by others and charge the cost of same to the Contractor.

C. Contractor shall be responsible for all damage from fire which originates in, or is propagated by, accumulations of the Contractor’s rubbish or debris.

D. After completion of all work and before final acceptance of the work, the Contractor shall thoroughly clean all equipment and materials and shall remove all foreign matter such as grease, dirt, plaster, labels, stickers, etc., from the exterior of equipment, fixtures and all other associated or adjacent fabrication.

1.43 PAINTING

A. Each fixture, device, panel, junction box, etc., that is located in a finished area shall be provided with finish of color and type as selected or approved by the Architect or Engineer. If custom color is required by the plans or specifications, it shall be provided at no additional cost to the Owner. All other equipment, fixtures or devices located in finished or unfinished areas, that are not required to have or are provided with finish color or coating shall be provided in a prime painted condition, ready to receive finish paint or coating. All galvanized metal in finished areas and exposed on exterior shall be properly prepared with special processes to receive finish paint as directed and approved by the Architect.

1.44 INDEMNIFICATION

A. The Contractor shall hold harmless and indemnify the Engineer, employees, officers, agents and consultants from all claims, loss, damage, actions, causes of actions, expense and/or liability resulting from, brought for, or on account of any personal injury or property damage received or sustained by any person, persons, (including third parties), or any property growing out of, occurring, or attributable to any work performed under or related to this contract, resulting in whole or in part from the negligence of the Contractor, any subcontractor, any employee, agent or representative.

1.45 HAZARDOUS MATERIALS

A. Any worker, occupant, visitor, inspector, etc., who encounters any material of whose content they are not certain shall promptly report the existence and location of that material to the Contractor and/or Owner. The Contractor shall, as a part of his work, insure that his workers are aware of this potential and what they are to do in the event of suspicion. He shall also keep uninformed persons from the premises during construction. Furthermore, the Contractor shall insure that no one comes near to or in contact with any such material or fumes therefrom until its content can be ascertained to be non-hazardous.

B. CMTA, Inc., Consulting Engineers, have no expertise in the determination of the presence of hazardous materials. Therefore, no attempt has been made by them to identify the existence or location of any such material. Furthermore, CMTA nor any affiliate thereof will neither offer nor make any recommendations relative to the removal, handling or disposal of such material.

C. If the work interfaces, connects or relates in any way with or to existing components which contain or bear any hazardous material, asbestos being one, then, it shall be the Contractor's sole responsibility to contact the Owner and so advise him immediately.

D. The Contractor by execution of the contract for any work and/or by the accomplishment of any work thereby agrees to bring no claim relative to hazardous materials for negligence, breach of contract, indemnity, or any other such item against CMTA, its principals, employees, agents or consultants. Also, the Contractor further agrees to defend, indemnify and hold CMTA, its principals, employees, agents and consultants, harmless from any such related claims which may be brought by any subcontractors, suppliers or any other third parties.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION (Not Applicable)

END OF SECTION 26 0000

SECTION 26 0502

DESCRIPTION OF ELECTRICAL SYSTEM

PART 1 - GENERAL

1.01 PRIMARY ELECTRICAL SERVICE

A. Primary electrical service is new, overhead and underground, nominal 15,000 volts, three-phase, wye, to pad-mounted transformers as indicated on the plans.

B. In general, the utility company provides the pad-mounted transformers, primary cable and its terminations. Conduits routed off the property and connected to or near a manhole or pole and all other work shall be in accord with utility company requirements. Contact the utility company prior to bidding the work and include any and all charges for their work in bid.

1.02 SECONDARY ELECTRICAL SERVICE

A. Secondary service shall be 277/480V/3Ø/4W with solid grounded neutral. See Electrical Riser Diagram. Trench, backfill, conduit duct bank, conductors, and lugs are by Electrical Contractor, all per utility company standards. Metering is at pad-mounted transformers.

1.03 ADDITIONAL UTILITY COMPANY REQUIREMENTS

A. Contact the utility company for specifics on construction of pads, conduit, etc., prior to bidding the work and determine all their requirements. All work shall be in accord with their standards.

1. Utility Company: CenterPoint Energy
2. Contact: xxx at (713) xxx-xxx

B. Contractor is responsible for all fees, permit costs, etc., from the electrical utility company and the telephone company. This includes any cost associated with the underground electrical service extension.

C. Each Contractor, prior to bidding the work, is to contact the electrical utility company (as well as the telephone and cable T.V. utility company) and determine the exact points of extension of all underground services in the field with a representative of each utility company. Also, obtain construction details on manholes, transformer pads, pedestal stub-ups, etc., from each utility company as applicable. Extension points indicated on the plans are approximate, and are given for the bidder's information only.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION (Not Applicable)

END OF SECTION 26 0502

SECTION 26 0503

ELECTRICAL SHOP DRAWINGS AND SUBMITTALS

PART 1 - GENERAL

1.01 SHOP DRAWINGS

A. Each Contractor shall submit to the Architect and/or Engineer, within thirty days after the date of the Contract, sets of shop drawings and/or manufacturer's descriptive literature (coordinate exact quantity with architectural specifications) on all equipment required for the fulfillment of his contract. Each shop drawing and/or manufacturer's descriptive literature shall have proper notation indicated on it and shall be clearly referenced so the specifications, schedules, light fixture numbers, panel names and numbers, etc., so that the Architect and/or Engineer may readily determine the particular item the Contractor proposes to furnish. All data and information scheduled, noted or specified by hand shall be noted in color red on the submittals. The Contractor shall make any corrections or changes required and shall resubmit for final review as requested. Review of such drawings, descriptive literature and/or schedules shall not relieve the Contractor from responsibility for deviation from drawings or specifications unless they have, in writing, directed the reviewer's attention to such deviations at the time of submission of drawings, literature and manuals; nor shall it relieve them from responsibility for errors or omissions of any nature in shop drawings, literature and manuals. The term "as specified" will not be accepted.

B. If the Contractor fails to comply with the requirements set forth above, the Architect and/or Engineer shall have the option of selecting any or all items listed in the specifications or on the drawings, and the Contractor will be required to provide all materials in accordance with this list.

C. Review of shop drawings by the Engineer applies only to conformance with the design concept of the project and general compliance with the information given in the contract documents. In all cases, the installing Contractor alone shall be responsible for furnishing the proper quantity of equipment and/or materials required, for seeing that all equipment fits the available space in a satisfactory manner and that piping, electrical and all other connections are suitably located.

D. The Engineer's review of shop drawings, schedules or other required submittal data shall not relieve the Contractor from responsibility for the adaptability of the equipment or materials to the project, compliance with applicable codes, rules, regulations, information that pertains to fabrication and installation, dimensions and quantities, electrical characteristics, and coordination of the work with all other trades involved in this project.

E. No cutting, fitting, rough-in, connections, etc., shall be accomplished until reviewed equipment shop drawings are in the hands of the Contractors concerned. It shall be each Contractor's responsibility to obtain reviewed shop drawings and to make all connections, etc. in the neatest and most workmanlike manner possible. Each Contractor shall coordinate with all the other Contractors having any connections, roughing-in, etc., to the equipment, to make certain proper fit, space coordination, voltage and phase relationships are accomplished.

F. In accord with the provisions specified hereinbefore, shop drawings, descriptive literature and schedules shall be submitted on each of the following indicated items as well as any equipment or systems deemed necessary by the Engineer:

1. Power Equipment:
    a. Switchboards and panelboards.
    b. Transformers.
    c. Generators.
    d. Automatic transfer switches.
    e. Circuit breakers or fusible switches, per each type.
    f. Power and lighting contactors.
    g. Disconnect switches.
    h. Fuses, per each type required.

i. Magnetic starters, if not submitted with unit equipment by supplier.

j. Control components (relays, timers, selector switches, pilots, etc.)

k. Building service grounding electrode components.

2. Raceways:

a. Conduit (each type).

b. Wireways and each type of wireway fitting.

c. Surface raceways and fittings.

d. J-hook assembly.

e. Junction, pull, and device boxes

3. Devices:

a. Building wire, cable splices, and terminations

b. Each type of wiring device and their coverplates.

c. Any special items not listed above.

4. Lighting:

a. Light fixtures, each by type, marked to indicate all required accessories and lamp selection. Also, provide original color selection chart to allow Architect and/or Engineer to indicate color selection.

b. Lighting standards or poles.

c. Sports lighting system.

d. Photocells, time clocks, contactors or other lighting accessories.

e. Control systems (lighting).

5. Miscellaneous

a. Control panel assemblies.

b. Non-standard junction/pullboxes

G. Specification Compliance Certification: Where this Section and other Sections of this Division require Specification Compliance Certification to be submitted, comply with the following:

1. Prepare a line-by-line Specification Compliance Certification by marking up a copy of the Contract Document specification section in the left margin. Accompany the markup with a written report explaining all items that are not marked with “Compliance”. Submit line-by-line markup, written report of deviations and alternates and a cover letter certified by Manufacturer or Installer that prepared the Specification Compliance Certification. Use the following key for preparing the line-by-line markup.

a. “C” for Compliance: By noting the term "compliance" or "C" in the margin, it shall be understood that the manufacturer is in full compliance with the item specified and will provide exactly the same with no deviations.

b. “D” for Deviation: By noting the term "deviation" or "D" in the margin, it shall be understood that the manufacturer prefers to provide a different component in lieu of that specified.

c. “A” for Alternate: By noting the term "alternate" or "A" in the margin, it shall be understood that the manufacturer proposes to provide the same operating function but prefers to do it in a different manner.

d. “N/A” for Not Applicable: By noting the term “not applicable” or “N/A” in the margin, it shall be understood that the specified item is not applicable to the project.

1.02 SPECIAL WRENCHES, TOOLS AND KEYS

A. Each Contractor shall provide, along with the equipment provided, any special wrenches or tools necessary to dismantle or service equipment or appliances installed by him. Wrenches

shall include necessary keys, handles and operators for valves, switches, breakers, etc. and keys to electrical panels, alarm pull boxes and panels, etc. At least two of any such special wrench, keys, etc. shall be turned over to the Architect prior to completion of the project. Obtain a receipt that this has been accomplished and forward a copy to the Engineer.

1.03 EMERGENCY, OPERATION, AND MAINTENANCE MANUALS

A. Upon Substantial Completion of the Project, the Electrical Contractor shall deliver to the Engineers (in addition to the required Shop Drawings) complete, tabbed, electronic copies of emergency, operation and maintenance instructions and parts lists for all equipment provided. These documents shall at least include:

1. Detailed operating instructions.
2. Detailed maintenance instructions including preventive maintenance schedules.
3. Addresses and phone numbers indicating where parts may be purchased.
4. Reference architectural specifications for additional requirements.

B. Refer to individual Contract Document Specification Sections for additional requirements.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION (Not Applicable)

END OF SECTION 26 0503

SECTION 26 0510
SCOPE OF THE ELECTRICAL WORK

PART 1 - GENERAL

1.01 SUMMARY

A. Each Electrical Contractor's attention is directed to Division 26 Section “Common Electrical Requirements” and all other Contract Documents as they apply to his work.

1.02 SCOPE

A. The Electrical work for this project includes all labor, materials, equipment, fixtures, excavation, backfill and related items required to completely install, test, place in service and deliver to the Owner complete electrical systems in accordance with the accompanying plans and all provisions of these specifications. This work shall primarily include, but is not limited to the following:

1. All conduits, conductors, outlet boxes, fittings, etc.
2. All j-hooks, supports, outlet boxes, fittings, etc. for Division 27 and 28.
3. All switchgear, panels, disconnect switches, fuses, transformers, contactors, etc.
4. All generators and automatic transfer switches.
5. All wiring devices and device plates.
6. All light fixtures, poles and lamps.

B. Electrical connection to all electrically operated equipment furnished and/or installed by others, including sports lighting equipment, HVAC equipment, plumbing equipment, foodservice equipment, AV equipment, technology equipment, etc.

C. Inspection of electrical system by an approved Electrical Inspector, in compliance with local requirements.

D. Grounding, both building and telecommunications, per NEC and the specified requirements.

E. All necessary coordination with electric utility company, telephone company, cable T.V. Co., etc., to ensure that work, connections, etc., that they are to provide is accomplished.

F. All necessary fees and cost for permits, inspections, etc. Provision of electrical power, telephone and cable television services into the building from the utility termination points outside.

G. Rough-in for data/voice network as indicated.

H. Rough-in for paging-intercom system as indicated.

I. Rough-in for integrated audio-video systems as indicated.

J. Rough-in for local sound systems as indicated.

K. Rough-in for video surveillance system as indicated.

L. Rough-in for intrusion detection system as indicated.

M. Rough-in for access control system as indicated.

N. Rough-in for emergency responder radio antenna system as indicated.

O. Rough-in for fire alarm system.

P. Special Note: A specialty sub-contractor (Electronic Systems Contractor) shall be utilized for all paging-intercom system, data/voice network, fire alarm work, sound systems, intrusion detection system and for the security access control system installation. The sub-contractor shall be especially skilled in such work and shall be able to demonstrate that their regular business involves such installations. The specialty sub-contractor(s) shall be acceptable to and approved by the Owner. The names of each such sub-contractor shall be listed on the form of proposal at the time of opening bids. Provisions for branch circuits, pulling of cabling, and installation of raceways for specialty systems may be regular sub-contractor if approved by

specialty contractor. All terminations, connections, check-out and testing shall be by specialty contractor.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION (Not Applicable)

END OF SECTION 26 0510

SECTION 26 0519

LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.01 SUMMARY

A. This Section includes the following:

1. Building wires and cables rated 600 V and less.
2. Variable frequency drive cable, rated 600 V and less.
3. Metal-clad cable, Type MC, rated 600 V and less.
4. Connectors, splices, and terminations rated 600 V and less.
5. Sleeves and sleeve seals for cables.

1.02 DEFINITIONS

A. EPDM: Ethylene-propylene-diene terpolymer rubber.

B. NBR: Acrylonitrile-butadiene rubber.

C. VFD: Variable frequency drive.

1.03 ACTION SUBMITTALS

A. Submit product data and shop drawings in accordance with Division 01 and Division 26 Section “Electrical Shop Drawings and Submittals” for products specified under PART 2 - PRODUCTS.

B. Product Data: For each type of product indicated. Provide data for conductors and cables including, but not be limited to, the following:

1. Complete physical properties of the conductors and cables.
2. Ampacity for use intended.
3. Allowable stresses and requirements for installations, including bend radii, linear stress, and other pertinent data.
4. Types of connectors for terminations.

1.04 INFORMATIONAL SUBMITTALS

A. Field quality-control test reports.

1.05 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For conductors and cables, to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Closeout Submittals," include the following:

1. Manufacturer's routine maintenance requirements for cables, terminations and all installed components.

1.06 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.

1.07 COORDINATION

A. Set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.

PART 2 - PRODUCTS

2.01 BUILDING WIRE

A. Description: Flexible, insulated and uninsulated, drawn copper current-carrying conductor with an overall insulation layer or jacket, or both, rated 600 V and less.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Alcan Products Corporation; Alcan Cable Division.
   2. Alpha Wire.
   3. Belden Inc.
   4. Encore Wire Corporation.
   5. General Cable Corporation.
   6. Southwire Company.

C. Standards:
   1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
   2. RoHS compliant.
   3. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide."

D. Copper Conductors: Comply with NEMA WC 70. All conductors shall be 98% conductive annealed copper unless noted otherwise. Comply with ASTM B 3 for bare annealed copper and with ASTM B 8 for stranded conductors.

E. Aluminum Conductors: Comply with NEMA WC 70. Comply with ASTM B 800 and ASTM B 801.

F. Aluminum Conductors: XHHW-2
   1. AA-8000 series electrical grade aluminum alloy conductor material in compliance with NFPA 70, Chapter 3.
   2. Compact stranded conductors.

G. Conductor Insulation:
   1. Type THHN and Type THWN-2: Comply with UL 83.
   2. Types THW and Type THW-2: Comply with NEMA WC-0/ICEA S-95-658 and UL 83.
   3. Type XHHW-2: Comply with UL 44.

2.02 VARIABLE FREQUENCY DRIVE (VFD) CABLE

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. AmerCable.
   2. General Cable Corporation.

B. Standards:
   1. Comply with UL 1277 Type TC-ER per NEC Article 336.
   2. Comply with UL 1685 vertical tray flame test.
   3. Comply with IEEE 1202 vertical tray flame test at 70,000 BTU/hour.
   4. Comply with CSA FT4.
   5. Comply with Oil & Sunlight resistant.
   6. RoHS compliant and CE approved.

C. Cable (minimum requirements):
   1. 600V/1000V rated, high stranded tinned copper conductors, shielded engineered for use with Variable Frequency Drives.
   2. Insulation shall be rated for 90 deg C wet/dry operating temperature.
   3. Suitable for Class I and II; Division 2 hazardous locations.

D. Conductor Material:

1. Stranded tinned copper: Annealed fine wire flexible high strand count.
2. Three (3) phase conductors, three (3) ground conductors. Each of the three ground conductors shall be the same size as the single ground conductor shown on the Drawings.

E. Insulation:

1. Flame-Retardant Cross-Lined Polyolefin.
2. Conductors shall be cabled together. Ground conductors shall be symmetrical. Fillers shall be included as necessary to make the cable round.

F. Shielding: Overall tinned copper braid plus aluminum/polyester tape foil, 100% coverage.

G. Jacket: Flame-retardant Thermoplastic, suitable for 90 deg C use.

H. Termination Kit: Pre-sized and pre-formed specifically for VFD cable constructions. Obtain from VFD cable manufacturer.

2.03 MULTICONDUCTOR CABLES

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

1. Belden Inc.
2. Encore Wire Corporation.
3. General Cable Corporation.
4. Southwire Company.

B. Metal-Clad Cable, Type MC: A factory assembly of insulated current-carrying conductors with an equipment grounding conductor in an overall metallic sheath.

1. Standards:
   a. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
   b. Comply with UL 1569.
   c. Listed for use in Environmental Air space according to NPFA 70 Article 300.
   d. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide."
2. Circuits:
   a. Single circuit.
   b. Power-Limited Fire-Alarm Circuits: Comply with UL 1424.
3. Conductors: Copper, complying with ASTM B 3 for bare annealed copper and with ASTM B 8 for stranded conductors.
4. Ground Conductor: Insulated.
5. Conductor Insulation: Type TFN/THHN/THWN-2: Comply with UL 83.
6. Armor: Steel, interlocked.

2.04 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. Splicing devices for use on No. 14 to No. 10 AWG conductors shall be pressure type such as T & B "STA-KON", Burndy, Reliable or approved equivalent.

D. Wire nuts shall be spring pressure type, insulation 600V, 105 deg. C insulation, up to #8 size. Greater than #6 Cu shall be a compression type connection, 600V insulation, cold shrink tubing, taped, for full insulation value.

E. Pressure crimp-applied ring type (or fork with upturned ends) terminations shall be employed on motor and equipment terminals where such terminals are provided on motor and equipment leads or on all stranded wire terminations using #10 AWG or smaller conductors.

F. Splices, where necessary, shall be made with hydraulically-set “Hy-press” or equivalent crimped connectors. All splices shall be insulated to the full value of the wiring insulation using a cold-shrink kit or the equivalent in built-up materials.

G. Large connectors (lugs) shall be compression, hydraulically set. Lugs furnished on equipment shall be per manufacturer’s recommendations.

H. Underground connections made between bare ground wires or to ground rods shall be exothermically welded, “Cadweld” or equivalent.

I. No aluminum splicing devices or connectors shall be used.

2.05 MISCELLANEOUS 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. Refer to Division 26 Section “Identification for Electrical Systems” for color-coding requirements.

PART 3 - EXECUTION

3.01 CONDUCTOR MATERIAL APPLICATIONS

A. Feeders: Copper for feeders smaller than No. 1/0 AWG; copper or aluminum for feeders No. 1/0 AWG and larger. Stranded for all wire.

B. Branch Circuits: Copper. Stranded for all wire.

C. VFD Output Circuits Cable: Extra-flexible stranded for all sizes.

D. Power-Limited Fire Alarm and Control: Solid for No. 12 AWG and smaller.

E. Provide conductors with minimum temperature ratings of 75 degrees C. For high temperature applications, provide conductors with temperature ratings in accordance with the NFPA 70 for the ambient condition.

F. Conductors used for motor connections and connections to vibrating or oscillating equipment shall be extra flexible stranded.

G. All conductors shall be new, in good condition, and delivered in standard coils and reels.

3.02 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

A. Service Entrance:

1. Aluminum: Type XHHW-2, single conductors in raceway.

2. Copper: Type THHN-THWN, single conductors in raceway.

B. Exposed Feeders 150A and Larger:

1. Aluminum: Type XHHW-2, single conductors in raceway.

2. Copper: Type THHN-THWN, single conductors in raceway.

C. Exposed Feeders Less Than 150A:

1. Copper: Type THHN-THWN, single conductors in raceway.

D. Feeders Concealed in Ceilings, Walls, Partitions, and Crawlspaces 150A and Larger:

1. Aluminum: Type XHHW-2, single conductors in raceway.
2. Copper: Type THHN-THWN, single conductors in raceway.

E. Feeders Concealed in Ceilings, Walls, Partitions, and Crawlspaces Less Than 150A:

1. Copper: Type THHN-THWN, single conductors in raceway.

F. Feeders Concealed in below Slabs-on-Grade, and Underground:

1. Aluminum: Type XHHW-2, single conductors in raceway is only allowed where indicated on the Electrical One-Line Diagram on Sheet E5.0.
2. Copper: Type THHN-THWN, single conductors in raceway.

G. Exposed Branch Circuits, Including in Crawlspaces:

1. Copper: Type THHN-THWN, single conductors in raceway.

H. Branch Circuits Concealed in Ceilings, Walls, and Partitions:

1. Copper: Type THHN-THWN, single conductors in raceway.

I. Branch Circuits Concealed in Concrete, below Slabs-On-Grade, and Underground:

1. Copper: Type THHN-THWN, single conductors in raceway.
2. Branch circuits shall not be routed in or below Slabs-On-Grade unless approved by the Engineer or serving a recessed floor box.

J. Connections to Luminaires: Metal-Clad Cable, Type MC, maximum of 72 inches.

K. Cord Drops and Portable Appliance Connections: Type SO, hard service cord with stainless-steel, wire-mesh, strain relief device at terminations to suit application.

L. VFD Output Circuits: Type TC-ER (XLPE) cable with braided shield.

M. Class 1 Control Circuits: Type THHN-THWN, in raceway.

N. Class 2 Control Circuits: Power-limited tray cable, in cable tray.

3.03 INSTALLATION OF CONDUCTORS AND CABLES

A. Run feeders in continuous lengths, without joints or splices. Where continuous runs are impractical; obtain Engineer's approval for splice locations and application.

B. Branch wiring and feeder conductors that are greater than 50-feet in length shall be increased at least one size to compensate for voltage drop. All circuits shall be installed and sized for a maximum 2% voltage drop as calculated using 80% of the supply breaker rating as the load. Adjust conductors and conduit size accordingly for actual field installed conditions.

C. Make joints in branch circuits only where circuits divide.

D. Do not use gutters of panelboards as raceways, junction boxes, or pull boxes for conductors not terminating in said panelboards.

E. Run conduits for emergency power conductors separate from all other wiring.

F. Make splices and terminations in cables with kits and instructions provided by the kit manufacturer. Each splice shall equal the integrity of the cable electrically and environmentally.

G. Bundling Conductors: Bundle conductors in switchboards, panelboards, cabinets, and the like, using nylon ties made for the purpose. Bundle conductors larger than No. 10 in individual circuits. Smaller conductors may be bundled in larger groups.

H. Install all conductors in raceways, unless otherwise indicated.

I. Sizes:

1. Provide conductors no smaller than No. 12 AWG, except for signal or control circuits.
2. Provide No. 10 AWG conductors for home runs on 120-volt, 20-ampere branch circuits, where the conductor length exceeds 100 lineal feet from panelboard to the first device.
3. Provide No. 10 AWG conductors for home runs on 277-volt, 20-ampere branch circuits, where the conductor length exceeds 200 lineal feet from panelboard to the first device.
4. Provide neutral conductors of the same size as the phase conductor(s) for individual branch circuit homeruns.
5. Run dedicated neutral conductor with each branch circuit. Sharing of neutral conductors in multi-circuit homeruns is not acceptable.
    a. Sharing of neutrals would necessitate the use of multiple-pole or tied branch circuit breakers to allow simultaneous disconnecting of current caring conductors in order to comply with NFPA 70 requirements and therefore is unacceptable.
6. Grouping of Multi-Circuit Homeruns: Grouping of multiple circuits into shared conduit homeruns is acceptable where they comply with the quantities and sizes listed in Table "A" below and where homeruns meet the following conditions:
    a. Where conductors are THWN/THHN installed in dry location.
    b. Where raceways are installed in ambient conditions less than 30-Deg C (86-Deg F).
    c. Consider neutral conductors as a current carrying conductor in branch circuits which serve receptacles or electronic ballasted luminaries.
    d. No more than seven conductors shall be installed in conduit except for switch legs and travelers in multi-point switching arrangements.

TABLE A

Number of Current Carrying Conductors in single raceway	Conductor Size for 20Ampere Single Pole Circuit	Conduit Size based on EMT
2 to 3	#12 AWG (THHN 75-Deg) or #12 AWG (THHN 90-Deg)	3/4" EMT
4 to 6	#12 AWG (THHN 75-Deg) or #12 AWG (THHN 90-Deg)	3/4" EMT
7 to 9	#10 AWG (THHN 75-Deg) or #12 AWG (THHN 90-Deg)	1" EMT 3/4" EMT

Notes:

1. Conductor and conduit sizes in table above are based on total conductor lengths under 100 lineal feet for 120-volt (200 lineal feet for 277-volt) from panelboard to the first device, 20-ampere branch circuits. Increase conductor and conduit size in accordance with NFPA 70 for longer lengths.

J. Terminations of multiple branch circuit conductors on a single circuit breaker is not acceptable.

K. Conceal cables in finished walls, ceilings, and floors, unless otherwise indicated.

L. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible. Cables that are installed exposed shall not be routed across ceilings or ductwork. They shall be held up against building structure or against permanent support members. They shall be installed in such a manner that they do not interfere with the operation of equipment or removal of ceiling tiles. Nylon tie-wraps shall be installed in such a manner so as to bundle conductors neatly, allowing runouts of single conductors or groups to drop down to equipment served. Install grommeting where dropping out of trays or into panels or service columns. Install sleeves with bushings where penetrating partitions. Firestop sleeves with approved material. Do not penetrate firewalls if so indicated on plans.

M. Intentional or unintentional painting of exposed low voltage or line voltage cabling is prohibited. Ensure that exposed cabling is adequately protected from direct painting or overspray whether painting is required within the electrical specifications or required by other disciplines/trades. Review the painting requirements for all disciplines and provide cabling protection as required. Where exposed cabling is being installed in exposed ceilings or wall spaces that are required to be painted, provide alternate options for cable colors and submittals for such cabling for Engineer to review.

N. Support cables according to Division 26 Section "Hangers and Supports for Electrical Systems."

3.04 WIRE PULLING

A. Pull no conductors into conduits until all Work of a nature which may cause injury to conductors is completed.

B. Follow manufacturers' recommendations for regulating temperature conditions of conductors prior to installation.

C. Exercise care in handling and installing cables to avoid damage. Carefully form cables in equipment pull boxes. Form bends in cables larger than the minimum radii shown in the cable manufacturer's published data for minimum bends such that bends will not reduce the cable life.

1. The radius of bending of conductors shall be not less than eighteen (18) times the outside diameter of the conductor insulation.

D. Provide suitable installation equipment to prevent abrasion and cutting of conductors by raceways during the pulling of conductors. Use ropes of polyethylene, nylon or other suitable non-metallic material to pull in feeders. Metallic ropes are prohibited.

E. Attach pulling lines to conductors by means of insulated woven basket grips or by pulling eyes attached directly to conductors. Do not use rope hitches, or bare steel basket grips. All conductors to be installed in a single conduit shall be pulled in simultaneously.

F. The pulling of all wires and cable on this project shall be performed in strict compliance with applicable sections of the National Electrical Code. No conductor entering or leaving a cabinet or box shall be deflected in such a manner as to cause excess pressure on the conductor insulation. Conductors shall only be installed after insulating bushings are in place.

G. Maximum permissible pulling tensions, as recommended by the manufacturer for any given type of cable or wire installed shall not be exceeded. Utilize special remote readout equipment to ensure compliance.

H. Before any wire is pulled into any conduit, thoroughly swab the conduit to remove all foreign material and to permit the wire itself to be pulled into a clean, dry conduit.

I. Use manufacturer-approved pulling compound or lubricant where necessary, of non-conducting type. Compounds used must not deteriorate the conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.

3.05 IDENTIFICATION

A. Identify and color-code conductors and cables according to Division 26 Section "Identification for Electrical Systems."

B. Identify each spare conductor at each end with identity number and location of other end of conductor, and identify as spare conductor.

3.06 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.

D. Wiring at Lighting Control Locations: Install a neutral conductor at each switch location controlling line-to-neutral lighting loads.

E. Connectors: Make splices and connections in conductors using approved connectors.

1. Provide lugs and connectors of proper size to match conductor size.
2. Stranded Conductors: Solder-less, bolted pressure or compression connectors.
3. Solid Conductors: Bolted pressure or spring connectors.
4. Motor Lead Pigtails: Crimp lugs with through-bolt fasteners between lugs. Furnish proper sized dies and tools to apply connectors.
5. Lighting Fixture Taps: Electrical spring connectors as specified for solid conductors.
6. Ground Connections: Ground connection materials and installation requirements are specified in Division 26 Section "Grounding and Bonding for Electrical Systems."
7. Wire Nuts:
   a. For up to #8 AWG in size, use spring pressure type, insulation 600V, 105 deg C insulation
   b. For greater than #8 AWG in size, use compression type connection, 600V insulation, cold shrink tubing, taped, for full insulation value.

F. Provide temperature ratings of connectors and splices to match wire rating.

G. Connections for Aluminum Conductors using Mechanical Screw Type Connectors:

1. Connectors shall be dual rated (AL7CU or AL9CU) and Listed by UL for use with aluminum and copper conductors and sized to accept aluminum conductors of the ampacity specified.
2. Using a suitable stripping tool, to avoid damage to the conductor, remove insulation from the required length of the conductor.
3. Clean the conductor surface using a wire brush and apply a Listed joint compound.
4. Tighten the connection per the connector manufacturer’s recommendation.
5. Wipe off any excess joint compound.

H. Connections for Aluminum Conductors using Mechanical Compression Type Connectors:

1. Connectors shall be dual rated (AL7CU or AL9CU) and Listed by UL for use with aluminum and copper conductors and sized to accept aluminum conductors of the ampacity specified.
2. The lugs shall be marked with wire size, die index, number and location of crimps and shall be suitably color coded. Lug barrel shall be factory prefilled with a joint compound Listed by UL.
3. Using a suitable stripping tool, to avoid damage to the conductor, remove insulation from the required length of the conductor.
4. Clean the conductor surface using a wire brush.
5. Crimp the connection per the connector manufacturer’s recommendation.
6. Wipe off any excess joint compound.

I. Termination of Aluminum Conductor to Aluminum Bus:

1. Prepare a mechanical connection conforming to G or H above.
2. Hardware:
   a. Bolts: Anodized aluminum alloy 2024-T4 and conforming to ANSI B18.2.1 and to ASTM B211 or B221 chemical and mechanical property limits.
   b. Nuts: Aluminum alloys 6061-T6 or 6262-T9 and conforming to ANSI B18.2.2.

c. Washers: Flat aluminum alloy 2024-T4, Type “A” plain, standard wide series conforming to ANSI B27.2.

d. Lubricate and tighten the hardware as per the manufacturer’s recommendations.

J. Termination of Aluminum Conductor to Copper Bus:

1. Prepare a mechanical connection conforming to G or H above.

2. Hardware:

a. Bolts: Plated or galvanized medium carbon steel; heat treated, quenched and tempered equal to ASTM A-325 or SAE grade 5.

b. Nuts: Heavy semi-finished hexagon, conforming to ANSI B18.2.2, threads to be unified coarse series (UNC), class 2B.

c. Washers: Steel; Type A plain standard wide series conforming to ANSI B27.2.

d. Belleville conical spring washers: hardened steel, cadmium plated or silicone bronze.

e. Lubricate and tighten the hardware as per the manufacturer’s recommendations.

K. Termination of Aluminum Conductor to Equipment Not Equipped for Termination of Aluminum Conductor:

1. Prepare compression connection using an adapter Listed by UL for the purpose or by pigtailing a short length of suitable size of copper conductor to the aluminum conductor with a compression connector Listed by UL.

2. Provide an insulating cover over adapter body or the compression connector.

3. Terminate the adapter or the pigtail on to the equipment per manufacturer’s recommendation.

3.07 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies.

3.08 FIRESTOPPING

A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly according to Division 07 Section "Penetration Firestopping."

3.09 FIELD QUALITY CONTROL

A. Prepare for acceptance tests as follows:

1. Perform insulation-resistance test on each conductor with respect to ground and adjacent conductors. Applied potential shall be 1000 volts dc for one minute.

2. Perform continuity test to insure correct cable connection.

3. After installing conductors and cables and before electrical circuitry has been energized, test service entrance and feeder conductors, and conductors of No. 2 AWG and larger for compliance with requirements.

4. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.

5. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each splice in cables and conductors No. 3 AWG and larger. Remove box and equipment covers so splices are accessible to portable scanner.

a. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

b. Record of Infrared Scanning: Prepare a certified report that identifies splices checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

B. Test Reports: Prepare a written report to record the following:

1. Test procedures used.
2. Test results that comply with requirements.
3. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.

C. Cables will be considered defective if they do not pass tests and inspections. Remove and replace malfunctioning units and retest as specified above.

END OF SECTION 26 0519

SECTION 26 0526

GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 SUMMARY

A. NFPA 70 and IEEE C2 include basic grounding requirements for electrical safety. This Section supplements the minimum safety requirements of the Code with requirements for additional grounding and with optional grounding methods and materials for both power and electronic systems.

B. Section includes grounding systems and equipment, plus the following special applications:

1. Underground distribution grounding.

1.02 ACTION SUBMITTALS

A. Submit product data and shop drawings in accordance with Division 01 and Division 26 Section “Electrical Shop Drawings and Submittals” for products specified under PART 2 - PRODUCTS.

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

1.03 INFORMATIONAL SUBMITTALS

A. Informational Submittals: Plans showing dimensioned as-built locations of grounding features specified in "Field Quality Control" Article, including the following:

1. Test wells.
2. Ground rods.
3. Grounding arrangements and connections for separately derived systems.

B. Field quality-control test reports.

1.04 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For grounding to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Closeout Submittals," include the following:

1. Instructions for periodic testing and inspection of grounding features at grounding connections for separately derived systems and test wells, based on NETA MTS.
    a. Tests shall determine if ground-resistance or impedance values remain within specified maximums, and instructions shall recommend corrective action if values do not.
    b. Include recommended testing intervals.

1.05 QUALITY ASSURANCE

A. 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.

B. Comply with UL 467 for grounding and bonding materials and equipment.

C. Comply with NFPA 70.

D. Comply with IEEE C2.

E. Comply with ANSI-J-STD-607-A.

PART 2 - PRODUCTS

2.01 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. Burndy; Part of Hubbell Electrical Systems.
2. Dossert; AFL Telecommunications LLC.

3. ERICO International Corporation.
4. Fushi Copperweld Inc.
5. Galvan Industries, Inc.; Electrical Products Division, LLC.
6. Harger Lightning and Grounding.
7. ILSCO.
8. O-Z/Gedney; an EGS Electrical Group brand; an Emerson Industrial Automation business.
9. Robbins Lightning, Inc.
10. Siemens Power Transmission & Distribution, Inc.

2.02 CONDUCTORS

A. Insulated Conductors: Copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.

B. Bare Copper Conductors:
   1. Solid Conductors: ASTM B 3.
   2. Stranded Conductors: ASTM B 8.
   3. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG conductor, 1/4 inch in diameter.
   4. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
   5. Bonding Jumper: Copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.
   6. Main Bonding Jumper: Stranded copper conductors sized as indicated on Drawings.
   7. Grounding Electrode Conductor: Stranded copper conductors sized as indicated on Drawings.
   8. Common Grounding Electrode Conductor: Stranded copper conductors sized as indicated on Drawings.

C. Grounding Bus: Predrilled rectangular bars of annealed copper, 1/4 by 4 inches in cross section, with 9/32-inch holes spaced 1-1/8 inches apart. Stand-off insulators for mounting shall comply with UL 891 for use in switchboards, 600 V. Lexan or PVC, impulse tested at 5000 V.

2.03 CONNECTORS

A. Listed and labeled by an NRTL 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, pressure type with at least two bolts.
   1. Pipe Connectors: Clamp type, sized for pipe.

C. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

D. Bus-bar Connectors: Mechanical type, cast silicon bronze, solderless compression-type wire terminals, and long-barrel, two-bolt connection to ground bus bar.

E. Beam Clamps: Mechanical type, terminal, ground wire access from four directions, with dual, tin-plated or silicon bronze bolts.

F. Cable Tray Ground Clamp: Mechanical type, zinc-plated malleable iron.

G. Conduit Hubs: Mechanical type, terminal with threaded hub.

H. Ground Rod Clamps: Mechanical type, copper or copper alloy, terminal with hex head bolt.

I. U-Bolt Clamps: Mechanical type, copper or copper alloy, terminal listed for direct burial.

2.04 GROUNDING ELECTRODES

A. Ground Rods: Copper-clad steel; 5/8-inch diameter by 96 inches long.

B. Other grounding electrodes permitted for grounding per NFPA 70 include:

1. Metal Underground Water Pipe: A metal underground water pipe in direct contact with the earth for a minimum of 10-feet and electrically continuous.

2. Concrete-Encased Electrode (Ufer Ground): Bare copper conductor not smaller than No. 4 AWG a minimum of 20-feet long encased in the center of the concrete foundation that is in direct contact with the earth.

3. Building Steel: The hold-down bolts securing the structural steel column shall be connected to the concrete-encased electrode.

PART 3 - EXECUTION

3.01 APPLICATIONS

A. Conductors: Install insulated solid conductor for No. 8 AWG and smaller and insulated stranded conductors for No. 6 AWG and larger, unless otherwise indicated.

B. Grounding Bus: Install in electrical and telephone equipment rooms, in rooms housing service equipment, and elsewhere as indicated.

1. Install bus on insulated spacers 2 inches minimum from wall, 12 inches above finished floor unless otherwise indicated.

2. Where indicated on both sides of doorways, route bus up to top of door frame, across top of doorway, and down to specified height above floor; connect to horizontal bus.

C. Conductor Terminations and Connections:

1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.

2. Underground Connections: Welded connectors except at test wells and as otherwise indicated.

3. Connections to Ground Rods at Test Wells: Bolted connectors.

4. Connections to Ground Rods: Welded connectors.

5. Connections to Structural Steel: Welded connectors.

3.02 GROUNDING AT THE SERVICE

A. Equipment grounding conductors and grounding electrode conductors shall be connected to the ground bus. Install a main bonding jumper between the neutral and ground buses.

3.03 GROUNDING SEPARATELY DERIVED SYSTEMS

A. Dry-Type Transformers: Install an insulated grounding conductor from the common point of connection of the transformer secondary neutral point and the transformer enclosure to the following:

1. The nearest grounding electrode per NFPA 70, including but not limited to building steel where available.

2. The grounding bus of the common electrode grounding system, located in the electrical equipment room.

3.04 EQUIPMENT GROUNDING

A. Install insulated equipment grounding conductors with all feeders and branch circuits.

1. Bond to each device, box, and luminaire, unless otherwise indicated.

2. Conductor insulation of the same rating as the phase conductors, for all feeders and branch circuits. Install the grounding conductors in the raceway with related phase and neutral conductors.

3. Where parallel conductors in separate raceways occur, provide a grounding conductor in each raceway that meets requirements of NFPA 70.

B. Enclosures: Install an insulated grounding conductor from grounding bushings to the frame of the enclosure, ground bus, and equipment grounding strap where each occurs. Install grounding bushings on all raceways connecting electrical enclosures constructed of separate enclosure panels, which are not integrally welded together.

C. Air-Duct Equipment Circuits: Install insulated equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners, heaters, dampers, humidifiers, and other duct electrical equipment. Bond conductor to each unit and to air duct and connected metallic piping.

D. Water Heater, Heat-Tracing, and Anti-frost Heating Cables: Install a separate insulated equipment grounding conductor to each electric water heater and heat-tracing cable. Bond conductor to heater units, piping, connected equipment, and components.

E. Signal and Communication Equipment: In addition to grounding and bonding required by NFPA 70, provide a separate grounding system complying with requirements in TIA/ATIS J-STD-607-A.

1. For telephone, alarm, voice and data, and other communication equipment, provide No. 4 AWG minimum insulated grounding conductor in raceway from grounding electrode system to each service location, terminal cabinet, wiring closet, and central equipment location.

2. Service and Central Equipment Locations and Wiring Closets: Terminate grounding conductor on a 1/4-by-4-by-12-inch grounding bus.

3. Terminal Cabinets: Terminate grounding conductor on cabinet grounding terminal.

3.05 INSTALLATION

A. All circuits shall have a separate grounding conductor.

B. Provide permanent service neutral and equipment grounding in accordance with NFPA 70 and subject to the following additional requirements.

C. Comply with mounting and support requirements specified in Division 26 Section "Hangers and Supports for Electrical Systems."

D. Connect the service neutral and equipment ground to a common point within the metallic enclosure containing the main service disconnecting means. Equipment grounds and the identified neutral of the wiring system shall not be interconnected beyond this point in the interior wiring system. From the common point of connection of the service neutral and the equipment ground, run in non-magnetic conduit a grounding electrode conductor without joint or splice to the grounding electrode system and connect it with an approved bolted pressure clamp.

E. 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.

F. Ground Rods: Drive rods until tops are 2 inches below finished floor or final grade unless otherwise indicated.

1. Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating if any.

2. For grounding electrode system, install at least three rods at least one-rod length from each other and located at least the same distance from other grounding electrodes, and connect to the service grounding electrode conductor.

G. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance except where routed through short lengths of conduit.

1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.

2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install bonding so vibration is not transmitted to rigidly mounted equipment.
3. Use exothermic-welded connectors for outdoor locations; if a disconnect-type connection is required, use a bolted clamp.
4. Where expansion joints or telescoping joints occur, provide bonding jumpers.

H. Test Wells: Ground rod driven through drilled hole in bottom of handhole. Handholes are specified in Division 26 Section "Underground Ducts and Raceways for Electrical Systems," and shall be at least 12 inches deep, with cover.

1. Test Wells: Install at least one test well for each service unless otherwise indicated. Install at the ground rod electrically closest to service entrance. Set top of test well flush with finished grade or floor.

I. Grounding and Bonding for Piping:

1. Metal Water Service Pipe: Install bare copper grounding conductors 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; use a bolted clamp connector or bolt a lug-type connector to a pipe flange by 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.

J. Grounding for Steel Building Structure: Install a driven ground rod at base of each corner column and at intermediate exterior columns at distances not more than 60 feet apart.

K. Concrete-Encased Grounding Electrode (Ufer Ground): Fabricate according to NFPA 70; use a minimum of 20 feet of bare copper conductor not smaller than No. 4 AWG.

1. If concrete foundation is less than 20 feet long, coil excess conductor within base of foundation.
2. Bond grounding conductor to reinforcing steel in at least four locations and to anchor bolts. Extend grounding conductor below grade and connect to building's grounding grid or to grounding electrode external to concrete.

L. Connections: Make connections so possibility of galvanic action or electrolysis is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact are galvanically compatible.

1. Use electroplated or hot-tin-coated materials to ensure high conductivity and to make contact points closer in order of galvanic series.
2. Make connections with clean, bare metal at points of contact.
3. Make aluminum-to-steel connections with stainless-steel separators and mechanical clamps.
4. Make aluminum-to-galvanized-steel connections with tin-plated copper jumpers and mechanical clamps.
5. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.

3.06 LABELING

A. Comply with requirements in Division 26 Section "Identification for Electrical Systems" Article for instruction signs. The label or its text shall be green.

B. Install labels at the telecommunications bonding conductor and grounding equalizer and at the grounding electrode conductor where exposed.

1. Label Text: "If this connector or cable is loose or if it must be removed for any reason, notify the facility manager."

3.07 FIELD QUALITY CONTROL

A. 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.

B. Tests and Inspections:

1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.

2. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.

3. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, and at individual ground rods. Make tests at ground rods before any conductors are connected.

a. Measure ground resistance no fewer than two full days after last trace of precipitation and without soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.

b. Perform tests by fall-of-potential method according to IEEE 81.

4. Prepare dimensioned Drawings locating each test well, ground rod and ground-rod assembly, and other grounding electrodes. Identify each by letter in alphabetical order, and key to the record of tests and observations. Include the number of rods driven and their depth at each location, and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.

C. Grounding system will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

E. Report measured ground resistances that exceed the following values:

1. Power and Lighting Equipment or System with Capacity of 1000 kVA and Less: 5 ohms.

2. Power and Lighting Equipment or System with Capacity More Than 1000 kVA: 3 ohms.

3. Power Distribution Units or Panelboards Serving Electronic Equipment: 1 ohm.

4. Substations and Pad-Mounted Equipment: 5 ohms.

F. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect promptly and include recommendations to reduce ground resistance.

END OF SECTION 26 0526

SECTION 26 0529

HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 SUMMARY

A. This Section includes the following:

1. Hangers and supports for electrical equipment and systems.
2. Construction requirements for concrete bases.

1.02 DEFINITIONS

A. EMT: Electrical metallic tubing.

B. FMC: Flexible metal conduit.

C. IMC: Intermediate metal conduit.

D. RMC: Rigid metal conduit.

E. RNC: Rigid nonmetallic conduit.

F. RSC: Rigid steel conduit.

1.03 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design supports for multiple raceways, using performance requirements and design criteria indicated.

B. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.

C. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

D. 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.

1.04 ACTION SUBMITTALS

A. Submit product data and shop drawings in accordance with Division 01 and Division 26 Section “Electrical Shop Drawings and Submittals” for products specified under PART 2 - PRODUCTS.

B. Product Data: For the following:

1. Steel slotted support systems.
2. Nonmetallic slotted support systems.

C. Shop Drawings: Show fabrication and installation details and include calculations for the following:

1. Trapeze hangers. Include Product Data for components.
2. Steel slotted channel systems. Include Product Data for components.
3. Nonmetallic slotted channel systems. Include Product Data for components.
4. Equipment supports.
5. Concrete bases for equipment.

1.05 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

B. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 07 Section "Roof Accessories."

PART 2 - PRODUCTS

2.01 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. GS Metals Corp.
    e. Thomas & Betts Corporation.
    f. Unistrut; Tyco International, Ltd.
    g. Wesanco, Inc.
2. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
3. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
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: Steel 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. Device Box Mounting Brackets and Stabilizer: Factory-fabricated sheet steel brackets for support of device boxes adjacent to or between studs.

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. Cooper B-Line, Inc.
    b. ERICO International Corporation.

F. Through-Stud Cable and Raceway Support Clips: Factory-fabricated spring steel clip for cables or raceways where run horizontally through metal studs.

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. Cooper B-Line, Inc.
    b. ERICO International Corporation.

G. Roof-mounted Raceway Support Blocking: Factory-fabricated support blocking for use under roof-mounted raceways. Wedge-shaped blocking constructed of 100% recycled UV-resistant Rubber with integral galvanized steel strut to accept raceway support clips.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Cooper B-Line C-Port series components or a comparable product by one of the following:
    a. Cooper B-Line, Inc.
    b. ERICO International Corporation.

H. Tee Bar Grid Box Hanger: Factory-fabricated metal electrical box hanger for supporting boxes at locations between ceiling system t-grid components. Height adjustable for various electrical box depths. Attached to ceiling tee bar with screws or integral clamp for stability. Includes tab for independent support wire attachment.

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. Cooper B-Line, Inc.

b. ERICO International Corporation.

I. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

J. 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, zinc-coated steel, for use in hardened Portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.

a. 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 or malleable-iron, 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

3.01 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. All electrical raceways shall be hung independently from the building structure with UL Listed and approved materials. Hangers and supports suspending from the support systems of other trades' work shall not be permitted. The use of tie wire for support or fastening of any raceway system is prohibited.

C. Supports for raceways shall be of materials compatible with the raceway, of malleable iron, spring steel, stamped steel or other approved material. Die-cast fittings are not permitted for supports.

D. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMT, IMC, and RMC as required by NFPA 70. Minimum rod size shall be 1/4 inch in diameter.

E. Minimum Hanger Rod Size for Raceway Supports: Minimum rod size shall be 1/4 inch in diameter, 20 threads per inch. Rods shall be furnished with a corrosion-resistant finish.

F. Single Raceways or Cables:

1. For Raceways 1-1/4-inch and smaller: Install adjustable steel band hanger suspended on threaded rod.
2. For Raceways larger than 1-1/4-inch: Install trapeze-type supports fabricated with steel slotted support system suspended on threaded rods. Size trapeze members, including the suspension rods, based on the support required for the size, and loaded weight of the conduits.
    a. Secure raceway or cable to support with two-bolt conduit clamps or single-bolt conduit clamps using spring friction action for retention in support channel.
3. For Individual Raceways on Building Walls: Secure with two hole galvanized malleable iron or stamped steel pipe strap or “minerallac” 2-piece straps. The straps are to be anchored by an approved means such as expansion anchors, toggle bolts, through bolts, etc. Where required by codes or other standards, provide spacers behind mounting clamps to space conduits off walls.
4. For Individual Raceways on Building Steel: Secure with clamp supports

G. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted support system suspended on threaded rods, where multiple raceways are run vertically or horizontally at the same elevations. Size trapeze members, including the suspension rods, based on the support required for the smallest conduit to be supported. Size 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.

H. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2-inch and smaller raceways serving branch circuits and communication systems above suspended ceilings and for fastening raceways to trapeze supports.

3.02 SUPPORT INSTALLATION

A. Comply with NFPA 70, NECA 1 and NECA 101 for installation requirements except as specified in this Article.

B. Fasten junction, pull and devices boxes securely to the building construction, independent of raceway system.

C. Install Device Box Mounting Brackets supported between two studs where boxes are not located adjacent to stud or where multiple boxes are located between studs.

D. Install Device Box Stabilizer where single box is located adjacent to stud.

E. Install Through-Stud Cable and Raceway Support Clips where cables or raceways run horizontally through metal studs.

F. Install Tee Bar Grid Box Hanger supported between two ceiling grid tee bars where devices boxes are located flush in recessed suspended ceilings.
    1. Install at least one independent support rod from box hanger to structure.

G. Install Roof-mounted Raceway Support Blocking where raceways run on across roofing.
    1. Coordinate installation of roof supports with items specified in Division 07 Section "Roof Accessories." Provide products compatible with rooftop materials included in the Work.

H. Provide minimum of two lock nuts per threaded support rod except where lock nut tightens against a threaded socket, one locknut may be used.

I. Support raceways at a distance above suspended ceilings to permit removal of ceiling panels and luminaires.
    1. No raceway shall be installed on acoustic tile ceiling tees and support wire, or in any location that will impair the functioning, access or code-required clearances for any equipment or system.

J. Locate raceways so as not to hinder access to mechanical equipment.

K. Do not secure conductors, raceways, or supports to suspended ceiling hanger rods or wires.

L. 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.

M. Where lighting fixtures, appliances or wiring devices are to be suspended from ceiling outlet boxes, they shall be provided with 3/4" rigid conduit pendants. Outlet boxes shall be malleable iron, provided with self-aligning covers with swivel ball joint (minimum 125 lb. support) and No. 14 gauge steel locking ring. Provide safety chain between building structure and ballast housing of light fixtures for all fixtures, appliances or devices greater than 10 lbs. weight. Fixtures shall be installed plumb and level. Cover pendants shall be finished to match fixtures.

N. 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. Where support anchors are required, establish their type and locate in concrete construction before concrete is poured, if possible. Fit each hanger rod with a nut at its upper end, and set nut in a universal concrete insert in the form. Where supported weight exceeds holding strength of a single insert, pass rods through top slot of inserts and interlock with reinforcing steel. Also, where particularly heavy loads are to be supported, suspend hanger rod or rods from a structural angle spanning two or more inserts and securely bolted thereto to distribute the weight.
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. Attachment to gypsum wall board is not acceptable as sole support means.

O. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars. Verify reinforcing locations with Structural Engineer. X-Ray existing concrete structures as required.

3.03 CONCRETE BASES

A. Construct concrete bases of dimensions indicated but not less than 3 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 3000-psi, 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in Division 03 Section "Cast-in-Place Concrete."

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.

3.04 PAINTING

A. Touchup: Comply with requirements in Division 09 Painting Sections for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.

B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION 26 0529

SECTION 26 0533
RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Metal conduits, tubing, and fittings.
   2. Nonmetal conduits, tubing, and fittings.
   3. Metal wireways and auxiliary gutters.
   4. Nonmetal wireways and auxiliary gutters.
   5. Surface raceways.
   6. Boxes, enclosures, and cabinets.

B. Related Requirements:
   1. Division 26 Section "Underground Ducts and Raceways for Electrical Systems" for exterior ductbanks, manholes, and underground utility construction.

1.02 DEFINITIONS

A. BAS: Building Automation System.

B. EMT: Electrical metallic tubing.

C. ENT: Electrical non-metallic tubing.

D. EPC: Electrical Plastic Conduit

E. EPDM: Ethylene-propylene-diene terpolymer rubber.

F. FMC: Flexible metal conduit.

G. GRC: Galvanized rigid steel conduit.

H. IMC: Intermediate metal conduit.

I. LFMC: Liquidtight flexible metal conduit.

J. LFNC: Liquidtight flexible nonmetallic conduit.

K. NBR: Acrylonitrile-butadiene rubber.

L. RAC: Rigid aluminum conduit.

M. RMC: Rigid metal conduit.

N. RNC: Rigid nonmetallic conduit (PVC)

O. RSC: Rigid Steel conduit.

1.03 ACTION SUBMITTALS

A. Submit product data and shop drawings in accordance with Division 01 and Division 26 Section “Electrical Shop Drawings and Submittals” for products specified under PART 2 - PRODUCTS.

B. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.

C. Shop Drawings: For custom enclosures and cabinets. Include plans, elevations, sections, and attachment details.

1.04 INFORMATIONAL SUBMITTALS

A. Source quality-control reports.

PART 2 - PRODUCTS

2.01 METAL CONDUITS, TUBING, AND FITTINGS

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

1. AFC Cable Systems, Inc.
2. Allied Tube & Conduit; a Tyco International Ltd. Co.
3. Anamet Electrical, Inc.
4. Calbond.
5. Electri-Flex Company.
6. Orbit Industries, Inc.
7. O-Z/Gedney; a brand of EGS Electrical Group.
8. Picoma Industries, a subsidiary of Mueller Water Products, Inc.
9. Plasti-Bond.
10. Republic Conduit.
11. Robroy Industries.
12. Sentinal Conduit.
13. Southwire Company.
14. Thomas & Betts Corporation.
15. Western Tube and Conduit Corporation.
16. Wheatland Tube Company; a division of John Maneely Company.

B. Listing and Labeling: Metal conduits, tubing, and fittings shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. RSC: Comply with ANSI C80.1, UL 6, and NEMA FB 2.10; Galvanized rigid steel, each length with a coupling on one end and thread protector on opposite end.

D. IMC: Comply with ANSI C80.6 and UL 1242.

E. Fittings for RSC and IMC: Provide factory made threaded couplings of same material as the conduit.

1. Molded thermoplastic insulating bushing at all boxes and cabinets, with locknuts inside and outside box or cabinet. In wet locations, provide watertight hubs for conduit entry into enclosures.
2. Thermoplastic insulated grounding bushing on all conduits where grounding bushings are required, with locknuts inside and outside the enclosure. In wet locations provide watertight hubs for conduit entry into enclosures.
3. Expansion joints: O-Z/Gedney or acceptable submission, with internal ground and external bonding jumper.
    a. Expansion fitting: Type AX.
    b. End type expansion fitting: Type EXE.
    c. Deflection fitting: Type DX.
    d. Pull box fitting: Type EXPB.
    e. Combination expansion/deflection fitting: Type AXDX.

F. PVC-Coated Steel Conduit: PVC-coated rigid steel conduit.

1. Comply with NEMA RN 1.
2. Coating Thickness: 0.040 inch, minimum.

G. EMT: Comply with ANSI C80.3 and UL 797.

H. FMC: Comply with UL 1; zinc-coated steel.

I. LFMC: Flexible steel conduit with flame retardant PVC jacket and copper grounding strand; comply with UL 360.

J. Fittings for Metal Conduit: Comply with NEMA FB 1 and UL 514B.

1. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 886 and NFPA 70.

2. Fittings for EMT:

a. Material: Steel.

b. Type: Mechanical set screw.

3. Expansion Fittings: PVC or steel to match conduit type, complying with UL 651, rated for environmental conditions where installed, and including flexible external bonding jumper.

4. Coating for Fittings for PVC-Coated Conduit: Minimum thickness of 0.040 inch, with overlapping sleeves protecting threaded joints.

K. Joint Compound for IMC, RSC, or RAC: Approved, as defined in NFPA 70, by authorities having jurisdiction for use in conduit assemblies, and compounded for use to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.

2.02 NONMETALLIC CONDUITS, TUBING, AND FITTINGS

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

1. AFC Cable Systems, Inc.

2. Anamet Electrical, Inc.

3. Arnco Corporation.

4. CANTEX Inc.

5. CertainTeed Corp.

6. Condux International, Inc.

7. Electri-Flex Company.

8. Kraloy.

9. Lamson & Sessions; Carlon Electrical Products.

10. Niedax-Kleinhuis USA, Inc.

11. RACO; a Hubbell company.

12. Thomas & Betts Corporation.

B. Listing and Labeling: Nonmetallic conduits, tubing, and fittings shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. ENT: Comply with NEMA TC 13 and UL 1653.

D. RNC: Type EPC-40-PVC, complying with NEMA TC 2 and UL 651 unless otherwise indicated.

E. Fittings for ENT and RNC: Comply with NEMA TC 3; match to conduit or tubing type and material.

2.03 METAL WIREWAYS AND AUXILIARY GUTTERS

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

1. Cooper B-Line, Inc.

2. Hoffman; a Pentair company.
3. Mono-Systems, Inc.
4. Square D; a brand of Schneider Electric.

B. Description: Sheet metal, complying with UL 870 and NEMA 250, Type 1 unless otherwise indicated, and sized according to NFPA 70.

1. Metal wireways installed outdoors shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Fittings and Accessories: Include covers, 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: Hinged type unless otherwise indicated.

E. Finish: Manufacturer's standard enamel finish.

2.04 SURFACE RACEWAYS

A. Listing and Labeling: Surface raceways and tele-power poles shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Surface Metal Raceways: Galvanized steel with snap-on covers complying with UL 5. Prime coated, ready for field painting.

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

a. Mono-Systems, Inc.
b. Panduit Corp.
c. Wiremold / Legrand.

2.05 BOXES, ENCLOSURES, AND CABINETS

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

1. Adalet.
2. Cooper Technologies Company; Cooper Crouse-Hinds.
3. EGS/Appleton Electric.
4. Erickson Electrical Equipment Company.
5. FSR Inc.
6. Hoffman; a Pentair company.
7. Hubbell Incorporated; Killark Division.
8. Kraloy.
9. Milbank Manufacturing Co.
10. Mono-Systems, Inc.
11. Orbit Industries, Inc.
12. O-Z/Gedney; a brand of EGS Electrical Group.
13. RACO; a Hubbell Company.
14. Robroy Industries.
15. Spring City Electrical Manufacturing Company.
16. Stahlin Non-Metallic Enclosures; a division of Robroy Industries.
17. Thomas & Betts Corporation.

18. Wiremold / Legrand.

B. General Requirements for Boxes, Enclosures, and Cabinets: Boxes, enclosures, and cabinets installed in wet locations shall be listed for use in wet locations.

C. Sheet Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.

D. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, ferrous alloy, Type FD, with gasketed cover.

E. Nonmetallic Outlet and Device Boxes: Comply with NEMA OS 2 and UL 514C.

F. Luminaire Outlet Boxes: Nonadjustable, designed for attachment of luminaire weighing 50 lb. Outlet boxes designed for attachment of luminaires weighing more than 50 lb shall be listed and marked for the maximum allowable weight.

G. Small Sheet Metal Pull and Junction Boxes: Comply with NEMA OS 1.

1. Construct boxes from code gauge sheet steel no lighter than 14 gauge with overlapped riveted or welded corners and with edges turned to receive trim.

2. Construct covers from same gauge as box with screw fasteners. Sectionalize boxes over 864 square inches.

H. Cast-Metal Access, Pull, and Junction Boxes: Comply with NEMA FB 1 and UL 1773, cast aluminum with gasketed cover.

I. Box extensions used to accommodate new building finishes shall be of same material as recessed box.

J. Device Box Dimensions: 4 inches square by 2-1/8 inches deep .

K. Gangable boxes are prohibited.

L. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250, Type 1 with continuous-hinge cover with flush latch unless otherwise indicated.

1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.

2. Nonmetallic Enclosures: Plastic.

3. Interior Panels: Steel; all sides finished with manufacturer's standard enamel.

M. Cabinets:

1. NEMA 250, Type 1 galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.

2. Hinged door in front cover with flush latch and concealed hinge.

3. Key latch to match panelboards.

4. Metal barriers to separate wiring of different systems and voltage.

5. Accessory feet where required for freestanding equipment.

6. Nonmetallic cabinets shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

PART 3 - EXECUTION

3.01 RACEWAY APPLICATION

A. Outdoors: Apply raceway products as specified below unless otherwise indicated:

1. Exposed Conduit: RSC or IMC.

2. Concealed Conduit, Aboveground: RSC or IMC.

3. Underground Conduit: RNC, Type EPC-40-PVC, concrete encased unless noted otherwise.

4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.

5. Boxes and Enclosures, Aboveground: NEMA 250, Type 3R.

B. Indoors: Apply raceway products as specified below unless otherwise indicated:
   1. Exposed, Not Subject to Physical Damage: EMT.
   2. Exposed and Subject to Physical Damage: RSC or IMC. Raceway locations include the following:
      a. Loading dock.
      b. Areas used for traffic of mechanized carts, forklifts, and pallet-handling units.
      c. Mechanical rooms.
      d. Ag Mechanic Shops.
      e. Gymnasiums.
      f. Exposed below 8'-0" a.f.f.
   3. Exposed and Subject to Pool Chemical Environment: RNC. Raceway locations include natatorium space, pool pump areas, chemical treatment room, etc.
   4. Concealed in Ceilings and Interior Walls and Partitions: EMT.
   5. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC, except use LFMC in damp or wet locations.
   6. Damp or Wet Locations: RSC or IMC.
   7. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4 stainless steel in institutional and commercial kitchens and damp or wet locations.

C. Minimum Raceway Size: 3/4-inch trade size.

D. Raceway Fittings: Compatible with raceways and suitable for use and location.
   1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings unless otherwise indicated. Comply with NEMA FB 2.10.
   2. PVC Externally Coated, Rigid Steel Conduits: Use only fittings listed for use with this type of conduit. Patch and seal all joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Use sealant recommended by fitting manufacturer and apply in thickness and number of coats recommended by manufacturer.
   3. EMT: Use mechanical set screw, steel fittings. Comply with NEMA FB 2.10.
   4. Flexible Conduit: Use only fittings listed for use with flexible conduit. Comply with NEMA FB 2.20.

E. Do not install aluminum conduits, boxes, or fittings in contact with concrete or earth.

F. Install surface raceways only where indicated on Drawings.

G. Do not install nonmetallic conduit where ambient temperature exceeds 120 deg F.

H. Do not install nonmetallic conduit in environmental air plenums.

I. Junction and Pull Boxes: Sheet steel boxes, unless otherwise indicated.
   1. Provide boxes no smaller than 4 inches square and 2-1/8 inches deep.
   2. Size all junction and pull boxes in accordance with the NFPA 70, unless project conditions dictate use of larger boxes.
   3. Boxes in Hazardous Areas: Cast metal boxes with appropriate sealing fittings.

J. Outlet and Device Boxes: Sheet steel boxes, unless otherwise indicated.
   1. For Lighting Fixture Outlets: 4 inch square with raised fixture ring.
   2. For Wall Switches, Receptacles, and Communication Use: 4 inch square, one-piece. Use boxes with plaster rings in all plastered walls where wall thickness permits. Use

boxes 1-1/2 inch deep only in locations where deep boxes cannot be accommodated by construction.

3. Boxes in Hazardous Areas: Cast metal boxes with appropriate sealing fittings.

K. Boxes Used Outdoors or in Damp/Wet Locations: Cast metal boxes with gasketed covers and threaded hubs.

3.02 INSTALLATION

A. Comply with NECA 1 and NECA 101 for installation requirements except where requirements on Drawings or in this article are stricter. Comply with NFPA 70 limitations for types of raceways allowed in specific occupancies and number of floors.

B. Keep raceways at least 6 inches away from parallel runs and 1 inch away from perpendicular runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.

C. Complete raceway installation before starting conductor installation.

D. Comply with requirements in Division 26 Section "Hangers and Supports for Electrical Systems" for hangers and supports.

E. Arrange stub-ups so curved portions of bends are not visible above finished slab.

1. Change from RNC to RSC or IMC before rising above the floor.

2. Protect conduit openings with plastic caps approved for this purpose.

F. Install no more than the equivalent of three 90-degree bends and a maximum of 150 feet between pull points in any conduit run except for control wiring conduits, for which fewer bends are allowed. Support within 12 inches of changes in direction.

G. Conceal conduit and EMT within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.

H. Support conduit within 12 inches of enclosures to which attached.

I. All exposed conduit shall be installed on strut system racks with runs parallel or perpendicular to walls, structural members or intersections of vertical planes and ceilings, with right angle turns consisting of cast metal fittings or symmetrical bends unless otherwise shown. All conduit shall have supports spaced not more than eight feet apart. Supports shall also be provided within 36” of all boxes, bends, and termination points. Where termination points are free standing, support shall be provided within 12”. Conduits randomly routed will not be accepted. Conduits shall be concealed in open structure (no finished ceiling) where possible and painted to match.

J. Level and square raceway runs, and install at proper elevations and required heights. Hold tight to structure wherever possible, to maximize available space and not restrict other trades. Do not attach or support from roof deck.

K. Raceways Embedded in Slabs: Only allowed when connecting to floor boxes embedded in concrete slab.

1. Run conduit larger than 1-inch trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support. Secure raceways to reinforcement at maximum 10-foot intervals.

2. Do not cross building expansion joints with embedded conduits.

3. Arrange raceways to keep a minimum of 1-inch of concrete cover in all directions.

4. Do not embed threadless fittings in concrete unless specifically approved by Architect for each specific location.

L. Stub-ups to Above Recessed Ceilings:

1. Use EMT, IMC, or RMC for raceways.

2. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.

M. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of raceway and fittings before making up joints. Follow compound manufacturer's written instructions.

N. Coat field-cut threads on PVC-coated raceway with a corrosion-preventing conductive compound prior to assembly.

O. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors including conductors smaller than No. 4 AWG.

P. EMT terminations at junction boxes, panelboards, etc. shall be made with case hardened locknuts and appropriate fittings, with insulated throat liners. Insulating terminations shall be manufactured as a single unit. The use of split sleeve insulators is not permitted.

Q. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install bushings on conduits up to 1-1/4-inch trade size and insulated throat metal bushings on 1-1/2-inch trade size and larger conduits terminated with locknuts. Install insulated throat metal grounding bushings on service conduits.

R. Install raceways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus 1/4 turn more.

S. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure to assure a continuous ground path.

T. Cut conduit perpendicular to the length. For conduits 2-inch trade size and larger, use roll cutter or a guide to make cut straight and perpendicular to the length.

U. 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. Cap underground raceways designated as spare above grade alongside raceways in use.

V. Surface Raceways:

1. Install surface raceway with a minimum 2-inch radius control at bend points.

2. Surface metal raceways and all components and fittings shall be furnished by a single manufacturer. All trim and cover fittings, flush feed boxes, splices, outlet fittings, etc. necessary for a complete installation shall be provided.

3. Secure surface raceway with screws or other anchor-type devices at intervals not exceeding 36 inches, or 6 inches from ends an don either side of a corner, and with no less than two supports per straight raceway section. Support surface raceway according to manufacturer's written instructions. Tape and glue are not acceptable support methods.

W. Exposed raceways installed in exterior locations shall receive one coat of primer, two coats finish paint after preparation of galvanizing, color selected by Architect. Exposed raceways in interior painted areas shall be similarly painted.

X. Install raceway sealing fittings at accessible locations according to NFPA 70 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 according to NFPA 70.

Y. Install devices to seal raceway interiors at accessible locations. Locate seals so no fittings or boxes are between the seal and the following changes of environments. Seal the interior of all raceways at the following points:

1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.

2. Where an underground service raceway enters a building or structure.

3. Where otherwise required by NFPA 70.

Z. Conduit shall be installed in such a manner so as to ensure against collection of trapped condensation. All runs of conduit shall be arranged so as to be devoid of traps. Trapped conduit runs shall be provided with explosion proof drains at low points. Runs of conduit between junctions shall not have more than the equivalent of three 90° bends.

AA. Comply with manufacturer's written instructions for solvent welding RNC and fittings.

BB. Expansion-Joint Fittings:

1. Install in each run of aboveground RNC that is located where environmental temperature change may exceed 30 deg F and that has straight-run length that exceeds 25 feet. Install in each run of aboveground RMC conduit that is located where environmental temperature change may exceed 100 deg F and that has straight-run length that exceeds 100 feet.

2. Install type and quantity of fittings that accommodate temperature change listed for each of the following locations:

a. Outdoor Locations Not Exposed to Direct Sunlight: 125 deg F temperature change.

b. Outdoor Locations Exposed to Direct Sunlight: 155 deg F temperature change.

c. Indoor Spaces Connected with Outdoors without Physical Separation: 125 deg F temperature change.

d. Attics: 135 deg F temperature change.

3. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per deg F of temperature change for PVC conduits. Install fitting(s) that provide expansion and contraction for at least 0.000078 inch per foot of length of straight run per deg F of temperature change for metal conduits.

4. Install expansion fittings at all locations where conduits cross building or structure expansion joints.

5. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement. Provide copper ground bonding jumper across expansion fitting.

CC. Flexible Conduit Connections: Comply with NEMA RV 3. Use a maximum of 72 inches of flexible conduit for recessed luminaires. Use a maximum of 36 inches of flexible conduit for equipment subject to vibration, noise transmission, or movement and for transformers and motors.

1. Use LFMC in damp or wet locations subject to severe physical damage.

2. Use LFMC or LFNC in damp or wet locations not subject to severe physical damage.

DD. Mount boxes at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements. Install boxes with height measured to bottom of box unless otherwise indicated.

EE. 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. Prepare block surfaces to provide a flat surface for a raintight connection between box and cover plate or supported equipment and box.

FF. Locate boxes so that cover or plate will not span different building finishes.

GG. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for the purpose.

HH. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel, unless intumescent putty pads are installed according to Division 07 Section "Firestopping."

II. Recessed Boxes in Fire-Rated Partitions: For boxes located on opposite sides of same partition do not install boxes back-to-back; separate boxes with a minimum of 24 inch separation, unless otherwise indicated in the installation requirements specified in Division 07 Section "Firestopping."

JJ. Recessed Boxes in partitions around Acoustically-Sensitive Spaces: For boxes located on opposite sides of same partition do not install boxes back-to-back; separate boxes with a minimum of 24 inch separation. Acoustically-Sensitive Spaces include, but are not limited to, the following:

1. Conference rooms, meeting rooms and similar spaces.
2. Classrooms, training rooms and similar spaces.
3. Interview rooms, consultation rooms and similar spaces.
4. Auditoriums, lecture rooms, and similar spaces.

KK. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.

LL. Set metal floor boxes level and flush with finished floor surface.

3.03 FIRESTOPPING

A. Install firestopping at penetrations of fire-rated floor and wall assemblies. Comply with requirements in Division 07 Section “Penetration Firestopping.”

3.04 PROTECTION

A. Protect coatings, finishes, and cabinets from damage and deterioration.

1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
2. Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.

3.05 CONNECTIONS

A. Ground raceways and boxes according to Division 26 Section "Grounding and Bonding for Electrical Systems."

3.06 IDENTIFICATION

A. Identify raceways and boxes as specified in Division 26 Section “Identification for Electrical Systems”.

3.07 SEGREGATION OF WIRING SYSTEMS

A. Segregation of wiring systems shall not be compromised by the use of common pullboxes, wireways, cabinets or any other type of enclosure.

B. The raceway system for each feeder shall be a separate system completely fault isolated from all other raceway systems.

C. The raceway system for the branch circuits of each panelboard shall be a separate system completely fault isolated from all other raceway systems.

D. In systems operating at more than 300 volts between phase conductors, and where different phase conductors are to be run to a common device or outlet box, provide code gauge barrier equal to box gauge between conductors so that two different phase wires will not be in the same compartment.

3.08 CLEANING

A. On completion of raceway installation but before any cable is installed, perform the following:

1. 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. On completion of box, enclosure, and cabinet installation but before any cable or wiring devices are installed, inspect interior of boxes and perform the following:

1. Vacuum dirt and debris; do not use compressed air to assist in cleaning.

END OF SECTION 26 0533

SECTION 26 0543

UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 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.
2. Handholes and boxes.
3. Manholes.

B. Related Sections include the following:

1. Division 26 Section "Raceways and Boxes for Electrical Systems" for raceways, fittings, boxes, enclosures, and cabinets for electrical wiring.

1.02 DEFINITION

A. Direct Buried: Duct or a duct bank that is buried in the ground, without any additional casing materials such as concrete.

B. Duct: An underground raceway. This term may be used interchangeably with the term raceway.

C. Duct Bank: Two or more raceways grouped together, irrespective of duct material or encasement material.

D. ENT: Electrical Non-Metallic Tubing

E. EPC: Electrical Polyvinyl Chloride (PVC) Conduit

F. RMC: Rigid metal conduit.

G. RNC: Rigid nonmetallic conduit.

H. RSC: Rigid Steel conduit.

I. Trafficways: Locations where vehicular or pedestrian traffic is a normal course of events.

1.03 ACTION SUBMITTALS

A. Submit product data and shop drawings in accordance with Division 01 and Division 26 Section “Electrical Shop Drawings and Submittals” for products specified under PART 2 - PRODUCTS.

B. Product Data: For the following:

1. Duct-bank materials, including separators and miscellaneous components.
2. Ducts and conduits and their accessories, including elbows, end bells, bends, fittings, and solvent cement.
3. Accessories for manholes, handholes, boxes.
4. Warning tape.

C. Shop Drawings for Precast or Factory-Fabricated Underground Utility Structures: Include dimensioned plans, elevations, sections, details, attachments to other work, and accessories, including the following:

1. Duct entry provisions, including locations and duct sizes.
2. Reinforcement details.
3. Frame and cover design and manhole frame support rings.
4. Ladder details.
5. Grounding details.
6. Dimensioned locations of cable rack inserts, pulling-in and lifting irons, and sumps.
7. Joint details.

D. Shop Drawings for Factory-Fabricated Handholes and Boxes Other Than Precast Concrete: Include dimensioned plans, sections, and elevations, and fabrication and installation details, including the following:

1. Duct entry provisions, including locations and duct sizes.
2. Cover design.
3. Grounding details.
4. Dimensioned locations of cable rack inserts and pulling-in and lifting irons.

1.04 INFORMATIONAL SUBMITTALS

A. Duct-Bank Coordination Drawings: Show duct profiles and coordination with other utilities and underground structures.

1. Include plans and sections, drawn to scale, and show bends and locations of expansion fittings.
2. Drawings shall be signed and sealed by a qualified professional engineer.

B. Product Certificates: For concrete and steel used in precast concrete manholes and handholes, as required by ASTM C 858.

C. Source quality-control test reports.

D. Field quality-control test reports.

1.05 QUALITY ASSURANCE

A. Comply with ANSI C2.

B. Comply with NFPA 70.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Deliver ducts to Project site with ends capped. Store nonmetallic ducts with supports to prevent bending, warping, and deforming.

B. Store precast concrete and other factory-fabricated underground utility structures at Project site as recommended by manufacturer to prevent physical damage. Arrange so identification markings are visible.

1.07 COORDINATION

A. Coordinate layout and installation of ducts, handholes, and boxes with final arrangement of other utilities, site grading, and surface features as determined in the field.

B. Coordinate elevations of ducts and duct-bank entrances into handholes, and boxes with final locations and profiles of ducts and duct banks as determined by coordination with other utilities, underground obstructions, and surface features. Revise locations and elevations from those indicated as required to suit field conditions and to ensure that duct runs drain to manholes and handholes, and as approved by Architect.

PART 2 - PRODUCTS

2.01 METAL CONDUITS

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

1. AFC Cable Systems, Inc.
2. Allied Tube & Conduit; a Tyco International Ltd. Co.
3. Anamet Electrical, Inc.
4. Calbond
5. Electri-Flex Company.
6. Orbit Industries, Inc.
7. O-Z/Gedney; a brand of EGS Electrical Group.

8. Picoma Industries, a subsidiary of Mueller Water Products, Inc.
9. Plasti-Bond
10. Republic Conduit.
11. Robroy Industries.
12. Sentinel Conduit.
13. Southwire Company.
14. Thomas & Betts Corporation.
15. Western Tube and Conduit Corporation.
16. Wheatland Tube Company; a division of John Maneely Company.

B. RSC: Rigid Steel Conduit, Galvanized. Comply with ANSI C80.1.

C. PVC-Coated, Steel Conduit: PVC-coated rigid steel conduit.
1. Comply with NEMA RN 1.
2. Coating Thickness: 0.040 inch, minimum.

2.02 NONMETALLIC DUCTS AND DUCT ACCESSORIES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. ARNCO Corp.
2. Beck Manufacturing.
3. Cantex, Inc.
4. CertainTeed Corp.; Pipe & Plastics Group.
5. Condux International, Inc.
6. ElecSys, Inc.
7. Electri-Flex Company.
8. IPEX Inc.
9. Lamson & Sessions; Carlon Electrical Products.
10. Manhattan/CDT; a division of Cable Design Technologies.
11. Spiraduct/AFC Cable Systems, Inc.

B. RNC: NEMA TC 2, Type EPC-40-PVC and Type EPC-80-PVC, UL 651, with matching fittings by same manufacturer as the conduit, complying with NEMA TC 3 and UL 514B.

C. Underground Plastic Utilities Duct: Type EPC-40-PVC and Type EPC-80-PVC RNC, complying with NEMA TC 2 and UL 651, with matching fittings complying with NEMA TC 3 and UL 514B by same manufacturer as duct.

D. 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 Division 26 Section "Identification for Electrical Systems."

2.03 PRECAST CONCRETE HANDHOLES AND BOXES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Carder Concrete Products.
2. Christy Concrete Products.
3. Elmhurst-Chicago Stone Co.

4. Oldcastle Precast Group.
5. Riverton Concrete Products; a division of Cretex Companies, Inc.
6. Utility Concrete Products, LLC.
7. Utility Vault Co.
8. Wausau Tile, Inc.

B. Comply with ASTM C 858 for design and manufacturing processes.

C. Description: Factory-fabricated, reinforced-concrete, monolithically poured walls and bottom unless open-bottom enclosures are indicated. Frame and cover shall form top of enclosure and shall have load rating consistent with that of handhole or box.

1. Frame and Cover: Weatherproof steel frame, with hinged steel access door assembly with tamper-resistant, captive, cover-securing bolts.
   a. Cover Hinges: Concealed, with hold-open ratchet assembly.
   b. Cover Handle: Recessed.
2. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
3. Cover Legend: Molded lettering, as indicated for each service.
4. Configuration: Units shall be designed for flush burial and have integral closed bottom, unless otherwise indicated.
5. Extensions and Slabs: Designed to mate with bottom of enclosure. Same material as enclosure.
   a. Extension shall provide increased depth of 12 inches.
   b. Slab: Same dimensions as bottom of enclosure and arranged to provide closure.
6. Duct Entrances in Handhole Walls: Cast end-bell or duct-terminating fitting in wall for each entering duct.
   a. Type and size shall match fittings to duct or conduit to be terminated.
   b. Fittings shall align with elevations of approaching ducts and be located near interior corners of handholes to facilitate racking of cable.
7. Handholes 12 inches wide by 24 inches long and larger shall have inserts for cable racks and pulling-in irons installed before concrete is poured.

2.04 HANDHOLES AND BOXES OTHER THAN PRECAST CONCRETE

A. Description: Comply with SCTE 77.

1. Color: Gray.
2. Configuration: Units shall be designed for flush burial and have integral closed bottom, unless otherwise indicated.
3. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure.
4. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
5. Cover Legend: Molded lettering, "ELECTRIC," "TELEPHONE," or as indicated for each service.
6. Direct-Buried Wiring Entrance Provisions: Knockouts equipped with insulated bushings or end-bell fittings, selected to suit box material, sized for wiring indicated, and arranged for secure, fixed installation in enclosure wall.
7. Duct Entrance Provisions: Duct-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.
8. Handholes 12 inches wide by 24 inches long and larger shall have factory-installed inserts for cable racks and pulling-in irons.

B. Polymer Concrete Handholes and Boxes with Polymer Concrete Cover: Molded of sand and aggregate, bound together with a polymer resin, and reinforced with steel or fiberglass or a combination of the two.

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

a. Armorcast Products Company.

b. Carson Industries LLC.

c. CDR Systems Corporation.

d. NewBasis.

C. Fiberglass Handholes and Boxes with Polymer Concrete Frame and Cover: Sheet-molded, fiberglass-reinforced, polyester resin enclosure joined to polymer concrete top ring or frame.

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

a. Armorcast Products Company.

b. Carson Industries LLC.

c. Christy Concrete Products.

d. Synertech Moulded Products, Inc.; a division of Oldcastle Precast.

2.05 PRECAST MANHOLES

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

1. Carder Concrete Products.

2. Christy Concrete Products.

3. Elmhurst-Chicago Stone Co.

4. Oldcastle Precast Group.

5. Riverton Concrete Products; a division of Cretex Companies, Inc.

6. Utility Concrete Products, LLC.

7. Utility Vault Co.

8. Wausau Tile, Inc.

B. Comply with ASTM C 858 and with interlocking mating sections, complete with accessories, hardware, and features.

1. Windows: Precast openings in walls, arranged to match dimensions and elevations of approaching ducts and duct banks plus an additional 12 inches vertically and horizontally to accommodate alignment variations.

a. Windows shall be located no less than 6 inches from interior surfaces of walls, floors, or roofs of manholes, but close enough to corners to facilitate racking of cables on walls.

b. Window opening shall have cast-in-place, welded wire fabric reinforcement for field cutting and bending to tie in to concrete envelopes of duct banks.

c. Window openings shall be framed with at least two additional No. 4 steel reinforcing bars in concrete around each opening.

C. Concrete Knockout Panels: 1-1/2 to 2 inches thick, for future conduit entrance and sleeve for ground rod.

D. Joint Sealant: Asphaltic-butyl material with adhesion, cohesion, flexibility, and durability properties necessary to withstand maximum hydrostatic pressures at the installation location with the ground-water level at grade.

2.06 UTILITY STRUCTURE ACCESSORIES

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

1. Bilco Company (The).
2. Campbell Foundry Company.
3. Carder Concrete Products.
4. Christy Concrete Products.
5. East Jordan Iron Works, Inc.
6. Elmhurst-Chicago Stone Co.
7. McKinley Iron Works, Inc.
8. Neenah Foundry Company.
9. NewBasis.
10. Oldcastle Precast Group.
11. Osburn Associates, Inc.
12. Pennsylvania Insert Corporation.
13. Riverton Concrete Products; a division of Cretex Companies, Inc..
14. Strongwell Corporation; Lenoir City Division.
15. Underground Devices, Inc.
16. Utility Concrete Products, LLC.
17. Utility Vault Co.
18. Wausau Tile, Inc.

B. Manhole Frames, Covers, and Chimney Components: Comply with structural design loading specified for manhole.

1. Frame and Cover: Weatherproof, gray cast iron complying with ASTM A 48/A 48M, Class 30B with milled cover-to-frame bearing surfaces; diameter, 26 inches.
    a. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
    b. Special Covers: Recess in face of cover designed to accept finish material in paved areas.
2. Cover Legend: Cast in. Selected to suit system.
    a. Legend: "ELECTRIC-LV" for duct systems with power wires and cables for systems operating at 600 V and less.
    b. Legend: "ELECTRIC-HV" for duct systems with medium-voltage cables.
    c. Legend: "SIGNAL" for communications, data, and telephone duct systems.
3. Manhole Chimney Components: Precast concrete rings with dimensions matched to those of roof opening.
    a. Mortar for Chimney Ring and Frame and Cover Joints: Comply with ASTM C 270, Type M, except for quantities less than 2.0 cu. ft. where packaged mix complying with ASTM C 387, Type M, may be used.

C. Manhole Sump Frame and Grate: ASTM A 48/A 48M, Class 30B, gray cast iron.

D. Pulling Eyes in Concrete Walls: Eyebolt with reinforcing-bar fastening insert, 2-inch- diameter eye, and 1-by-4-inch bolt.

1. Working Load Embedded in 6-Inch, 4000-psi Concrete: 13,000-lbf minimum tension.

E. Pulling Eyes in Nonconcrete Walls: Eyebolt with reinforced fastening, 1-1/4-inch- diameter eye, rated 2500-lbf minimum tension.

F. Pulling-In and Lifting Irons in Concrete Floors: 7/8-inch- diameter, hot-dip galvanized, bent steel rod; stress relieved after forming; and fastened to reinforcing rod. Exposed triangular opening.

1. Ultimate Yield Strength: 40,000-lbf shear and 60,000-lbf tension.

G. Bolting Inserts for Concrete Utility Structure Cable Racks and Other Attachments: Flared, threaded inserts of noncorrosive, chemical-resistant, nonconductive thermoplastic material; 1/2-inch ID by 2-3/4 inches deep, flared to 1-1/4 inches minimum at base.

1. Tested Ultimate Pullout Strength: 12,000 lbf minimum.

H. Expansion Anchors for Installation after Concrete Is Cast: Zinc-plated, carbon-steel-wedge type with stainless-steel expander clip with 1/2-inch bolt, 5300-lbf rated pullout strength, and minimum 6800-lbf rated shear strength.

I. Cable Rack Assembly: Steel, hot-dip galvanized, except insulators.

1. Stanchions: T-section or channel; 2-1/4-inch nominal size; punched with 14 holes on 1-1/2-inch centers for cable-arm attachment.

2. Arms: 1-1/2 inches wide, lengths ranging from 3 inches with 450-lb minimum capacity to 18 inches with 250-lb minimum capacity. Arms shall have slots along full length for cable ties and be arranged for secure mounting in horizontal position at any vertical location on stanchions.

3. Insulators: High-glaze, wet-process porcelain arranged for mounting on cable arms.

J. Duct-Sealing Compound: Nonhardening, safe for contact with human skin, not deleterious to cable insulation, and workable at temperatures as low as 35 deg F. Capable of withstanding temperature of 300 deg F without slump and adhering to clean surfaces of plastic ducts, metallic conduits, conduit coatings, concrete, masonry, lead, cable sheaths, cable jackets, insulation materials, and common metals.

K. Fixed Manhole Ladders: Arranged for attachment to roof or wall and floor of manhole. Ladder and mounting brackets and braces shall be fabricated from nonconductive, structural-grade, fiberglass-reinforced resin.

L. Cover Hooks: Heavy duty, designed for lifts 60 lbf and greater. Two (2) required.

2.07 SOURCE QUALITY CONTROL

A. Test and inspect precast concrete utility structures according to ASTM C 1037.

B. Nonconcrete Handhole and Pull-Box Prototype Test: Test prototypes of manholes and boxes for compliance with SCTE 77. Strength tests shall be for specified tier ratings of products supplied.

1. Tests of materials shall be performed by a independent testing agency.

2. Strength tests of complete boxes and covers shall be by either an independent testing agency or the manufacturer. A qualified registered professional engineer shall certify tests by manufacturer.

3. Testing machine pressure gages shall have current calibration certification complying with ISO 9000 and ISO 10012, and traceable to NIST standards.

PART 3 - EXECUTION

3.01 PREPARATION

A. Coordinate layout and installation of duct, duct bank, manholes, handholes, and boxes with final arrangement of other utilities, site grading, and surface features as determined in the field. Notify Architect if there is a conflict between areas of excavation and existing structures or archaeological sites to remain.

B. Coordinate elevations of duct and duct-bank entrances into manholes, handholes, and boxes with final locations and profiles of duct and duct banks, as determined by coordination with other utilities, underground obstructions, and surface features. Revise locations and elevations as required to suit field conditions and to ensure that duct and duct bank will drain to manholes and handholes, and as approved by Architect.

C. Remove and stockpile topsoil for reapplication according to Division 31 Section "Site Clearing."

3.02 UNDERGROUND DUCT APPLICATION

A. Ducts for Electrical Cables Over 600 V: RNC, NEMA Type EPC-40-PVC, in concrete-encased duct bank, unless otherwise indicated.

B. Ducts for Electrical Feeders 600 V and Less: RNC**,** NEMA Type EPC-40-PVC, in concrete-encased duct bank, unless otherwise indicated.

C. Ducts for Electrical Branch Circuits: RNC, NEMA Type EPC-40-PVC, in direct-buried duct bank, unless otherwise indicated.

D. Underground Ducts for Telephone, Communications, or Data Utility Service Cables: RNC, NEMA Type EPC-40-PVC, installed in direct-buried duct bank, unless otherwise indicated.

E. Underground Ducts for Telephone, Communications, or Data Circuits: RNC, NEMA Type EPC-40-PVC, in direct-buried duct bank, unless otherwise indicated.

F. Underground Ducts Crossing Paved Paths, Walks, Driveways, and Roadways: RNC, NEMA Type EPC-40-PVC, encased in reinforced concrete.

3.03 UNDERGROUND ENCLOSURE APPLICATION

A. Handholes and Boxes for 600 V and Less, Including Telephone, Communications, and Data Wiring:

1. Units in Roadways and Other Deliberate Traffic Paths: Precast concrete. AASHTO HB 17, H-10 structural load rating.
2. Units in Driveway, Parking Lot, and Off-Roadway Locations, Subject to Occasional, Nondeliberate Loading by Heavy Vehicles: Precast concrete, AASHTO HB 17, H-20 structural load rating.
3. Units in Sidewalk and Similar Applications with a Safety Factor for Nondeliberate Loading by Vehicles: Polymer concrete units, SCTE 77, Tier 8 structural load rating.
4. Units Subject to Light-Duty Pedestrian Traffic Only: Fiberglass-reinforced polyester resin, structurally tested according to SCTE 77 with 3000-lbf vertical loading.

B. Manholes: Precast concrete.

1. Units Located in Roadways and Other Deliberate Traffic Paths by Heavy or Medium Vehicles: H-20 structural load rating according to AASHTO HB 17.
2. Units Not Located in Deliberate Traffic Paths by Heavy or Medium Vehicles: H-10 load rating according to AASHTO HB 17.

3.04 EARTHWORK

A. Excavation and Backfill: Comply with Division 31 Section "Earth Moving," but do not use heavy-duty, hydraulic-operated, compaction equipment.

1. Beyond building perimeter, provide bentonite “trench plug” that extends at least 5 feet out from the face of the building’s exterior.

B. Restore surface features at areas disturbed by excavation and reestablish original grades, unless otherwise indicated. Replace removed sod immediately after backfilling is completed.

3.05 DUCT INSTALLATION

A. 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 to drain in both directions.

B. Depths of bury shall be:

1. 42” minimum to top of primary ducts
2. 36” minimum to top of secondary ducts
3. 36” minimum to top of branch exterior circuits

4. 36” minimum to top of telephone/communications ducts

C. Curves and Bends: Use 5-degree angle couplings for small changes in direction. Use manufactured long sweep bends with a minimum radius of 48 inches, both horizontally and vertically, at other locations, unless otherwise indicated.

D. 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.

E. Duct Entrances to Concrete and Polymer Concrete 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. Direct-Buried Duct Banks: Install an expansion and deflection fitting in each conduit in the area of disturbed earth adjacent to manhole or handhole.

3. Grout end bells into structure walls from both sides to provide watertight entrances.

F. Building Wall Penetrations: Make a transition from underground duct to rigid steel conduit at least 10 feet outside the building wall without reducing duct line slope away from the building, and without forming a trap in the line. Use fittings manufactured for duct-to-conduit transition.

G. 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 hydrostatic pressure.

H. Pulling Cord: Install 100-lbf test nylon cord in ducts, including spares.

I. Concrete-Encased Ducts: Support ducts on duct separators coordinated with duct size, duct spacing, and outdoor temperature.

1. Excavate trench bottom to provide firm and uniform support for duct. Prepare trench bottoms as specified in Division 31 Section “Earth Moving” for pipes less than 6 inches in nominal diameter.

2. Separator Installation: Space separators close enough to prevent sagging and deforming of ducts, with not less than 4 spacers per 20 feet of duct. Place separators within 24 inches of duct ends. 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. Concrete: All concrete used in duct bank construction shall be 3000 PSI minimum 28-day compressive strength unless otherwise noted in accord with latest ACI standards complying with Division 03 Section "Cast-in-Place Concrete." Testing of concrete shall be the responsibility of the Contractor.

4. Concreting Pouring Sequence: Pour each run of envelope between manholes 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.

5. 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.

6. Concrete Cover: Install a minimum of 3 inches of concrete cover between edge of duct to exterior envelope wall.
7. Concrete Reinforcement: Reinforce concrete-encased duct banks where they cross disturbed earth and where indicated. Arrange reinforcing rods and ties without forming conductive or magnetic loops around ducts or duct groups.
8. 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.
9. Install backfill as specified in Division 31 Section "Earth Moving."
    a. Backfill shall be accomplished with clean debris free earth and tamped at 12-inch intervals so as to avoid earth sinks along the trench.
    b. Backfill trenches only after conduit has been inspected by Agencies, Engineer and Owner, tested, and locations of lines have been recorded on Record Drawings. Provide at least one week's written notification to all parties of impending work that needs to be reviewed.
    c. Backfill below paved areas shall be brought to proper grade to receive the sub-base and paving. No paving shall be placed on uncompacted fill.
    d. Backfill below sodded or seeded areas shall be brought to within six inches of finished grade. The remaining six inches shall be backfilled with clean soil.
    e. Concrete for concrete encasement shall cure a minimum of 3 days prior to backfill.
10. Minimum Space between Ducts: 3 inches between ducts and exterior envelope wall, 2 inches between ducts for like services, and 4 inches between power and signal ducts.
11. Stub-Ups: Use manufactured PVC-coated rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through the floor.
    a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches of concrete.
    b. Stub-Ups to Equipment: For equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of 60 inches from edge of base. Install insulated grounding bushings on terminations at equipment.
12. Detectable Warning Tape: Bury detectable warning tape approximately 18 inches above all concrete-encased ducts and duct banks. 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 18 inches. Space additional tapes 12 inches apart, horizontally.

J. Direct-Buried Duct Banks:

1. Support ducts on duct separators coordinated with duct size, duct spacing, and outdoor temperature.
2. Space separators close enough to prevent sagging and deforming of ducts, with not less than 4 spacers per 20 feet of duct. Place spacers within 24 inches of duct ends. 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 duct bank. Prepare trench bottoms as specified in Division 31 Section "Earth Moving" for pipes less than 6 inches in nominal diameter.
4. Install backfill as specified in Division 31 Section "Earth Moving."
    a. Backfill shall be accomplished with clean debris free earth and tamped at 12-inch intervals so as to avoid earth sinks along the trench.

b. Backfill trenches only after conduit has been inspected by Agencies, Engineer and Owner, tested, and locations of lines have been recorded on Record Drawings. Provide at least one week's written notification to all parties of impending work that needs to be reviewed.

c. Backfill below paved areas shall be brought to proper grade to receive the sub-base and paving. No paving shall be placed on uncompacted fill.

d. Backfill below sodded or seeded areas shall be brought to within six inches of finished grade. The remaining six inches shall be backfilled with clean soil.

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 as specified in Division 31 Section "Earth Moving."

6. Install ducts with a minimum of 3 inches between ducts for like services and 6 inches between power and signal ducts.

7. Width: Excavate trench 3 inches wider than duct on each side.

8. Set elevation of bottom of duct bank below the frost line.

9. Stub-Ups: Install manufactured PVC-coated rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through the floor.

a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches of concrete for a minimum of 12 inches on each side of the coupling.

b. For stub-ups at equipment mounted on outdoor concrete bases and where conduits penetrate building foundations, extend steel conduit horizontally a minimum of 60 inches from edge of equipment base or foundation. Install insulated grounding bushings on terminations at equipment.

10. Detectable Warning Tape: Bury detectable warning tape approximately 18 inches above all direct bury duct banks. 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 18 inches. Space additional tapes 12 inches apart, horizontally.

3.06 INSTALLATION OF CONCRETE MANHOLES, HANDHOLES, AND BOXES

A. Precast Concrete Handhole and Manhole Installation:

1. Comply with ASTM C 891, unless otherwise indicated.

2. Install units level and plumb and with orientation and depth coordinated with connecting ducts to minimize bends and deflections required for proper entrances.

3. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.

B. Elevations:

1. Manhole Roof: Install with rooftop at least 15 inches below finished grade.

2. Manhole Frame: In paved areas and trafficways, set frames flush with finished grade. Set other manhole frames 1 inch above finished grade.

3. Install handholes with bottom below the frost line.

4. Handhole Covers: In paved areas and trafficways, set surface flush with finished grade. Set covers of other handholes 1 inch above finished grade.

5. Where indicated, cast handhole cover frame integrally with handhole structure.

C. Drainage: Install drains in bottom of manholes where indicated. Coordinate with drainage provisions indicated.

D. Manhole Access: Circular opening in manhole roof; sized to match cover size.

1. Manholes with Fixed Ladders: Offset access opening from manhole centerlines to align with ladder.

2. Install chimney, constructed of precast concrete collars and rings to support frame and cover and to connect cover with manhole roof opening. Provide moisture-tight masonry joints and waterproof grouting for cast-iron frame to chimney.

E. Hardware: Install removable hardware, including pulling eyes, cable stanchions, and cable arms,as required for installation and support of cables and conductors and as indicated.

F. Fixed Manhole Ladders: Arrange to provide for safe entry with maximum clearance from cables and other items in manholes.

G. Field-Installed Bolting Anchors in Manholes and Concrete Handholes: Do not drill deeper than 3-7/8 inches for manholes and 2 inches for handholes, for anchor bolts installed in the field. Use a minimum of two anchors for each cable stanchion.

H. Warning Sign: Install "Confined Space Hazard" warning sign on the inside surface of each manhole cover.

3.07 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 units on a level bed of crushed stone or gravel, graded from 1/2-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.

C. Elevation: In paved areas and trafficways, set so cover surface will be flush with finished grade. Set covers of other handholes 1 inch above finished grade.

D. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Select arm lengths to be long enough to provide spare space for future cables, but short enough to preserve adequate working clearances in the enclosure.

E. 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.

F. For enclosures installed in asphalt paving and subject to occasional, nondeliberate, heavy-vehicle loading, form and pour a concrete ring encircling, and in contact with, enclosure and with top surface screeded to top of box cover frame. Bottom of ring shall rest on compacted earth.

1. Concrete: 3000 psi, 28-day strength, complying with Division 03 Section "Cast-in-Place Concrete," with a troweled finish.

2. Dimensions: 10 inches wide by 12 inches deep.

3.08 GROUNDING

A. Ground underground ducts and utility structures according to Division 26 Section "Grounding and Bonding for Electrical Systems."

3.09 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 and utility structures.

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.

3. Test handhole grounding to ensure electrical continuity of grounding and bonding connections. Measure and report ground resistance as specified in Division 26 Section "Grounding and Bonding for Electrical Systems."

B. Correct deficiencies and retest as specified above to demonstrate compliance.

3.10 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, including sump. Remove foreign material.

END OF SECTION 26 0543

SECTION 26 0553
IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Identification for raceways.
   2. Identification of power and control cables.
   3. Identification for conductors.
   4. Underground-line warning tape.
   5. Warning labels and signs.
   6. Instruction signs.
   7. Equipment identification labels.
   8. Miscellaneous identification products.

B. Related Sections include the following:
   1. Division 26 Section "Wiring Devices" for wall plates and wiring device identification requirements.

1.02 ACTION SUBMITTALS

A. Submit product data and shop drawings in accordance with Division 01 and Division 26 Section “Electrical Shop Drawings and Submittals” for products specified under PART 2 - PRODUCTS.

B. Product Data: For each electrical identification product indicated.

C. Samples: For each type of label and sign to illustrate size, colors, lettering style, mounting provisions, and graphic features of identification products.

D. Identification Schedule: An index of nomenclature of electrical equipment and system components used in identification signs and labels.

1.03 QUALITY ASSURANCE

A. Comply with ANSI A13.1.

B. Comply with NFPA 70.

C. Comply with 29 CFR 1910.144 and 29 CFR 1910.145.

D. Comply with ANSI Z535.4 for safety signs and labels.

E. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.

1.04 COORDINATION

A. Coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, 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

2.01 CONDUCTOR 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. Self-Adhesive Wraparound Labels: Write-on, 3-mil-thick, vinyl flexible label with acrylic pressure-sensitive adhesive.

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. Brady Corporation.

b. Gardner.

c. T&B.

2. Self-Lamination: Clear; UV-, weather- and chemical-resistant; self-laminating, protective shield over the legend. Labels sized such that the clear shield overlaps the entire printed legend.

3. Marker for Labels: Machine-printed, permanent, waterproof, black ink recommended by printer manufacturer.

2.02 FLOOR MARKING TAPE

A. 2-inch- wide, 5-mil pressure-sensitive vinyl tape, with black and white stripes and clear vinyl overlay.

2.03 UNDERGROUND-LINE WARNING TAPE

A. Tape:

1. Recommended by manufacturer for the method of installation and suitable to identify and locate underground electrical utility lines.

2. Printing on tape shall be permanent and shall not be damaged by burial operations.

3. Tape material and ink shall be chemically inert, and not subject to degrading when exposed to acids, alkalis, and other destructive substances commonly found in soils.

4. Tape to be minimum 6 mil thick and 6-inches wide with aluminum backing to be detectable underground using a non-ferrous locator.

B. Color and Printing:

1. Comply with ANSI Z535.1 through ANSI Z535.5.

2. Inscriptions for Red-Colored Tapes: ELECTRIC LINE, HIGH VOLTAGE,.

3. Inscriptions for Orange-Colored Tapes: TELEPHONE CABLE, CATV CABLE, COMMUNICATIONS CABLE, OPTICAL FIBER CABLE.

2.04 WARNING LABELS AND SIGNS

A. Comply with NFPA 70 and 29 CFR 1910.145.

B. Self-Adhesive Warning Labels: Factory-printed, multicolor, pressure-sensitive adhesive labels, configured for display on front cover, door, or other access to equipment unless otherwise indicated.

C. Warning label shall include, but are not limited to, the following legends:

1. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."

2. Workspace Clearance Warning: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR ## INCHES." Verify work space required for specific project conditions with NFPA 70 and replace “##” in previous sentence with appropriate distance.

3. Arc Flash Warning and Instruction: “WARNING – ARC FLASH AND SHOCK HAZARD. WEAR APPROPRIATE PPE.” Determine appropriate protective clothing and personal protective equipment (PPE) for the task from NFPA 70E.

2.05 EQUIPMENT IDENTIFICATION LABELS

A. Engraved, Laminated Acrylic or Melamine Label: Punched or drilled for screw mounting. White letters on a dark-gray background. Minimum letter height shall be 3/8 inch.

1. Power Circuits:

a. Normal: White lettering on Black background.

b. Emergency Systems (Life Safety) and Legally Required Standby: White lettering on Red background.

c. Optional Standby: White lettering on Red background.

2.06 CABLE TIES

A. General-Purpose Cable Ties: Fungus inert, self extinguishing, one piece, self locking, Type 6/6 nylon.

1. Minimum Width: 3/16 inch.
2. Tensile Strength at 73 deg F, According to ASTM D 638: 12,000 psi.
3. Temperature Range: Minus 40 to plus 185 deg F.
4. Color: Black except where used for color-coding.

B. UV-Stabilized Cable Ties: Fungus inert, designed for continuous exposure to exterior sunlight, self extinguishing, one piece, self locking, Type 6/6 nylon.

1. Minimum Width: 3/16 inch.
2. Tensile Strength at 73 deg F, According to ASTM D 638: 12,000 psi.
3. Temperature Range: Minus 40 to plus 185 deg F.
4. Color: Black.

C. Plenum-Rated Cable Ties: Self extinguishing, UV stabilized, one piece, self locking.

1. Minimum Width: 3/16 inch.
2. Tensile Strength at 73 deg F, According to ASTM D 638: 7000 psi.
3. UL 94 Flame Rating: 94V-0.
4. Temperature Range: Minus 50 to plus 284 deg F.
5. Color: Black.

2.07 MISCELLANEOUS IDENTIFICATION PRODUCTS

A. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Verify identity of each item before installing identification products.

B. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.

C. Apply identification devices to surfaces that require finish after completing finish work.

D. Self-Adhesive Identification Products: Clean surfaces before application, using materials and methods recommended by manufacturer of identification device.

E. Conductor Color-Coding Key: Install Instructional Label denoting the conductor color-coding scheme on all panelboards, distribution boards, switchboards, switchgear, motor-control center and similar equipment.

F. All conductors shall be identified by color code and by means of labels placed on conductors in junction boxes and at terminal points with labels indicating source, circuit No. or terminal No.

G. Conductor Color-Coding for Identification, 600 V and Less: Use the colors listed below for ungrounded service, feeder, and branch-circuit conductors.

1. Color shall be factory applied to conductors or for sizes larger than No. 8 AWG, if authorities having jurisdiction permit, field applied.
2. Colors for Grounding Conductors:
    a. Equipment Grounding Conductor: Green.
3. Colors for 208/120-V Wye Systems:
    a. Phase A: Black.
    b. Phase B: Red.
    c. Phase C: Blue.
    d. Grounded Conductor (Neutral): White
4. Colors for 480/277-V Wye Systems:
    a. Phase A: Brown.
    b. Phase B: Purple.
    c. Phase C: Yellow.
    d. Grounded Conductor (Neutral): Gray
5. Control Wiring: Red, or as indicated.
6. D.C. Wiring:
    a. Positive: Light Blue
    b. Negative: Dark Blue
7. 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.

H. Cable Ties: For attaching tags. Use general-purpose type, except as listed below:

1. Outdoors: UV-stabilized nylon.
2. In Spaces Handling Environmental Air: Plenum rated.

I. Underground-Line Warning Tape: During backfilling of trenches install continuous detectable underground-line warning tape approximately 18 inches above all concrete-encased ducts and direct bury duct banks. 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 18 inches. Space additional tapes 12 inches apart, horizontally.

3.02 IDENTIFICATION SCHEDULE

A. Concealed Raceways, Duct Banks, More Than 600 V, within Buildings: Tape and stencil 4-inch- wide black stripes on 10-inch centers over orange background that extends full length of raceway or duct and is 12 inches wide. Stencil legend "DANGER CONCEALED HIGH VOLTAGE WIRING" with 3-inch- high black letters on 20-inch centers. Stop stripes at legends. Apply to the following finished surfaces:

1. Floor surface directly above conduits running beneath and within 12 inches of a floor that is in contact with earth or is framed above unexcavated space.
2. Wall surfaces directly external to raceways concealed within wall.
3. Accessible surfaces of concrete envelope around raceways in vertical shafts, exposed in the building, or concealed above suspended ceilings.

B. Accessible Raceways and Cables within Buildings: Identify the covers of each junction and pull box of the following systems with self-adhesive vinyl labels with the wiring system legend and system voltage. System legends shall be as follows:

1. Emergency Power.
2. Power.

C. Conductors to Be Extended in the Future: Attach write-on tags to conductors and list source.

D. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, and signal connections.

1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.
2. Use system of marker tape designations that is uniform and consistent with system used by manufacturer for factory-installed connections.
3. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual.

E. Locations of Underground Lines: Identify with underground-line warning tape for power, lighting, communication, and control wiring and optical fiber cable.

1. Install underground-line warning tape for both direct-buried cables and cables in raceway.

F. Workspace Indication: Install floor marking tape to show working clearances in the direction of access to live parts. Workspace shall be as required by NFPA 70 and 29 CFR 1926.403 unless otherwise indicated. Do not install at flush-mounted panelboards and similar equipment in finished spaces.

G. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Self-adhesive warning labels.

1. Comply with 29 CFR 1910.145.
2. Identify system voltage with black letters on an orange background.
3. Apply to exterior of door, cover, or other access.
4. For equipment with multiple power or control sources, apply to door or cover of equipment including, but not limited to, the following:
    a. Power transfer switches.
    b. Main-Tie-Main Switchboards.
    c. Controls with external control power connections.
5. For equipment requiring workspace clearance according to NFPA 70, apply to door or cover of equipment but not on flush panelboards and similar equipment in finished spaces.
6. Arc Flash Warning Labels: Apply label to door or cover at all access point of equipment including, but not limited to, the following:
    a. Disconnect switches.
    b. Electrical switchgear and switchboards.
    c. Emergency system boxes and enclosures.
    d. Enclosed circuit breakers.
    e. Meter Sockets and assemblies.
    f. Motor starters.
    g. Panelboards.
    h. Power transfer equipment (ATS).
    i. Transformers.
7. Available Fault Current Field Marking: Apply label to cover of existing and new service equipment enclosure with the date in which the fault current was calculated and the available fault current as determined by the OCPD coordination study. Table 1 below lists a typical example of label format, coordinate project specific requirements with Drawings.

Table 1 (Example Only)

MAX. AVAILABLE FAULT: XX,XXXA DATE: X/X/XX

H. Junction Boxes and Pull Boxes: Identify voltage, source, and circuit number(s) on cover of pull and junction boxes with hand-written legible block lettering using black permanent marking pen.

I. Instruction Signs:

1. Operating Instruction Signs: Install instruction signs to facilitate proper operation and maintenance of electrical systems and items to which they connect. Install instruction signs with approved legend where instructions are needed for system or equipment operation.

2. Emergency Operating Instruction Signs: Install instruction signs with white legend on a red background with minimum 3/8-inch-high letters for emergency instructions at equipment used for power transfer and kirk key controlled breakers.

J. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and the 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: Engraved, laminated acrylic or melamine label. Unless otherwise indicated, provide a single line of text with 1/2-inch- high letters on 1-1/2-inch- high label; where two lines of text or more are required, use label height as required to accommodate 3/8-inch-high letters.

b. Outdoor Equipment: Engraved, laminated acrylic or melamine label.

c. Elevated Components: Increase sizes of labels and letters to those appropriate for viewing from the floor.

d. Unless provided with self-adhesive means of attachment, fasten labels with appropriate mechanical fasteners that do not change the NEMA or NRTL rating of the enclosure.

2. Equipment to Be Labeled:

a. Panelboards: Typewritten directory of circuits in the location provided by panelboard manufacturer. Panelboard identification shall be self-adhesive, engraved, laminated acrylic or melamine label.

b. Enclosures and electrical cabinets.

c. Access doors and panels for concealed electrical items.

d. Switchboards.

e. Transformers: Label that includes tag designation shown on Drawings for the transformer, feeder, and panelboards or equipment supplied by the secondary.

f. Transfer switches.

g. Emergency system boxes and enclosures.

h. Enclosed switches.

i. Enclosed circuit breakers.

j. Enclosed controllers.

k. Variable-speed drives.

l. Push-button stations.

m. Power transfer equipment.

n. Contactors.

o. Remote-controlled switches, dimmer modules, and control devices.

p. Power-generating units.

q. Monitoring and control equipment.

3. Provide identification for each feeder overcurrent protective device in each switchgear, switchboard, distribution panelboard, motor control center, and any other similar equipment furnished under this Division, identification as to the specific load that it serves.

4. Provide brass phase rotation tags for each 3-phase motor securely attached to the equipment.

END OF SECTION 26 0553

SECTION 26 0573

OVERCURRENT PROTECTIVE DEVICE STUDIES

PART 1 - GENERAL

1.01 SUMMARY

A. This Section includes requirements for computer-based, fault-current and overcurrent protective device coordination studies. Protective devices shall be set based on Engineer's review of submitted results of the protective device coordination study.

1. Coordination of series-rated devices is not permitted.
2. Delegated Design Requirements for Arc Flash Hazard Analysis.

1.02 PERFORMANCE REQUIREMENTS

A. Overcurrent Protective Device Coordination for Emergency Systems and Legally Required Standby Systems: All overcurrent protective devices proposed for inclusion in the Work on the Emergency Systems branch (NEC Article 700) and the Legally Required Standby System branch (NEC Article 701) shall be selected to be selectively coordinated with the overcurrent protective devices installed on their supply side such that an overcurrent event (overload, short-circuit, or ground-fault) occurring at the lowest level in the system (branch circuit) cannot cause the feeder protective device supplying the branch circuit panelboard to open. This coordination shall be carried through each level of distribution for both normal and emergency power.

B. Overcurrent Protective Device Coordination: All other overcurrent protective devices proposed for inclusion in the Work shall be selected to be coordinated with the overcurrent protective devices installed on their supply side such that an overcurrent event (overload, short-circuit, or ground-fault) occurring at the lowest level in the system (branch circuit) cannot cause the feeder protective device supplying the branch circuit panelboard to open. This coordination shall be carried through each level of distribution for all branches of normal and emergency power to 0.10 seconds.

C. Delegated Design for Arc Flash Hazard Analysis: Prepare computer-based, arc-flash study to determine the arc-flash hazard distance and the incident energy to which personnel could be exposed during work on or near electrical equipment.

1.03 ACTION SUBMITTALS

A. Submit product data and shop drawings in accordance with Division 01 and Division 26 Section "Electrical Shop Drawings and Submittals" for products specified under PART 2 - PRODUCTS.

B. Product Data: For computer software program to be used for studies.

C. Simultaneous Action Submittals: The following action submittals shall be made in conjunction with the approval process for system protective devices specified in other Division 26 Sections. The release of electrical equipment submittals (panelboards, engine generators, switchgear, etc.) is dependent on the receipt of a complete and accurate overcurrent protective device coordination study. The Architect and Engineer require a full submittal review period as delineated in Division 01 Section "Submittal Procedures" to adequately review the OCPD study against the submitted electrical components prior to release of submittals for equipment procurement. The submittal schedule required by Division 01 requirements shall provide for this review time in the action submittal process. Delay claims arising due to Contractor's failure to coordinate simultaneous action submittals will not be considered by the Owner. The following submittals shall be in digital form:

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 study input data, including completed computer program input data sheets.
5. Arc Flash Hazard Analysis Report.

1.04 INFORMATIONAL SUBMITTALS

A. Qualification Data: For coordination-study specialist.

B. Product Certificates: For coordination-study and fault-current-study computer software programs, certifying compliance with IEEE 399. For arc flash hazard analysis software, certifying compliance with IEEE 1584 and NFPA 70E.

1.05 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For the overcurrent protective devices to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Closeout Submittals," include the following:

1. The following parts from the Protective Device Coordination Study Report:
    a. One-line diagram.
    b. Protective device coordination study.
    c. Time-current coordination curves.
    d. Coordination setting schedules.
2. Power system data.

B. Maintenance procedures according to requirements in NFPA 70E shall be provided in the equipment manuals.

C. Operation and Maintenance Procedures: In addition to items specified in Division 01 Section “Closeout Submittals,” provide maintenance procedures for use by Owner’s personnel that comply with requirements in NFPA 70E.

1.06 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.

1. Professional engineer, licensed in the state where Project is located, shall be responsible for the study. All elements of the study shall be performed under the direct supervision and control of engineer.

C. Comply with IEEE 242 for short-circuit currents and coordination time intervals.

D. Comply with IEEE 399 for general study procedures.

E. Comply with IEEE 1584 for performing Arc Flash Hazard Calculations.

PART 2 - PRODUCTS

2.01 COMPUTER SOFTWARE DEVELOPERS

A. Computer Software Developers: Subject to compliance with requirements, provide products by one of the following:

1. SKM Systems Analysis, Inc.

2.02 COMPUTER SOFTWARE PROGRAM REQUIREMENTS

A. Comply with IEEE 242 and IEEE 399 for fault-current and overcurrent protective device coordination studies.

B. 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.

2.03 SHORT-CIRCUIT STUDY REPORT CONTENTS

A. Executive Summary

B. Study descriptions, purpose, basis, and scope. Include case descriptions, definition of terms, and guide for interpretation of the computer printout.

C. One-line diagram, showing the following:

1. Protective device designations and ampere ratings.
2. Cable size and lengths.
3. Transformer kilovolt ampere (kVA) and voltage ratings.
4. Motor and generator designations and kVA ratings.
5. Switchgear, switchboard, and panelboard designations.

D. Short-Circuit Study Input Data: As described in "Power System Data" Article in the Evaluations.

E. Short-Circuit Study Output:

1. Interrupting Duty Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:
   a. Voltage.
   b. Calculated symmetrical fault-current magnitude and angle.
   c. Fault-point X/R ratio.
   d. No AC Decrement (NACD) ratio.
   e. Equivalent impedance.
   f. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on a symmetrical basis.
   g. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on a total basis.

2.04 PROTECTIVE DEVICE COORDINATION STUDY REPORT CONTENTS

A. Executive summary.

B. Study descriptions, purpose, basis and scope. Include case descriptions, definition of terms and guide for interpretation of the computer printout.

C. One-line diagram, showing the following:

1. Protective device designations and ampere ratings.
2. Cable size and lengths.
3. Transformer kilovolt ampere (kVA) and voltage ratings.
4. Motor and generator designations and kVA ratings.
5. Switchgear, switchboard, and panelboard designations.

D. Study Input Data: As described in "Power System Data" Article.

E. Short-Circuit Study Output: As specified in "Short-Circuit Study Output" Paragraph in "Short-Circuit Study Report Contents" Article above.

F. Protective Device Coordination Study:

1. Report recommended settings of protective devices, ready to be applied in the field. Use manufacturer's data sheets for recording the recommended setting of overcurrent protective devices when available.
   a. Phase and Ground Relays:
      1) Device tag.
      2) Relay current transformer ratio and tap, time dial, and instantaneous pickup value.
      3) Recommendations on improved relaying systems, if applicable.

b. Circuit Breakers:
   1) Adjustable pickups and time delays (long time, short time, ground).
   2) Adjustable time-current characteristic.
   3) Adjustable instantaneous pickup.
   4) Recommendations on improved trip systems, if applicable.
c. Fuses: Show current rating, voltage, and class.

G. Time-Current Coordination Curves: Determine settings of overcurrent protective devices to achieve selective coordination. Graphically illustrate that adequate time separation exists between devices installed in series, including power utility company's upstream devices. Prepare separate sets of curves for the switching schemes and for emergency periods where the power source is local generation. Show the following information:
1. Device tag and title, one-line diagram with legend identifying the portion of the system covered.
2. Terminate device characteristic curves at a point reflecting maximum symmetrical or asymmetrical fault current to which the device is exposed.
3. Identify the device associated with each curve by manufacturer type, function, and, if applicable, tap, time delay, and instantaneous settings recommended.
4. Plot the following listed characteristic curves, as applicable:
   a. Power utility's overcurrent protective device.
   b. Medium-voltage equipment overcurrent relays.
   c. Medium- and low-voltage fuses including manufacturer's minimum melt, total clearing, tolerance, and damage bands.
   d. Low-voltage equipment circuit-breaker trip devices, including manufacturer's tolerance bands.
   e. Transformer full-load current, magnetizing inrush current, and ANSI through-fault protection curves.
   f. Cables and conductors damage curves.
   g. Ground-fault protective devices.
   h. Motor-starting characteristics and motor damage points.
   i. The largest feeder circuit breaker in each motor-control center and panelboard.
5. Provide adequate time margins between device characteristics such that selective operation is achieved.
6. Comments and recommendations for system improvements.

2.05 ARC FLASH STUDY REPORT CONTENT

A. Executive summary.
B. Study descriptions, purpose, basis and scope.
C. One-line diagram, showing the following:
1. Protective device designations and ampere ratings.
2. Cable size and lengths.
3. Transformer kilovolt ampere (kVA) and voltage ratings.
4. Motor and generator designations and kVA ratings.
5. Switchgear, switchboard, and panelboard designations.
D. Study Input Data: As described in “Power System Data” Article.
E. Protective Device Coordination Study Report Contents: As specified in “Protective Device Coordination Study Report Contents” Article above.

F. Arc-Flash Study Output:
   1. Interrupting Duty Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:
      a. Voltage.
      b. Calculated symmetrical fault-current magnitude and angle.
      c. Fault-point X/R ratio.
      d. No AC Decrement (NACD) ratio.
      e. Equivalent impedance.
      f. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on a symmetrical basis.
      g. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on a total basis.

G. Incident Energy and Flash Protection Boundary Calculations:
   1. Arcing fault magnitude.
   2. Protective device clearing time.
   3. Duration of arc.
   4. Arc-flash boundary.
   5. Working distance.
   6. Incident energy.
   7. Hazard risk category.
   8. Recommendations for arc-flash energy reduction.

H. Fault study input data, case descriptions, and fault-current calculations including a definition of terms and guide for interpretation of the computer printout.

I. Equipment specific Arc Flash Warning Labels.

2.06 ARC-FLASH WARNING LABELS

A. Comply with requirements in Division 26 Section "Identification for Electrical Systems." Produce a 3.5-by-5-inch thermal transfer label of high-adhesion polyester for each work location included in the analysis.

B. The label shall have an orange header with the wording, "WARNING, ARC-FLASH HAZARD," and shall include the following information taken directly from the arc-flash hazard analysis:
   1. Flash Hazard Boundary
   2. Short Circuit Current Available
   3. Shock Hazard when Cover is Removed
   4. Limited Approach Boundary
   5. Restricted Approach Boundary
   6. Prohibited Approach Boundary
   7. PPE Requirements, including the following:
      a. Hazard Risk Category
      b. Required Minimum Arc Rating of PPE in cal/cm^2
      c. Clothing Description
   8. Engineering report number, revision number, and issue date.

C. Labels shall be machine printed, with no field-applied markings.

PART 3 - EXECUTION

3.01 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.

1. Proceed with coordination study only after relevant equipment submittals have been assembled.

    a. Coordination study shall accompany submission of relevant equipment submittals.

3.02 POWER SYSTEM DATA

A. Delegated Design System Analyst performing the short-circuit, protective device coordination study and arc flash hazard analysis shall furnish the Contractor with a list of required data immediately after award of the contract. Contractor shall expedite collection of the data to ensure completion of the study and analysis as required.

B. For new equipment, use characteristics submitted under the provisions of action submittals and information submittals for this Project.

C. Source combination shall include present and future motors and generators indicated in the documents.

D. If applicable, include fault contribution of existing motors in the study and analysis.

E. 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: In hard-copy and electronic-copy formats, showing the following:

    a. Circuit-breaker and fuse-current ratings and types.

    b. Relays and associated power and current transformer ratings and ratios.

    c. Transformer kilovolt amperes, primary and secondary voltages, connection type, impedance, and X/R ratios.

    d. Generator short-circuit current contribution data, including short-circuit reactance, rated kilovolt amperes, size, rated voltage, and X/R ratio.

    e. Cables: Indicate conduit material, sizes of conductors, conductor material, insulation, and length.

    f. Busway ampacity, impedance, lengths, and conductor material.

    g. Motor horsepower and code letter designation according to NEMA MG 1.

    h. Low-voltage cable sizes, lengths, number, conductor material and conduit material (magnetic or nonmagnetic).

    i. Medium-voltage cable sizes, lengths, conductor material, and cable construction and metallic shield performance parameters.

4. Data sheets to supplement electrical distribution system diagram, cross-referenced with tag numbers on diagram, showing the following:

    a. Special load considerations, including starting inrush currents and frequent starting and stopping.

    b. Transformer characteristics, including primary protective device, magnetic inrush current, and overload capability.

c. Motor full-load current, locked rotor current, service factor, starting time, type of start, and thermal-damage curve.

d. Generator thermal-damage curve.

e. Ratings, types, and settings of utility company's overcurrent protective devices.

f. 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.

3.03 FAULT-CURRENT STUDY

A. A short-circuit current ratings indicated in the Contract Documents are based on Fault-Current study prepared by the Engineer during design and are based on available information and anticipated feeder lengths. Calculate the maximum available short-circuit current in amperes rms symmetrical at circuit-breaker positions of the electrical power distribution system. The calculation shall be for a current immediately after initiation and for a three-phase bolted short circuit at each of the following:

1. Electric Utility’s supply termination point.
2. Service Entrance Equipment.
3. Switchboard bus.
4. Distribution panelboard.
5. Branch circuit panelboard.
6. Enclosed Fused Switch.
7. Enclosed Circuit Breaker.

B. Study electrical distribution system from normal and alternate power sources throughout electrical distribution system for Project. Include studies of system-switching configurations and alternate operations that could result in maximum fault conditions.

C. Calculate momentary and interrupting duties on the basis of maximum available fault current.

D. Calculate short-circuit currents according to IEEE 551.

E. In addition to IEEE 551 short-circuit current calculations, calculate the short-circuit currents at the following:

1. Motor Controllers: Rated greater than or equal to 2hp at 300V or more.
2. Air-Conditioning and Refrigerating Equipment Controllers: Including, but not limited to, equipment supplied from a branch circuit protected at greater than 60A.
3. Elevator Controllers.

F. Calculations to verify interrupting ratings of overcurrent protective devices shall comply with IEEE 241 and IEEE 242.

1. Transformers:
   a. ANSI C57.12.10.
   b. ANSI C57.12.22.
   c. ANSI C57.12.40.
   d. IEEE C57.12.00.
   e. IEEE C57.96.

2. Low-Voltage Circuit Breakers: IEEE 1015 and IEEE C37.20.1.
3. Low-Voltage Fuses: IEEE C37.46.

G. Study Report:
1. Show calculated X/R ratios and equipment interrupting rating (1/2-cycle) fault currents on electrical distribution system diagram, including existing and new Service Entrance equipment.

H. Equipment Evaluation Report:
1. For 600-V overcurrent protective devices, ensure that interrupting ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.
2. For devices and equipment rated for asymmetrical fault current, apply multiplication factors listed in the standards to 1/2-cycle symmetrical fault current.
3. Ensure that short-circuit withstand ratings are equal to or higher than the calculated ½-cycle symmetrical fault current for the following:
   a. Electrical Distribution Equipment: Including, but not limited to, switchgear, switchboards, and panel boards.
   b. Motor Controllers.
   c. Air-Conditioning and Refrigerating Equipment Controllers.
4. Verify adequacy of phase conductors at maximum three-phase bolted fault currents; verify adequacy of equipment grounding conductors and grounding electrode conductors at maximum ground-fault currents. Ensure that short-circuit withstand ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.
5. Notify Engineer, in writing, of any existing circuit protective devices improperly rated for the calculated available fault current.

3.04 COORDINATION STUDY

A. Perform coordination study using approved computer software program. Prepare a written report using results of fault-current study. Comply with IEEE 399.
1. Calculate the maximum and minimum 1/2-cycle short-circuit currents.
2. Calculate the maximum and minimum ground-fault currents.

B. Comply with IEEE 242 recommendations for fault currents and time intervals.

C. Transformer Primary Overcurrent Protective Devices:
1. Device shall not operate in response to the following:
   a. Inrush current when first energized.
   b. Self-cooled, full-load current or forced-air-cooled, full-load current, whichever is specified for that transformer.
   c. Permissible transformer overloads according to IEEE C57.96 if required by unusual loading or emergency conditions.
2. Device settings shall protect transformers according to IEEE C57.12.00, for fault currents.

D. Conductor Protection: Protect cables against damage from fault currents according to ICEA P-32-382, ICEA P-45-482, and conductor melting curves in IEEE 242. Demonstrate that equipment withstands the maximum short-circuit current for a time equivalent to the tripping time of the primary relay protection or total clearing time of the fuse. To determine temperatures that damage insulation, use curves from cable manufacturers or from listed standards indicating conductor size and short-circuit current.

E. 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 devices installed in series, including power utility company's upstream devices. Prepare separate sets of curves for the switching schemes and for emergency periods where the power source is local generation. Show the following information:

a. Device tag.

b. Voltage and current ratio for curves.

c. Three-phase and single-phase damage points for each transformer.

d. No damage, melting, and clearing curves for fuses.

e. Cable damage curves.

f. Transformer inrush points.

g. Maximum fault-current cutoff point.

h. Motor starting characteristics, damage points and overload relay.

i. Thermal damage curve for motors larger than 100 HP.

F. Completed data sheets for setting of overcurrent protective devices.

G. Complete Schedule of breaker settings to summarize information contained on data sheets. Sample schedule has been included at the end of this section for preferred format.

3.05 ARC FLASH HAZARD ANALYSIS

A. Comply with NFPA 70E and its Annex D for hazard analysis study.

B. The flash protection boundary and the incident energy shall be calculated at all significant locations in the electrical distribution system where work could be performed on energized parts including, but not limited to, the following:

1. Disconnect switches.

2. Electrical switchgear and switchboards.

3. Enclosed circuit breakers.

4. Motor starter.

5. Panelboards.

6. Transformers.

C. When appropriate, the short circuit calculations and the clearing times of the phase overcurrent devices will be retrieved from the short-circuit and coordination study model. Ground overcurrent protection relays should not be taken into consideration when determining the clearing time when performing incident energy calculations.

D. Calculate the arc-flash protection boundary and the corresponding incident energy calculations for multiple system scenarios to be compared and the greatest incident energy to be uniquely reported for each equipment location. Calculations to be performed to represent the maximum and minimum contributions of fault current magnitude for all normal and emergency operating conditions.

1. The minimum calculation will assume that the utility contribution is at a minimum and will assume a minimum motor contribution (all motors off).

2. The maximum calculation will assume a maximum contribution from the utility and will assume the maximum amount of motors to be operating. .

E. Incident energy calculations shall consider the accumulation of energy over time when performing arc flash calculations on buses with multiple sources. Iterative calculations must take into account the changing current contributions, as the sources are interrupted or decremented with time. Fault contribution from motors to be decremented as follows:

1. Fault contribution from induction motors should not be considered beyond 3-5 cycles.

2. Fault contribution from synchronous motors should be decayed to match the actual decrement of each as closely as possible.

F. For each equipment location with a separately enclosed main device, calculations for incident energy and flash protection boundary shall include both the line and load side of the main breaker.

1. When performing incident energy calculations on the line side of a main breaker, the line side and load side contributions must be included in the fault calculation.

G. Mis-coordination should be checked amongst all devices within the branch containing the immediate protective device to compute the incident energy for the corresponding location.

H. Arc Flash calculations shall be based on actual overcurrent protective device clearing time. Maximum clearing time will be capped at 2 seconds based on IEEE 1584 section B.1.2. Where it is not physically possible to move outside of the flash protection boundary in less than 2 seconds during an arc flash even, a maximum clearing time based on the specific location shall be utilized.

I. Complete Arc Flash report to be used for the preparation of Arc Flash Warning labels for electrical equipment. Refer to Division 26 Section “Identification for Electrical Systems” for requirements of Arc Flash Study and labels.

3.06 CORRECT DEFICIENCIES, RE-CALULCATE AND REPORT

A. After Engineer’s initial review, correct unsatisfactory conditions and recalculate to demonstrate compliance; resubmit overcurrent protective devices as required to bring system into compliance.

B. Revise and Resubmit report multiple times as necessary to demonstrate compliance with requirements.

3.07 APPLICATION OF WARNING LABELS

A. Install arc-flash warning labels as specified in Division 26 Section “Identification for Electrical Systems”. Install labels under the direct supervision and control of the Arc-Flash Hazard Study Specialist.

END OF SECTION 26 0573

SECTION 26 0800
COMMISSIONING OF ELECTRICAL

PART 1 - GENERAL

1.01 RELATED WORK

A. Division 22 - Plumbing

B. Division 23 - HVAC

1.02 REFERENCES

A. Drawings and general provisions of contract, including general and supplementary conditions, general mechanical provisions and Division-1 Specification sections, apply to work of this section.

B. ASHRAE Guideline 1-1996

C. ASHRAE Guideline 0-2005

D. ACG Commissioning Guideline – 2005

1.03 DESCRIPTION OF WORK

A. The purpose of the commissioning process is to provide the owner/operator of the facility with a high level of assurance that the mechanical systems have been installed in the prescribed manner, and operate within the performance guidelines set in the Basis of Design Documents (BOD). The CA shall provide the owner with an unbiased, objective view of the system's installation, operation, and performance. This process is not intended to take away or reduce the responsibility of the design team or installing contractors to provide a finished product. Commissioning is intended to enhance the quality of system start-up and aid in the orderly transfer of systems for beneficial use by the owner. The CA will be a member of the construction team, administrating and coordinating commissioning activities with the design team, construction manager, subcontractors, manufacturers and equipment suppliers.

B. The independent commissioning agent (CA) contracted directly with the owner for this project. This specification has been included for reference only to define contractors' responsibilities. Each contractor should review this procedure and include adequate time in their proposal.

PART 2 - PRODUCTS

PART 3 - EXECUTION

3.01 ROLES OF THE COMMISSIONING AGENCY

A. The primary point of responsibility is to inform the construction manager, the owner and design team on the status, integration, and performance of HVAC systems within the facility.

B. The CA shall function as a catalyst and initiator to disseminate information and assist the design and construction teams in implementing completion of the construction process. This shall include system verification, functional performance testing, and conformance with the intended design of each system. Services include documenting construction observations, verification and functional performance testing, and documenting proper distribution of performance and operating information to the owner's O&M staff.

C. Assist the responsible parties to maintain a high quality level of installation by meeting or exceeding prevailing standards and specifications.

D. The CA shall observe and coordinate testing as required to assure system performance meets the design intent.

E. The CA shall document the results of the performance testing directly and/or assure that the appropriate technicians document testing. The CA shall approve standard forms to be used by all parties for consistency of approach and type of information to be recorded.

F. The CA shall provide technical expertise to oversee and verify the correction of deficiencies found during the commissioning process.

G. The CA is to remain an independent party with specific knowledge of the project. The CA shall investigate the scope and extent of the problem and facilitate communication to determine responsibilities by delineating specifications. The CA shall monitor resolution for conformance with design intent and prevailing industry standards.

H. The CA shall document the date of acceptance as determined by the construction manager, owner and design team. System Verification Checklists and Functional Performance Test results may be used in determining the start of the warranty period for HVAC systems and subsystems.

I. The CA will review operating and maintenance materials for HVAC systems.

J. The CA will review phasing plans as provided by the CM relating to temporary use of HVAC equipment, O&M considerations, warranty issues, impact of construction sequencing on occupied areas, and interruption of services from the existing equipment.

3.02 SYSTEMS INCLUDED IN THE COMMISSIONING PROCESS

A. Main Normal Distribution

B. Emergency Power System

C. Lighting Control Systems

D. Energy Metering System

3.03 ELECTRICAL COMMISSIONING PLAN

A. Commissioning Team

1. The Commissioning Team (CT) shall consist of key parties involved in design, construction and testing of this facility. It is necessary for each agency to appoint team members that will have long-term commitments to this project. Switching team members during the project will reduce the ability of the CT to provide continuity and acceptable results to the building owner. Team members must maintain an ongoing supervisory position on this project. One team member shall be provided by each of the parties listed below:

    a. Program Manager (PrM)
    b. Facilities Management Division (FMD)
    c. Commissioning Agent (CA)
    d. Design Team (DT)
    e. Construction Manager (CM)
    f. Mechanical Contractor (MC)
    g. Controls Contractor (CC)
    h. Test and Balance Contractor (TABC)
    i. Electrical Contractor (EC)

B. Basis of Design Document

1. The Basis of Design Document (BOD) represents a composite of design drawings, project specifications, submittals, change orders and industry standards that describe the systems of this facility. References to design intent will be taken from these contract documents. The BOD is an evolving manuscript maintained by the design professional to track and incorporate design alterations that occur throughout the construction process. Any industry standards used for this project will be specifically noted when referenced.
2. The CA will review the BOD documents for adequate commissioning provisions, functional performance, optimization of performance, accessibility, TAB provisions, and O&M considerations.

C. Commissioning Meetings

1. Commissioning meetings will be held in conjunction with progress meetings as necessary. Commissioning meetings will be used to address any problems that alter the

design intent or affect the commissioning process. These meetings provide an open forum for exchange of ideas between contractors, vendors, designers, users and owners.

D. Resolution Tracking Forms (RTF)

1. The use of Resolution Tracking Forms is a method employed by the CA to monitor and record problems, their causes, and solutions. The use of these lists promotes communication between the installing contractors, design team, commissioning agent, and owner, in order to expedite their resolution in a timely manner.
2. The CA will regularly submit RTF's to the CT in order to document and resolve deficiencies as quickly as possible. The frequency of RTF submission will be adjusted as project conditions dictate.

E. System Verification Checklists (SVC) / Manufacturers' Checklists

1. The MC/PC shall provide SVC's based on the manufacturers start-up procedures. These tests will be created for systems and subsystems. See SYSTEMS INCLUDED IN THE COMMISSIONING PROCESS. Draft copies will be submitted to the CT for review and comment prior to placement on the job site. A master copy of the SVC's will be bound in a three-ring binder and placed on the job site for use by the installing contractors. No system will be started until the appropriate SVC's have been completed.
2. The CA will review the SVC for each piece of equipment prior to start-up. Equipment will be released for start-up only after these checklists have been completed by the installing contractor and reviewed by the CA.
3. The equipment manufacturers' checklists must also be reviewed by the CA prior to start-up. These lists must be completed by the installing contractor, and reviewed by the CA before start-up can commence.

F. Start-Up

1. The appropriate contractors and/or manufacturer's representative will be required on site to perform start-up. No system will be started until the appropriate SVC's have been completed. No system will be started until the Manufacturer's checklists have been completed. Start-up will be performed according to the Manufacturer's recommended procedures. The CA will visit the site to review completeness of installation in conjunction with progress meetings prior to starting Plumbing equipment.
2. CT members involved in installation, fabrication, manufacture, control, or design of equipment are required to be present at the time of start-up. A factory-authorized technician will be on site to start equipment when required by the specifications. This will minimize delays in bringing equipment on line and expedite acceptable functional performance in accordance with the BoD.

G. Controls Monitoring

1. Close monitoring of the Control Contractor's progress will promote efficient coordination of the TAB work. The CC will be expected to submit point-to-point checklists verifying that his work has been completed and all systems are ready for TAB work and Functional Performance Testing. Programming and graphics will be surveyed by the CA for completeness and conformance with the BoD and the owner's scheduling requirements.

H. TAB Monitoring

1. The preliminary TAB report set-up will be reviewed prior to Electrical equipment start-up, in order to assure that the final TAB report format and content is acceptable.
2. TAB work will be monitored so that any problems that prevent or hinder proper air and water balance can be addressed and corrected with minimal delays. By addressing these problems as quickly as possible, we can assure that functional performance testing and owner training will take place on schedule.

3. A pencil copy of the TAB report will be reviewed prior to submission of the final TAB report. A written review will be submitted to the TAB contractor and to the DT for their comments. A TAB report approved by the DT will be required before Functional Performance Testing can be carried out. The CA will visit the site during the TAB process in order to assist TABC and CC in the effective completion of their scope of work.

I. Functional Performance Tests (FPT)

1. The CA will write FPT's based on the BoD. These tests will be created for systems and subsystems. See SYSTEMS INCLUDED IN THE COMMISSIONING PROCESS above.
2. Each major system will be tested. A random sample of each subsystem will be tested. This will be coordinated and witnessed by the CA and the owner's maintenance staff. Witnessing the FPT's will serve as a compliment to the O&M Training. No FPT's will be performed until the system and related subsystems have been started, the TAB report has been submitted and reviewed, and the completion of the control system has been documented through point-to-point checklists and other documentation.
3. The Functional Performance Tests shall include Electrical, Lighting and related equipment.

    a. The Electrical trade representative will demonstrate to the CxA: main power disconnect switch and feeder disconnect switches over current ground fault sensor trip settings by the primary injection method and in accordance with NETA-ATS Section 7.6, switchboard assemblies megger tested in accordance with NETA-ATS Section 7, switchboard metering instrumentation tests in accordance with NETA-ATS Sections 7.10 and 7.11, and switchboard single phase monitor tests for operation upon loss of a phase.
    b. The Electrical trade representative, with the CxA present, will field test for power operation for the emergency generator and transfer switches.
    c. Lighting controls will be tested under relevant operating conditions.
    d. A remote connection to energy metering system, energy dashboard, PV system, or any other system should be provided to the CA prior to system start-up for use as a tool to determine completion and accuracy of systems. CA in conjunction with the CT will ensure that all systems function properly through FPT's and through trend verification of systems.

4. Deferred Testing

    a. If tests cannot be completed because of a deficiency outside the scope of the responsible contractor, the deficiencies shall be documented and reported to the Owner. Deficiencies shall be resolved and corrected by the appropriate parties and test rescheduled.
    b. Off-season mode testing will be implemented as necessary to assure conformance with the BoD. Installing contractors will be expected to participate as required by the project specifications.

5. Rescheduled Functional Performance Test

    a. During Functional Performance Testing period, it is assumed that the contractors will be complete with all checklists when the commissioning agents travel to site. If the work is not ready for commissioning when the commissioning personnel are on site, their time will be billed at a rate of $1500.00 per day to the contractor as an additional fee.
    b. If the contractor has deficiencies that cannot be corrected at the time of the test, that part of the sequence will be retested at a later date. If the deficiency does not

pass during the retest, the contractor will be billed $1500.00 per day for the commissioning personnel's return trip.

J. Building Turn-Over / Owner Orientation / User Training

1. The CA will assist contractors prepare, coordinate and review O&M manuals, working closely with each contractor to achieve specificity and completeness.
2. The CA will review as-built drawings, working closely with each contractor to achieve specificity and completeness.
3. Owner training will be coordinated with the assistance of the CA. The training will be provided by the installing contractor, or manufacturer's representative. This training should include both classroom training and hands-on operational training. The owner may choose to videotape this training for future use. The CA will visit the site during the Turn-Over and Training period to assure that any on-going Electrical related problems are being addressed and corrected in a timely and efficient manner.
4. The CA will assist the owner/user with warranty issues.
5. The CA will assist in the coordination of off-season testing, calibrating, and servicing as specified in the contract documents.

3.04 RESPONSIBILITIES OF TEAM MEMBERS

A. Construction Manager (CM)

1. Include commissioning requirements in the mechanical, electrical, and controls contracts, as well as other subcontracts, to assure full cooperation of all parties in the Plumbing commissioning process.
2. Assure acceptable representation, with the means and authority to prepare and coordinate execution of the mechanical commissioning program as described in the contract documents.
3. Assure that the CA shall receive a copy of all construction documents, addenda, change orders and appropriate approved submittals and shop drawings for review and use in development of the commissioning plan.
4. Coordinate inclusion of commissioning activities in the construction schedule.
5. Facilitate resolution of deficiencies identified by observation or performance testing.
6. Assist the CA in monitoring the duct leakage testing.

B. Electrical Contractor (EC)

1. Include cost for commissioning requirements in the contract price.
2. Review design for provision of power to the Electrical equipment.
3. Attend commissioning meetings scheduled by the CA.
4. Verify proper installation and performance of all Electrical services provided.
5. Complete System Verification Checklists and manufacturer's pre-start checklists prior to scheduling startup of equipment.
6. Monitor and respond to Resolution Tracking Forms distributed by the CA in order to expedite corrective actions necessary to achieve design intent.
7. Provide an Electrical system technician to assist during verification and performance testing.
8. Participate in the Functional Performance Tests as required to achieve design intent.
9. Participate in the off-season mode testing as required to achieve design intent.
10. Participate in O&M Training as required by project specifications.

END OF SECTION 26 0800

SECTION 26 0923
LIGHTING CONTROL DEVICES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Universal voltage power packs.
2. Indoor, low-voltage, ceiling-mounted occupancy sensors.
3. Indoor, low-voltage, wall-mounted occupancy sensors.
4. Low-voltage, momentary switches.
5. Wall switch sensor light switches with dual technology sensors.
6. Lighting contactors.

B. Related Requirements:

1. Division 26 Section "Wiring Devices" for manual light switches and wall plates.
2. Division 26 Section “Digital Lighting Control Systems” for low-voltage, digital, room controller-type systems.

1.2 PERFORMANCE REQUIREMENTS

A. Delegated Design: These specifications and the accompanying Drawings define the intent of the lighting control system to be provided. The switches, sensors, control stations and switching group designations shown on the Drawings define how lighting should be grouped for control. Provide the necessary quantity and type of distributed control products necessary to achieve the design intent. In addition to the system as specified herein and shown on the Drawings, provide all planning, design, calculations, equipment, devices, cabling, system programming and any other component or service required for a complete, fully operational and code compliant system.

1.3 ACTION SUBMITTALS

A. Submit product data and shop drawings in accordance with Division 01 and Division 26 Section “Electrical Shop Drawings and Submittals” for products specified under PART 2 - PRODUCTS.

B. Product Data: For control modules, power distribution components, control network materials, manual switches and plates, and conductors and cables.

C. Maintenance Data: Include instructions for replacing and maintaining coil and contacts.

1.4 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For each type of lighting control device to include in emergency, operation, and maintenance manuals.

1.6 COORDINATION

A. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including but not limited to luminaires, HVAC equipment, smoke detectors, fire-suppression system, and partition assemblies.

1.7 WARRANTY

A. Warranty: Manufacturer agrees to repair or replace components of lighting control devices that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:
   a. Damage from transient voltage surges.

2. Warranty Period: Cost to repair or replace any parts for five (5) years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 UNIVERSAL VOLTAGE POWER PACKS

A. Basis-of-Design Product: Subject to compliance with requirements, provide WattStopper BZ-150 series or comparable product by one of the following:

1. Eaton, Cooper Industries, Inc.
2. Leviton Mfg. Company Inc.
3. Lutron Electronics Co., Inc.
4. nLight, Acuity Brands Lighting, Inc.

B. General Requirements for Power Packs: Self-contained power supply relay system, plenum rated.

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Provide 24 VDC operating voltage to low-voltage occupancy sensors.
3. Integrates with low-voltage momentary switch to control any 24 VDC occupancy sensor.
4. Mounting: Externally mounted through a 1/2-inch knockout in a standard electrical enclosure.
5. Indicator: LED indicator on device to indicate status of relay or if there is a low-voltage overcurrent.
6. Auto On or Manual On: Dip switch setting allows the user to select Auto On or Manual On as the operating mode.
7. Hold-On Feature: Provide with Hold-On inputs. For power packs used in corridors to control egress lighting, a signal from the generator life safety automatic transfer switch to the power pack shall hold lights On regardless of occupancy during a normal power outage.

2.2 INDOOR, LOW-VOLTAGE, CEILING-MOUNTED OCCUPANCY SENSORS

A. Basis-of-Design Product: Subject to compliance with requirements, provide WattStopper DT-300 series or comparable product by one of the following:

1. Eaton, Cooper Industries, Inc.
2. Leviton Mfg. Company Inc.
3. Lutron Electronics Co., Inc.
4. nLight, Acuity Brands Lighting, Inc.

B. General Requirements for Sensors: Ceiling-mounted, solid-state indoor occupancy sensors.

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Sensor Output: Contacts rated to operate the connected relay, complying with UL 773A.
3. Mounting:
   a. Sensor: Suitable for mounting in any position on a standard outlet box.
   b. Power Pack Relay: Externally mounted through a 1/2-inch knockout in a standard electrical enclosure.
   c. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.
4. Indicator: LED indicator on sensor to show when motion is detected during testing and normal operation of sensor.

5. Automatic Light-Level Sensor: Adjustable from 10 to 300 fc; turn lights off when selected lighting level is present.
6. Manual On Function: Sensor shall have a manual on function that is facilitated by a low-voltage momentary switch.

C. Dual-Technology Type: Ceiling mounted; detect occupants in coverage area using PIR and ultrasonic detection methods. The particular technology or combination of technologies that control on-off functions is selectable in the field by operating controls on unit.

1. Sensitivity Adjustment: Separate for each sensing technology.
2. Detector Sensitivity: Detect occurrences of 6-inch- minimum movement of any portion of a human body that presents a target of not less than 36 sq. in., and detect a person of average size and weight moving not less than 12 inches in either a horizontal or a vertical manner at an approximate speed of 12 inches/s.
3. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 750 sq. ft. when mounted on a 96-inch- high ceiling.

D. Operation:

1. Occupancy Mode in Corridors: Turn lights on automatically at 100% when covered area is occupied and turn them off automatically when unoccupied.
2. Vacancy Mode in Storage Rooms: Turn lights on manually when covered area is occupied and turn them off automatically when unoccupied.
3. Time delay for turning lights off shall be adjustable over a minimum range of 5 to 30 minutes.

2.3 INDOOR, LOW-VOLTAGE, WALL-MOUNTED OCCUPANCY SENSORS

A. Basis-of-Design Product: Subject to compliance with requirements, provide WattStopper DT-200 series or comparable product by one of the following:

1. Eaton, Cooper Industries, Inc.
2. Leviton Mfg. Company Inc.
3. Lutron Electronics Co., Inc.
4. nLight, Acuity Brands Lighting, Inc.

B. General Requirements for Sensors: Wall-mounted, solid-state indoor occupancy sensors.

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Sensor Output: Contacts rated to operate the connected relay, complying with UL 773A.
3. Mounting:
   a. Sensor: Swivel mounting bracket attached to sensor allows sensor to be angled for wall or ceiling mounting on a standard outlet box.
   b. Power Pack Relay: Externally mounted through a 1/2-inch knockout in a standard electrical enclosure.
   c. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.
4. Indicator: LED indicator on sensor to show when motion is detected during testing and normal operation of sensor.
5. Automatic Light-Level Sensor: Adjustable from 10 to 200 fc; turn lights off when selected lighting level is present.

C. Dual-Technology Type: Wall-mounted; detect occupants in coverage area using PIR and ultrasonic detection methods. The particular technology or combination of technologies that control on-off functions is selectable in the field by operating controls on unit.

1. Sensitivity Adjustment: Separate for each sensing technology.
2. Detection Coverage (Standard Room): Detect walking motion occupancy anywhere within a circular area of 2000 sq. ft. and desktop motion within a circular area of 1000 sq. ft. when mounted at 10-foot above floor.

D. Operation:

1. Occupancy Mode in Corridors: Turn lights on automatically at 100% when covered area is occupied and turn them off automatically when unoccupied.
2. Time delay for turning lights off shall be adjustable over a minimum range of 5 to 30 minutes.

2.4 LOW-VOLTAGE, MOMENTARY SWITCHES

A. Basis-of-Design Product: Subject to compliance with requirements, provide WattStopper LVSW-100 series or comparable product by one of the following:

1. Eaton, Cooper Industries, Inc.
2. Leviton Mfg. Company Inc.
3. Lutron Electronics Co., Inc.
4. nLight, Acuity Brands Lighting, Inc.

B. General Description:

1. Decorator styling compatible with screwless or standard wall plates.
2. Internal green LED which can function as either a locator or pilot light, depending upon application and how the switch is wired.
3. When top of switch is pressed, an internal contact between an on and common terminal is made; when bottom of switch is pressed, an internal contact between an off and common terminal is made.

C. Wall Plate: Comply with wall plate requirements in Division 26 Section “Wiring Devices”.

D. Finish: Comply with finishes requirements in Division 26 Section “Wiring Devices”.

2.5 SWITCHBOX-MOUNTED OCCUPANCY SENSORS

A. Basis-of-Design Product: Subject to compliance with requirements, provide WattStopper DSW series or comparable product by one of the following:

1. Eaton, Cooper Industries, Inc.
2. Hubbell Building Automation, Inc.
3. Lutron Electronics Co., Inc.

B. Description: Switchbox-mounted, combination lighting-control sensor and conventional switch lighting-control unit using dual technology.

1. Connections: Hard wired, line-voltage.
2. Rated 1200 W at 277 VAC for LED lighting, and ¼ hp at 120 VAC.
3. Adjustable time delay of 15 minutes.
4. Able to be locked to Manual-On mode.
5. Automatic Light-Level Sensor: Adjustable from 2 to 200 fc
6. Comply with NEMA WD 1, UL 20, and FS W-S-896.

C. General Requirements for Sensors: Automatic-wall-switch occupancy sensor, suitable for mounting in a single gang switchbox.

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Operating Ambient Conditions: Dry interior conditions, 32 to 120 deg F.

D. Finishes, including device color, wall plate and lettering: Comply with Division 26 Section “Wiring Devices.”

E. Wall Plates: Comply with wall plate requirements in Division 26 Section “Wiring Devices.”

2.6 LIGHTING CONTACTORS

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

1. ABB/General Electric Company; GE Consumer & Industrial - Electrical Distribution; Total Lighting Control.
2. ASCO Power Technologies, LP; a division of Emerson Electric Co.
3. Eaton Corporation.
4. Square D; a brand of Schneider Electric.

B. Description: Electrically operated and mechanically held, combination-type lighting contactors with non-fused disconnect, complying with NEMA ICS 2 and UL 508.

1. Current Rating for Switching: Listing or rating consistent with type of load served, including tungsten filament, inductive, and high-inrush ballast (ballast with 15 percent or less total harmonic distortion of normal load current).
2. Fault Current Withstand Rating: Equal to or exceeding the available fault current at the point of installation.
3. Enclosure: Comply with NEMA 250.
4. Provide with control and pilot devices as indicated on Drawings, matching the NEMA type specified for the enclosure.

C. BAS Interface: Provide hardware interface to enable the BAS to monitor and control lighting contactors.

1. Monitoring: On-off status.
2. Control: On-off operation based on BAS time schedule.

2.7 CONDUCTORS AND CABLES

A. Power Wiring to Supply Side of Remote-Control Power Sources: Not smaller than No. 12 AWG. Comply with requirements in Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

B. Classes 2 and 3 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 18 AWG. Comply with requirements in Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

C. Class 1 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 14 AWG. Comply with requirements in Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

PART 3 - EXECUTION

3.1 SENSOR INSTALLATION

A. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, smoke detectors, fire-suppression systems, and partition assemblies.

B. Install and aim sensors in locations to achieve not less than 90 percent coverage of areas indicated. Do not exceed coverage limits specified in manufacturer's written instructions.

C. Switchbox mounted sensors:

1. Set field selectable sensors to automatic “on” automatic “off” for all devices indicated to be Occupancy sensors on the Drawings. Set all other sensors to field selectable manual “on”.

2. Comply with installation and connection requirements in Division 26 Section “Wiring Devices.”

3.2 CONTACTOR INSTALLATION

A. Mount electrically held lighting contactors with elastomeric isolator pads to eliminate structure-borne vibration, unless contactors are installed in an enclosure with factory-installed vibration isolators.

3.3 WIRING INSTALLATION

A. Wiring Method: Comply with Division 26 Section "Low-Voltage Electrical Power Conductors and Cables." Minimum conduit size is 1/2 inch.

B. Wiring within Enclosures: Comply with NECA 1. Separate power-limited and nonpower-limited conductors according to conductor manufacturer's written instructions.

C. Size conductors according to lighting control device manufacturer's written instructions unless otherwise indicated.

D. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

3.4 IDENTIFICATION

A. Identify components and power and control wiring according to Division 26 Section "Identification for Electrical Systems."

1. Identify controlled circuits in lighting contactors.
2. Identify circuits or luminaires controlled by photoelectric and occupancy sensors at each sensor.

B. Label contactors with a unique designation.

3.5 FIELD QUALITY CONTROL

A. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

1. Operational Test: After installing time switches and sensors, and after electrical circuitry has been energized, start units to confirm proper unit operation.
2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

B. Lighting control devices will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

3.6 ADJUSTING

A. Time-Schedule Adjustments: Times indicated in documents represent initial settings known at time of design documentation. Coordinate final program settings for time-of-day and holiday schedules with Owner prior to Substantial Completion. When requested within 3 months of date of Substantial Completion, provide on-site assistance in adjust schedules to suit Owner. Provide up to one visit to Project during other-than-normal occupancy hours for this purpose.

B. Occupancy Adjustments: When requested within 12 months from date of Substantial Completion, provide on-site assistance in adjusting sensors to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

1. For occupancy and motion sensors, verify operation at outer limits of detector range. Set time delay to suit Owner's operations.

3.7 CLEANING

A. Clean components according to manufacturer's written instructions.

B. On completion of device box installation but before any wiring devices are installed, inspect interior of boxes and perform the following:

1. Vacuum dirt and debris; do not use compressed air to assist in cleaning.

C. On completion of wall plate installation, inspect exterior surfaces and perform the following:

1. Remove paint splatters and other spots.
2. Replace cracked or damaged wall plates.
3. Wipe down all wall plates with approve cleaning agent to remove fingerprints and dust.

END OF SECTION 26 0923

SECTION 26 0943

DIGITAL LIGHTING CONTROL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Digital lighting and plug load controls.
2. Occupancy, vacancy and daylighting sensor control.
3. Room controllers.
4. Room controller wall stations.
5. Emergency lighting control.

B. Related Sections include the following:

1. Division 26 Section “Wiring Devices”
2. Division 26 Section “Interior Lighting”
3. Division 26 Section “Lighting Control Devices”

1.2 DEFINITIONS

A. BAS: Building automation system.

B. DDC: Direct digital control.

C. IP: Internet protocol.

1.3 DESIGN / PERFORMANCE REQUIREMENTS

A. Digital Lighting Management System shall accommodate the square-footage coverage requirements for each area controlled, utilizing room controllers, digital occupancy sensors, switches, daylighting sensors and accessories that suit the required lighting and electrical system parameters.

B. System shall conform to requirements of NFPA 70.

C. System shall comply with FCC emission standards specified in part 15, sub-part J for commercial and residential application.

D. System shall be listed under UL sections 916 and/or 508.

1.4 LIGHTING CONTROL APPLICATIONS

A. Minimum lighting control performance required, unless local Energy Code is more stringent:

1. Occupancy/Vacancy Requirements: Provide an occupancy/vacancy sensor with Manual On / Automatic Off or Automatic On / Automatic Off functionality in all spaces. Manual On vacancy sensors should be used for any enclosed space with a Manual On switch that does not require hands free operation. Spaces with multiple occupants or where line of sight might be obscured ceiling mount sensors and manual wallstations would be required. Automatic On of lighting via occupancy sensor cannot exceed 50% of lighting.
2. Daylight Zones: Primary sidelit areas within an enclosed space shall be controlled separately and automatically by a multi-level photocontrol device without the need for programming.
3. Provide smooth and continuous daylight dimming for areas marked on drawings. Daylighting control system may be designed to dim electric light to the lowest light level.
4. Provide the ability to adjust the high end and low end trim of the dimmers to ensure the lighting automatically provides energy saving even when daylighting calls for full illumination.

5. Provide the ability for the dimmers and the relays to function separately. Systems where the 0-10V dimmers and relays are tied together reduce design capabilities and shall not be acceptable.

1.5 ACTION SUBMITTALS

A. Submit product data and shop drawings in accordance with Division 01 and Division 26 Section “Electrical Shop Drawings” for products specified under PART 2 - PRODUCTS.

B. Specification Compliance Certification: Submit a Specification Compliance Certification in accordance with Division 26 Section “Electrical Shop Drawings and Submittals”.

C. Product Data: For each type of product.

1. Catalog sheets and specifications.
2. Ratings, configurations, standard wiring diagrams, dimensions, colors, service condition requirements and installed features.
3. Storage and handling requirements and recommendations.
4. Installation instructions.

D. Shop Drawings: For each relay panel and related equipment.

1. Composite wiring and/or schematic diagram of each control circuit, as proposed, to be installed.
2. Show location of all devices, including at minimum sensors, load controllers, and switches/dimmers for each area on Drawings.
3. Provide room/area details including products and sequence of operation for each room or area. Illustrate typical acceptable room/area connection topologies.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For testing agency.

B. Field quality-control reports.

C. Software licenses and upgrades required by and installed for operation and programming of digital and analog devices.

D. Sample Warranty: For manufacturer's special warranty.

1.7 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For lighting controls to include in emergency, operation, and maintenance manuals.

1. Approved Shop Drawings and product data.
2. Sequence of Operation, identifying operation for each room or area.
3. Manufacturer’s maintenance information.
4. Detailed information on device programming and setup.
5. Startup and test reports.

B. Project Record Documents: Record actual installed locations and settings for lighting control devices.

C. Warranty: Copy of special warranty.

1.8 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. Occupancy Sensors: Provide 1 of each product type for every 100 installed, to be used for maintenance.
2. Daylight Sensors: Provide 1 of each product type for every 50 installed, to be used for maintenance.

3. Wallstations: Provide 1 of each product type for every 100 installed, to be used for maintenance.
4. Room Controller: Provide 1 of each product type for every 100 installed, to be used for maintenance.

1.9 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing of centralized and distributed lighting control systems with a minimum of 10 years documented experience.

B. Installer Qualifications: Company certified by the manufacturer and specializing in installation of networked lighting control products with minimum three years documented experience.

C. System Components: Demonstrate that individual components have undergone quality control and testing prior to shipping.

D. Testing Agency Qualifications: Accredited by NETA.

1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

E. All components shall be UL 916 listed (or listed with other equivalent listing sources) as an energy management system.

F. All control wiring shall be in accordance to the NEC for class 2 remote control systems (Article 725).

G. The lighting control system shall comply with all IECC 2015 energy codes (at a minimum). If local or state energy codes exceed this requirement, those codes shall be the reference standard for compliance.

H. Comply with the latest edition of the NEC and all local/state codes as required.

I. Source Limitations: Obtain control systems from a single manufacturer.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Packaging: All components of the lighting control system shall be packaged in a single box or as individual components. The catalog number will be marked on package label along with bill of materials. Individual component packages will be marked with product catalog number.

B. Handling: Packaging will include clear installation instructions for all components with typical illustrations of installation locations and connections. The installing contractor can easily match each package to the layout on the design floor plans.

C. Store products in a clean, dry space in original manufacturer's packaging in accordance with manufacturer's written instructions until ready for installation.

1.11 PROJECT CONDITIONS

A. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's absolute limits

B. Do not install equipment until following conditions can be maintained in spaces to receive equipment:

1. Ambient temperature: 32° to 104° F.
2. Relative Humidity: Maximum 90 percent, non-condensing.

C. Coordinate layout and installation of luminaires and controls with other construction.

D. Coordinate site commissioning with manufacturer no less than 21 days prior to required date.

1.12 WARRANTY

A. Warranty: Manufacturer agrees to repair or replace components of room controllers that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Damage from transient voltage surges.

2. Warranty Period: Cost to repair or replace any parts for five (5) years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Basis-of-Design Product: Subject to compliance with requirements, provide WattStopper Digital Lighting Management System or a comparable product by one of the following:

1. Eaton, Cooper Industries.
2. Leviton Mfg. Company Inc.
3. Lutron Electronics Co., Inc.
4. nLight, Acuity Brands Lighting, Inc.

2.2 DIGITAL LIGHTING CONTROL SYSTEM

A. Provide Digital Lighting Management System (DLM) complete with all necessary enclosures, wiring, and system components to ensure a complete and properly functioning system as indicated on Drawings and specified herein.

1. Space Control Requirements: Provide occupancy/vacancy sensors with Manual- or Partial-ON functionality as indicated in all spaces except corridors, toilet rooms, storerooms, or other applications where hands-free operation is desirable and Automatic-ON occupancy sensors are more appropriate. Provide Manual-ON occupancy/vacancy sensors for any enclosed office, conference room, meeting room, classroom, open plan system and training room.
2. Plug Loads: Provide automatic shut off of non-essential vending machine plug loads in spaces as indicated on Drawings. Provide Automatic-ON of plug loads whenever spaces are occupied. For spaces with multiple occupants a single shut off consistent with the overhead lighting may be used for the area.
3. Daylit Areas: Provide daylight-responsive automatic control in spaces where daylight contribution is available as defined by relevant local building energy code:
    a. All luminaires within code-defined daylight zones shall be controlled separately from luminaires outside of daylit zones.
    b. Daytime setpoints for total ambient illumination (combined daylight and electric light) levels that initiate dimming shall be programmed in compliance with relevant local building energy codes.
    c. Provide smooth and continuous daylight dimming for areas marked on drawings. Daylighting control system may be designed to turn off electric lighting when daylight is at or above required lighting levels, only if system functions to turn lamps back on at dimmed level, rather than turning full-on prior to dimming.

B. Equipment Required: Lighting Control and Automation system as defined under this section covers the following equipment.

1. Digital Lighting Management (DLM) local network: Free topology, plug-in wiring system (Cat 5e) for power and data to room devices.
2. Digital Room Controllers: Self-configuring, digitally addressable one, two or three relay plenum-rated controllers for on/off control. Selected models include 0-10 volt or line voltage forward phase control dimming outputs and integral current monitoring capabilities.
3. Digital Plug Load Controllers: Self-configuring, digitally addressable, single relay, plenum-rated application-specific controllers. Selected models include integral current monitoring capabilities.
4. Digital Occupancy Sensors: Self-configuring, digitally addressable, calibrated occupancy sensors with LCD display and two-way active infrared (IR) communications.

5. Digital Switches: Self-configuring, digitally addressable pushbutton on/off, dimming, and scene switches with two-way active infrared (IR) communications.
6. Digital Daylighting Sensors: Single-zone closed loop daylighting sensors with two-way active infrared (IR) communications for daylight harvesting using dimming control.
7. Emergency Lighting Control Unit (ELCU): Allows a standard lighting control device to control emergency lighting in conjunction with normal lighting in any area within a building.

C. Local Network LMRJ-Series: DLM local network is a free topology lighting control physical connection and communication protocol designed to control a small area of a building.
1. Features of the DLM local network include:
a. Plug n' Go automatic configuration and binding of occupancy sensors, switches and lighting loads to the most energy-efficient sequence of operation based upon the device attached.
b. Simple replacement of any device in the local DLM network with a standard off the shelf unit without requiring significant commissioning, configuration or setup.
c. Push n' Learn configuration to change the automatic configuration, including binding and load parameters without tools, using only the buttons on the digital devices in the local network.
d. Two-way infrared communications for control by handheld remotes, and configuration by a handheld tool including adjusting load parameters, sensor configuration and binding, within a line of sight of up to 30 feet from a sensor, wall switch or IR receiver.
2. Digital room devices connect to the local network using pre-terminated Cat 5e cables with RJ-45 connectors, which provide both data and power to room devices. Systems that utilize RJ-45 patch cords but do not provide serial communication data from individual end devices are not acceptable.
3. If manufacturer's pre-terminated Cat5e cables are not used for the installation each cable must be individually tested and observed by authorized service representative following installation.

2.3 DIGITAL LOAD CONTROLLERS (ROOM AND PLUG LOAD CONTROLLERS)

A. Digital Load Controllers: Digital controllers for lighting zones, and/or plug loads automatically bind room loads to the connected control devices in the space without commissioning or the use of any tools. Provide controllers to match the room lighting and plug load control requirements. Control units include the following features:
1. Automatic room configuration to the most energy-efficient sequence of operation based upon the devices in the room.
2. Simple replacement using the default automatic configuration capabilities, a room controller may be replaced with an off-the-shelf device.
3. Multiple room controllers connected together in a local network must automatically arbitrate with each other, without requiring any configuration or setup, so that individual load numbers are assigned starting with load 1 to a maximum of 64, assigned based on each controller's device ID's from highest to lowest.
4. Device status LEDs to indicate:
a. Data transmission.
b. Device has power.
c. Status for each load.
d. Configuration status.
5. Installation features include:

a. Standard junction box mounting.

b. Quick low voltage connections using standard RJ-45 patch cable.

6. Based on individual configuration, each load shall be capable of the following behavior on power up following the loss of utility power:

a. Turn On to 100 percent.

b. Turn Off.

c. Turn On to last level.

7. Each load shall be configurable to operate in the following sequences based on occupancy:

a. Auto On to 50% / Auto Off

b. Manual On / Auto Off

8. All digital parameter data programmed into an individual room controller or plug load controller shall be retained in non-volatile FLASH memory within the controller itself. Memory shall have an expected life of no less than 10 years.

9. Dimming room controllers shall share the following features:

a. Each load shall have an independently configurable preset on level for Normal Hours and After Hours events to allow different dimmed levels to be established at the start of both Normal Hours and After Hours events.

b. Fade rates for dimming loads shall be specific to bound switch buttons, and the load shall maintain a default value for any bound buttons that do not specify a unique value.

c. The following dimming attributes may be changed or selected using a wireless configuration tool:

1) Establish preset level for each load from 0-100 percent.

2) Set high and low trim for each load.

d. Override button for each load provides the following functions:

1) Press and release for on/off control.

2) Press and hold for dimming control.

e. Each dimming output channel shall have an independently configurable minimum and maximum calibration trim level to set the dimming range to match the true dynamic range of the connected driver. LED level indicators on bound dimming switches shall utilize this new maximum and minimum trim.

f. Each dimming output channel shall have an independently configurable minimum and maximum trim level to set the dynamic range of the output within the new 0-100 percent dimming range defined by the minimum and maximum calibration trim.

g. Calibration and trim levels must be set per output channel. Devices that set calibration or trim levels per controller (as opposed to per load) are not acceptable.

h. All configuration shall be digital. Devices that set calibration or trim levels per output channel via trim pots or dip-switches are not acceptable.

B. On/Off/0-10V Dimming Enhanced Room Controllers shall include:

1. One, two or three relay configurations.

2. Four (4) RJ-45 DLM local network ports. Provide integral strain relief.

3. One (1) dimming output per relay.

a. 0-10V Dimming - Where indicated, one 0-10 volt analog output per relay for control of compatible LED drivers. The 0-10 volt output shall automatically open upon loss

of power to the Room Controller to assure full light output from the controlled lighting (LMRC-210 series).

4. WattStopper product numbers: LMRC-111, LMRC-112, LMRC-211, LRMC-212, LRMC-213.

C. Plug Load Controllers shall include:

1. 120 VAC, 60 Hz rated for 20A total load. Controller carries application-specific UL 20 rating for receptacle control.
2. One relay configuration with additional connection for unswitched load.
3. Configurable additive time delay to extend plug load time delay beyond occupancy sensor time delay (e.g. a 10 minute additive delay in a space with a 20 minute occupancy sensor delay ensures that plug loads turn off 30 minutes after the space is vacated).
4. Factory default operation is Auto-on/Auto-off, based on occupancy.
5. RJ-45 DLM local network ports
   a. Four RJ-45 ports (LMPL-201)
6. WattStopper product numbers:
   a. Plug Load Controllers: LMPL-201.
   b. Wireless Transceiver and Receptacles: WRC-TX-LM, WRC-15-1/2, WRC-20-1/2.

2.4 DIGITAL WALL OR CEILING MOUNTED OCCUPANCY SENSOR

A. Digital Occupancy Sensors shall provide graphic LCD display for digital calibration and electronic documentation. Features include the following:

1. Digital calibration and pushbutton configuration for the following variables:
   a. Sensitivity, 0-100 percent in 10 percent increments.
   b. Time delay, 1-30 minutes in 1 minute increments.
   c. Test mode, Five second time delay.
   d. Dual Technology activation and/or re-activation.
   e. Walk-through mode.
2. Load parameters including Auto/Manual-ON, blink warning, and daylight enable/disable when photosensors are included in the DLM local network.
3. Programmable control functionality including:
   a. Sensor shall be capable of activating one of 16 user-definable lighting scenes.
   b. Adjustable retrigger time period for manual-on loads. Load will retrigger (turn on) automatically within a configurable period of time (default 10 seconds) after turning off.
4. Two-way infrared (IR) transceiver to allow remote programming through handheld commissioning tool and control by remote personal controls.
5. Device Status LEDs, which may be disabled for selected applications, including:
   a. PIR detection.
   b. Ultrasonic detection
   c. Configuration mode
   d. Load binding
6. Assignment of occupancy sensor to a specific load within the room without wiring or special tools.
7. Manual override of controlled loads.

8. All digital parameter data programmed into an individual occupancy sensor shall be retained in non-volatile FLASH memory within the sensor itself. Memory shall have an expected life of no less than 10 years.

B. Multiple Occupancy Sensors may be installed in a room by connecting them to the topology DLM local network. No additional configuration will be required.

C. WattStopper product numbers: LMPX, LMDX, LMPC, LMUC, LMDC.

2.5 ROOM CONTROLLER ZONE WALLSTATIONS

A. Low voltage momentary pushbutton switches in 1-button configuration; available in white; compatible with wall plates with decorator opening. Wallstations shall include the following features:

1. Two-way infrared (IR) transceiver for use with personal and configuration remote controls.
2. Removable buttons for field replacement with engraved buttons and/or alternate color buttons. Button replacement may be completed without removing the switch from the wall.
3. Configuration LED on each switch that blinks to indicate data transmission.
4. All digital parameter data programmed into an individual wall switch shall be retained in non-volatile FLASH memory within the sensor itself. Memory shall have an expected life of no less than 10 years.
5. Two RJ-45 ports for connection to the DLM local network.
6. WattStopper product numbers: LMSW-100 series.

B. Low voltage momentary pushbutton dimming switches in 1-button configuration; available in white; compatible with wall plates with decorator opening. Wallstations shall include the following features:

1. LED bar graph on side of device indicates relative light level of controlled load.
2. Two-way infrared (IR) transceiver for use with personal and configuration remote controls.
3. Removable buttons for field replacement with engraved buttons and/or alternate color buttons. Button replacement may be completed without removing the switch from the wall.
4. Configuration LED on each switch that blinks to indicate data transmission.
5. All digital parameter data programmed into an individual wall switch shall be retained in non-volatile FLASH memory within the sensor itself. Memory shall have an expected life of no less than 10 years.
6. Two RJ-45 ports for connection to the DLM local network.
7. WattStopper product number: LMDM-100 series.

C. Multiple digital wallstations may be installed in a room by simply connecting them to the DLM local network. No additional configuration will be required to achieve multi-way switching.

2.6 DIGITAL DAYLIGHT SENSORS

A. Digital daylighting sensors shall work with load controllers and relay panels to provide automatic switching, bi-level, or tri-level or dimming daylight harvesting capabilities for any load type connected to the controller or panel. Daylighting sensors shall be interchangeable without the need for rewiring.

1. Closed loop sensors measure the ambient light in the space and control a single lighting zone.

B. Digital daylight sensors include the following features:

1. An internal photodiode that measures lightwaves within the visible spectrum and has a response curve that closely matches the photopic curve.

2. Sensor light level range shall be from 1-6,553 foot-candles (fc).
3. For dimming daylight harvesting, the photosensor shall provide the option, when the daylight contribution is sufficient, of turning lights off or dimming lights to a field-selectable minimum level.
4. Photosensors shall have a digital, independently configurable fade rate for both increasing and decreasing light level in units of percent per second.
5. Integral infrared (IR) transceiver for configuration and/or commissioning with a handheld configuration tool, to transmit detected light level to wireless configuration tool, and for communication with personal remote controls.
6. Configuration LED status light on device that blinks to indicate data transmission.
7. One RJ45 port for connection to Room Controller local network.
8. Status LED indicates test mode, override mode and load binding.
9. All digital parameter data programmed into a photosensor shall be retained in non-volatile FLASH memory within the photosensor itself. Memory shall have an expected life of no less than 10 years.

C. Closed loop digital daylight sensor includes the following additional features:

1. An internal photodiode that measures light in a 100-degree angle, cutting off the unwanted light from bright sources outside of this cone.
2. Automatic self-calibration, initiated from the photosensor, a wireless configuration tool or a PC with appropriate software.
3. Automatically establishes application-specific setpoints following self-calibration. For switching operation, an adequate deadband between the ON and OFF setpoints shall prevent the lights from cycling; for dimming operation a sliding setpoint control algorithm with separate Day and Night setpoints shall prevent abrupt ramping of loads.
4. WattStopper product number: LMLS-400 series.

2.7 EMERGENCY LIGHTING CONTROL DEVICES

A. Emergency Power Control – A UL 924 listed device installs down line of an output that monitors a switched or dimmed circuit providing normal lighting to an area. The unit provides normal ON/OFF or 0-10V dimming control of emergency lighting along with the normal lighting. Upon normal power failure the emergency lighting circuit will close, forcing the emergency lighting ON until normal power is restored. Features include:

1. 120/277 volts, 50/60 Hz., 20 amp ballast rating.
2. Push to test button.
3. Auxiliary contact for remote test or fire alarm system interface

PART 3 - EXECUTION

3.1 EXAMINATION

A. Receive, inspect, handle, and store panels according to NECA 407.

B. Examine elements and surfaces to receive room controllers for compliance with installation tolerances and other conditions affecting performance of the Work.

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

3.2 EQUIPMENT INSTALLATION

A. The control system shall be installed and fully wired as shown on the plans by the installing contractor. The contractor shall complete all electrical connections to all control circuits.

B. Install all room/area devices using manufacturer's factory-tested Cat 5e cable with pre-terminated RJ-45 connectors.

1. If pre-terminated cable is not used for room/area wiring, each field-terminated cable shall be tested following installation and testing results submitted to the Manufacturer's Representative for approval prior to proceeding with the Work.
2. If fixtures have internal DLM Control Modules, ensure that they are also connected with Cat 5e cable.
3. Install all room to room network devices using manufacturer-supplied LM-MSTP network wire or wireless devices. Network wire substitution is not permitted and may result in loss of product warranty.
4. Low voltage wiring topology must comply with manufacturer's specifications.
5. Route network wiring as indicated on the Drawings as closely as possible. Document final wiring location, routing and topology on as built drawings.

C. Install the work of this Section in accordance with manufacturer’s printed instructions unless otherwise indicated.

D. All line voltage connections shall be tagged to indicate circuit and switched legs.

E. Test all devices to ensure proper communication.

F. Calibrate all sensor time delays and sensitivity to guarantee proper detection of occupants and energy savings. Adjust time delay so that controlled area remains lighted while occupied.

G. Provide written or computer-generated documentation on the commissioning of the system including room by room description including:

1. Sensor parameters, time delays, sensitivities and daylighting setpoints.
2. Sequence of operation.
3. Load parameters.

3.3 WIRING INSTALLATION

A. Comply with NECA 1.

B. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

C. 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.

D. General requirements:

1. All cabling shall be plenum rated cable for all plenum areas.
2. It is permissible to install cabling exposed (without conduit) in areas above lay-in ceilings. All other low voltage cabling shall be installed in conduit. This includes but is not limited to mechanical rooms, areas without lay-in style ceilings, areas with hard (non-removable) ceilings, etc.
3. All cabling installed exposed shall be installed in J-hooks. It is not acceptable to “tie-wrap” cables to structural building members, install cables unsupported, or to install cable through structural members as a means of support. Cables shall also be installed in a neat and orderly manner. Cable shall be installed at angles parallel or perpendicular to structural members. Diagonal or “shortest path” installations of cable is not acceptable.
4. Conduits ends shall include bushings for protection of the cable(s) entering or leaving the conduit when transitioning from areas requiring installation in conduit to areas that do not require conduit installation.

3.4 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

B. Provide self-adhesive label on ceiling or ceiling grid below each local room controller to identify the specific module mounted above ceiling. Provide unique naming convention for each local room controller. Provide same label to room controller itself.

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 according to manufacturer's start-up procedures.

B. Prepare test and inspection reports, including a certified report that identifies lighting control panels and describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations made after remedial action.

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.
2. Confirm correct communications wiring, initiate communications between panels, and program the lighting control system according to approved configuration schedules, time-of-day schedules, and input override assignments.

3.7 PRODUCE SUPPORT AND SERVICE

A. Factory telephone support shall be available at no cost to the owner. Factory assistance shall consist of solving programming or application questions concerning the control equipment.

3.8 COMMISSIONING

A. Upon completion of the installation, the system shall be commissioned by both the manufacturer's factory authorized representative who will verify a complete fully functional system as well as the Project's Commissioning Agent.

B. The electrical contractor shall provide both the manufacturer and the electrical engineer with twenty-one working days written notice of the system startup and adjustment date.

C. Upon completion of the system commissioning, the factory-authorized technician shall provide the proper training to the owner's personnel on the adjustment and maintenance of the system.

3.9 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain the control unit and operator interface.

END OF SECTION 26 0943

SECTION 26 2200
LOW-VOLTAGE TRANSFORMERS

PART 1 - GENERAL

1.01 SUMMARY

A. This Section includes the following types of high efficiency, dry-type transformers rated 600 V and less, with capacities up to 1000 kVA:

1. Distribution transformers.

1.02 ACTION SUBMITTALS

A. Submit product data and shop drawings in accordance with Division 01 and Division 26 Section “Electrical Shop Drawings and Submittals” for products specified under PART 2 - PRODUCTS.

B. Specification Compliance Certification: Submit a Specification Compliance Certification in accordance with Division 26 Section “Electrical Shop Drawings and Submittals”.

C. Product Data: Include rated nameplate data, capacities, weights, dimensions, minimum clearances, installed devices and features, and performance for each type and size of transformer indicated.

1. Include typical manufacturer’s test data reports for each type and size transformer. Reports shall include but not be limited to the following data:

a. Efficiency in accordance with DOE 2016 Efficiency.

b. Efficiency at 35-percent, 50-percent and 100-percent load.

c. Percent voltage regulation at 80-percent and 100-percent power factor.

d. Losses in kVA at no load and full load conditions.

e. Percent X and Percent R values,

f. Maximum sound level of transformer in enclosure (in dBA).

g. Maximum 30-Deg hot spot and average temperature rise over a 40-degree C ambient.

D. 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. Wiring Diagrams: Power, signal, and control wiring.

E. Warranty: Copy of special warranty specified in this Section.

1.03 INFORMATIONAL SUBMITTALS

A. Source quality-control test reports.

B. Field quality-control test reports.

1.04 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For transformers to include in emergency, operation, and maintenance manuals.

B. Warranty: Copy of warranty.

1.05 QUALITY ASSURANCE

A. Source Limitations: Obtain each transformer type 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 IEEE C57.12.91, "Test Code for Dry-Type Distribution and Power Transformers."

1.06 DELIVERY, STORAGE, AND HANDLING

A. Prepare equipment for shipment.

1. Provide suitable crating, blocking, and supports so equipment will withstand expected domestic shipping and handling shocks and vibration.

2. Weatherproof equipment for shipment. Close connection openings to prevent entrance of foreign material during shipment and storage.

B. Installation Pathway: Coordinate delivery of equipment to allow movement into designated space.

1. Deliver in shipping splits in sizes that can be moved past obstructions in delivery path.

2. Remove and replace access fencing, doors, lift-out panels, and structures to provide pathway for moving equipment into place.

C. Temporary Heating: Apply temporary heat according to manufacturer's written instructions within the enclosure of each ventilated-type unit, throughout periods during which equipment is not energized and when transformer is not in a space that is continuously under normal control of temperature and humidity.

D. Store equipment indoors in clean dry space with uniform temperature in accordance with manufacturer’s requirements to prevent condensation. Protect equipment from exposure to dirt, fumes, water, corrosive substances, and physical damage.

E. Handle equipment components according to manufacturer's written instructions. Use factory-installed lifting provisions.

1.07 COORDINATION

A. Coordinate size and location of concrete bases with actual transformer provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

B. Coordinate installation of wall-mounting and structure-hanging supports with actual transformer provided.

1.08 WARRANTY

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

1. Warranty Period: Twenty-five (25) year pro-rated warranty from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

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

1. Mirus International, Inc.

2. Power Quality International.

3. Powersmiths International Corp.

2.02 GENERAL TRANSFORMER REQUIREMENTS

A. Description: Factory-assembled and -tested, air-cooled units for 60-Hz service.

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. Transformers Rated 15 kVA and Larger:

1. Exceed 10 CFR 431 (DOE 2016) efficiency levels by 20 percent minimum.

2. Marked as compliant with DOE 2016 efficiency levels by an NRTL.

D. Comply with IEEE C57.12.91, "Test Code for Dry-Type Distribution and Power Transformers."

2.03 DISTRIBUTION TRANSFORMERS

A. Comply with NEMA ST 20, and list and label as complying with UL 1561.

B. Cores: Electrical grade, non-aging, silicon steel with high magnetic permeability and low hysteresis and eddy current losses. Magnetic flux densities are to be kept well below saturation to allow for a minimum of 10% over voltage excitation. The cores shall be clamped with structural angles (formed angles not acceptable) and bolted to the enclosure to prevent damage during shipment or rough handling.

1. One leg per phase.
2. Core volume shall allow efficient transformer operation at 10 percent above the nominal tap voltage.
3. Grounded to enclosure; the core and coils shall be visibly grounded to the frame of the transformer cubicle by means of a flexible grounding strap of adequate size.

C. Coils: Continuous windings without splices except for taps.

1. Coil Material: Copper.
2. Internal Coil Connections: Brazed or pressure type.
3. Terminal Connections: Welded.
4. Vacuum impregnated with non-hygroscopic, thermosetting varnish.
5. Each layer shall have end fillers or tie downs to provide maximum mechanical strength.
6. Materials incorporated must have at least a minimum of one year of proven field usage. Accelerated laboratory tests not acceptable in lieu of this field usage.
7. Provide final wrap of electrical insulating material to prevent injury to the magnet wire. Transformers having coils with magnet wire visible will not be acceptable.

D. Encapsulation: Transformers smaller than 30 kVA shall have core and coils completely resin encapsulated.

E. Enclosure for Interior Transformers: Ventilated, NEMA 250, Type 2.

1. Core and coil shall be encapsulated within resin compound, sealing out moisture and air.
2. Core and coil unit shall be completely isolated from the enclosure by means of a vibration isolating system and shall be so designed as to provide for continual securement of the core and coil unit to the enclosure.
3. KVA Ratings: Based on convection cooling only and not relying on auxiliary fans.
4. Wiring Compartment: Sized for conduit entry and wiring installation.

F. Transformer Enclosure Finish: Comply with NEMA 250. The entire enclosure shall be finished utilizing a continuous process consisting of degreasing, cleaning and phosphatizing, followed by electrostatic deposition of a polymer polyester powder coating and baking cycle to provide uniform coating of all edges and surfaces.

1. Finish Color: Gray weather-resistant enamel.

G. Taps for Transformers Smaller Than 3 kVA: None.

H. Taps for Transformers 7.5 to 14 kVA: One 5 percent tap above and one 5 percent tap below normal full capacity.

I. Taps for Transformers 15 kVA and Larger: Two 2.5 percent taps above and four 2.5 percent taps below normal full capacity.

J. Insulation Class, Smaller Than 30 kVA: 180 deg C, UL-component-recognized insulation system with a maximum of 130 deg C rise above 40 deg C ambient temperature.

K. Insulation Class, 30 kVA and Larger: 220 deg C, UL-component-recognized insulation system with a maximum of 130 deg C rise above 40 deg C ambient temperature.

L. The maximum top of case temperature shall not exceed 35 deg C above ambient.

M. Grounding: Provide ground bar kit or a ground bar installed on the inside of the transformer enclosure.

N. K-Factor Rating: Transformers shall be K-13 rated and shall comply with UL 1561 requirements for non-sinusoidal load current-handling capability to the degree defined by designated K-factor.

1. Unit shall not overheat when carrying full-load current with harmonic distortion corresponding to designated K-factor, without exceeding the indicated insulation class in a 40 deg C maximum ambient and a 24-hour average ambient of 30 deg C.
2. Indicate value of K-factor on transformer nameplate.
3. Construct K-rated transformers in accordance with requirements of Distribution Transformers listed above, unless otherwise indicated.
4. Unit shall comply with requirements of DOE 2016 efficiency levels when tested according to NEMA TP2 with a K-factor equal to one.

O. Electrostatic Shielding: Each winding shall have an independent, single, full-width copper electrostatic shield arranged to minimize interwinding capacitance.

1. Arrange coil leads and terminal strips to minimize capacitive coupling between input and output terminals.
2. Include special terminal for grounding the shield.

P. Neutral: Rated 200 percent of full load current for K-factor-rated transformers.

Q. Impedance: Between 3.5% and 5.8% unless otherwise noted.

R. Zero Sequence Impedance/Reactance: Less than 0.95% and 0.3% respectively.

S. Wall Brackets: Manufacturer's standard brackets.

T. Low-Sound-Level Requirements: Maximum sound levels, when factory tested according to IEEE C57.12.91, as follows:

1. 9 kVA and Less: 40 dBA
2. 10 to 45 kVA: 42 dBA
3. 46 to 150 kVA: 45 dBA
4. 151 to 300 kVA: 50 dBA
5. 301 to 500 kVA: 54 dBA
6. 501 to 750 kVA: 57 dBA
7. 751 to 1000 kVA: 59 dBA

2.04 IDENTIFICATION DEVICES

A. Nameplates: Engraved, laminated-plastic or metal nameplate for each distribution transformer, mounted with corrosion-resistant screws. Nameplates and label products are specified in Division 26 Section "Identification for Electrical Systems."

2.05 SOURCE QUALITY CONTROL

A. Test and inspect transformers according to IEEE C57.12.01 and IEEE C57.12.91.

1. Resistance measurements of all windings at rated voltage connections and at all tap connections.
2. Ratio tests at rated voltage connections and at all tap connections.
3. Phase relation and polarity tests at rated voltage connections.
4. No load losses, and excitation current and rated voltage at rated voltage connections.
5. Impedance and load losses at rated current and rated frequency at rated voltage connections.
6. Applied and induced tensile tests.

7. Regulation and efficiency at rated load and voltage.
8. Insulation-Resistance Tests:
   a. High-voltage to ground.
   b. Low-voltage to ground.
   c. High-voltage to low-voltage.
9. Temperature tests.

B. Factory Sound-Level Tests: Conduct sound-level tests on equipment for this Project.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine conditions for compliance with enclosure- and ambient-temperature requirements for each transformer.

B. Verify that field measurements are as needed to maintain working clearances required by NFPA 70 and manufacturer's written instructions.

C. Examine walls, floors, roofs, and concrete bases for suitable mounting conditions where transformers will be installed.

D. Verify that ground connections are in place and requirements in Division 26 Section "Grounding and Bonding for Electrical Systems" have been met. Maximum ground resistance shall be 5 ohms at location of transformer.

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

3.02 APPLICATION

A. Transformer Mounting
   1. 15 kVA or less: Floor mounted or suspended, as indicated.
   2. 30 kVA and 45kVA: floor mounted, rack mounted or suspended, as indicated.
   3. 75 kVA: Floor mounted or rack mounted, as indicated.
   4. Greater than 75 kVA: Floor mounted or rack mounted, unless otherwise indicated.

3.03 INSTALLATION

A. Comply with NECA 409, “Recommended Practice for Installing and Maintaining Dry-Type Transformers” as published by the National Electrical Contractors Association.

B. Install wall-mounted transformers level and plumb with wall brackets fabricated by transformer manufacturer.
   1. Coordinate installation of wall-mounted and structure-hanging supports with actual transformer provided.

C. Install transformer level and plumb on a concrete base with vibration-dampening supports. Locate transformers away from corners and not parallel to adjacent wall surface.

D. Construct concrete bases and anchor floor-mounting transformers level on concrete bases, 4-inch nominal thickness according to manufacturer's written instructions and requirements in Division 26 Section "Hangers and Supports for Electrical Systems." Concrete materials and installation requirements are specified in Division 3.

E. Construction steel channel support system for rack-mounted or suspended transformers according to manufacturer’s written instruction and requirements of Division 26 Section “Hangers and Supports for Electrical Systems.”

F. Secure covers to enclosure and tighten all bolts to manufacturer-recommended torques to reduce noise generation.

G. Remove shipping bolts, blocking, and wedges.

3.04 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in Division 26 Section "Identification for Electrical Systems."

B. Transformer Nameplates: Label each transformer with Engraved, laminated-plastic or metal nameplate for each transformer, mounted with corrosion-resistant screws. Nameplates and label products are specified in Division 26 Section "Identification for Electrical Systems."

3.05 CONNECTIONS

A. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

B. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power 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-486B.

D. Provide flexible metal conduit with a minimum 12-inch to a maximum 24-inch length for wiring connections to transformer enclosure.

3.06 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.

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.

B. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.

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

D. Infrared Scanning: Two months after Substantial Completion, perform an infrared scan of transformer connections.

1. Use an infrared-scanning device designed to measure temperature or detect significant deviations from normal values. Provide documentation of device calibration.

2. Prepare a certified report identifying transformer checked and describing results of scanning. Include notation of deficiencies detected, remedial action taken, and scanning observations after remedial action.

E. Test Labeling: On completion of satisfactory testing of each unit, attach a dated and signed "Satisfactory Test" label to tested component.

3.07 ADJUSTING

A. Record transformer secondary voltage at each unit for at least 48 hours of typical occupancy period. Adjust transformer taps to provide optimum voltage conditions at secondary terminals. Optimum is defined as not exceeding nameplate voltage plus 10 percent and not being lower than nameplate voltage minus 3 percent at maximum load conditions. Submit recording and tap settings as test results.

B. Output Settings Report: Prepare a written report recording output voltages and tap settings.

3.08 CLEANING

A. Clean components according to manufacturer's written instructions.

B. On completion of installation, inspect interior and exterior surfaces and perform the following:

1. Remove paint splatters and other spots.

2. Vacuum dirt and debris; do not use compressed air to assist in cleaning.

3. Repair exposed surfaces to match original finish.

3.09 PROTECTION

A. Temporary Heating: Maintain a clean dry space with uniform temperature in accordance with manufacturer's requirements to prevent condensation. Apply temporary heating as required.

B. Protect equipment from exposure to dirt, fumes, water, corrosive substances, and physical damage.

END OF SECTION 26 2200

SECTION 26 2413
SWITCHBOARDS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Service and distribution switchboards rated 600 V and less.
2. Surge protection devices.
3. Disconnecting and overcurrent protective devices.
4. Instrumentation.
5. Control power.
6. Accessory components and features.
7. Identification.

B. Related Sections include the following:

1. Division 26 Section "Overcurrent Protective Device Studies" for short-circuit rating of devices and for setting of overcurrent protective devices.
2. Division 26 Section "SPD for Low-Voltage Electrical Power Circuits" for internal surge protective devices.

1.02 DEFINITIONS

A. DPM: Multifunction Digital-Metering Monitor

B. EMI: Electromagnetic interference.

C. GFCI: Ground-fault circuit interrupter.

D. GFEP: Ground-fault equipment protection.

E. RFI: Radio-frequency interference.

F. RMS: Root mean square.

G. SCADA: Supervisory Control And Data Acquisition.

H. SPDT: Single pole, double throw.

1.03 PERFORMANCE REQUIREMENTS

A. Overcurrent Protective Device Coordination for Emergency Systems and Legally Required Standby Systems: All overcurrent protective devices proposed for inclusion in the Work on the Emergency Systems branch (NEC Article 700) and the Legally Required Standby System branch (NEC Article 701) shall be selected to be selectively coordinated with the overcurrent protective devices installed on their supply side such that an overcurrent event (overload, short-circuit, or ground-fault) occurring at the lowest level in the system (branch circuit) cannot cause the feeder protective device supplying the branch circuit panelboard to open. This coordination shall be carried through each level of distribution for both normal and emergency power. Refer to Division 26 Section "Overcurrent Protective Device Studies" for additional requirements.

B. Overcurrent Protective Device Coordination: All other overcurrent protective devices proposed for inclusion in the Work shall be selected to be coordinated with the overcurrent protective devices installed on their supply side such that an overcurrent event (overload, short-circuit, or ground-fault) occurring at the lowest level in the system (branch circuit) cannot cause the feeder protective device supplying the branch circuit panelboard to open. This coordination shall be carried through each level of distribution for all branches of normal and emergency power to 0.10 seconds. Refer to Division 26 Section "Overcurrent Protective Device Studies" for additional requirements.

1.04 ACTION SUBMITTALS

A. Submit product data and shop drawings in accordance with Division 01 and Division 26 Section “Electrical Shop Drawings and Submittals” for products specified under PART 2 - PRODUCTS.

B. Specification Compliance Certification: Submit a Specification Compliance Certification in accordance with Division 26 Section “Electrical Shop Drawings and Submittals”.

C. Simultaneous Action Submittals: Switchboard Product Data submittal shall be made in conjunction with action submittals required under Division 26 Section “Overcurrent Protective Device Studies.” The release of electrical equipment submittals (panelboards, engine generators, switchgear, etc.) is dependent on the receipt of a complete and accurate overcurrent protective device coordination study. The Architect and Engineer require a full submittal review period as delineated in Division 01 Section “Administrative Requirements” to adequately review the OCPD study against the submitted electrical components prior to release of submittals for equipment procurement. The submittal schedule required by Division 01 requirements shall provide for this review time in the action submittal process. Delay claims arising due to Contractor’s failure to coordinate simultaneous action submittals will not be considered by the Owner.

D. Product Data: For each type of switchboard, overcurrent protective device, transient voltage suppression device, ground-fault protector, accessory, and component indicated, include the following:

1. Manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.
2. Rated capacities, features, operating characteristics, furnished specialties, factory settings, accessories and time-current characteristic curves for individual relays and overcurrent protective devices.
    a. Time-current curves for each type of overcurrent protection device. Include hardcopy of characteristic curve and TCC Number for use with Power Tools by SKM Systems Analysis, Inc. Indicate available setting points and selectable ranges for each type of adjustable overcurrent protection device.
3. Hardcopy layout of each display screen in HMI and DPM.
4. Power Monitoring Block Diagram: Show devices monitored and interconnections between components specified in this Section. Indicate data communication paths and identify networks, data buses, data gateways, concentrators, and other devices to be used. Describe characteristics of network and other data communication lines. Illustrate coordination among related equipment and power monitoring and control.

E. Shop Drawings: For each switchboard and related equipment, include the following:

1. Dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show method of field assembly and location and size of each field connection. Include the following:
    a. Tabulation of installed devices with equipment features and ratings.
    b. Enclosure types and details for types other than NEMA 250, Type 1.
    c. Outline and general arrangement drawing showing dimensions, shipping sections, and weights of each assembled section.
    d. Bus configuration with size and number of conductors in each bus run, including phase, neutral, and ground conductors of main and branch buses.
    e. One-line diagram.
    f. Horizontal and vertical bus current and voltage ratings.

g. Short-time and short-circuit current rating of switchboards and overcurrent protective devices.

h. Feeder entry locations and lug configuration.

i. Floor plan drawing showing locations for anchor bolts.

j. Nameplate legends.

k. Descriptive documentation of optional barriers specified for electrical insulation and isolation.

l. Evidence of NRTL listing for series rating of installed devices.

m. Features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.

n. Schematic and wiring diagrams for power, signal, and control wiring.

2. Wiring Diagrams: For each type of switchboard and related equipment, include the following:

a. Power, signal, and control wiring.

b. Three-line diagrams of current and future secondary circuits showing device terminal numbers and internal diagrams.

c. Schematic control diagrams.

d. Diagrams showing connections of component devices and equipment.

e. Schematic diagrams showing connections to remote devices.

F. Warranty: Copy of special warranty specified in this Section.

1.05 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer.

B. Field Quality-Control Reports:

1. Test procedures used.

2. Test results that comply with requirements.

3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

1.06 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For switchboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Closeout Submittals," include the following:

1. Routine maintenance requirements for switchboards and all installed components.

2. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.

3. Time-current coordination curves for each type and rating of overcurrent protective device included in switchboards. Submit on translucent log-log graft paper; include selectable ranges for each type of overcurrent protective device.

4. Manufacturer’s sample system checklists and log sheets.

B. Warranty: Copy of warranty.

1.07 QUALITY ASSURANCE

A. Installer Qualifications: An employer of workers qualified as defined in NEMA PB 2.1 and trained in electrical safety as required by NFPA 70E.

B. Testing Agency Qualifications: Member company of NETA or an NRTL.

1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.

C. Source Limitations: Obtain switchboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.

1. Breaker Manufacturer: Manufacturer for breakers shall be the same as the manufacturer of other breakers proposed for other portions of the Work.

D. Product Selection for Restricted Space: Drawings indicate maximum dimensions for switchboards including clearances between switchboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.

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.

F. Comply with NEMA PB 2.

G. Comply with NFPA 70.

H. Comply with UL 891.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Prepare equipment for shipment.

1. Provide suitable crating, blocking, and supports so equipment will withstand expected domestic shipping and handling shocks and vibration.

2. Weatherproof equipment for shipment. Close connection openings to prevent entrance of foreign material during shipment and storage.

B. Deliver switchboards in sections or lengths that can be moved past obstructions in delivery path.

C. Remove loose packing and flammable materials from inside switchboards and install temporary electric heating (250 W per section) to prevent condensation.

D. Installation Pathway: Coordinate delivery of equipment to allow movement into designated space.

1. Deliver in shipping splits in sizes that can be moved past obstructions in delivery path.

2. Remove and replace access fencing, doors, lift-out panels, and structures to provide pathway for moving equipment into place.

E. Store equipment indoors in clean dry space with uniform temperature in accordance with manufacturer’s requirements to prevent condensation. Protect equipment from exposure to dirt, fumes, water, corrosive substances, and physical damage.

F. Handle equipment components according to manufacturer's written instructions. Use factory-installed lifting provisions.

G. Handle and prepare switchboards for installation according to NEMA PB 2.1.

1.09 PROJECT CONDITIONS

A. Installation Pathway: Remove and replace access fencing, doors, lift-out panels, and structures to provide pathway for moving switchboards into place.

B. Environmental Limitations:

1. Do not deliver or install switchboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above switchboards 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.

2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:

a. Ambient Temperature: Not exceeding 104 deg F.

b. Altitude: Not exceeding 6600 feet.

C. Service Conditions: NEMA PB 2, usual service conditions, as follows:

1. Ambient temperatures within limits specified.

2. Altitude not exceeding 6600 feet.

1.10 COORDINATION

A. Coordinate layout and installation of switchboards 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 sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

1.11 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace transient voltage suppression devices that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Two (2) years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

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

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.

2. ABB (General Electric Company); Industrial Connection & Solutions, LLC.

3. Siemens Energy & Automation, Inc.

4. Square D; a brand of Schneider Electric.

2.02 RATINGS

A. Suitable for application in 3-phase, 60-Hz, solidly grounded-neutral system, unless otherwise indicated.

B. Nominal System Voltage: As indicated on the Drawings.

C. Main-Bus: Amperage as indicated on the Drawings. Provide continuous rating across entire length of main-bus.

D. Short-Time and Short-Circuit Current: Match rating of highest-rated overcurrent protective device in switchboard assembly.

1. Available Short-Circuit Current: As indicated on the Drawings. Refer to Division 26 Section "Overcurrent Protective Device Studies" for additional requirements.

2.03 MANUFACTURED UNIT FABRICATION

A. Factory assembled and tested and complying with UL 891; including devices complying with UL 489.

B. Mounting height of breakers shall be in accordance with NFPA 70 requirements. Fabrication of equipment shall take housekeeping pad dimension into account in determining height of top breaker in all sections. Refer to Division 26 Section "Hangers and Supports for Electrical Systems" for housekeeping pad specifications.

C. Front-Connected, Front-Accessible Switchboards: Front and Rear aligned, with features as follows:

1. Main and Tie Devices: Fixed, individually mounted, insulated case circuit breakers.
2. Feeder Devices: Panel mounted, thermal-magnetic circuit breakers.
    a. Provide electronic trip-unit circuit breakers for feeders serving Emergency Systems or Legally Required Standby Systems.

D. Indoor Enclosure Fabrication: Steel, rated for environmental conditions at installed location.

1. Indoor Location Rating: NEMA 250, Type 1.
2. Wet or Damp Indoor Location Rating: NEMA 250, Type 4.
3. Finish: Factory-applied finish in manufacturer's standard ANSI Gray enamel over corrosion-resistant treatment or rust-inhibiting primer coat.
4. Hinged Front Panels: Allow access to metering, accessory, and blank compartments. Hinged panels must be arranged for minimum of 120-degree swing; standard 90-degrees swing is not acceptable.
5. Access: Removable, Hinged Front and Compartment Covers secured by captive bolts for access to interior of switchboard.

E. Enclosure Finish for Indoor Units: Factory-applied finish in manufacturer's standard gray finish over a rust-inhibiting primer on treated metal surface.

F. Barriers: Between adjacent switchboard sections.

G. Insulation and isolation for main and vertical buses of feeder sections.

H. Service Entrance Rating: Switchboards intended for use as service entrance equipment shall contain from one to six service disconnecting means with overcurrent protection, a neutral bus with disconnecting link, a grounding electrode conductor terminal, and a main bonding jumper.

I. Customer Metering Compartment: A separate customer metering compartment and section with front hinged door, for indicated metering, and current transformers for each meter. Current transformer secondary wiring shall be terminated on shorting-type terminal blocks.

J. Bus Transition and Incoming Pull Sections: Matched and aligned with basic switchboard.

K. Hinged Front Panels: Allow access to circuit breaker, metering, accessory, and blank compartments.

L. Buses and Connections: Three phase, four wire unless otherwise indicated.

1. Provide phase bus arrangement A, B, C from front to back, top to bottom, and left to right when viewed from the front of the switchboard.
2. Phase- and Neutral-Bus Material: Hard-drawn copper of 98 percent conductivity, silver-plated, with copper feeder circuit-breaker line connections.
3. Ground Bus: 1/4-by-2-inch-, hard-drawn copper of 98 percent conductivity, equipped with mechanical connectors for feeder and branch-circuit ground conductors. For busway feeders, extend insulated equipment grounding cable to busway ground connection and support cable at intervals in vertical run.
4. Main Phase Buses and Equipment Ground Buses: Uniform capacity for entire length of switchboard's main and distribution sections. Provide for future extensions from both ends.
5. Disconnect Links:
    a. Isolate neutral bus from incoming neutral conductors.
    b. Bond neutral bus to equipment-ground bus for switchboards utilized as service equipment or separately derived systems.

6. Neutral Buses: 100 percent of the ampacity of phase buses unless otherwise indicated, equipped with mechanical connectors for outgoing circuit neutral cables. Brace bus extensions for busway feeder neutral bus.

M. Future Devices: Equip compartments with mounting brackets, supports, bus connections, and appurtenances at full rating of circuit-breaker compartment.

N. Surge Protection Device: Where indicated on Drawings. IEEE C62.41-compliant, internally mounted in its own compartment, solid-state, parallel-connected, modular (with field-replaceable modules) type, with sine-wave tracking suppression and filtering modules, short-circuit current rating complying with UL 1449, second edition, and matching or exceeding the switchboard short-circuit rating, redundant suppression circuits, with individually fused metal-oxide varistors.

O. Phase Loss Protection: Provide a phase failure relay on main circuit breaker complete with capacitor trip device and shunt trip. Relay shall be able to be bypassed at any time. All devices shall be factory installed.

1. Manufacturer: Taylor Electronics, Inc. Phase-Guard PND Model or Owner-approved equal.
2. Provide the following options and accessories on the phase failure relay:
   a. Adjustable phase unbalance from 5 to 15 percent.
   b. Adjustable time delay from 0.5 to 20 seconds.
   c. Remote display module mounted to the front of the main section of the switchboard with USB connection for computer.
   d. Relay shall not trip on total power loss.

2.04 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

A. Enclosed, Insulated-Case Circuit Breaker (ICCB): 100 percent rated, sealed, insulated-case power circuit breaker with interrupting capacity rating to meet available fault current.

1. Fixed circuit-breaker mounting.
2. Two-step, stored-energy closing.
3. Standard-function, microprocessor-based trip units with interchangeable rating plug, trip indicators, and the following field-adjustable settings:
   a. Instantaneous trip.
   b. Long- and short-time time adjustments with I2t response.
   c. Long- and short-time pickup levels.
   d. Ground-fault pickup level, time delay, and I2t response.
4. Remote trip indication and control.
5. Insulated-Case Circuit-Breaker (ICCB) Features and Accessories:
   a. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor material; UL 486B listed, dual rated and marked for use with copper or aluminum load-side conductors.
   b. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
   c. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function and short-time function.
   d. Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at 55 percent of rated voltage.
   e. Auxiliary Contacts: One SPDT switch with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts.

f. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.

g. Padlocking Provisions: For installing at least three padlocks on each circuit breaker to secure its enclosure and prevent movement mechanism, including draw out mechanism.

B. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with interrupting capacity to meet available fault currents.

1. Electronic trip circuit breakers with rms sensing; field-replaceable rating plug or field-replicable electronic trip; and the following field-adjustable settings:

a. Instantaneous trip.

b. Long- and short-time pickup levels.

c. Long- and short-time time adjustments.

2. 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 material; UL 486B listed, dual rated and marked for use with copper or aluminum load-side conductors.

c. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge (HID) lighting circuits.

d. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function and short-time function.

e. Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at 55 percent of rated voltage.

f. Padlocking Provisions: For installing at least three padlocks on each circuit breaker to secure its enclosure and prevent movement mechanism.

2.05 INSTRUMENTATION

A. Instrument Transformers: IEEE C57.13, NEMA EI 21.1, and the following:

1. Current Transformers: IEEE C57.13; 5 A, 60 Hz, secondary; [wound] [bushing] [bar or window] type; [single] [double] secondary winding and secondary shorting device. Burden and accuracy shall be consistent with connected metering and relay devices.

2. Control-Power Transformers: Dry type, mounted in separate compartments for units larger than 3 kVA.

B. Multifunction Digital-Metering Monitor: Microprocessor-based unit suitable for three- or four-wire systems and with the following features:

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

a. Electro Industries/GaugeTech Shark 100 meter.

2. Switch-selectable digital display of the following values with maximum accuracy tolerances as indicated:

a. Phase Currents, Each Phase: Plus or minus 1 percent.

b. Phase-to-Phase Voltages, Three Phase: Plus or minus 1 percent.

c. Phase-to-Neutral Voltages, Three Phase: Plus or minus 1 percent.

d. Megawatts: Plus or minus 2 percent.

e. Megavars: Plus or minus 2 percent.

f. Power Factor: Plus or minus 2 percent.

g. Frequency: Plus or minus 0.5 percent.

h. Accumulated Energy, Megawatt Hours: Plus or minus 2 percent; accumulated values unaffected by power outages up to 72 hours.

i. Megawatt Demand: Plus or minus 2 percent; demand interval programmable from five to 60 minutes.

j. Contact devices to operate remote impulse-totalizing demand meter.

3. Mounting: Display and control unit flush or semi-flush mounted in instrument compartment door.

4. Meter shall have 10/100BaseT Ethernet with Modbus TCP protocol capabilities to interface with building automation controls system. Coordinate with controls system manufacturer for exact connection type and requirements.

2.06 CONTROL POWER

A. Control Circuits: 120-V ac, supplied through secondary disconnecting devices from control-power transformer.

2.07 ACCESSORY COMPONENTS AND FEATURES

A. Portable Test Set: For testing functions of solid-state trip devices without removing from switchboard. Include relay and meter test plugs suitable for testing switchboard meters and switchboard class relays.

2.08 IDENTIFICATION

A. Service Equipment Label: NRTL labeled for use as service equipment for switchboards with one or more service disconnecting and overcurrent protective devices.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Receive, inspect, handle, and store switchboards according to NEMA PB 2.1.

1. Lift or move panelboards with spreader bars and manufacturer-supplied lifting straps following manufacturer's instructions.

2. Use rollers, slings, or other manufacturer-approved methods if lifting straps are not furnished.

3. Protect from moisture, dust, dirt, and debris during storage and installation.

4. Install temporary heating during storage per manufacturer's instructions.

B. Examine switchboards before installation. Reject switchboards that are moisture damaged or physically damaged.

C. Examine elements and surfaces to receive switchboards for compliance with installation tolerances and other conditions affecting performance of the Work.

D. Examine rough-in of conduits to verify the following:

1. Wiring entries comply with layout requirements.

2. Entries are within conduit-entry tolerances specified by manufacturer and no feeders will have to cross section barriers to reach load or line lugs.

E. Verify that ground connections are in place and that requirements in Division 26 Section “Grounding and Bonding for Electrical Systems” have been met.

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

3.02 INSTALLATION

A. Install switchboards and accessories according to NEMA PB 2.1.

B. Equipment Mounting: Install switchboards on concrete base, 4-inch nominal thickness. Comply with requirements for concrete base specified in Division 03 Section "Cast-in-Place Concrete."

1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.

2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.

3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

4. Install anchor bolts to elevations required for proper attachment to switchboards.

C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from switchboard units and components once unit is secured in place.

D. Operating Instructions: Frame and mount the printed basic operating instructions for switchboards, including control and key interlocking sequences and emergency procedures. Fabricate frame of finished wood or metal and cover instructions with clear acrylic plastic. Mount on front of switchboards.

E. Install filler plates in unused spaces of panel-mounted sections.

F. Install overcurrent protective devices, transient voltage suppression devices, and instrumentation.

1. Set field-adjustable switches and circuit-breaker trip ranges.

G. Arrange conductors in gutters into groups and bundle and wrap with wire ties.

H. Close unused conduit opening or other unused holes in sides of box with proper mating blank-off plates.

I. Comply with NECA 1.

3.03 CONNECTIONS

A. Tighten bus joints, electrical connectors, and terminals according to manufacturer’s published torque-tightening values.

B. Ground equipment according to Division 26 Section “Grounding and Bonding for Electrical Systems.”

C. Connect wiring according to Division 26 Section “Low-Voltage Electrical Power Conductors and Cables.”

3.04 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

B. Switchboard Nameplates: Label each switchboard compartment with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

C. Device Nameplates: Label each disconnecting and overcurrent protective device and each meter and control device mounted in compartment doors with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

3.05 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. Perform factory start-up of switchboard.

B. Acceptance Testing Preparation:

1. Test insulation resistance for each switchboard bus, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

C. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
3. Perform the following infrared scan tests and inspections and prepare reports:
    a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each switchboard. Remove front panels so joints and connections are accessible to portable scanner.
    b. Instruments and Equipment:
        1) Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
4. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

D. Switchboard will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports, including a certified report that identifies switchboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.06 ADJUSTING

A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

B. Set field-adjustable circuit-breaker trip ranges as specified in Division 26 Section "Overcurrent Protective Device Studies."

3.07 CLEANING

A. Clean components according to manufacturer's written instructions.

B. Prior to installation of front trim and cover plates, inspect interior surfaces and perform the following:

1. Remove paint splatters and other spots.
2. Vacuum dirt and debris; do not use compressed air to assist in cleaning.

C. On completion of front trim and cover installation, inspect exterior surfaces and perform the following:

1. Remove paint splatters and other spots.
2. Remove all temporary markings and labels.
3. Vacuum dirt and debris; do not use compressed air to assist in cleaning.
4. Repair exposed surfaces to match original finish.

3.08 PROTECTION

A. Temporary Heating: Apply temporary heat, to maintain temperature according to manufacturer's written instructions, until switchboard is ready to be energized and placed into service.

B. Protect equipment from exposure to dirt, fumes, water, corrosive substances, and physical damage.

3.09 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain switchboards, overcurrent protective devices, instrumentation, and accessories.

END OF SECTION 26 2413

SECTION 26 2416
PANELBOARDS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Distribution panelboards.
2. Lighting and appliance branch-circuit panelboards.

B. Related Sections include the following:

1. Division 26 Section “Overcurrent Protective Device Studies” for short-circuit rating of devices and for setting of overcurrent protective devices.
2. Division 26 Section “SPD for Low-Voltage Electrical Power Circuits” for surge protective devices.

1.02 DEFINITIONS

A. DPM: Multi-function Digital-Metering Monitor.

B. EMI: Electromagnetic Interference.

C. GFCI: Ground-fault circuit interrupter.

D. GFEP: Ground-fault equipment protection.

E. MCCB: Molded-case circuit breaker.

F. RFI: Radio-frequency interference.

G. RMS: Root mean square.

H. SPD: Surge protective device.

I. SPDT: Single pole, double throw.

J. SVR: Suppressed voltage rating.

K. VPR: Voltage protection rating.

1.03 PERFORMANCE REQUIREMENTS

A. Overcurrent Protective Device Coordination for Emergency Systems and Legally Required Standby Systems: All overcurrent protective devices proposed for inclusion in the Work on the Emergency Systems branch (NEC Article 700) and the Legally Required Standby System branch (NEC Article 701) shall be selected to be selectively coordinated with the overcurrent protective devices installed on their supply side such that an overcurrent event (overload, short-circuit, or ground-fault) occurring at the lowest level in the system (branch circuit) cannot cause the feeder protective device supplying the branch circuit panelboard to open. This coordination shall be carried through each level of distribution for both normal and emergency power. Refer to Division 26 Section "Overcurrent Protective Device Studies" for additional requirements.

B. Overcurrent Protective Device Coordination: All other overcurrent protective devices proposed for inclusion in the Work shall be selected to be coordinated with the overcurrent protective devices installed on their supply side such that an overcurrent event (overload, short-circuit, or ground-fault) occurring at the lowest level in the system (branch circuit) cannot cause the feeder protective device supplying the branch circuit panelboard to open. This coordination shall be carried through each level of distribution for all branches of normal and emergency power to 0.10 seconds. Refer to Division 26 Section "Overcurrent Protective Device Studies" for additional requirements.

1.04 ACTION SUBMITTALS

A. Submit product data and shop drawings in accordance with Division 01 and Division 26 Section “Electrical Shop Drawings and Submittals” for products specified under PART 2 - PRODUCTS.

B. Specification Compliance Certification: Submit a Specification Compliance Certification in accordance with Division 26 Section “Electrical Shop Drawings and Submittals”.

C. Simultaneous Action Submittals: Panelboard Product Data submittal shall be made in conjunction with action submittals required under Division 26 Section “Overcurrent Protective Device Studies.” The release of electrical equipment submittals (panelboards, engine generators, switchgear, etc.) is dependent on the receipt of a complete and accurate overcurrent protective device coordination study. The Architect and Engineer require a full submittal review period as delineated in Division 01 Section “Administrative Requirements” to adequately review the OCPD study against the submitted electrical components prior to release of submittals for equipment procurement. The submittal schedule required by Division 01 requirements shall provide for this review time in the action submittal process. Delay claims arising due to Contractor’s failure to coordinate simultaneous action submittals will not be considered by the Owner.

D. Product Data: For each type of panelboard, switching and overcurrent protective device, accessory, and related component, include the following:

1. Manufacturer’s dimensions and technical data on features, performance, electrical characteristics, ratings, and finishes.
2. Related capacities, features, operating characteristics, furnished specialties, factory settings, accessories and time-current characteristic curves for individual relays and overcurrent protective devices.
    a. Time-current curves for each type of overcurrent protection device. Include hardcopy of characteristic curve and TCC Number for use with Power Tools by SKM Systems Analysis, Inc. Indicate available setting points and selectable ranges for each type of adjustable overcurrent protection device.

E. Shop Drawings: For each panelboard and related equipment, include the following:

1. Dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show method of field assembly and location and size of each field connection. Include the following:
    a. Tabulation of installed devices, equipment features, and ratings.
    b. Enclosure types and details for types other than NEMA 250, Type 1.
    c. Outline and general arrangement drawing showing dimensions, shipping sections, and weights of each assembled section.
    d. Bus configuration with size and number of conductors in each bus run, including phase, neutral, and ground conductors of main and branch buses.
    e. Bus current and voltage ratings.
    f. One-line diagram.
    g. Short-circuit current rating of panelboards and overcurrent protective devices.
    h. Feeder entry locations and lug configuration.
    i. Elevation drawing showing locations for anchor bolts.
    j. Nameplate legends.
2. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
3. Wiring diagrams: For each type of panelboard and related equipment, include power, signal, and control wiring.

F. Warranty: Copy of special warranty specified in this Section.

1.05 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified testing agency.

B. Field Quality-Control Reports:

1. Test procedures used.
2. Test results that comply with requirements.
3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

C. Panelboard Schedules: For installation in panelboards.

1.06 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Closeout Submittals," include the following:

1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
2. Manufacturer’s routine maintenance requirements for panelboard and all installed components.
3. Time-current curves, including selectable ranges for each type of overcurrent protective device that allows adjustments.
4. Manufacturer’s sample system checklists and log sheets.

B. Warranty: Copy of warranty.

1.07 QUALITY ASSURANCE

A. Source Limitations: Obtain panelboards, overcurrent protective devices, components, and accessories from single source from single manufacturer, unless otherwise indicated.

1. Breaker Manufacturer: Manufacturer for breakers shall be the same as the manufacturer of other breakers proposed for other portions of the Work.

B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for panelboards including clearances between panelboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.

C. 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.

D. Comply with NEMA PB 1.

E. Comply with NFPA 70.

1.08 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.

C. Handle equipment components according to manufacturer’s written instructions. Use factory-installed lifting provisions.

D. Prepare equipment for shipment.

1. Provide suitable crating, blocking, and supports so equipment will withstand expected domestic shipping and handling shocks and vibration.
2. Weatherproof equipment for shipment. Close connection openings to prevent entrance of foreign material during shipment and storage.

E. Installation Pathway: Coordinate delivery of equipment to allow movement into designated space.

1. Deliver in shipping splits in sizes that can be moved past obstructions in delivery path.

2. Remove and replace access fencing, doors, lift-out panels, and structures to provide pathway for moving equipment into place.

F. Store equipment indoors in clean dry space with uniform temperature in accordance with manufacturer's requirements to prevent condensation. Protect equipment from exposure to dirt, fumes, water, corrosive substances, and physical damage.

1.09 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.

2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:

a. Ambient Temperature: Not exceeding 23 deg F to plus 104 deg F.

b. Altitude: Not exceeding 6600 feet.

B. Service Conditions: NEMA PB 1, usual service conditions, as follows:

1. Ambient temperatures within limits specified.

2. Altitude not exceeding 6600 feet.

1.10 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 sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

1.11 WARRANTY

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

1. Warranty Period: Two (2) years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

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

1. Cutler-Hammer, Inc.; Eaton Corporation.

2. ABB (General Electric Company); Industrial Connections & Solutions, LLC.

3. Siemens Energy & Automation, Inc.

4. Square D; Schneider Electric.

2.02 RATINGS

A. Suitable for application in 3-phase, 60-Hz, solidly grounded-neutral system, unless otherwise indicated.

B. Nominal System Voltage: As indicated on the Drawings.

C. Main-Bus: Amperage as indicated on the Drawings. Provide continuous rating across entire length of main-bus.

D. Short-Time and Short-Circuit Current: Match rating of highest-rated overcurrent protective device in panelboard assembly.

1. Available Short-Circuit Current: As indicated on the Drawings. Refer to Division 26 Section "Overcurrent Protective Device Coordination Study" for additional requirements.

2.03 GENERAL REQUIREMENTS FOR PANELBOARDS

A. Mounting height of breakers shall be in accordance with NFPA 70 requirements. Fabrication of equipment shall take housekeeping pad dimension into account in determining height of top breaker in all sections. Refer to Division 26 Section "Hangers and Supports for Electrical Systems" for housekeeping pad specifications.

B. Enclosures: Surface-mounted cabinets.

1. Rated for environmental conditions at installed location.

a. Indoor Dry and Clean Locations: NEMA 250, Type 1.

b. Outdoor Locations: NEMA 250, Type 3R.

c. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.

2. Height: 84-inches maximum.

3. Front Cover: Provide the following, unless otherwise indicated:

a. Hinged Front Cover: Door-in-Door construction with entire front trim hinged to box and with standard door within hinged trim cover to access device handles.

4. Finishes:

a. Panels and Trim: Steel, factory finished immediately after cleaning and pretreating with manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.

b. Back Boxes: Galvanized steel.

5. Directory Card: Inside panelboard door, mounted in transparent card holder.

C. Incoming Mains Location: Top and bottom.

D. Phase, Neutral, and Ground Buses:

1. Material: Hard-drawn copper, 98 percent conductivity.

a. Plating shall run entire length of bus.

b. Bus shall be fully rated the entire length.

2. Panelboard interior assembly shall be dead front with panelboard front removed. Interiors shall be factory assembled into a unit. Replacing switching and protective devices shall not disturb adjacent units or require removing the main bus connectors.

3. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment grounding conductors; bonded to box.

4. Full-Sized Neutral: Equipped with full-capacity bonding strap for service entrance applications. Mount electrically isolated from enclosure. Do not mount neutral bus in gutter.

5. Extra-Capacity Neutral Bus: Neutral bus rated 200 percent of phase bus and listed and labeled by an NRTL acceptable to authority having jurisdiction, as suitable for nonlinear loads in electronic-grade panelboards served from K-rated transformers. Connectors shall be sized for double-sized or parallel conductors as indicated on Drawings. Do not mount neutral bus in gutter.

E. Conductor Connectors: Suitable for use with conductor material and sizes.

1. Material: Hard-drawn copper, 98 percent conductivity.
2. Terminations shall allow use of 75 deg C rated conductors without derating.
3. Size: Lugs suitable for indicated conductor sizes, with additional gutter space, if required, for larger conductors.
4. Main and Neutral Lugs: Mechanical type, with a lug on the neutral bar for each pole in the panelboard.
5. Ground Lugs and Bus-Configured Terminators: Mechanical type, with a lug on the bar for each pole in the panelboard.
6. Feed-Through Lugs: Mechanical type, suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.
7. Extra-Capacity Neutral Lugs: Rated 200 percent of phase lugs mounted on extra-capacity neutral bus.

F. Future Devices: Mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.
   1. Percentage of Future Space Capacity: Ten percent.

G. Panelboard Short-Circuit Current Rating: Fully rated to interrupt symmetrical short-circuit current available at terminals. Panelboard bus structure and main lugs or main breaker shall have current ratings as shown on the panelboard schedule. Such ratings shall be established by heat rise tests with maximum hot spot temperature on any connector or bus bar not to exceed 50 deg C rise above ambient. Heat rise tests shall be conducted in accordance with UL 67. The use of conductor dimensions will not be accepted in lieu of actual heat tests.

2.04 DISTRIBUTION PANELBOARDS

A. Panelboards: NEMA PB 1, power and feeder distribution type.

B. Doors: Secured with vault-type latch with tumbler lock; keyed alike.
   1. For doors more than 48 inches high, provide two latches, keyed alike.

C. Main Overcurrent Protection Device Type: Circuit breaker.
   1. Main OCPD rated less than 250 Amps: Thermal-Magnetic Circuit Breakers.
   2. Main OCPD rated 250 Amps and greater: Electronic Trip-Unit Circuit Breakers.
   3. Main OCPD for Emergency Systems or Legally Required Standby Systems: Electronic Trip-Unit Circuit Breakers.

D. Feeder Overcurrent Protection Device Type: Provide overcurrent device as follows, unless otherwise indicated: Circuit breaker.
   1. Feeder OCPD rated less than 250 Amps: Thermal-Magnetic; Bolt-on circuit breakers.
   2. Feeder OCPD rated 250 Amps and greater: Thermal-Magnetic**;** Bolt-on circuit breakers or plug-in circuit breakers where individual positive-locking device requires mechanical release for removal.
   3. Feeder OCPD for Emergency Systems or Legally Required Standby Systems: Electronic Trip-Unit Circuit Breakers.

E. Branch Overcurrent Protection Device Type: Provide overcurrent device as follows, unless otherwise indicated: Circuit breaker.
   1. Branch OCPD rated less than 125 Amps: Bolt-on Thermal-Magnetic circuit breakers.
   2. Branch OCPD rated 125 Amps and Greater: Bolt-on Thermal-Magnetic circuit breakers; plug-in circuit breakers where individual positive-locking device requires mechanical release for removal.

F. Circuit breakers shall be equipped with individually insulated, braced and protected connectors. The front faces of all circuit breakers shall be flush with each other. Large, permanent,

individual circuit numbers shall be affixed to each breaker in a uniform position. Tripped indication shall be clearly shown by the breaker handle taking a position between “ON” and “OFF”. Provisions for additional breakers shall be such that no additional connectors will be required to add breakers.

G. Surge Protection Device: Where indicated on Drawings. IEEE C62.41-compliant, externally mounted, bolt-on, solid-state, parallel-connected, modular (with field-replaceable modules) type, with sine-wave tracking suppression and filtering modules, short-circuit current rating complying with UL 1449, second edition, and matching or exceeding the panelboard short-circuit rating, redundant suppression circuits, with individually fused metal-oxide varistors.

2.05 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

A. Panelboards: NEMA PB 1, lighting and appliance branch-circuit type. Panelboards shall be of the dead-front, quick-make, quick-break, bolt-on circuit breaker type.

B. Main Overcurrent Protection Device Type: Circuit breaker or lugs only.

1. Main OCPD rated less than 250 Amps: Thermal-Magnetic Circuit Breakers.
2. Main OCPD rated 250 Amps and Greater: Thermal-Magnetic Circuit Breakers.
3. Main OCPD for Emergency Systems or Legally Required Standby Systems: Electronic Trip-Unit Circuit Breakers.

C. Branch Overcurrent Protective Devices: Thermal-Magnetic; Bolt-on circuit breakers, replaceable without disturbing adjacent units.

D. Doors: Concealed hinges; secured with flush latch with tumbler lock; keyed alike.

E. Surge Protection Device: Where indicated on Drawings. IEEE C62.41-compliant, externally mounted, bolt-on, solid-state, parallel-connected, modular (with field-replaceable modules) type, with sine-wave tracking suppression and filtering modules, short-circuit current rating complying with UL 1449, second edition, and matching or exceeding the panelboard short-circuit rating, redundant suppression circuits, with individually fused metal-oxide varistors.

2.06 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

A. 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. Electronic Trip Circuit Breakers: RMS sensing; field-replaceable rating plug or field-replicable electronic trip; and the following field-adjustable settings:
    a. Instantaneous trip.
    b. Long- and short-time pickup levels.
    c. Long- and short-time time adjustments.
3. Arc-Fault Circuit Interrupter (AFCI) Circuit Breakers: Comply with UL 1699; 120/240-V, single-pole configuration. Provide as indicated and as required by NFPA 70 for personnel protection.
4. Molded-Case Circuit-Breaker (MCCB) Features and Accessories:
    a. Standard frame sizes, trip ratings, and number of poles.
    b. Breaker handle indicates tripped status.
    c. UL listed for reverse connection without restrictive line or load ratings.
    d. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor materials.

e. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge (HID) lighting circuits.

f. Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at 75 percent of rated voltage.

g. Multipole units enclosed in a single housing or factory assembled to operate as a single unit.

h. Handle Padlocking Device: Fixed attachment, for locking circuit-breaker handle in off position.

2.07 IDENTIFICATION

A. Panelboard Label: Manufacturer's name and trademark, voltage, amerage, number of phases, and number of poles shall be located on the interior of the panelboard door.

B. Breaker Labels: Faceplate shall list current rating, UL and IEC certification standards, and AIC rating.

C. Circuit Directory: Computer-generated circuit directory mounted inside panelboard door with transparent plastic cover.

1. Circuit directory shall identify specific purpose with detail sufficient to distinguish it from all other circuits.

2.08 ACCESSORY COMPONENTS AND FEATURES

A. Accessory Set: Include tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.

B. Portable Test Set: For testing functions of solid-state trip devices without removing from panelboard. Include relay and meter test plugs suitable for testing panelboard meters and switchboard class relays.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify actual conditions with field measurements prior to ordering panelboards to verify that equipment fits in allocated space in, and comply with, minimum required clearances specified in NFPA 70. 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. Examine roughing-in of conduits to verify the following:

1. Wiring entries comply with layout requirements.

2. Entries are within conduit-entry tolerances specified by manufacturer and no feeders will have to cross section barriers to reach load or line lugs.

E. Verify that ground connections are in place and that requirements in Division 26 Section "Grounding and Bonding for Electrical Systems" have been met.

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

3.02 INSTALLATION

A. Install panelboards and accessories according to NEMA PB 1.1.

B. Panelboards with circuit breakers installed before the building has been completed and cleaned shall be masked.

C. Equipment Mounting: Install panelboards on concrete bases, 4-inch nominal thickness. Comply with requirements for concrete base specified in Division 03 Section "Cast-in-Place Concrete."

1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around full perimeter of base.
2. For panelboards, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
4. Install anchor bolts to elevations required for proper attachment to panelboards.
5. Attach panelboard to the vertical finished or structural surface behind the panelboard.

D. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from panelboards.

E. Mount top of trim 74 inches above finished floor unless otherwise indicated. Panelboards of extra height shall be installed at least 18 inches above floor.

F. 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.

G. Install overcurrent protective devices and controllers not already factory installed.

1. Set field-adjustable, circuit-breaker trip ranges.

H. Install filler plates in unused spaces.

I. For Recessed Panels: Stub four 1-inch empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future. Stub four 1-inch empty conduits into raised floor space or below slab not on grade. Paint trim to match wall.

J. Arrange conductors in gutters into groups and bundle and wrap with wire ties. All wiring shall be properly formed; no splices are permitted in gutters.

K. Comply with NECA 1.

3.03 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with Division 26 Section "Identification for Electrical Systems."

B. Panelboard Directory: Create a directory to indicate installed circuit loads; incorporate Owner's final room designations. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are not acceptable. A directory of each panelboard shall be completed and available for review by Engineer during final punch list inspection. Provide description of load and location (i.e. “Lighting, East Wall, Room 101”).

C. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

D. Device Nameplates: Label each branch circuit device in distribution panelboards with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

3.04 CONNECTIONS

A. Tighten bus joints, electrical connectors, and terminals according to manufacturer's published torque-tightening values.

B. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

C. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.05 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. Perform factory start-up of panelboards.

B. Acceptance Testing Preparation:

1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.

2. Test continuity of each circuit.

C. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.

2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

3. Perform the following infrared scan tests and inspections and prepare reports:

a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each panelboard. Remove front panels so joints and connections are accessible to portable scanner.

b. Instruments and Equipment:

1) Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

D. Panelboards will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports, including a certified report that identifies panelboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.06 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 as specified in Division 26 Section "Overcurrent Protective Device Coordination Study."

3.07 CLEANING

A. Clean components according to manufacturer's written instructions.

B. All dust and debris shall be removed from the panels before they are energized and placed into service.

C. All panelboard fronts shall be omitted until final punch list inspection is conducted. Prior to installation of front trim and cover plates inspect interior surfaces and perform the following:

1. Remove paint splatters and other spots.

2. Vacuum dirt and debris; do not use compressed air to assist in cleaning.

D. On completion of front trim and cover installation, inspect exterior surfaces and perform the following:

1. Remove paint splatters and other spots.

2. Remove all temporary markings and labels.

3. Vacuum dirt and debris; do not use compressed air to assist in cleaning.

E. Repair exposed surfaces to match original finish.

3.08 PROTECTION

A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions. Maintain a clean dry space with uniform temperature in accordance with manufacturer’s requirements to prevent condensation.

B. Protect equipment from exposure to dirt, fumes, water, corrosive substances, and physical damage.

END OF SECTION 26 2416

SECTION 26 2550
GENERATOR DOCKING STATION

PART 1 - GENERAL

1.01 SUMMARY

A. This Section includes a packaged single-purpose temporary generator docking station to connect a temporary generator to the life safety branch automatic transfer switch in the school.

1.02 ACTION SUBMITTALS

A. Submit product data and shop drawings in accordance with Division 01 and Division 26 Section “Electrical Shop Drawings and Submittals” for products specified under PART 2 - PRODUCTS.

B. Specification Compliance Certification: Submit a Specification Compliance Certification in accordance with Division 26 Section “Electrical Shop Drawings and Submittals”.

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

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

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

D. 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.

E. Warranty: Special warranty specified in this Section.

1.03 INFORMATIONAL SUBMITTALS

A. Qualification Data: For manufacturer.

B. Field quality-control test reports.

1.04 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For each type of product to include in emergency, operation, and maintenance manuals.

1.05 QUALITY ASSURANCE

A. 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.

B. Comply with NFPA 70.

C. UL 1008 or ETL Listed to UL 1008 Standards.

D. Comply with NEC 700.3(F)

E. UL 508A NEMA 3R Enclosure

1.06 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of docking station and associated auxiliary components that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Two (2) years from date of Substantial Completion.

B. The equipment installed under this contract shall be left in proper working order. Replace, without additional charge, new work or material which develops defects from ordinary use within one year.

C. New materials and equipment shall be guaranteed against defects in composition, design or workmanship. Guarantee certificates shall be furnished.

PART 2 - PRODUCTS

2.01 GENERATOR CAMLOCK DOCKING STATION (65KA)

A. Manufacturers: Subject to compliance with requirements, provide products by the following:
   1. Power Temp Systems.
   2. Trystar.
   3. ASCO.

2.02 GENERAL REQUIREMENTS

A. A set of Camlocks shall be provided for each of the following:
   1. Portable Generator

B. Protective Caps
   1. All Camlocks shall be protected with spring-loaded weather-proof flip covers that are clear in color to allow for easy viewing of phase color and gender.

C. Enclosures:
   1. Wall, Bottom/Side/Top Cable Entry, NEMA 3R rain-tight, stainless-steel enclosure with rake system for cable entry at the bottom.
   2. Pad-lockable front door shall include a hinged access plate at the bottom for entry of temporary cabling that prevents unauthorized tampering while in use.
   3. NEMA 3R integrity shall be maintained while temporary cabling is connected during use.
   4. Front and side shall be accessible for maintenance.
   5. Top, side, and bottom shall be accessible for permanent cabling.
   6. Finishes:
      a. Paint after fabrication. Powder coated Hammer Gray or Black.

D. Phase, Neutral, and Ground Buses:
   1. Material: Silver-plated copper.
   2. Equipment Ground Bus: Bonded to box.
   3. Isolated Ground Bus: Insulated from box.
   4. Ground Bus: 50% of phase size.
   5. Neutral Bus: Neutral bus rated 100 percent of phase bus.
   6. Round edges on bus.

E. Temporary generator connectors shall be Camlock style mounted on gland plate.
   1. Camlock shall be 16 Series model and color coded according to system voltage requirements.
   2. Camlock connections shall be Bus Bar Style, Cabling or Double Set Screw is not acceptable.
   3. Camlock connection shall be protected against accidental contact while not in use.

F. Permanent Connection shall be factory installed broad range set-screw mechanical type, located behind a physical barrier.

G. Short Circuit and Withstand Rating: Minimum 65 kAIC unless otherwise indicated on Drawings.

H. Voltage & Amperage: 480/277V, 3-phase, refer to Drawings for amperage.

I. Factory Installed Phase Rotation Monitor Device: Phase monitoring relay to be Siemens 3U4512-1AR20 or equal and factory installed.

J. Additional accessories shall be included in submittal drawing as follows:

1. K#: Kirk Key Door Interlock. The door of the enclosure shall be kirk key interlocked with the main breaker on the permanent generator feeding the Life Safety ATS.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine elements and surfaces to receive Generator Docking Station for compliance with installation tolerances and other conditions affecting performance of the Work.

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

3.02 INSTALLATION

A. Surface, Flush or Base Mounted: Specified with order.

B. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

3.03 IDENTIFICATION

A. Comply with requirements in Division 26 Section "Identification for Electrical Systems."

B. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.

C. Label each enclosure with engraved metal or laminated-plastic nameplate.

3.04 FIELD QUALITY CONTROL

A. Generator Docking Station vendor shall be required to send a technical representative to the job site to inspect and review installation to ensure it meets the requirements of the consulting engineer.

B. Prepare inspection report that identifies Generator Docking Station with notations of any remedial action taken to correct any issues.

END OF SECTION 26 2550

SECTION 26 2726
WIRING DEVICES

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Receptacles, receptacles with integral GFCI, receptacles with integral USB, and associated device plates.
2. Twist-locking receptacles.
3. Weather-resistant receptacles.
4. Snap switches.
5. Wall plates.

B. Related Requirements:

1. Division 26 Section “Lighting Control Devices” for occupancy and vacancy sensor light switches and low-voltage momentary switches.

1.02 DEFINITIONS

A. EMI: Electromagnetic interference.

B. GFCI: Ground-fault circuit interrupter.

C. Pigtail: Short lead used to connect a device to a branch-circuit conductor.

D. RFI: Radio-frequency interference.

E. TVSS: Transient voltage surge suppressor.

F. UTP: Unshielded twisted pair.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Receptacles for Owner-Furnished Equipment: Match plug configurations.
2. Cord and Plug Sets: Match equipment requirements.

1.04 ACTION SUBMITTALS

A. Submit product data and shop drawings in accordance with Division 01 and Division 26 Section “Electrical Shop Drawings and Submittals” for products specified under PART 2 - PRODUCTS.

B. Product Data: For each type of product.

C. Shop Drawings: List of legends and description of materials and process used for pre-marking wall plates.

1.05 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.06 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For wiring devices to include in all manufacturers' packing-label warnings and instruction manuals that include labeling conditions.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Manufacturers' Names: Shortened versions (shown in parentheses) of the following manufacturers' names are used in other Part 2 articles:

1. Cooper Arrow-Hart Wiring Devices; Division of Cooper Industries, Inc. (Eaton).
2. Hubbell Incorporated; Wiring Device-Kellems (Hubbell).

3. Leviton Mfg. Company Inc. (Leviton).
4. Pass & Seymour/Legrand (Pass & Seymour).

B. Source Limitations: Obtain each type of wiring device and associated wall plate from single source from single manufacturer.

2.02 GENERAL WIRING-DEVICE REQUIREMENTS

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

B. Comply with NFPA 70.

2.03 STRAIGHT-BLADE RECEPTACLES

A. Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498, and FS W-C-596.

1. Products: Subject to compliance with requirements, provide one of the following:
   a. Eaton; AH5361 (single), AH5362 (duplex).
   b. Hubbell; HBL5361 (single), HBL5362 (duplex).
   c. Leviton; 5361 (single), 5362 (duplex).
   d. Pass & Seymour; 5361 (single), 5362 (duplex).

2.04 USB CHARGER DEVICES

A. USB Charger Receptacles: 12 V dc, 2.0 A, USB Type A; comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498, UL 1310, and FS W-C-596.

1. Description: Single-piece, rivetless, nickel-plated, all-brass grounding system. Nickel-plated, brass mounting strap.
2. USB Receptacles with Line Voltage Receptacles: Dual, Type A USB with dual, two-pole, three-wire, and self-grounding.
3. USB Receptacles Stand-Alone: Quad, Type A.

2.05 GFCI RECEPTACLES

A. General Description:

1. Straight blade, feed-through type.
2. Comply with NEMA WD 1, NEMA WD 6, UL 498, UL 943 Class A, and FS W-C-596.
3. Include indicator light that shows when the GFCI has malfunctioned and no longer provides proper GFCI protection.

B. Duplex GFCI Convenience Receptacles, 125 V, 20 A:

1. Products: Subject to compliance with requirements, provide one of the following:
   a. Eaton; VGF20.
   b. Hubbell; GFR5352.
   c. Pass & Seymour; 2095.
   d. Leviton; 6898.

2.06 TWIST-LOCKING RECEPTACLES

A. Single Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 Configuration L5-20R, and UL 498.

1. Products: Subject to compliance with requirements, provide one of the following:
   a. Eaton; CWL520R.
   b. Hubbell; HBL2310.

c. Leviton; 2310.

d. Pass & Seymour; L520R.

B. Single Convenience Receptacles, 125 V, 30 A: Comply with NEMA WD 1, NEMA WD 6 Configuration L5-30R, and UL 498.

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

a. Eaton; CWL530R.

b. Hubbell; HBL2310.

c. Leviton; 2310.

d. Pass & Seymour; L530R.

2.07 CORD AND PLUG SETS

A. Description:

1. Match voltage and current ratings and number of conductors to requirements of equipment being connected.

2. Cord: Rubber-insulated, stranded-copper conductors, with Type SOW-A jacket; with green-insulated grounding conductor and ampacity of at least 130 percent of the equipment rating.

3. Plug: Nylon body and integral cable-clamping jaws. Match cord and receptacle type for connection.

2.08 TOGGLE SWITCHES

A. Comply with NEMA WD 1, UL 20, and FS W-S-896.

B. Switches, 120/277 V, 20 A:

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

a. Single Pole:

1) Eaton; AH1221.

2) Hubbell; HBL1221.

3) Leviton; 1221-2.

4) Pass & Seymour; CSB20AC1.

b. Two Pole:

1) Eaton; AH1222.

2) Hubbell; HBL1222.

3) Leviton; 1222-2.

4) Pass & Seymour; CSB20AC2.

c. Three Way:

1) Eaton; AH1223.

2) Hubbell; HBL1223.

3) Leviton; 1223-2.

4) Pass & Seymour; CSB20AC3.

d. Four Way:

1) Eaton; AH1224.

2) Hubbell; HBL1224.

3) Leviton; 1224-2.

4) Pass & Seymour; CSB20AC4.

C. Key-Operated Switches:
   1. Line Voltage 120/277 V, 20 A:
      a. Products: Subject to compliance with requirements, provide one of the following:
         1) Pass & Seymour; PS20AC1-L.
      b. Description: Single pole, with factory-supplied key in lieu of switch handle.
      c. For low-voltage lighting control systems, key switch shall be wired as a maintained contact, low-voltage switch in the lighting control system. See Drawings for detail.

D. Single-Pole, Double-Throw, Momentary-Contact, Center-off Switches: 120/277 V, 20 A; for use with mechanically held lighting contactors.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Eaton; 1995.
      b. Hubbell; HBL1557.
      c. Leviton; 1257.
      d. Pass & Seymour; 1251.

2.09 WALL PLATES

A. Single and combination types shall match corresponding wiring devices.
   1. Plate-Securing Screws: Metal with head color to match plate finish.
   2. Material for Finished Spaces: 0.035-inch- thick, satin-finished, Type 302 stainless steel.
   3. Material for Pool Area and Pool Equipment Area: Smooth, high-impact thermoplastic (nylon).
   4. Material for Unfinished Spaces: Galvanized steel.
   5. Material for Damp Locations: Cast aluminum with spring-loaded lift cover, and listed and labeled for use in wet and damp locations.

B. Wet-Location, Weatherproof Cover Plates: NEMA 250, complying with Type 3R, weather-resistant, die-cast aluminum with lockable cover.

2.10 FLOOR SERVICE FITTINGS

A. Flush-Type Service Fittings:
   1. Description: Type: Modular, flush-type, dual-service units suitable for wiring method used.
   2. Compartments: Barrier separates power from voice and data communication cabling.
   3. Service Plate: Rectangular, die-cast aluminum with satin finish.
   4. Power Receptacle: NEMA WD 6 Configuration 5-20R, gray finish, unless otherwise indicated.
   5. Data Communication Outlet: Two modular, keyed, color-coded, RJ-45 jacks for twisted pair cable, complying with requirements in Division 27 Section "Voice Data System."

2.11 POWER PEDESTALS

A. Basis-of-Design Product: The design for power pedestals and components is based on the Wiremold® Power Pedestals manufactured by Legrand/Wiremold.

B. Outdoor power pedestals provided with two devices.
   1. Supplied with color-matched door that can be easily replaced by a color-matched locking door or a transparent door.
   2. Interior illuminates when door is open. Door closes automatically to meet while-in-use requirements.

C. Two-Gang Outdoor Power Pedestal: Catalog No. XCSPP2GRU-[XX] with one (1) 20A weather-resistant GFCI and one (1) 4-port 4.2A USB outlets; powder coat finish, verify color with Architect.

2.12 FINISHES

A. Device Color:

1. Wiring Devices Connected to Normal Power System: White unless otherwise indicated or required by NFPA 70 or device listing.
2. Wiring Devices Connected to Emergency Power System: Red.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Comply with NECA 1, including mounting heights listed in that standard, unless otherwise indicated.

B. Coordination with Other Trades:

1. Protect installed devices and their boxes. 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 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. Install wiring devices after all wall preparation, including painting, is complete.

C. Conductors:

1. Do not strip insulation from conductors until right before they are spliced or terminated on devices.
2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
3. The length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300, without pigtails.

D. Device Installation:

1. Replace devices that have been in temporary use during construction and that 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. Connect devices to branch circuits using pigtails that are not less than 6 inches in length.
5. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, two-thirds to three-fourths of the way around terminal screw.
6. Use a torque screwdriver when a torque is recommended or required by manufacturer.
7. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.
8. Tighten unused terminal screws on the device.
9. When mounting into metal boxes, remove the fiber or plastic washers used to hold device-mounting screws in yokes, allowing metal-to-metal contact.

E. Receptacle Orientation:

1. Install ground pin of vertically mounted receptacles up, and on horizontally mounted receptacles to the right.

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.

G. Dimmers:

1. Install dimmers within terms of their listing.
2. Verify that dimmers used for fan speed control are listed for that application.
3. Install unshared neutral conductors on line and load side of dimmers according to manufacturers' device listing conditions in the written instructions.

H. 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, multi-gang wall plates.

I. Adjust locations of floor service outlets and service poles to suit arrangement of partitions and furnishings.

3.02 GFCI RECEPTACLES

A. Install non-feed-through-type GFCI receptacles where protection of downstream receptacles is not required.

3.03 IDENTIFICATION

A. Comply with Division 26 Section "Identification for Electrical Systems."

B. Identify each receptacle with panelboard identification and circuit number. Use adhesive P-touch label with machine printed black lettering on both the face of plate and the backside of the plate.

3.04 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Test Instruments: Use instruments that comply with UL 1436.
2. Test Instrument for Convenience Receptacles: Digital wiring analyzer with digital readout or illuminated digital-display indicators of measurement.

B. Tests for Convenience Receptacles:

1. Line Voltage: Acceptable range is 105 to 132 V.
2. Percent Voltage Drop under 15-A Load: A value of 6 percent or higher is unacceptable.
3. Ground Impedance: Values of up to 2 ohms are acceptable.
4. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.
5. Using the test plug, verify that the device and its outlet box are securely mounted.
6. Tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault current path, defective devices, or similar problems. Correct circuit conditions, remove malfunctioning units and replace with new ones, and retest as specified above.

C. Wiring device will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

END OF SECTION 26 2726

SECTION 26 2813
FUSES

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Cartridge fuses rated 600-V ac and less for use in control circuits, enclosed switches, and enclosed controllers.
2. Spare-fuse cabinets.

1.02 PERFORMANCE REQUIREMENTS

A. Overcurrent Protective Device Coordination for Emergency Systems and Legally Required Standby Systems: All overcurrent protective devices proposed for inclusion in the Work on the Emergency Systems branch (NEC Article 700) and the Legally Required Standby System branch (NEC Article 701) shall be selected to be selectively coordinated with the overcurrent protective devices installed on their supply side such that an overcurrent event (overload, short-circuit, or ground-fault) occurring at the lowest level in the system (branch circuit) cannot cause the feeder protective device supplying the branch circuit panelboard to open. This coordination shall be carried through each level of distribution for both normal and emergency power. Refer to Division 26 Section "Overcurrent Protective Device Studies" for additional requirements.

B. Overcurrent Protective Device Coordination: All other overcurrent protective devices proposed for inclusion in the Work shall be selected to be coordinated with the overcurrent protective devices installed on their supply side such that an overcurrent event (overload, short-circuit, or ground-fault) occurring at the lowest level in the system (branch circuit) cannot cause the feeder protective device supplying the branch circuit panelboard to open. This coordination shall be carried through each level of distribution for all branches of normal and emergency power to 0.10 seconds. Refer to Division 26 Section "Overcurrent Protective Device Studies" for additional requirements.

1.03 ACTION SUBMITTALS

A. Submit product data and shop drawings in accordance with Division 01 and Division 26 Section “Electrical Shop Drawings and Submittals” for products specified under PART 2 - PRODUCTS.

B. Specification Compliance Certification: Submit a Specification Compliance Certification in accordance with Division 26 Section “ Electrical Shop Drawings and Submittals”.

C. Simultaneous Action Submittals: Fuse Product Data submittal shall be made in conjunction with action submittals required under Division 26 Section “Overcurrent Protective Device Studies.” The release of electrical equipment submittals (panelboards, switchgear, etc.) is dependent on the receipt of a complete and accurate overcurrent protective device coordination study. The Architect and Engineer require a full submittal review period as delineated in Division 01 Section “Administrative Requirements” to adequately review the OCPD study against the submitted electrical components prior to release of submittals for equipment procurement. The submittal schedule required by Division 01 requirements shall provide for this review time in the action submittal process. Delay claims arising due to Contractor’s failure to coordinate simultaneous action submittals will not be considered by the Owner.

D. Product Data: For each type of product indicated. Include construction details, material, dimensions, descriptions of individual components, and finishes for spare-fuse cabinets. Include the following for each fuse type indicated:

1. Ambient Temperature Adjustment Information: If ratings of fuses have been adjusted to accommodate ambient temperatures, provide list of fuses with adjusted ratings.
    a. For each fuse having adjusted ratings, include location of fuse, original fuse rating, local ambient temperature, and adjusted fuse rating.
    b. Provide manufacturer's technical data on which ambient temperature adjustment calculations are based.

2. Dimensions and manufacturer's technical data on features, performance, electrical characteristics, and ratings.
3. Current-limitation curves for fuses with current-limiting characteristics.
4. Time-current curves, coordination charts and tables, and related data. Include hardcopy of characteristic curve and TCC Number for use with Power Tools by SKM Systems Analysis, Inc.
5. Tabulated schedule which indicates type, characteristics, and ratings of individual fuses and lists the devices and equipment in which they will be applied.
6. Fuse sizes for elevator feeders and elevator disconnect switches.

1.04 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For fuses to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Closeout Submittals," include the following:
1. Ambient temperature adjustment information.
2. Current-limitation curves for fuses with current-limiting characteristics.
3. Time-current curves, coordination charts and tables, and related data.

1.05 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. Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.

1.06 QUALITY ASSURANCE

A. Source Limitations: Obtain fuses, for use within a specific product or circuit, 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 FU 1 for cartridge fuses.

D. Comply with NFPA 70.

E. Comply with UL 248-11 for plug fuses.

1.07 PROJECT CONDITIONS

A. Where ambient temperature to which fuses are directly exposed is less than 40 deg F or more than 100 deg F, apply manufacturer's ambient temperature adjustment factors to fuse ratings.

1.08 COORDINATION

A. Coordinate fuse ratings with utilization equipment nameplate limitations of maximum fuse size and with system short-circuit current levels.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Cooper Bussmann, Inc.
2. Edison Fuse, Inc.
3. Ferraz Shawmut, Inc.
4. Littelfuse, Inc.

2.02 CARTRIDGE FUSES

A. Characteristics: NEMA FU 1, nonrenewable cartridge fuses with voltage ratings consistent with circuit voltages.

2.03 SPARE-FUSE CABINET

A. Characteristics: Wall-mounted steel unit with full-length, recessed piano-hinged door and key-coded cam lock and pull.

1. Size: Adequate for storage of spare fuses specified with 15 percent spare capacity minimum.
2. Finish: Gray, baked enamel.
3. Identification: "SPARE FUSES" in 1-1/2-inch- high letters on exterior of door.
4. Fuse Pullers: For each size of fuse, where applicable and available, from fuse manufacturer.
5. Manufacturer: Bussmann model SFC or equal.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine fuses before installation. Reject fuses that are moisture damaged or physically damaged.

B. Examine holders to receive fuses for compliance with installation tolerances and other conditions affecting performance, such as rejection features.

C. Examine utilization equipment nameplates and installation instructions. Install fuses of sizes and with characteristics appropriate for each piece of equipment.

D. Evaluate ambient temperatures to determine if fuse rating adjustment factors must be applied to fuse ratings.

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

3.02 FUSE APPLICATIONS

A. Cartridge Fuses:

1. Service Entrance: Class L, time delay, Bussmann Hi-Cap Time Delay Fuses KRP-C.
2. Feeders: Class RK1, time delay, Bussmann Low-Peak Dual Element Fuses LPS-RK.
3. Motor Branch Circuits: Class RK1, time delay, Bussmann Low Peak Dual Element Fuses LPN-RK (250V) or LPS-RK (600V).
4. Other Branch Circuits: Class RK1, time delay.
5. Control Circuits: Class CC, fast acting.

3.03 INSTALLATION

A. Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse.

B. Install spare-fuse cabinet(s).

3.04 IDENTIFICATION

A. Install labels complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems" and indicating fuse replacement information on inside door of each fused switch and adjacent to each fuse block, socket, and holder.

B. Install labels indicating Type and Rating of fuse installed on outside of door of each fused switch.

END OF SECTION 26 2813

SECTION 26 2816

ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Fusible switches.
2. Non-fusible switches.
3. Molded-case circuit breakers (MCCBs).
4. Enclosures.

1.02 DEFINITIONS

A. GFCI: Ground-fault circuit interrupter.

B. GFEP: Ground-fault equipment protection.

C. HD: Heavy duty.

D. NC: Normally closed.

E. NO: Normally open.

F. RMS: Root mean square.

G. SPDT: Single pole, double throw.

1.03 PERFORMANCE REQUIREMENTS

A. Overcurrent Protective Device Coordination for Emergency Systems and Legally Required Standby Systems: All overcurrent protective devices proposed for inclusion in the Work on the Emergency Systems branch (NEC Article 700) and the Legally Required Standby System branch (NEC Article 701) shall be selected to be selectively coordinated with the overcurrent protective devices installed on their supply side such that an overcurrent event (overload, short-circuit, or ground-fault) occurring at the lowest level in the system (branch circuit) cannot cause the feeder protective device supplying the branch circuit panelboard to open. This coordination shall be carried through each level of distribution for both normal and emergency power. Refer to Division 26 Section "Overcurrent Protective Device Studies" for additional requirements.

B. Overcurrent Protective Device Coordination: All other overcurrent protective devices proposed for inclusion in the Work shall be selected to be coordinated with the overcurrent protective devices installed on their supply side such that an overcurrent event (overload, short-circuit, or ground-fault) occurring at the lowest level in the system (branch circuit) cannot cause the feeder protective device supplying the branch circuit panelboard to open. This coordination shall be carried through each level of distribution for all branches of normal and emergency power to 0.10 seconds. Refer to Division 26 Section "Overcurrent Protective Device Studies" for additional requirements.

1.04 ACTION SUBMITTALS

A. Submit product data and shop drawings in accordance with Division 01 and Division 26 Section “Electrical Shop Drawings and Submittals” for products specified under PART 2 - PRODUCTS.

B. Specification Compliance Certification: Submit a Specification Compliance Certification in accordance with Division 26 Section “Electrical Shop Drawings and Submittals”.

C. Simultaneous Action Submittals: Enclosed Switches and Circuit Breaker Product Data submittal shall be made in conjunction with action submittals required under Division 26 Section “Overcurrent Protective Device Studies.” The release of electrical equipment submittals (panelboards, engine generators, switchgear, etc.) is dependent on the receipt of a complete and accurate overcurrent protective device coordination study. The Architect and Engineer require a full submittal review period as delineated in Division 01 Section “Administrative Requirements” to adequately review the OCPD study against the submitted electrical components prior to release of submittals for equipment procurement. The submittal schedule

required by Division 01 requirements shall provide for this review time in the action submittal process. Delay claims arising due to Contractor's failure to coordinate simultaneous action submittals will not be considered by the Owner.

D. 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, accessories, and finishes.

1. Enclosure types and details for types other than NEMA 250, Type 1.
2. Current and voltage ratings.
3. Short-circuit current ratings (interrupting and withstand, as appropriate).
4. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices, accessories, and auxiliary components.
5. Time-current curves for each type of overcurrent protection device. Include hardcopy of characteristic curve and TCC Number for use with Power Tools by SKM Systems Analysis, Inc.

E. Shop Drawings: For enclosed switches and circuit breakers. Include plans, elevations, sections, details, and attachments to other work.

1. Wiring Diagrams: For power, signal, and control wiring.

1.05 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified testing agency.

B. Field quality-control reports.

1. Test procedures used.
2. Test results that comply with requirements.
3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

C. Manufacturer's field service report.

1.06 CLOSEOUT SUBMITTALS

A. 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 01 Section "Closeout Submittals," include the following:

1. Manufacturer's written instructions for testing and adjusting enclosed switches and circuit breakers.
2. Manufacturer's routing maintenance requirements for enclosed switches and circuit breakers and all installed components.
3. Time-current curves, including selectable ranges for each type of circuit breaker. Include directory listing each adjustable breaker included in the Work and their final set points.

1.07 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. Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
2. Fuse Pullers: Two for each size and type.

1.08 QUALITY ASSURANCE

A. Source Limitations: Obtain enclosed switches and circuit breakers, overcurrent protective devices, components, and accessories, within same product category, from single source from single manufacturer.

B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed switches and circuit breakers, including clearances between enclosures, and adjacent surfaces and other items. Comply with indicated maximum dimensions.

C. 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.

D. Comply with NFPA 70.

1.09 DELIVERY, STORAGE, AND HANDLING

A. Prepare equipment for shipment.

1. Provide suitable crating, blocking, and supports so equipment will withstand expected domestic shipping and handling shocks and vibration.

2. Weatherproof equipment for shipment. Close connection openings to prevent entrance of foreign material during shipment and storage.

B. Installation Pathway: Coordinate delivery of equipment to allow movement into designated space.

1. Deliver in shipping splits in sizes that can be moved past obstructions in delivery path.

2. Remove and replace access fencing, doors, lift-out panels, and structures to provide pathway for moving equipment into place.

C. Store equipment indoors in clean dry space with uniform temperature in accordance with manufacturer's requirements to prevent condensation. Protect equipment from exposure to dirt, fumes, water, corrosive substances, and physical damage.

D. Handle equipment components according to manufacturer's written instructions. Use factory-installed lifting provisions.

1.10 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.

1.11 COORDINATION

A. Coordinate layout and installation of switches, circuit breakers, and components with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Coordinate ratings with utilization equipment nameplate limitations of maximum overcurrent protection device size. Provide enclosed switch or circuit breakers to match utilization equipment requirements.

PART 2 - PRODUCTS

2.01 FUSIBLE SWITCHES

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

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.

2. ABB (General Electric Company); Industrial Connections & Solutions, LLC.

3. Siemens Energy & Automation, Inc.

4. Square D; a brand of Schneider Electric.

B. Type HD, Heavy Duty, Single Throw, 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate specified fuses, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

C. 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; labeled for copper and aluminum neutral conductors.
3. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
4. Auxiliary Contact Kit: One NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open.
5. Hookstick Handle: Allows use of a hookstick to operate the handle.
6. Lugs: Mechanical type, suitable for number, size, and conductor material.
7. Service-Rated Switches: Labeled for use as service equipment.
8. Accessory Control Power Voltage: Remote mounted and powered; 120-V ac.

2.02 NONFUSIBLE SWITCHES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
2. ABB (General Electric Company); Industrial Connections & Solutions, LLC.
3. Siemens Energy & Automation, Inc.
4. Square D; a brand of Schneider Electric.

B. Type HD, Heavy Duty, Single Throw, 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

C. 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; labeled for copper and aluminum neutral conductors.
3. Auxiliary Contact Kit: One NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open.
4. Hookstick Handle: Allows use of a hookstick to operate the handle.
5. Lugs: Mechanical type, suitable for number, size, and conductor material.
6. Accessory Control Power Voltage: Remote mounted and powered; 120-V ac.

2.03 MOLDED-CASE CIRCUIT BREAKERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
2. ABB (General Electric Company); Industrial Connections & Solutions, LLC.
3. Siemens Energy & Automation, Inc.
4. Square D; a brand of Schneider Electric.

B. General Requirements: Comply with UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents.

C. 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.

D. Electronic Trip Circuit Breakers: Field-replaceable rating plug, rms sensing, with the following field-adjustable settings:

1. Instantaneous trip.
2. Long- and short-time pickup levels.
3. Long- and short-time time adjustments.

E. Features and Accessories:

1. Standard frame sizes, trip ratings, and number of poles.
2. Lugs: Mechanical type, suitable for number, size, trip ratings, and conductor material.
3. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge lighting circuits.
4. Shunt Trip: Trip coil energized from separate circuit, with coil-clearing contact.
5. Auxiliary Contacts: One SPDT switch with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts.

2.04 ENCLOSURES

A. Enclosed Switches and Circuit Breakers: NEMA AB 1, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location.

1. Indoor, Dry and Clean Locations: NEMA 250, Type 1.
2. Outdoor Locations: NEMA 250, Type 3R.
3. Other Wet or Damp, Indoor Locations: NEMA 250, Type 4.

B. Enclosure Finish for Outdoor Units: Factory-applied finish in manufacturer's standard ANSI Gray enamel over corrosion-resistant treatment or rust-inhibiting primer coat, undersurfaces treated with corrosion-resistant undercoating.

C. Enclosure Finish for Indoor Units: Factory-applied finish in manufacturer's standard ANSI Gray enamel over corrosion-resistant treatment or rust-inhibiting primer coat.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in of conduits to verify the following:

1. Wiring entries comply with layout requirements.
2. Entries are within conduit-entry tolerances specified by manufacturer and no feeders will have to cross section barriers to reach load or line lugs.

C. Verify that ground connections are in place and that requirements in Division 26 Section "Grounding and Bonding for Electrical Systems" have been met.

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

3.02 APPLICATION

A. Fused Power Circuit Device Operating Mechanism: Mechanical Trip, except Electrical Trip for switches with ground-fault protection or remotely tripped switches.

B. Molded-Case Circuit Breakers OCPD Type: Thermal-Magnetic Circuit Breakers, unless otherwise indicated.

3.03 INSTALLATION

A. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.

B. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

C. Install fuses in fusible devices.

D. Comply with NECA 1.

E. Anchor floor-mounting switches to concrete base.

F. Mount top of trim 74 inches above finished floor, unless otherwise indicated.

G. Mount plumb and rigid without distortion of box. Mount recessed equipment with fronts uniformly flush with wall finish.

H. Install filler plates in unused spaces.

I. Arrange conductors in gutters into groups and bundle and wrap with wire ties.

J. Close unused conduit opening or other unused holes in sides of box with proper mating blank-off plates.

K. Do not use gutters of equipment as raceways for routing feeder conductors from bottom entrance to top-feed lugs or vice versa; an external gutter or conduit shall be used for this purpose.

3.04 IDENTIFICATION

A. Comply with requirements in Division 26 Section "Identification for Electrical Systems."

1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.

2. Label each enclosure with engraved metal or laminated-plastic nameplate.

3.05 FIELD QUALITY CONTROL

A. 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.

B. Acceptance Testing Preparation:

1. Test insulation resistance for each enclosed switch and circuit breaker, component, connecting supply, feeder, and control circuit.

2. Test continuity of each circuit.

C. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.

2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

3. Perform the following infrared scan tests and inspections and prepare reports:

a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each enclosed switch and circuit breaker. Remove front panels so joints and connections are accessible to portable scanner.

b. Instruments and Equipment: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

4. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

D. Enclosed switches and circuit breakers will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports, including a certified report that identifies enclosed switches and circuit breakers and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.06 ADJUSTING

A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

B. Set field-adjustable overcurrent protection device trip characteristics according to settings provided by Engineer-of-Record.

1. Settings will be provided by Engineer-of-Record after the submittal process and review of report required by Division 26 Section "Overcurrent Protective Device Studies." are completed.

3.07 CLEANING

A. Clean components according to manufacturer's written instructions.

B. Prior to installation of front trim and cover plates inspect interior surfaces and perform the following:

1. Remove paint splatters and other spots.
2. Vacuum dirt and debris; do not use compressed air to assist in cleaning.

C. On completion of front trim and cover installation, inspect exterior surfaces and perform the following:

1. Remove paint splatters and other spots.
2. Remove all temporary markings and labels.
3. Vacuum dirt and debris; do not use compressed air to assist in cleaning.
4. Repair exposed surfaces to match original finish.

3.08 PROTECTION

A. Temporary Heating: Maintain a clean dry space with uniform temperature in accordance with manufacturer’s requirements to prevent condensation. Apply temporary heating as required.

B. Protect equipment from exposure to dirt, fumes, water, corrosive substances, and physical damage.

END OF SECTION 26 2816

SECTION 26 3213
ENGINE GENERATORS

PART 1 - GENERAL

1.01 SUMMARY

A. This Section includes packaged engine-generator sets for emergency power supply with the following features:

1. Gas engine.
2. Unit-mounted cooling system.
3. Unit-mounted control and monitoring.
4. Outdoor enclosure.

B. Related Sections include the following:

1. Division 26 Section "Transfer Switches" for transfer switches including sensors and relays to initiate automatic-starting and -stopping signals for engine-generator sets.

1.02 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.

B. LP: Liquid petroleum.

1.03 PERFORMANCE REQUIREMENTS

A. Overcurrent Protective Device Coordination for Emergency Systems and Legally Required Standby Systems: All overcurrent protective devices proposed for inclusion in the Work on the Emergency Systems branch (NEC Article 700) and the Legally Required Standby System branch (NEC Article 701) shall be selected to be selectively coordinated with the overcurrent protective devices installed on their supply side such that an overcurrent event (overload, short-circuit, or ground-fault) occurring at the lowest level in the system (branch circuit) cannot cause the feeder protective device supplying the branch circuit panelboard to open. This coordination shall be carried through each level of distribution for both normal and emergency power. Refer to Division 26 Section "Overcurrent Protective Device Studies" for additional requirements.

B. Overcurrent Protective Device Coordination: All other overcurrent protective devices proposed for inclusion in the Work shall be selected to be coordinated with the overcurrent protective devices installed on their supply side such that an overcurrent event (overload, short-circuit, or ground-fault) occurring at the lowest level in the system (branch circuit) cannot cause the feeder protective device supplying the branch circuit panelboard to open. This coordination shall be carried through each level of distribution for all branches of normal and emergency power to 0.10 seconds. Refer to Division 26 Section "Overcurrent Protective Device Studies" for additional requirements.

1.04 ACTION SUBMITTALS

A. Submit product data and shop drawings in accordance with Division 01 and Division 26 Section “Electrical Shop Drawings and Submittals” for products specified under PART 2 - PRODUCTS.

B. Specification Compliance Certification: Submit a Specification Compliance Certification in accordance with Division 26 Section “Electrical Shop Drawings and Submittals”.

C. Simultaneous Action Submittals: Engine Generator Product Data submittal shall be made in conjunction with action submittals required under Division 26 Section “Overcurrent Protective Device Studies.” The release of electrical equipment submittals (panelboards, engine generators, switchgear, etc.) is dependent on the receipt of a complete and accurate overcurrent protective device coordination study. The Architect and Engineer require a full submittal review period as delineated in Division 01 Section “Submittal Procedures” to

adequately review the OCPD study against the submitted electrical components prior to release of submittals for equipment procurement. The submittal schedule required by Division 01 requirements shall provide for this review time in the action submittal process. Delay claims arising due to Contractor's failure to coordinate simultaneous action submittals will not be considered by the Owner.

D. 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.

E. 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: Signed and sealed by a qualified professional engineer. Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.
3. Wiring Diagrams: Power, signal, and control wiring.

1.05 INFORMATIONAL SUBMITTALS

A. Qualification Data: For installer, manufacturer, and testing agency.

B. 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. Certified Summary of Performance Tests: Certify compliance with specified requirement to meet performance criteria for sensitive loads.
4. Report of factory test on units to be shipped for this Project, showing evidence of compliance with specified requirements.
5. Report of sound generation.
6. Report of exhaust emissions showing compliance with applicable regulations.
7. Certified Torsional Vibration Compatibility: Comply with NFPA 110.

C. Field quality-control test reports.

D. Warranty: Special warranty specified in this Section.

1.06 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For packaged engine generators to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Closeout Submittals," 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.

1.07 MAINTENANCE MATERIAL SUBMITTALS

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.

1.08 QUALITY ASSURANCE

A. General Requirements: It is the intent of this specification to secure an emergency generator system that has been prototype tested, factory built, production tested, site tested, of the latest commercial design, together with all accessories necessary for a complete installation as shown on the plans and drawings, and specifications herein. The equipment supplied and installed shall meet the requirements of the National Electrical Code, along with all applicable local codes and regulations. All equipment shall be new, of current productions of a national firm. The standby generator set(s) including generator, controls, and transfer switch(es), shall be assembled as a matched unit so that there is a one-source responsibility for warranty, parts, and service without a local representative with factory-trained servicemen.

B. 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 four hours' normal travel time from Installer's place of business to Project site.

2. Engineering Responsibility: Preparation of data for vibration isolators and seismic restraints of engine skid mounts, including Shop Drawings, based on testing and engineering analysis of manufacturer's standard units in assemblies similar to those indicated for this Project.

C. Manufacturer Qualifications: A qualified manufacturer. Maintain, within 200 miles of Project site, a service center capable of providing training, parts, and emergency maintenance repairs.

D. Source Limitations: Obtain packaged generator sets and auxiliary components through one source from a single manufacturer.

E. 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.

F. Comply with ASME B15.1.

G. Comply with NFPA 37, NFPA 70, NFPA 101, and NFPA 110 requirements for Level 1 emergency power supply system.

H. Comply with UL 2200.

I. Engine Exhaust Emissions: Comply with applicable state and local government requirements.

J. Noise Emission: Comply with applicable state and local government requirements for maximum noise level at adjacent property boundaries due to sound emitted by generator set including engine, engine exhaust, engine cooling-air intake and discharge, and other components of installation.

1.09 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: 5 to 40 deg C.

2. Relative Humidity: 0 to 95 percent.

3. Altitude: Sea level to 1000 feet.

1.10 COORDINATION

A. Coordinate size and location of concrete bases for package engine generators. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

1.11 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: Five (5) years or 1500 hours, whichever occurs first, from date of Substantial Completion.
2. For standby power applications, the complete electrical power system (generator set, controls and associated switches, switchgear and accessories), as provided by the single-source manufacturer, shall be warranted by said manufacturer against defects in materials and workmanship for the above warranty period.
3. Said coverage shall include parts, labor, travel expenses, and labor to remove/reinstall said equipment.
4. There shall be no deductibles applied to said warranty.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

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

1. Caterpillar; Engine Div.
2. Cummins Power Generation; Industrial Business Group.
3. Kohler.

2.02 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.
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: 0.25 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 250 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.

2.03 ENGINE

A. Fuel: Natural gas.

B. Rated Engine Speed: 1800 rpm.

C. Maximum Piston Speed for Four-Cycle Engines: 2250 fpm.

D. Manufacturer: Engine shall be the same manufacturer as the engine-generator set manufacturer.

E. 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.

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 maximum working pressure with coolant at 180 deg F, and non-collapsible under vacuum.
    b. End Fittings: Flanges or steel pipe nipples with clamps to suit piping and equipment connections.

I. Muffler: 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.
2. Sound level measured at a distance of 10 feet from exhaust discharge after installation is complete shall be 95 dBA or less.

J. Air-Intake Filter: Standard-duty, engine-mounted air cleaner with replaceable dry-filter element and "blocked filter" indicator.

K. Starting System: 12-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 twice 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. 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.

2.04 CONTROL AND MONITORING

A. Automatic Starting System Sequence of Operation: When mode-selector switch on the control and monitoring panel is in the “AUTO” 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 “START” position, generator set starts and accelerates to rated speed and voltage. The “STOP” position of same switch initiates generator-set shutdown and shall immediately stop, bypassing all time delays. 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:

1. As required by NFPA 110 for Level 1 system, and the following:
    a. AC voltmeter.
    b. AC ammeter.
    c. AC frequency meter.
    d. DC voltmeter (alternator battery charging).
    e. Engine-coolant temperature gage.
    f. Engine lubricating-oil pressure gage.
    g. Running-time meter.
    h. Ammeter-voltmeter, phase-selector switch(es).
    i. Generator-voltage adjusting rheostat.
2. Alarm and status indicating lamps to indicate non-automatic generator status and existing alarm and shutdown conditions. The generator set control shall indicate the existence of the following alarm and shutdown conditions on the display panel:
    a. Switch off (flashing)
    b. Low oil pressure (alarm)
    c. Low oil pressure (shutdown)
    d. Low coolant temperature (alarm)
    e. High coolant temperature (alarm)
    f. High coolant temperature (shutdown)
    g. Low coolant level (shutdown)
    h. Overcrank (shutdown)
    i. Overspeed (shutdown)

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. Connection to Data Link: A separate terminal block, factory wired to Form C dry contacts, for each alarm and status indication is reserved for connections for data-link transmission of indications to remote data terminals.

F. Remote Emergency-Stop Switch: Flush; wall mounted, unless otherwise indicated; and labeled. Push button shall be protected from accidental operation.

2.05 GENERATOR OVERCURRENT AND FAULT PROTECTION

A. Generator Circuit Breaker: Molded-case, electronic trip type; 100 percent rated; complying with NEMA AB 1 and UL 489.

1. Tripping Characteristic: Designed specifically for generator protection to protect the generator from damage due to its own high current capability.
2. Trip Rating: Matched to generator rating.
3. Shunt Trip: Connected to trip breaker when generator set is shut down by other protective devices.

4. Kirk Key Door Interlock: The main breaker on the permanent life-safety generator feeding the Life Safety ATS shall be kirk key interlocked with the enclosure door of the generator docking station for a temporary generator connection.
5. Mounting: Adjacent to or integrated with control and monitoring panel.
6. Coordination: Must meet selective coordination requirements as outlined in Performance Requirements section above to allow selective tripping of downstream circuit breakers under a fault condition.
7. This breaker shall not automatically reset preventing restoration of voltage if maintenance is being performed.

2.06 GENERATOR, EXCITER, AND VOLTAGE REGULATOR

A. Comply with NEMA MG 1.

B. Drive: Generator shaft shall be directly connected to engine shaft. Exciter shall be rotated integrally with generator rotor.

C. Electrical Insulation: Class H or Class F.

D. Stator-Winding Leads: Brought out to terminal box to permit future reconnection for other voltages if required.

E. 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.

F. Enclosure: Dripproof.

G. Instrument Transformers: Mounted within generator enclosure.

H. 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 2 percent adjustment of output-voltage operating band at any constant load from 0 to 100 percent of rating.
2. Regulator must be isolated to prevent tracking when connected to SCR loads and provide individual adjustments for voltage range, stability and volts-per-hertz operation.

I. Strip Heater: Thermostatically controlled unit arranged to maintain stator windings above dew point.

J. Windings: Two-thirds pitch stator winding and fully linked amortisseur winding.

K. Subtransient Reactance: 12 percent, maximum.

2.07 OUTDOOR GENERATOR-SET ENCLOSURE

A. Description: Vandal-resistant, weatherproof, stainless-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.

B. Engine Cooling Airflow through Enclosure: Maintain temperature rise of system components within required limits when unit operates at 110 percent of rated load for 2 hours with ambient temperature at top of range specified in system service conditions.

1. Louvers: Fixed-engine, cooling-air inlet and discharge. Storm-proof and drainable louvers prevent entry of rain and snow.
2. Automatic Dampers: At engine cooling-air inlet and discharge. Dampers shall be closed to reduce enclosure heat loss in cold weather when unit is not operating.

2.08 MOTORS

A. General requirements for motors are specified in Division 23 Section "Common Motor Requirements for HVAC Equipment."

1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
2. Controllers, Electrical Devices, and Wiring: Electrical devices and connections are specified in Division 26 Sections.

2.09 FINISHES

A. Indoor and Outdoor Enclosures and Components: Manufacturer's standard finish over corrosion-resistant pretreatment and compatible primer.

2.10 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.

B. Project-Specific Equipment Tests: Before shipment, factory test engine-generator set and other system components and accessories manufactured specifically for this Project. Perform tests at rated load and power factor. Include the following tests:
   1. Test components and accessories furnished with installed unit that are not identical to those on tested prototype to demonstrate compatibility and reliability.
   2. Full load run.
   3. Maximum power.
   4. Voltage regulation.
   5. Transient and steady-state governing.
   6. Single-step load pickup.
   7. Safety shutdown.
   8. Provide 14 days' advance notice of tests and opportunity for observation of tests by Owner's representative.
   9. Report factory test results within 10 days of completion of test.

PART 3 - EXECUTION

3.01 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.

3.02 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. Install packaged engine generator with elastomeric isolator pads having a minimum deflection of 1 inch on 4-inch-high concrete base. Secure sets to anchor bolts installed in concrete bases.

D. Electrical Wiring: Install electrical devices furnished by equipment manufacturers but not specified to be factory mounted.

3.03 CONNECTIONS

A. Piping installation requirements are specified in Division 23 Sections. Drawings indicate general arrangement of piping and specialties.

B. Connect fuel, cooling-system, and exhaust-system piping adjacent to packaged engine generator to allow service and maintenance.

C. Connect engine exhaust pipe to engine with flexible connector.

D. Connect fuel piping to engines with a gate valve and union and flexible connector.

1. Natural-gas piping, valves, and specialties for gas distribution are specified in Division 23 Section "Natural Gas Piping."

E. Connect remote monitoring system to generator and verify functionality. Engage a factory-authorized service representative to assist with programming and setup.

F. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

G. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

H. Connect remote monitoring system to generator control panel inside generator enclosure with supplied 5-pin data I/O cable.

3.04 IDENTIFICATION

A. Identify system components according to Division 23 Section "Identification for HVAC Piping and Equipment" and Division 26 Section "Identification for Electrical Systems."

3.05 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.

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.

B. Tests and Inspections:

1. Perform tests recommended by manufacturer and each electrical test and visual and mechanical inspection for "AC Generators and for Emergency Systems" specified in NETA Acceptance Testing Specification. Certify compliance with test parameters.

2. Load Test: Run generator under full load for a minimum of six (6) hours and record results. Generator shall be capable of delivering full capacity while operating in an ambient temperature of 122 degrees F. Resistive load bank shall be furnished and connected to the generator to achieve a full load per generator capacity.

a. Record coolant temperature, lube oil pressure, output voltage (each phase), and output current (each phase) at 1-hour intervals.

3. 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.

4. 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.

5. Battery-Charger Tests: Verify specified rates of charge for both equalizing and float-charging conditions.

6. 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.
7. Voltage and Frequency Transient Stability Tests: Use recording oscilloscope to measure voltage and frequency transients for 50 and 100 percent step-load increases and decreases, and verify that performance is as specified.
8. Harmonic-Content Tests: Measure harmonic content of output voltage under 25 percent and at 100 percent of rated linear load. Verify that harmonic content is within specified limits.

C. Coordinate tests with tests for transfer switches and run them concurrently.

D. Test instruments shall have been calibrated within the last 12 months, traceable to standards of NIST, and adequate for making positive observation of test results. Make calibration records available for examination on request.

E. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.

F. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation. Upon completion of load test, operate the generator under actual load conditions connected to the building. Test shall be run for a minimum of two (2) hours.

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.

K. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each power wiring termination and each bus connection. Remove all access panels so terminations and connections are accessible to portable scanner.

1. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
2. Record of Infrared Scanning: Prepare a certified report that identifies terminations and connections checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.06 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain packaged engine generators. Provide at least 7-day notice to Owner and Engineer of training date. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION 26 3213

SECTION 26 3600
TRANSFER SWITCHES

PART 1 - GENERAL

1.01 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. Division 21 Section "Electric-Drive, Centrifugal Fire Pumps" for automatic transfer switches for fire pumps.

1.02 ACTION SUBMITTALS

A. Submit product data and shop drawings in accordance with Division 01 and Division 26 Section “Electrical Shop Drawings and Submittals” for products specified under PART 2 - PRODUCTS.

B. Specification Compliance Certification: Submit a Specification Compliance Certification in accordance with Division 26 Section “Electrical Shop Drawings and Submittals”.

C. Simultaneous Action Submittals: Transfer Switch Product Data submittal shall be made in conjunction with action submittals required under Division 26 Section “Overcurrent Protective Device Studies.” The release of electrical equipment submittals (panelboards, engine generators, switchgear, etc.) is dependent on the receipt of a complete and accurate overcurrent protective device coordination study. The Architect and Engineer require a full submittal review period as delineated in Division 01 Section “Submittal Procedures” to adequately review the OCPD study against the submitted electrical components prior to release of submittals for equipment procurement. The submittal schedule required by Division 01 requirements shall provide for this review time in the action submittal process. Delay claims arising due to Contractor’s failure to coordinate simultaneous action submittals will not be considered by the Owner.

D. Product Data: For each type of product indicated. Include rated capacities, weights, operating characteristics, furnished specialties, and accessories.

E. 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.

F. Warranty: Special warranty specified in this Section.

1.03 INFORMATIONAL SUBMITTALS

A. Qualification Data: For manufacturer.

B. Field quality-control test reports.

1.04 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For each type of product to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Closeout Submittals," 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.

1.05 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.

1.06 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

1.07 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: Five (5) years from date of Substantial Completion.

2. For standby power applications, the complete electrical power system (generator set, controls and associated switches, switchgear and accessories), as provided by the single-source manufacturer, shall be warranted by said manufacturer against defects in materials and workmanship for the above warranty period.

3. Said coverage shall include parts, labor, travel expenses, and labor to remove/reinstall said equipment.

4. There shall be no deductibles applied to said warranty.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

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

1. Contactor Transfer Switches:

a. Emerson; ASCO Power Technologies, LP.

b. Cummins Power Generation; Industrial Business Group.

c. Russelectric, Inc.

2.02 GENERAL TRANSFER-SWITCH PRODUCT REQUIREMENTS

A. 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.

B. 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.

C. 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.

D. 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.

E. Electrical Operation: Accomplish by a non-fused, momentarily energized solenoid or electric-motor-operated mechanism, mechanically and electrically interlocked in both directions.

F. 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.

G. Neutral Switching. Where four-pole switches are indicated, provide neutral pole switched simultaneously with phase poles.

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 Division 26 Section "Identification for Electrical Systems."

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: General-purpose NEMA 250, Type 1, complying with NEMA ICS 6 and UL 508, unless otherwise indicated.

2.03 AUTOMATIC TRANSFER SWITCHES

A. Comply with Level 1 equipment according to NFPA 110.

B. Switching Arrangement: Double-throw type, incapable of pauses or intermediate position stops during normal functioning, unless otherwise indicated.

C. Manual Switch Operation: Under load, with door closed and with either or both sources energized. Transfer time is same as for electrical operation. Control circuit automatically disconnects from electrical operator during manual operation.

D. Signal-Before-Transfer Contacts: A set of normally open/normally closed dry contacts operates in advance of retransfer to normal source. Interval is adjustable from 1 to 30 seconds.

E. Digital Communication Interface: Matched to capability of remote annunciator or annunciator and control panel.

F. Motor Disconnect and Timing Relay: Controls designate starters so they disconnect motors before transfer and reconnect them selectively at an adjustable time interval after transfer. Control connection to motor starters is through wiring external to automatic transfer switch. Time delay for reconnecting individual motor loads is adjustable between 1 and 60 seconds, and settings are as indicated. Relay contacts handling motor-control circuit inrush and seal currents are rated for actual currents to be encountered.

G. Programmed Neutral Switch Position: Switch operator has a programmed neutral position arranged to provide a midpoint between the two working switch positions, with an intentional, time-controlled pause at midpoint during transfer. Pause is adjustable from 0.5 to 30 seconds minimum and factory set for 0.5 second, unless otherwise indicated. Time delay occurs for both transfer directions. Pause is disabled unless both sources are live.

H. Automatic Transfer-Switch 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 override of normal-source voltage sensing to delay transfer and 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 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.
5. Test Switch: Simulate normal-source failure.
6. Switch-Position Pilot Lights: Indicate source to which load is connected.
7. 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."
8. Unassigned Auxiliary Contacts: Two normally open, single-pole, double-throw contacts for each switch position, rated 10 A at 240-V ac.
9. 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.
10. Engine Starting Contacts: One isolated and normally closed, and one isolated and normally open; rated 10 A at 32-V dc minimum.
11. 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.
12. 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 30 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.

2.04 INSTRUMENTATION

A. Multifunction Digital-Metering Monitor: Microprocessor-based unit suitable for three- or four-wire systems and with the following features:
    1. Manufacturers: Subject to compliance with requirements, provide products by the following:

a. Electro Industries/GaugeTech Shark 100 meter.

2. Switch-selectable digital display of the following values with maximum accuracy tolerances as indicated:
   a. Phase Currents, Each Phase: Plus or minus 1 percent.
   b. Phase-to-Phase Voltages, Three Phase: Plus or minus 1 percent.
   c. Phase-to-Neutral Voltages, Three Phase: Plus or minus 1 percent.
   d. Megawatts: Plus or minus 2 percent.
   e. Megavars: Plus or minus 2 percent.
   f. Power Factor: Plus or minus 2 percent.
   g. Frequency: Plus or minus 0.5 percent.
   h. Accumulated Energy, Megawatt Hours: Plus or minus 2 percent; accumulated values unaffected by power outages up to 72 hours.
   i. Megawatt Demand: Plus or minus 2 percent; demand interval programmable from five to 60 minutes.
3. Mounting: Display and control unit flush or semi-flush mounted in separate NEMA 1 enclosure adjacent to automatic transfer switch.
4. Meter shall have 10/100BaseT Ethernet with Modbus TCP protocol capabilities to interface with building automation controls system. Coordinate with controls system manufacturer for exact connection type and requirements.

2.05 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

3.01 INSTALLATION

A. Identify components according to Division 26 Section "Identification for Electrical Systems."

B. Set field-adjustable intervals and delays, relays, and engine exerciser clock.

3.02 CONNECTIONS

A. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

B. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.03 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installation, including connections, and to assist in testing.

2. After installing equipment and after electrical circuitry has been energized, test for compliance with requirements.

3. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.

4. Measure insulation resistance phase-to-phase and phase-to-ground with insulation-resistance tester. Include external annunciation and control circuits. Use test voltages and procedure recommended by manufacturer. Comply with manufacturer's specified minimum resistance.

   a. Check for electrical continuity of circuits and for short circuits.

b. Inspect for physical damage, proper installation and connection, and integrity of barriers, covers, and safety features.

c. Verify that manual transfer warnings are properly placed.

d. Perform manual transfer operation.

5. 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.

6. Ground-Fault Tests: Coordinate with testing of ground-fault protective devices for power delivery from both sources.

   a. Verify grounding connections and locations and ratings of sensors.

7. After installing equipment and after electrical circuitry has been energized, test for compliance with requirements.

8. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.

9. Measure insulation resistance phase-to-phase and phase-to-ground with insulation-resistance tester. Include external annunciation and control circuits. Use test voltages and procedure recommended by manufacturer. Comply with manufacturer's specified minimum resistance.

   a. Check for electrical continuity of circuits and for short circuits.

   b. Inspect for physical damage, proper installation and connection, and integrity of barriers, covers, and safety features.

   c. Verify that manual transfer warnings are properly placed.

   d. Perform manual transfer operation.

10. 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. Test bypass/isolation unit functional modes and related automatic transfer-switch operations.

    f. Perform contact-resistance test across main contacts and correct values exceeding 500 microhms and values for 1 pole deviating by more than 50 percent from other poles.

g. 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.

11. Ground-Fault Tests: Coordinate with testing of ground-fault protective devices for power delivery from both sources.

a. Verify grounding connections and locations and ratings of sensors.

B. Coordinate tests with tests of generator and run them concurrently.

C. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation and contact resistances and time delays. Attach a label or tag to each tested component indicating satisfactory completion of tests.

D. Remove and replace malfunctioning units and retest as specified above.

E. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each switch. Remove all access panels so joints and connections are accessible to portable scanner.

1. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

2. Record of Infrared Scanning: Prepare a certified report that identifies switches checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.04 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain transfer switches and related equipment as specified below. Refer to Division 01 Section "Demonstration and Training."

B. Coordinate this training with that for generator equipment.

END OF SECTION 26 3600

SECTION 26 4313
SURGE PROTECTIVE DEVICES

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes field-mounted SPD for low-voltage (120 to 600 V) power distribution and control equipment.

B. Related Requirements:

1. Section 26 2413 Switchboards for factory installed SPDs.
2. Section 26 2416 Panelboards for field installed SPDs.

1.02 DEFINITIONS

A. ATS: Acceptance Testing Specifications.

B. I-nominal: Nominal discharge current.

C. MCOV: Maximum continuous operating voltage.

D. MOV: Metal-oxide varistor; an electronic component with a significant non-ohmic current-voltage characteristic.

E. OCPD: Overcurrent protective device.

F. SCCR: Short-circuit current rating.

G. SVR: Suppressed voltage rating.

H. SPD: Surge Protective Device(s), both singular and plural; also, transient voltage surge suppression.

I. VPR: Voltage protection rating.

1.03 ACTION SUBMITTALS

A. Submit product data and shop drawings in accordance with Division 01 and Division 26 Section “Electrical Shop Drawings and Submittals” for products specified under PART 2 - PRODUCTS.

B. Specification Compliance Certification: Submit a Specification Compliance Certification in accordance with Division 26 Section “Electrical Shop Drawings and Submittals”.

C. Product Data: For each type of product indicated. Include rated capacities, clamp times, physical construction, operating weights, electrical characteristics, furnished specialties, and accessories. Include UL 1449, 3rd Edition Listing documentation verifying:

1. Short Circuit Current Rating (SCCR).
2. Voltage Protection Ratings (VPRs) for all modes.
3. Maximum Continuous Operating Voltage rating (MCOV). The MCOV shall be a tested value per UL 1449 3rd Edition, section 37 .7.3. MCOV values based solely on the components used in the construction of the SPD will not be accepted.
4. I-nominal rating (I-n).
5. Type 1 or Type 2 Device Listing.
6. Manufacturer shall provide written test report showing the SPD can survive a single surge at its raged value without the use of circuit breakers or fuses. Single surge ratings based on the sum of components used in the construction of the SPD will not be acceptable.
7. kA rating per phase.
8. kA rating per mode.

D. Warranty: Special warranty specified in this Section.

1.04 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified testing agency.

B. Product Certificates: For SPD devices, from manufacturer.

C. Field quality-control reports.

1.05 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For SPD devices to include in emergency, operation, and maintenance manuals.

1.06 QUALITY ASSURANCE

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

B. Comply with IEEE C62.41.2 and test devices according to IEEE C62.45.

C. Comply with NEMA LS 1.

D. Comply with UL 1449, 3rd Edition.

E. Comply with NFPA 70.

1.07 PROJECT CONDITIONS

A. Service Conditions: Rate SPD devices for continuous operation under the following conditions unless otherwise indicated:

1. Maximum Continuous Operating Voltage: Not less than 115 percent of nominal system operating voltage.
2. Operating Temperature: 30 to 120 deg F.
3. Humidity: 0 to 85 percent, noncondensing.
4. Altitude: Less than 20,000 feet above sea level.

1.08 COORDINATION

A. Coordinate location of field-mounted SPD devices to allow adequate clearances for maintenance.

1.09 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of surge suppressors that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Fifteen (15) years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 SERVICE ENTRANCE SUPPRESSORS

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

1. ACT Communications, Inc.
2. Current Technology Inc.; Danaher Power Solutions.
3. Danaher Power Solutions; United Power Products.
4. Liebert Corporation; a division of Emerson Network Power.
5. Southern Tier Technologies.

B. Surge Protection Devices:

1. Comply with UL 1449, Type 1.
2. Modular design (with field-replaceable modules).

3. Internal Device Overcurrent Protection (Fuses): All protection modes (including Neutral to Ground) of each surge suppression device shall be internally fused at the component level with fuse I^2T capability allowing the suppressor's maximum rated transient current to pass through the suppressor without fuse operation. If the rated I^2T characteristic of the fusing is exceeded, the fusing shall be capable of opening in less than one millisecond and clear both high and low impedance fault conditions. The fusing shall be capable of interrupting up to 200 kA symmetrical fault current with 600 VAC applied. This overcurrent protection circuit shall be monitored to provide indication of suppression failure. Conductor level fuses or circuit breakers internal or external to the surge suppression units are not acceptable as meeting this requirement.
4. Each MOV shall be individually fuse protected to avoid cascading faults.
5. Fabrication using bolted compression lugs for internal wiring.
6. Integral disconnect switch.
7. Redundant suppression circuits.
8. Redundant replaceable modules.
9. Arrangement with copper bus bars and for bolted connections to phase buses, neutral bus, and ground bus.
10. Arrangement with wire connections to phase buses, neutral bus, and ground bus.
11. LED indicator lights for power and protection status.
12. Audible alarm, with silencing switch, to indicate when protection has failed.
13. Form-C contacts rated at 5 A and 250-V ac, one normally open and one normally closed, for remote monitoring of protection status. Contacts shall reverse on failure of any surge diversion module or on opening of any current-limiting device. Coordinate with building power monitoring and control system.
14. Six-digit transient-event counter set to totalize transient surges.

C. Peak Surge Current Rating: The minimum single-pulse surge current withstand rating per phase shall not be less than 320 kA. The peak surge current rating shall be the arithmetic sum of the ratings of the individual MOVs in a given mode.

D. Minimum single impulse current ratings, using 8-by-20-mic.sec waveform described in IEEE C62.41.2
   1. Line to Neutral: 200,000 A.
   2. Line to Ground: 200,000 A.
   3. Line to Line: 200,000 A.
   4. Neutral to Ground: 200,000 A.

E. Protection modes and UL 1449 VPR for grounded wye circuits with 480Y/277 V, 3-phase, 4-wire circuits shall be as follows:
   1. Line to Neutral: 1200 V for 480Y/277 V.
   2. Line to Ground: 1200 V for 480Y/277 V.
   3. Line to Line: 2000 V for 480Y/277 V.
   4. Neutral to Ground: 1200V for 480Y/277 V.

F. SCCR: Equal or exceed 200 kA.

G. I-nominal Rating: UL labeled with 20 kA nominal for compliance with UL 96A Lightning Protection Master Label and NFPA 780.

2.02 PANELBOARD SUPPRESSORS

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

1. ACT Communications, Inc.
2. Current Technology Inc.; Danaher Power Solutions.
3. Danaher Power Solutions; United Power Products.
4. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
5. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
6. Liebert Corporation; a division of Emerson Network Power.
7. Siemens Energy & Automation, Inc.
8. Southern Tier Technologies.
9. Square D; a brand of Schneider Electric.

B. Surge Protection Devices:

1. Comply with UL 1449, Type 2.
2. Modular design (with field-replaceable modules).
3. Short-circuit current rating complying with UL 1449, and matching or exceeding the panelboard short-circuit rating and redundant suppression circuits; with individually fused metal-oxide varistors.
4. Internal Device Overcurrent Protection (Fuses): All protection modes (including Neutral to Ground) of each surge suppression device shall be internally fused at the component level with fuse I^2T capability allowing the suppressor's maximum rated transient current to pass through the suppressor without fuse operation. If the rated I^2T characteristic of the fusing is exceeded, the fusing shall be capable of opening in less than one millisecond and clear both high and low impedance fault conditions. The fusing shall be capable of interrupting up to 200 kA symmetrical fault current with 600 VAC applied. This overcurrent protection circuit shall be monitored to provide indication of suppression failure. Conductor level fuses or circuit breakers internal or external to the surge suppression units are not acceptable as meeting this requirement.
5. Each MOV shall be individually fuse protected to avoid cascading faults
6. Fabrication using bolted compression lugs for internal wiring.
7. Redundant suppression circuits.
8. Redundant replaceable modules.
9. Arrangement with wire connections to phase buses, neutral bus, and ground bus.
10. LED indicator lights for power and protection status.
11. Audible alarm, with silencing switch, to indicate when protection has failed.
12. Form-C contacts rated at 5 A and 250-V ac, one normally open and one normally closed, for remote monitoring of protection status. Contacts shall reverse on failure of any surge diversion module or on opening of any current-limiting device. Coordinate with building power monitoring and control system.
13. Four-digit transient-event counter set to totalize transient surges.

C. Peak Surge Current Rating: The minimum single-pulse surge current withstand rating per phase shall not be less than 200 kA. The peak surge current rating shall be the arithmetic sum of the ratings of the individual MOVs in a given mode.

D. Minimum single impulse current ratings, using 8-by-20-mic.sec waveform described in IEEE C62.41.2:

1. Line to Neutral: 100,000 A.
2. Line to Ground: 100,000 A.
3. Line to Line: 100,000 A.
4. Neutral to Ground: 100,000 A.

E. Protection modes and UL 1449 SVR for grounded wye circuits with 480Y/277 V or 208Y/120 V, 3-phase, 4-wire circuits shall not exceed the follows:

1. Line to Neutral: 1200 V for 480Y/277 V and 700 V for 208Y/120 V.
2. Line to Ground: 1200 V for 480Y/277 V and 700 V for 208Y/120 V.
3. Neutral to Ground: 1200 V for 480Y/277 V and 700 V for 208Y/120 V.
4. Line to Line: 2000 V for 480Y/277 V and 1200 V for 208Y/120 V.

F. SCCR: Equal or exceed 100 kA.

2.03 ENCLOSURES

A. Indoor Enclosures: NEMA 250 Type 1.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install SPD devices at service entrance on load side, with ground lead bonded to service entrance ground.

1. Provide direct tap off load side of main bus in switchboard. Utilize #2/0 AWG wire for connection to switchboard with maximum wire length of three feet.

B. Install SPD devices for panelboards and auxiliary panels conductors between suppressor and points of attachment as short and straight as possible, and adjust circuit-breaker positions to achieve shortest and straightest leads. Do not splice and extend SPD leads unless specifically permitted by manufacturer. Do not exceed manufacturer's recommended lead length. Do not bond neutral and ground.

1. Provide 30-A circuit breaker as a dedicated disconnecting means for SPD unless otherwise indicated. Utilize #8 AWG wire for connection to panelboard with maximum wire length of three feet.

C. Use crimped connectors and splices only. Wire nuts are unacceptable.

3.02 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.

1. Verify that electrical wiring installation complies with manufacturer's written installation requirements.

B. 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.

C. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test stated in NETA ATS, "Surge Arresters, Low-Voltage Surge Protection Devices" Section. Certify compliance with test parameters.
2. After installing SPD devices but before electrical circuitry has been energized, test for compliance with requirements.
3. Complete startup checks according to manufacturer's written instructions.

D. SPD will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

3.03 STARTUP SERVICE

A. Complete startup checks according to manufacturer's written instructions.

B. Do not perform insulation-resistance tests of the distribution wiring equipment with SPDs installed. Disconnect SPDs before conducting insulation-resistance tests, and reconnect them immediately after the testing is over.

C. Do not energize or connect service entrance equipment or panelboards to their sources until SPD devices are installed and connected.

END OF SECTION 26 4313

SECTION 26 5100
INTERIOR LIGHTING

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Interior lighting fixtures.
2. Building mounted exterior lighting fixtures.
3. Exit signs.
4. Lighting fixture supports and accessories.

1.02 DESCRIPTION OF WORK

A. This work consists of providing all labor, materials, accessories, mounting hardware and equipment necessary for an operationally and aesthetically complete installation of all luminaries, including accessories, in accordance with the contract documents.

B. Furnish and install all lighting fixtures, as herein specified, complete with lamps, drivers, power supplies, ballasts and accessories for safe and effective operation. All fixtures shall be installed and left in an operable condition with no broken, damaged or soiled parts.

C. All items furnished shall comply with the latest applicable standards applicable, including UL, NEMA and ETL, and shall bear labels accordingly.

D. All fixtures shall be the color specified or as selected by the Architect during shop drawing review. Wherever fixtures have evident damage, they shall be restored to new condition or shall be replaced. Likewise, fixtures showing dirt, dust or finger prints shall be restored to new condition or shall be replaced.

E. Specifications and scale drawings are intended to convey all salient features, functions and characteristics of the light fixtures only, and do not undertake to illustrate or set forth every item or detail necessary for the work.

F. Minor details, not usually indicated on the drawings nor specified, but that are necessary for proper execution and completion of the luminaries, shall be included, the same as if they were herein specified or indicated on the drawings.

G. The Owner, Architect and Engineer shall not be held responsible for the omission or absence of any detail, construction feature, etc. which may be required in the production of the light fixtures. The responsibility of accurately fabricating the light fixtures to the fulfillment of the specification rests with the Contractor.

H. Where emergency battery packs are provided with fixtures (if any), they shall be connected to an unswitched power line and wired in accord with applicable codes and the manufacturer's recommendations.

I. Refer to architectural details as applicable for recessed soffit fixtures or wherever fixture installations depend upon work of other trades. Coordinate all installations with other trades. Verify dimensions of spaces for fixtures, and if necessary, adjust lengths to assure proper fit and illumination of diffuser and/or area below.

J. Pre-manufactured flexible wiring systems are not permitted for this project.

1.03 DEFINITIONS

A. CCT: Correlated color temperature.

B. CRI: Color-rendering index.

C. CU: Coefficient of utilization.

D. DLC: DesignLights Consortium.

E. IECC: international Energy Conservation Code.

F. LED: Light emitting diode.

G. LER: Luminaire efficacy rating.

H. Lumen: Measured output of lamp and luminaire, or both.

I. Luminaire: Complete lighting fixture, including ballast housing if provided.

J. RCR: Room cavity ratio.

K. UL: Underwriters Laboratory

1.04 REFERENCE STANDARDS

A. IESNA LM-80 – Measuring Lumen Maintenance of LED Light Sources.

B. IESNA HB-10 – IES Lighting Handbook – Tenth Edition.

C. NEMA 250 – Enclosures for Electrical Equipment (1000 Volts Maximum)

D. NFPA 101 – Life Safety Code

E. NFPA 70 – National Electrical Code.

F. UL 924 – Standard for Emergency Lighting and Power Equipment.

G. UL 1310 – Standard for Safety Class 2 Power Units.

H. UL 1598 – Luminaires.

1.05 ACTION SUBMITTALS

A. Submit product data and shop drawings in accordance with Division 01 and Division 26 Section "Electrical Shop Drawings and Submittals" for products specified under PART 2 – PRODUCTS.

B. 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. Energy-efficiency data.

4. Life, output (lumens, CCT, and CRI), and energy-efficiency data for lamps.

5. Photometric data and adjustment factors based on laboratory tests, complying with IESNA Lighting Measurements Testing & Calculation Guides, of each lighting fixture type. The adjustment factors shall be for lamps, ballasts, and accessories identical to those indicated for the lighting fixture as applied in this Project.

a. Testing Agency Certified Data: For indicated fixtures, photometric data shall be certified by a qualified independent testing agency. Photometric data for remaining fixtures shall be certified by manufacturer.

C. Installation instructions.

D. Warranty: Sample copy of warranty.

1.06 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified agencies providing photometric data for lighting fixtures.

B. Field quality-control reports.

1.07 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For lighting equipment and fixtures to include in emergency, operation, and maintenance manuals.

1. Provide a list of all lamp types used on Project; use ANSI and manufacturers' codes.

2. Submit operation and maintenance data in accordance with IECC and as specified herein, showing all light fixtures, control devices and all interconnecting control wire, conduit and associated hardware.

3. Contractor shall be responsible for obtaining from his supplying light fixture manufacturers, for each type of light fixture, a recommended maintenance manual including, tools required, types of cleaners to be used and replacement parts identification list.

B. Warranty: Copy of warranty.

1.08 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. Provide entire fixture attic stock as indicated on the Lighting Fixture Schedule on the Drawings.

1.09 QUALITY ASSURANCE

A. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by an independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910, complying with the IESNA Lighting Measurements Testing & Calculation Guides.

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 NFPA 70.

D. In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word, “shall” had been substituted for “should” wherever it appears. Interpret references in these publications to the “Authority Having Jurisdiction,” equipment, materials, installation, and workmanship shall be in accordance with the mandatory and advisory provisions of NFPA 70 and NEMA unless more stringent requirements are specified or indicated.

E. Luminaire drawings shall include dimensions, accessories, and installation and construction details. Photometric data, including zonal lumen data, average and minimum ratio, aiming diagrams and computerized candlepower distribution data shall accompany shop drawings.

F. Fixtures shall be DLC or Energy Star rated/listed.

1.10 COORDINATION

A. Coordinate layout and installation of lighting fixtures and suspension system with other construction that penetrates ceilings or is supported by them, including HVAC equipment, fire-suppression system, and partition assemblies.

1.11 WARRANTY

A. The equipment items shall be supported by service organizations which are reasonably convenient (less than 100 miles from project site) to the equipment installation in order to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

1. All light fixtures/luminaries and controls shall have an unconditional 10-year warranty. Contractor shall warrant light fixtures, lamps, drivers, finishes and all components to be free from defects in materials and workmanship for a period of ten (10) years from date of Owner’s acceptance. Replacement of light fixtures and cost of labor shall be the responsibility of the Contractor.

2. Warranty specified in this Article shall not deprive the Owner of other rights the Owner may have under provisions of the Contract Documents and shall be in addition to, and

run concurrently with other warranties made by the Contractor under requirements of the Contract Documents.

3. Light fixtures and associated equipment shall be supported by service organizations which are reasonably convenient to the equipment installation in order to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

4. Furnish the electronic LED driver manufacturer's warranty. The warranty period shall not be less than 10 years from the date of substantial completion of the electronic LED driver. The warranty shall state the malfunctioning LED driver shall be exchanged by the manufacturer and promptly shipped to the Owner. The replacement LED driver shall be identical to, or an improvement upon, the original design of the malfunctioning LED driver.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Subject to compliance with requirements, provide one of the products indicated on Light Fixture Schedule. Refer to Light Fixture Schedule for manufacturers and model numbers. Basis of design for each type shall be the first fixture manufacturer and model number listed for each type.

B. Manufacturer's catalog numbers together with the descriptions on the drawings and these specifications are indicative of required design, appearance, quality and performance. Refer any discrepancies between any of these to the Engineer for resolution prior to bid. In absence of such notice to the Engineer, provide the greater requirement as directed by the Engineer, without additional cost.

2.02 GENERAL REQUIREMENTS FOR LIGHTING FIXTURES AND COMPONENTS

A. Recessed Fixtures: Comply with NEMA LE 4 for ceiling compatibility for recessed fixtures.

B. Metal Parts: Free of burrs and sharp corners and edges.

C. Sheet Metal Components: Steel unless otherwise indicated. Form and support to prevent warping and sagging.

D. 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.

E. Diffusers 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 otherwise indicated.

   b. UV stabilized.

2. Glass: Annealed crystal glass unless otherwise indicated.

F. Provide in-line fuse-holders with fuses sized per manufacturer's recommendation for each fixture.

G. All light fixtures shall be completely wired at the factory in accordance with applicable codes and UL.

H. All trims and canopies shall fit snugly and securely to the ceiling so that no light leak occurs.

I. Exterior building mounted light fixtures shall be UL classified for damp or wet locations as applicable and shall be complete with gaskets, cast aluminum outlet box and grounding. All dissimilar metal materials shall be separated by non-conductive materials to prevent galvanic action.

J. Factory-Applied Labels: Comply with UL 1598. All light fixtures shall be clearly marked for operation of specific LED's and drivers according to proper type. The following characteristics shall be noted in the format "Use Only _____":

1. LED type, and nominal wattage for light fixture.
2. Driver type.
3. Correlated color temperature (CCT) and color rendering index (CRI) for light fixtures.
4. All markings related to lamp type shall be clear and located to be readily visible to service personnel, but unseen from normal viewing angles when lamps are in place. Ballasts shall have clear markings indicating multi-level outputs and indicate proper terminals for the various outputs.

K. Provide "maximum wattage label" on all light fixture based on the specified maximum wattage indicated on the light fixture schedule.

L. Each light fixture shall be packaged with complete instructions and illustrations on how to install.

M. Each light fixture box, container, etc shall be labeled at the factory with the type designation as indicated on the Light Fixture Schedule.

2.03 LIGHT EMITTING DIODE (LED)

A. Light emitting diodes shall be tested under IES LM-80 standards.

B. Color Rendering Index (CRI) shall be 80 (minimum).

C. Color temperature of 4000K, or as indicated on light fixture schedule.

D. Rated lumen maintenance of 90% lumen output at 50,000 hours (minimum).

E. Rated lumen maintenance of 70% lumen output at 100,000 hours (minimum).

F. Provide light fixture types that the LED boards and drivers can be re-placed from the bottom and below ceiling. Trim for the exposed surface of flush-mounted fixtures shall be white or as indicated on light fixture schedule.

2.04 LIGHT EMITTING DIODE (LED) ELECTRONIC DRIVERS

A. Driver shall comply with UL 1310 Class 2 requirements for dry and damp locations, NFPA 70 unless specified otherwise. Drives shall be designed for the wattage of the LEDs used in the indicated application. Drivers shall be designed to operate on the voltage system to which they are connected.

B. Power factor shall be 0.95 (minimum).

C. Class A Sound Rating.

D. Current crest Factor of 1.5 or less.

E. Total harmonic distortion (THD): Shall be 20 percent (maximum).

2.05 SUSPENDED FIXTURES

A. Provide hangers capable of supporting twice the combined weight of fixtures supported by hangers.

B. Provide with swivel hangers to ensure a plumb installation.

C. Hangers shall be cadmium-plated steel with a swivel-ball tapped for the conduit size indicated.

D. Hangers shall allow fixtures to swing within an angle of 45 degrees. Brace pendants 4 feet or longer to limit swinging.

E. Single-unit suspended fixtures shall have twin-stem hangers.

F. Multiple-unit or continuous row fixtures shall have a tubing or stem for wiring at one point and a tubing or rod suspension provided for each unit length of chassis, including one at each end.

G. Rods shall be a minimum 0.18-inch diameter.

2.06 EXIT SIGNS

A. General Requirements for Exit Signs: Comply with UL 924, NFPA 70, and NFPA 101; for sign colors, visibility, luminance, and lettering size, comply with authorities having jurisdiction.

B. Internally Lighted Signs:

1. Lamps for AC Operation: LEDs, 50,000 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.

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.

f. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and a flashing red LED.

C. Provide single or double face as scheduled, indicated on plans or as required by the local Authority Having Jurisdiction. Adjust installation position if required for clear visibility, in accordance with applicable codes.

D. Provide directional arrows (chevrons) as indicated on floor plans and to suit the means of egress or as required by the local Authority Having Jurisdiction

2.07 LIGHTING FIXTURE SUPPORT COMPONENTS

A. Comply with Division 26 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. Wires for Humid Spaces: ASTM A 580/A 580M, Composition 302 or 304, annealed stainless steel, 12 gage.

F. Rod Hangers: 3/16-inch minimum diameter, cadmium-plated, threaded steel rod.

G. Hook Hangers: Integrated assembly matched to fixture and line voltage and equipped with threaded attachment, cord, and locking-type plug.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Lighting fixtures:

1. Set level, plumb, and square with ceilings and walls unless otherwise indicated.

2. Mounting heights specified or indicated shall be to the bottom of fixture for ceiling-mounted fixtures and to center of fixture for wall-mounted fixtures.

3. Install in accordance with light fixture manufacturer's written instructions, applicable requirements of NEC, NECA's "Standard of Installation", and NEMA standards.

B. Temporary Lighting: If it is necessary, and approved by Architect, to use permanent luminaires for temporary lighting, install and energize the minimum number of luminaires necessary. When construction is sufficiently complete, remove the temporary luminaires, disassemble, clean thoroughly, install new lamps, and reinstall.

C. Lay-in Ceiling Lighting Fixtures Supports:

1. Install ceiling support system rods or wires, independent of the ceiling suspension devices, for each fixture. Locate not more than 6 inches from lighting fixture corners.

2. 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.

3. 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.

4. Install at least four independent support wires from structure to a tab on lighting fixture located near each corner of each fixture. Wire shall have breaking strength of the weight of fixture at a safety factor of 3. Round fixtures or fixtures smaller in size than the ceiling grid shall be independently supported from the building structure by minimum of four wires per fixture spaced approximately equidistant around the fixture.

a. Support light fixtures with four (4) wires, with one (1) at each corner. Hanger wires shall be installed within 15 degrees of plumb or additional support shall be provided. Wires shall be attached to fixture body and to the building structure (not to the supports of other work or equipment).

b. Where building structure is located such that 15 degrees cannot be maintained, the Contractor shall provide "Uni-strut" or similar structure to meet this requirement.

c. Support Clips: All light fixtures shall be furnished with hold down clips to meet applicable seismic codes. Provide four (4) clips per fixture minimum or the equivalent thereof in the installation trim. Fasten to light fixtures and to ceiling grid members at or near each fixture corner with clips that are UL listed for the application. Contractor shall install clips per manufacturer's requirements. If screws are required, they shall be provided.

D. Suspended Lighting Fixture Support:

1. Pendants and Rods: Where longer than 48 inches, brace to limit swinging.

2. Stem-Mounted, Single-Unit Fixtures: Suspend with twin-stem hangers.

3. 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.

a. Suspended fixtures in continuous rows shall have internal wireway systems for end to end wiring and shall be properly aligned to provide a straight and continuous row without bends, gaps, light leaks or filler pieces.

b. Aligning splines shall be used on extruded aluminum fixtures to assure hairline joints.

c. Steel fixtures shall be supported to prevent "oil-canning" effects.

4. Do not use grid as support for pendant luminaires. Connect support wires or rods to building structure.

5. Pendants shall be finished to match fixtures.

6. Aircraft cable shall be stainless steel.

7. Canopies shall be finished to match the ceiling and shall be low profile unless otherwise shown.

E. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

F. Wire exit signs ahead of the switch to the un-switched emergency lighting life-safety branch circuit located in the same room or area.

G. Exterior building mounted light fixtures shall not be installed until after the building exterior has been rinsed clean of any corrosive cleaning materials. Damaged fixtures shall be replaced by the Contractor at no cost.

H. Light fixture whips shall be supported from the building structure. Do not clip to lay-in ceiling support wires.

I. Light fixture locations in mechanical and electrical equipment rooms/areas, as indicated on floor plans, are approximate. Locate light fixtures to avoid equipment, ductwork, and piping. Locate around and between equipment to maximize the available light. Coordinate mounting heights and locations of light fixtures to clear equipment. Request a meeting with the Engineer if uncertain about an installation. All suspended light fixtures shall be mounted square and plumb.

J. All reflecting surfaces, glass or plastic lenses, driver housings, louvers, downlighting alzak cones and specular reflectors shall be handled with care during installation or lamping to avoid fingerprints or dirt deposits. It is preferred that louvers be shipped and installed with clear plastic bags to protect louvers. At close of project, and after construction air filters are changed, remove bags.

3.02 IDENTIFICATION

A. Install labels with panel and circuit numbers on concealed junction and outlet boxes. Comply with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

3.03 CLEANING

A. At the time of final acceptance by the Owner, all lighting fixtures shall have been thoroughly cleaned with materials and methods recommended by the manufacturer.

B. Any louver or cone showing dirt or fingerprints shall be cleaned with solvent recommended by the manufacturer to a like-new condition, or replaced as necessary in order to turn over to the Owner new fixtures at beneficial occupancy.

3.04 FIELD QUALITY CONTROL

A. Upon completion of installation, verify that equipment is properly installed, connected, and adjusted. Conduct an operating test to show that equipment operates in accordance with requirements of this section.

B. Electronic Dimming Drivers. Test for full range of dimming capability. Observe for visually detectable flicker over full dimming range.

C. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery and retransfer to normal.

D. Inspect each light fixture for damage. Replace damaged light fixtures at no cost to the Owner.

E. 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.

END OF SECTION 26 5100

SECTION 26 5613
LIGHTING POLES AND STANDARDS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Poles and accessories for support of luminaires.

B. Related Requirements:

1. Division 26 Section “LED Exterior Lighting” for exterior solid-state luminaires that are to be installed throughout the site.

1.02 DEFINITIONS

A. EPA: Equivalent projected area.

B. Luminaire: Complete luminaire.

C. Pole: Luminaire-supporting structure, including tower used for large-area illumination.

D. Standard: See "Pole."

1.03 ACTION SUBMITTALS

A. Submit product data and shop drawings in accordance with Division 01 and Division 26 Section “Electrical Shop Drawings and Submittals” for products specified under PART 2 - PRODUCTS.

B. Product Data: For each pole, accessory, and luminaire-supporting device, arranged as indicated.

1. Include data on construction details, profiles, EPA, cable entrances, materials, dimensions, weight, rated design load, and ultimate strength of individual components.
2. Include finishes for lighting poles and luminaire-supporting devices.
3. Anchor bolts.
4. Manufactured pole foundations.

C. Shop Drawings:

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 poles and pole accessories.
4. Foundation construction details, including material descriptions, dimensions, anchor bolts, support devices, and calculations, signed and sealed by a professional engineer licensed in the state of installation.
5. Anchor bolt templates keyed to specific poles and certified by manufacturer.
6. Method and procedure of pole installation. Include manufacturer's written installations.

D. Warranty: Sample copy of warranty.

1.04 INFORMATIONAL SUBMITTALS

A. Pole and Support Component Certificates: Signed by manufacturers of poles, certifying that products are designed for indicated load requirements according to AASHTO LTS-6-M and that load imposed by luminaire and attachments has been included in design. The certification shall be based on design calculations signed and sealed by a professional engineer.

B. Qualification Data: For Installer.

C. Material Test Reports:

1. For each foundation component, by a qualified testing agency.

2. For each pole, by a qualified testing agency.

D. Source quality-control reports.

E. Field quality-control reports.

F. Soil test reports.

1.05 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For poles to include in emergency, operation, and maintenance manuals.

1. In addition to items specified in Division 01 Section "Closeout Submittals," include pole inspection and repair procedures.

B. Warranty: Copy of warranty.

1.06 MAINTENANCE MATERIAL SUBMITTALS

A. Pole repair materials.

1.07 QUALITY ASSURANCE

A. Testing Agency Qualifications: Qualified according to ASTM C 1093 for foundation testing.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Store poles on decay-resistant skids at least 12 inches above grade and vegetation. Support poles to prevent distortion and arrange to provide free air circulation.

B. Retain factory-applied pole wrappings on metal poles until right before pole installation. Handle poles with web fabric straps.

1.09 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of pole(s) that fail in materials or workmanship; that corrode; or that fade, stain, perforate, erode, or chalk due to effects of weather or solar radiation within a specified warranty period. Manufacturer may exclude lightning damage, hail damage, vandalism, abuse, or unauthorized repairs from special warranty period.

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

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. Structural Characteristics: Comply with AASHTO LTS-6-M.

1. The effects of fatigue shall be considered during design at the equivalent static wind pressure as determined by AASHTO LTS-6-M with the fatigue importance factor indicated.

2. Fatigue Category I.

3. Maximum permitted stresses for the fatigue analysis shall be based on an infinite number of cycles as determined by ANSI/AISC 360-10, including Appendix 3.

B. Dead Load: Weight of luminaire and its horizontal and vertical supports and supporting structure, applied according to AASHTO LTS-6-M.

C. Wind Load: Poles and other support structures, brackets, arms, bases, anchorages and foundations shall be designed to resist wind loads as determined by ASCE 7-10 based on a Wind Speed (3 second gust) as indicated for the Project location in the Mapped Basic Wind Speeds for Risk Category and Exposure Category indicated. Luminaires, visors and crossarms shall be designed to resist wind loads while maintaining luminaire aiming alignment. All designs shall comply with the 2012 International Building Code (IBC).

1. Ultimate Wind Speed: 151 mph (3-second gust)

2. Nominal Wind Speed: 117 mph (3-second gust)

3. Risk Category: III

4. Exposure Category: C

D. Luminaire Attachment Provisions: Comply with luminaire manufacturers' mounting requirements. Use stainless-steel fasteners and mounting bolts unless otherwise indicated.

2.02 STEEL POLES

A. Poles: Comply with ASTM A 500, Grade B, carbon steel with a minimum yield of 46,000 psig; one-piece construction up to 40 feet in height with access handhole in pole wall.

1. Shape: Round, tapered.
2. Mounting Provisions: Butt flange for bolted mounting on foundation or breakaway support.

B. Brackets for Luminaires: Detachable, cantilever, without underbrace.

1. Adapter fitting welded to pole, allowing the bracket to be bolted to the pole mounted adapter, then bolted together with stainless-steel bolts.
2. Cross Section: Square with straight tubular end section to accommodate luminaire.
3. Match pole material and finish.

C. Pole-Top Tenons: Fabricated to support luminaire or luminaires and brackets indicated, and securely fastened to pole top.

D. Grounding and Bonding Lugs: Welded 1/2-inch threaded lug, complying with requirements in Division 26 Section "Grounding and Bonding for Electrical Systems," listed for attaching grounding and bonding conductors of type and size listed in that Section, and accessible through handhole.

E. Cable Support Grip: Wire-mesh type with rotating attachment eye, sized for diameter of cable and rated for a minimum load equal to weight of supported cable times a 5.0 safety factor.

F. Factory-Painted Finish: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

1. Surface Preparation: Clean surfaces to comply with SSPC-SP 1, "Solvent Cleaning," to remove dirt, oil, grease, and other contaminants that could impair paint bond. Grind welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning," or with SSPC-SP 8, "Pickling."
2. Interior Surfaces of Pole: One coat of bituminous paint, or otherwise treat for equal corrosion protection.
3. Exterior Surfaces: Manufacturer's standard finish consisting of one or more coats of primer and two finish coats of high-gloss, high-build polyurethane enamel.
   a. Color: As selected by Architect from manufacturer's full range.

2.03 MOUNTING HARDWARE

A. Anchor Bolts: Manufactured to ASTM F 1554, Grade 55, with a minimum yield strength of 55,000 psi.

1. Galvanizing: Hot dip galvanized according to ASTM A 153, Class C.
2. Headed rods.
3. Threading: Uniform National Coarse, Class 2A.

B. Nuts: ASTM A 563, Grade A, Heavy-Hex

1. Galvanizing: Hot dip galvanized according to ASTM A 153, Class C.
2. Two nuts provided per anchor bolt, shipped with nuts pre-assembled to the anchor bolts.

C. Washers: ASTM F 436, Type 1.

1. Galvanizing: Hot dip galvanized according to ASTM A 153, Class C.
2. Two washers provided per anchor bolt.

2.04 GENERAL FINISH REQUIREMENTS

A. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

B. Appearance of Finished Work: Noticeable variations in same piece are 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.

PART 3 - EXECUTION

3.01 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 poles, luminaire-mounting devices, and pole accessories before installation. Components that are scratched, dented, marred, wet, moisture damaged, or visibly damaged are considered defective.

C. Examine roughing-in for foundation and conduit to verify actual locations of installation.

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

3.02 POLE FOUNDATION

A. Concrete Pole Foundations: Cast in place, with anchor bolts to match pole-base flange. Structural steel complying with ASTM A 36/A 36M and hot-dip galvanized according to ASTM A 123/A 123 M; and with top-plate and mounting bolts to match pole-base flange and strength required to support pole, luminaire, and accessories. Concrete, reinforcement, and formwork are specified in Division 03 Section "Cast-in-Place Concrete."

B. Anchor Bolts: Install plumb using manufacturer-supplied steel template, uniformly spaced.

3.03 POLE INSTALLATION

A. Alignment: Align pole foundations and poles for optimum directional alignment of luminaires and their mounting provisions on pole.

B. Clearances: Maintain the following minimum horizontal distances of poles from surface and underground features unless otherwise indicated on drawing.

1. Fire Hydrants and Water Piping: 60 inches.
2. Water, Gas, Electric, Communications, and Sewer Lines: 10 feet.
3. Trees: 15 feet from tree trunk.

C. Concrete Pole Foundations: Set anchor bolts according to anchor-bolt templates furnished by pole manufacturer. Concrete materials, installation, and finishing requirements are specified in Division 03 Section "Cast-in-Place Concrete."

D. Foundation-Mounted Poles: Mount pole with leveling nuts and tighten top nuts to torque level according to pole manufacturer's written instructions.

1. Use anchor bolts and nuts selected to resist seismic forces defined for the application and approved by manufacturer.
2. Install base covers unless otherwise indicated.
3. Use a short piece of 1/2 -inch diameter pipe to make a drain hole through grout. Arrange to drain condensation from interior of pole.

E. Poles and Pole Foundations Set in Concrete-Paved Areas: Install poles with a minimum 6-inch-wide, unpaved gap between the pole or pole foundation and the edge of the adjacent concrete slab. Fill unpaved ring with pea gravel. Insert material to a level 1 inch below top of concrete slab.

F. Raise and set pole using web fabric slings (not chain or cable) at locations indicated by manufacturer.

3.04 CORROSION PREVENTION

A. Aluminum: Do not use in contact with earth or concrete. When in direct contact with a dissimilar metal, protect aluminum using insulating fittings or treatment.

B. Steel Conduits: Comply with requirements in Division 26 Section "Raceways and Boxes for Electrical Systems." In concrete foundations, wrap conduit with 0.010-inch-thick, pipe-wrapping plastic tape applied with a 50-percent overlap.

3.05 GROUNDING

A. Ground Metal Poles and Support Structures: Comply with requirements in Division 26 Section "Grounding and Bonding for Electrical Systems."

1. Install grounding electrode for each pole unless otherwise indicated.
2. Install grounding conductor pigtail in the base for connecting luminaire to grounding system.

B. Ground Nonmetallic Poles and Support Structures: Comply with requirements in Division 26 Section "Grounding and Bonding for Electrical Systems."

1. Install grounding electrode for each pole.
2. Install grounding conductor and conductor protector.
3. Ground metallic components of pole accessories and foundation.

3.06 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

3.07 FIELD QUALITY CONTROL

A. Special Inspections: Engage a qualified special inspector to perform the following special inspections:

1. Inspect poles for nicks, mars, scratches, and other damage.
2. System function tests.

END OF SECTION 26 5613

SECTION 26 5619
LED EXTERIOR LIGHTING

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Exterior solid-state luminaires that are designed for and exclusively use LED lamp technology.
2. Luminaire supports.

B. Related Requirements:

1. Division 26 Section "Lighting Poles and Standards" for poles and standards used to support exterior lighting equipment.

1.02 DEFINITIONS

A. CCT: Correlated color temperature.

B. CRI: Color rendering index.

C. Fixture: See "Luminaire."

D. DLC: DesignLights Consortium.

E. IP: International Protection or Ingress Protection Rating.

F. Lumen: Measured output of lamp and luminaire, or both.

G. Luminaire: Complete lighting unit, including lamp, reflector, and housing.

1.03 ACTION SUBMITTALS

A. Submit product data and shop drawings in accordance with Division 01 and Division 26 Section “Electrical Shop Drawings and Submittals” for products specified under PART 2 - PRODUCTS.

B. Product Data: For each type of luminaire.

1. Include data on features, accessories, and finishes.
2. Include physical description and dimensions of luminaire.
3. Lamps, include life, output (lumens, CCT, and CRI), and energy-efficiency data.
4. Photometric data and adjustment factors based on laboratory tests, complying with IES LM-79.
    a. Manufacturer's Certified Data: Photometric data certified by manufacturer's laboratory with a current accreditation under the NVLAP for Energy Efficient Lighting Products.
5. Wiring diagrams for power, control, and signal wiring.
6. Means of attaching luminaires to supports and indication that the attachment is suitable for components involved.

C. Product Schedule: For luminaires and lamps. Use same designations indicated on Drawings.

D. Delegated-Design Submittal: For luminaire supports.

1. Include design calculations for luminaire supports.

E. Warranty: Sample copy of warranty.

1.04 INFORMATIONAL SUBMITTALS

A. Qualification Data: For testing laboratory providing photometric data for luminaires.

B. Product Certificates: For each type of luminaire.

C. Product Test Reports: For each luminaire, for tests performed by manufacturer and witnessed by a qualified testing agency.

D. Source quality-control reports.

1.05 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For luminaires to include in operation and maintenance manuals.

B. Warranty: Copy of warranty information.

1.06 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. Provide entire fixture attic stock as indicated on the Lighting Fixture Schedule on the Drawings.

1.07 QUALITY ASSURANCE

A. Luminaire Photometric Data Testing Laboratory Qualifications: Luminaire manufacturers' laboratory that is accredited under the NVLAP for Energy Efficient Lighting Products.

B. Provide luminaires from a single manufacturer for each luminaire type.

C. Each luminaire type shall be binned within a three-step MacAdam Ellipse to ensure color consistency among luminaires.

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

E. Fixtures shall be DLC or Energy Star rated/listed.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Protect finishes of exposed surfaces by applying a strippable, temporary protective covering prior to shipping.

1.09 FIELD CONDITIONS

A. Verify existing and proposed utility structures prior to the start of work associated with luminaire installation.

B. Mark locations of exterior luminaires for approval by Architect prior to the start of luminaire installation.

1.10 WARRANTY

A. The equipment items shall be supported by service organizations which are reasonably convenient (less than 100 miles from project site) to the equipment installation in order to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

1. All light fixtures/luminaries and controls shall have an unconditional 10-year warranty. Contractor shall warrant light fixtures, lamps, drivers, finishes and all components to be free from defects in materials and workmanship for a period of ten (10) years from date of Owner’s acceptance. Replacement of light fixtures and cost of labor shall be the responsibility of the Contractor.

2. Warranty specified in this Article shall not deprive the Owner of other rights the Owner may have under provisions of the Contract Documents and shall be in addition to, and run concurrently with other warranties made by the Contractor under requirements of the Contract Documents.

3. Light fixtures and associated equipment shall be supported by service organizations which are reasonably convenient to the equipment installation in order to render

satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

4. Furnish the electronic LED driver manufacturer's warranty. The warranty period shall not be less than 10 years from the date of substantial completion of the electronic LED driver. The warranty shall state the malfunctioning LED driver shall be exchanged by the manufacturer and promptly shipped to the Owner. The replacement LED driver shall be identical to, or an improvement upon, the original design of the malfunctioning LED driver.

PART 2 - PRODUCTS

2.01 LUMINAIRE REQUIREMENTS

A. 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.

B. NRTL Compliance: Luminaires shall be listed and labeled for indicated class and division of hazard by an NRTL.

C. UL Compliance: Comply with UL 1598 and listed for wet location.

D. Lamp base complying with ANSI C81.61 or IEC 60061-1.

E. CRI of minimum 80. CCT of 3000 K.

F. L70 lamp life of 100,000 hours.

G. Lamps dimmable from 100 percent to 0 percent of maximum light output.

H. Internal driver.

I. Nominal Operating Voltage: 277 V ac.

J. In-line Fusing: On the primary for each luminaire.

K. Lamp Rating: Lamp marked for outdoor use and in enclosed locations.

L. Source Limitations: Obtain luminaires from single source from a single manufacturer.

2.02 LUMINAIRE TYPES

A. Area and Site:

1. Manufacturers:

   a. Subject to compliance with requirements, provide one of the products indicated on Light Fixture Schedule. Refer to Light Fixture Schedule for manufacturers and model numbers. Basis of design for each type shall be the first fixture manufacturer and model number listed for each type.

   b. Manufacturer's catalog numbers together with the descriptions on the drawings and these specifications are indicative of required design, appearance, quality and performance. Refer any discrepancies between any of these to the Engineer for resolution prior to bid. In absence of such notice to the Engineer, provide the greater requirement as directed by the Engineer, without additional cost.

2. Luminaire Shape: Square.

3. Mounting: Pole with extruded-aluminum rectangular arm, 7 inches in length.

4. Luminaire-Mounting Height: Refer to Light Fixture Schedule on Drawings.

5. Distribution: Refer to Light Fixture Schedule on Drawings.

6. Housings:

   a. Extruded-aluminum housing and heat sink.

   b. Bronze powder-coat finish, verify color with Architect.

B. Decorative Post Top:

1. Manufacturers:
    a. Subject to compliance with requirements, provide one of the products indicated on Light Fixture Schedule. Refer to Light Fixture Schedule for manufacturers and model numbers. Basis of design for each type shall be the first fixture manufacturer and model number listed for each type.
    b. Manufacturer's catalog numbers together with the descriptions on the drawings and these specifications are indicative of required design, appearance, quality and performance. Refer any discrepancies between any of these to the Engineer for resolution prior to bid. In absence of such notice to the Engineer, provide the greater requirement as directed by the Engineer, without additional cost.
2. Luminaire-Mounting Height: Refer to Light Fixture Schedule on Drawings.
3. Mounting Type: Tenon.
4. Distribution: Refer to Light Fixture Schedule on Drawings.
5. Housings:
    a. Extruded-aluminum housing and heat sink.
    b. Powder-coat finish, verify color with Architect.

2.03 MATERIALS

A. Metal Parts: Free of burrs and sharp corners and edges.

B. Sheet Metal Components: Corrosion-resistant aluminum. 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. Doors shall be removable for cleaning or replacing lenses.

D. Lens and Refractor Gaskets: Use heat- and aging-resistant resilient gaskets to seal and cushion lenses and refractors in luminaire doors.

E. 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.

F. Housings:
1. Rigidly formed, weather- and light-tight enclosure that will not warp, sag, or deform in use.
2. Provide filter/breather for enclosed luminaires.

G. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps. Labels shall be located where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.
1. Label shall include the following lamp characteristics:
    a. "USE ONLY" and include specific lamp type.
    b. Lamp diameter, shape, size, wattage and coating.
    c. CCT and CRI for all luminaires.

2.04 FINISHES

A. Variations in Finishes: 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.

B. Luminaire Finish: Manufacturer's standard paint applied to factory-assembled and -tested luminaire before shipping. Where indicated, match finish process and color of pole or support materials.

C. Factory-Applied Finish for Aluminum Luminaires: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

1. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.

2. Class I, Color-Anodic Finish: AA-M32C22A42/A44 (Mechanical Finish: Medium satin; Chemical Finish: Etched, medium matte; Anodic Coating: Architectural Class I, integrally colored or electrolytically deposited color coating 0.018 mm or thicker), complying with AAMA 611.

a. Color: Verify color with Architect.

PART 3 - EXECUTION

3.01 EXAMINATION

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

B. Examine roughing-in for luminaire electrical conduit to verify actual locations of conduit connections before luminaire installation.

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

3.02 GENERAL INSTALLATION REQUIREMENTS

A. Comply with NECA 1.

B. Fasten luminaire to structural support.

C. Supports:

1. Sized and rated for luminaire weight.

2. Able to maintain luminaire position after cleaning and relamping.

3. Support luminaires without causing deflection of finished surface.

4. Luminaire-mounting devices shall be capable of supporting a horizontal force of 100 percent of luminaire weight and a vertical force of 400 percent of luminaire weight.

D. Wiring Method: Install cables in raceways. Conceal raceways and cables.

E. Install luminaires level, plumb, and square with finished grade unless otherwise indicated.

F. Coordinate layout and installation of luminaires with other construction.

G. Adjust luminaires that require field adjustment or aiming.

H. Comply with requirements in Division 26 Section "Low-Voltage Electrical Power Conductors and Cables" and Division 26 Section "Raceways and Boxes for Electrical Systems" for wiring connections and wiring methods.

3.03 CORROSION PREVENTION

A. Aluminum: Do not use in contact with earth or concrete. When in direct contact with a dissimilar metal, protect aluminum by insulating fittings or treatment.

B. Steel Conduits: Comply with Division 26 Section "Raceways and Boxes for Electrical Systems." In concrete foundations, wrap conduit with 0.010-inch-thick, pipe-wrapping plastic tape applied with a 50 percent overlap.

3.04 FIELD QUALITY CONTROL

A. Inspect each installed luminaire for damage. Replace damaged luminaires and components.

B. Perform the following tests and inspections:

1. Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.

C. Luminaire will be considered defective if it does not pass tests and inspections.

D. 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.

END OF SECTION 26 5619

SECTION 26 5668

EXTERIOR ATHLETIC LIGHTING

PART 1 - GENERAL

1.1 SUMMARY

A. Work covered by this section of the specifications shall conform to the contract documents, engineering plans as well as state and local codes.

B. The purpose of these specifications is to define the lighting system performance and design standards for High School Athletic Fields using an LED Lighting source. The manufacturer / contractor shall supply lighting equipment to meet or exceed the standards set forth in these specifications.

C. The sports lighting will be for the following venue:

1. Football Field.
2. Track.
3. Baseball Field.
4. Softball Field.

D. The primary goals of this sports lighting project are:

1. Guaranteed Light Levels: Selection of appropriate light levels impact the safety of the players and the enjoyment of spectators. Therefore, light levels are guaranteed for a period of 25 years.
2. Environmental Light Control: It is the primary goal of this project to minimize spill light to adjoining properties and glare to the players, spectators and neighbors. The LED design should provide better control than a good HID design.
3. Life-cycle Cost: In order to reduce the operating budget, the preferred lighting system shall be energy efficient and cost effective to operate. All maintenance costs shall be eliminated for the duration of the warranty.
4. Control and Monitoring: To allow for optimized use of labor resources and avoid unneeded operation of the facility, customer requires a remote on/off control system for the lighting system. Field should be proactively monitored to detect luminaire outages over a 25-year life-cycle. All communication and monitoring costs for 25-year period shall be included in the bid.

E. All lighting designs shall comply with UIL standards, except where exceeded by this specification, and local lighting ordinances.

1.2 LIGHTING PERFORMANCE

A. Illumination Levels and Design Factors: Playing surfaces shall be lit to an average target illumination level in the chart below. Lighting calculations shall be developed and field measurements taken on the grid spacing with a minimum number of grid points specified below. Appropriate light loss factors shall be applied and submitted for the basis of design. Average illumination level shall be measured in accordance with the IESNA LM-05-04 (IESNA Guide for Photometric Measurements of Area and Sports Lighting Installations). Illumination levels shall not drop below desired target values in accordance to IES RP-6-15, Page 2, Maintained Average Illuminance and shall be guaranteed for the full warranty period.

Area of Lighting	Average Target Light Levels	Maximum to Minimum Uniformity Ratio	Grid Points	Grid Spacing
Football	50 footcandles	2.0:1.0	72	30’ x 30’
Track	30 footcandles	5.0:1.0	48	30’ x 30’
Baseball (Infield)	50 footcandles	2.0:1.0	25	30’ x 30’

Baseball (Outfield)	30 footcandles	2.5:1.0	105	30’ x 30’
Baseball (Bullpens)	30 footcandles	2.5:1.0	32/24	10’ X 10’
Baseball (Batting Cage)	30 footcandles	2.5:1.0	16	20’ X 14’
Softball (Infield)	50 footcandles	2.0:1.0	25	20’ X 20’
Softball (Outfield)	30 footcandles	2.5:1.0	86	20’ X 20’
Softball (Bullpens)	30 footcandles	2.5:1.0	18/24	10’ X 10’
Softball (Batting Cage)	30 footcandles	2.5:1.0	16	20’ X 14’

B. Hours of Usage: Designs shall be based on 150 hours annual usage and 3,750 hours over a 25-year usage period.

C. Color: The lighting system shall have a minimum color temperature of 5700K and a CRI of 75.

D. Mounting Heights: To ensure proper aiming angles for reduced glare and to provide better playability, minimum mounting heights shall be as follows. Higher mounting heights may be required based on photometric report and ability to ensure the top of the field angle is a minimum of 10 degrees below horizontal.

1. Football: Two (2) 80-feet and two (2) 70-feet
2. Baseball: Two (2) 90-feet, two (2) 80-feet, and two (2) 70-feet
3. Softball: Two (2) 80-feet and two (2) 70-feet

E. Security Fixtures: There shall be security lights on certain poles as shown on the Drawings. The fixture(s) shall be provided by the field lighting manufacturer and integrated into the lighting system structure with remote electrical components located 10-feet above grade. Fixtures to be on a separate circuit from field lighting.

1.3 ENVIRONMENTAL LIGHT CONTROL

A. Light Control Luminaires: All luminaires shall utilize spill light and glare control devices including, but not limited to, internal shields, louvers and external shields. No symmetrical beam patterns are accepted.

B. The first page of a photometric report for all luminaire types proposed showing horizontal and vertical axial candle power shall be provided to demonstrate the capability of achieving the specified performance. Reports shall be certified by a qualified independent testing laboratory with a minimum of five years’ experience or by a manufacturer’s laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products. A summary of the horizontal and vertical aiming angles for each luminaire shall be included with the photometric report.

1.4 LIFE-CYCLE COSTS

A. Manufacturer shall submit a 25-year life cycle cost calculation as outlined in the required submittal information.

B. Preventative and Spot Maintenance: Manufacturer shall provide all preventative and spot maintenance, including parts and labor for 25 years from the date of equipment shipment. Individual outages shall be repaired when the usage of any field is materially impacted. Owner agrees to check fuses in the event of a luminaire outage.

1.5 ACTION SUBMITTALS

A. Submit product data and shop drawings in accordance with Division 01 and Division 26 Section “Electrical Shop Drawings and Submittals” for products specified under PART 2 - PRODUCTS.

B. Specification Compliance Certification: Submit a Specification Compliance Certification in accordance with Division 26 Section “Electrical Shop Drawings and Submittals”.

C. Product Data: For each type of luminaire.

1. Arrange in order of luminaire designation.
2. Include data on features, accessories, and finishes.
3. Include physical description and dimensions of luminaire.
4. Lamps, include life, output (lumens, CCT, and CRI), and energy-efficiency data.
5. Photometric data and adjustment factors based on laboratory tests, complying with IES LM-79.
    a. Manufacturer's Certified Data: Photometric data certified by manufacturer's laboratory with a current accreditation under the NVLAP for Energy Efficient Lighting Products.
6. Wiring diagrams for power, control, and signal wiring.
7. Means of attaching luminaires to supports and indication that the attachment is suitable for components involved.

D. Product Schedule: For luminaires and lamps. Use same designations indicated on Drawings.

E. Delegated-Design Submittal: For luminaire supports.

1. Include design calculations for luminaire supports.

F. Warranty: Sample of special warranty.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For testing laboratory providing photometric data for luminaires.

B. Product Certificates: For each type of luminaire.

C. Product Test Reports: For each luminaire, for tests performed by manufacturer and witnessed by a qualified testing agency.

D. Source quality-control reports.

1.7 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For luminaires to include in operation and maintenance manuals.

B. Warranty: Copy of special warranty.

1.8 WARRANTY AND GUARANTEE

A. 25-Year Warranty: Manufacturer shall supply a signed warranty covering the entire system for 25 years from the date of shipment. Warranty shall guarantee specified light levels. Manufacturer shall maintain specifically-funded financial reserves to assure fulfillment of the warranty for the full term. Warranty does not cover weather condition events such as lightning or hail damage, improper installation, vandalism or abuse, unauthorized repairs or alterations, or product made by other manufacturers.

B. Maintenance: Manufacturer shall monitor the performance of the lighting system, including on/off status, hours of usage and luminaire outage for 25 years from the date of equipment shipment. Parts and labor shall be covered such that individual luminaire outages will be repaired when the usage or any field is materially impacted. Owner agrees to check fuses in the event of a luminaire outage.

PART 2 - PRODUCT

2.1 MANUFACTURER

A. Manufacturers: Subject to compliance with requirements, provide products by the following:

1. Musco Lighting.

B. Design Approval: The Owner and Engineer will review shop drawings from the manufacturer to ensure compliance to the specification.

2.2 LIGHTING SYSTEM CONSTRUCTION

A. Manufacturing Requirements: All components shall be designed and manufactured as a system. All luminaires, wire harnesses, drivers and other enclosures shall be factory assembled, aimed, wired and tested.

B. Durability: All exposed components shall be constructed of corrosion resistant material and/or coated to help prevent corrosion. All exposed carbon steel shall be hot dip galvanized per ASTM A123. All exposed aluminum shall be powder coated with high performance polyester or anodized. All exterior reflective inserts shall be anodized, coated, and protected from direct environmental exposure to prevent reflective degradation or corrosion. All exposed hardware and fasteners shall be stainless steel of 18-8 grade or better, passivated and coated with aluminum-based thermosetting epoxy resin for protection against corrosion and stress corrosion cracking. Structural fasteners may be carbon steel and galvanized meeting ASTM A153 and ISO/EN 1461 (for hot dipped galvanizing), or ASTM B695 (for mechanical galvanizing). All wiring shall be enclosed within the cross-arms, pole, or electrical components enclosure.

C. System Description: Lighting system shall consist of the following:

1. Galvanized steel poles and cross arm assembly
2. Non-approved pole technology:
    a. Square static cast concrete poles.
    b. Direct bury steel poles which utilize the extended portion of the steel shaft for their foundation will not be accepted due to potential for internal and external corrosive reaction to the soils and long-term performance concerns.
3. Lighting systems shall use concrete foundations as defined below:
    a. For a foundation using pre-stressed concrete base embedded in concrete backfill, the concrete shall be air-entrained and have a minimum compressive design strength at 28 days of 3,000 PSI. 3,000 PSI concrete specified for early pole erection, actual required minimum allowable concrete strength is 1,000 PSI. All piers and concrete backfill must bear on and against firm undisturbed soil.
    b. For anchor bolt foundations or foundations using a pre-stressed concrete base in a suspended pier or re-enforced pier design, pole erection may occur after 7 days or after a concrete sample from the same batch achieves a certain strength.
4. Manufacturer will supply all drivers and supporting electrical equipment.
    a. Remote drivers and supporting electrical equipment shall be mounted approximately 10 feet above grade in aluminum enclosures. The enclosures shall be touch-safe and include drivers and fusing with indicator lights on fuses to notify when a fuse is to be replaced for each luminaire. Disconnect per circuit for each pole structure will be located in the enclosure.
5. Manufacturer shall provide surge protection at the pole equal to or greater than 40 kA for each line to ground (Common Mode) as recommended by IEEE C62.41.2_2002.
6. Wire harness complete with an abrasion protection sleeve, strain relief and plug-in connections for fast, trouble-free installation.
7. All luminaires, visors, and cross-arm assemblies shall withstand 150 mph winds and maintain luminaire aiming alignment.

8. Control cabinet to provide remote on-off control and monitoring of the lighting system. See Section 2.4 for further details.
9. Manufacturer shall provide lightning grounding as defined by NFPA 780 and be UL Listed per UL 96 and UL 96A.
    a. Integrated grounding via concrete encased electrode grounding system.
    b. If grounding is not integrated into the structure, the manufacturer shall supply grounding electrodes, copper down conductors, and exothermic weld kits. Electrodes and conductors shall be sized as required by NFPA 780.The grounding electrode shall be minimum size of 5/8 inch diameter and 8 feet long, with a minimum of 10 feet embedment. Grounding electrode shall be connected to the structure by a grounding electrode conductor with a minimum size of 2 AWG for poles with 75 feet mounting height or less, and 2/0 AWG for poles with more than 75 feet mounting height.

D. Safety: All system components shall be UL Listed for the appropriate application.

2.3 ELECTRICAL

A. Electric Power Requirements for the Sports Lighting Equipment.
1. Electric Power: 480V, 3-phase.
2. Maximum Total Voltage Drop: Voltage drop to the disconnect switch located on the poles shall not exceed three (3) percent of the rated voltage.

B. Energy Consumption: The kW consumption for the field lighting system shall be 124 kW or less.

2.4 STRUCTURAL PARAMETERS

A. Wind Loads: Poles and other support structures, brackets, arms, bases, anchorages and foundations shall be designed to resist wind loads as determined by ASCE 7-10 based on a Wind Speed (3 second gust) as indicated for the Project location in the Mapped Basic Wind Speeds for Risk Category and Exposure Category indicated. Luminaires, visors and crossarms shall be designed to resist wind loads while maintaining luminaire aiming alignment. All designs shall comply with the 2015 International Building Code (IBC).
1. Ultimate Wind Speed: 151 mph (3-second gust)
2. Nominal Wind Speed: 117 mph (3-second gust)
3. Risk Category: III
4. Exposure Category: C

B. Pole Structural Design: The stress analysis and safety factor of the poles shall conform to 2013 AASHTO Standard Specification for Structural Supports for Highway Signs, Luminaires, and Traffic Signals (LTS-6).

C. Foundation Design: The foundation design shall be based on soil parameters as outlined in the geotechnical report. If a geotechnical report is not provided the foundation design shall be based on class 5 soils.

D. Foundation Drawings: Project specific foundation drawings stamped by a registered engineer in the state where the project is located are required. The foundation drawings must list the moment, shear (horizontal) force, and axial (vertical) force at ground level for each pole. These drawings must be submitted at time of bid to allow for accurate pricing.

2.5 CONTROL

A. Instant On/Off Capabilities: System shall provide for instant on/off of luminaires.

B. Lighting contactor cabinet constructed of NEMA Type 4 aluminum, designed for easy installation with contactors, labeled to match field diagrams and electrical design. Manual off-on-auto selector switches shall be provided.

C. Remote Lighting Control System: System shall allow Owner and users with a security code to schedule on/off system operation via a web site, phone, fax or email up to ten years in

advance. Manufacturer shall provide and maintain a two-way TCP/IP communications link. Trained staff shall be available 24/7 to provide scheduling support and assist with reporting needs.

1. The Owner may assign various security levels to schedulers by function and/or fields. This function must be flexible to allow a range of privileges such as full scheduling capabilities for all fields to only having permission to execute “early off” commands by phone. Scheduling tool shall be capable of setting curfew limits.
2. Controller shall accept and store 7-day schedules, be protected against memory loss during power outages, and shall reboot once power is regained and execute any commands that would have occurred during outage.

D. Remote Monitoring System: System shall monitor lighting performance and notify manufacturer if individual luminaire outage is detected so that appropriate maintenance can be scheduled. The controller shall determine switch position (manual or auto) and contactor status (open or closed).

E. Management Tools: Provide a web-based database and dashboard tool of actual field usage and provide reports by facility and user group. Dashboard shall also show current status of luminaire outages, control operation and service. Mobile application will be provided suitable for IOS, Android and Blackberry devices.

F. Hours of Usage: Provide a means of tracking actual hours of usage for the field lighting system that is readily accessible to the Owner.

1. Cumulative Hours: Tracked to show the total hours used by the facility.
2. Report hours saved by using early off and push buttons by users.

G. Communication Costs: Include communications costs for operating the controls and monitoring system for a period of 25 years.

PART 3 - EXECUTION

3.1 FIELD QUALITY CONTROL

A. Illumination Measurements: Upon substantial completion of the project and in the presence of the Contractor, Project Engineer, Owner's Representative, and Manufacturer's Representative, illumination measurements shall be taken and verified. The illumination measurements shall be conducted in accordance with IESNA LM-5-04.

B. Field Light Level Accountability:

1. Light levels are guaranteed not to fall below the target maintained light levels for the entire warranty period of 25 years.
2. The Contractor/Manufacturer shall be responsible for an additional inspection one year from the date of commissioning of the lighting system and will utilize the Owner’s light meter in the presence of the Owner.
3. The Contractor/Manufacturer will be held responsible for any and all changes needed to bring these fields back to compliance for light levels and uniformities. Contractor/Manufacturer will be held responsible for any damage to the fields during these repairs.

C. Correcting Non-Conformance: If, in the opinion of the Owner or his appointed Representative, the actual performance levels including footcandles and uniformity ratios are not in conformance with the requirements of the performance specifications and submitted information, the Manufacturer shall be required to make adjustments to meet specifications and satisfy the Owner.

3.2 SOIL QUALITY CONTROL

A. It shall be the Contractor’s responsibility to notify the Owner if soil conditions exist other than those on which the foundation design is based, or if the soil cannot be readily excavated. Contractor may issue a change order request / estimate for the Owner’s approval / payment for additional costs associated with:

1. Providing engineered foundation embedment design by a registered engineer in the State of Texas for soils other than specified soil conditions.
2. Additional materials required to achieve alternate foundation.
3. Excavation and removal of materials other than normal soils, such as rock caliche, etc.

3.3 DELIVERY TIMING

A. Delivery Timing Equipment On-Site: The equipment must be on-site 6-8 weeks from receipt of approved submittals and receipt of complete order information.

END OF SECTION 26 5668

SECTION 26 5670
STRUCTURAL REQUIREMENTS FOR ATHLETIC LIGHTING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Structural performance and design standards for sports lighting

1.02 RELATED REQUIREMENTS

A. Division 26 - Exterior Athletic Lighting

1.03 REFERENCE STANDARDS

A. AASHTO LTS-5 Standard Specifications for Structural Supports for Highway Signs, Luminares and Traffic Signals

B. ASCE 7-16 Minimum Design Loads for Buildings and Other Structures

1.04 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements, for submittal procedures.

B. Provide engineered drawings stating compliance with this specification section

C. The Professional Engineer performing the design of the athletic light pole foundations shall include a statement in their submittal regarding whether the mix design for light poles in Section 03 3000 is structurally acceptable to use for the athletic light pole foundations. If it is not structurally acceptable, the pole foundation engineer shall detail in their submittal what changes are necessary for the athletic light pole foundations, and the Contractor shall make those changes to the mix when placing athletic light pole foundation concrete.

1.05 QUALITY ASSURANCE

A. Work covered by this section of the specifications shall conform to the contract documents, as well as state and local codes.

B. The purpose of these specifications is to define the structural performance and design standards for sports lighting. The manufacturer/contractor shall supply lighting equipment to meet or exceed the standards set forth by the criteria set forth in these specifications

1.06 STRUCTURAL PARAMETERS

A. A Professional Engineer licensed in the State of Texas and hired by the Contractor shall design all exterior athletic lighting structures and submit sealed calculations (as a separate submittal from the electrical submittal) to Huckabee Engineering for Structural Engineering review before fabrication. Poles and other support structures, brackets, arms, bases, anchorages and foundations shall be designed to resist wind loads as determined by ASCE 7-16 based on a Basic Wind Speed (3 second gust) as shown for the project location in the Mapped Basic Wind Speeds for Risk Category III with Exposure Category C. Luminares, visors and crossarms shall be designed to resist wind loads based on a Basic Wind Speed of 150 mph (3 second Gust) or the ASCE 7-16 mapped Basic Wind Speed (3 second gust), whichever is higher, while maintaining luminaire aiming alignment. All designs shall comply with the 2018 International Building Code (IBC). The effects of fatigue shall be considered during design at the equivalent static wind pressure as determined by AASHTO LTS-5 “Standard Specifications for Structural Supports for Highway Signs, Luminares and Traffic Signals” with the fatigue importance factor associated with Fatigue Category I and the maximum permitted stresses for the fatigue analysis shall be based on an infinite number of cycles as determined by ANSI/AISC 360-10, including Appendix 3.

B. If the project location is near the line between different mapped Basic Wind Speeds, proposers shall assume for proposal purposes that the higher wind speed shall be required unless the Buiding Official indicates otherwise.

C. The athletic light pole designs shall comply with the requirements in this specification section, even if other specification sections have different structural requirements for light poles, so that all requirements are met.

D. If the locally adopted building code cited in Specification Section 01 4100 "Regulatory Requirements" is different than the 2018 IBC, then the athletic light pole designs shall also comply with the locally adopted building code in addition to complying with the requirements in this specfication section, which are based on the 2018 IBC.

E. Corrosion Resistance Requirements: To reduce the potential for corrosion, which could lead to structural failure of the poles during the intended design life, all steel shall be galvanized. All welding shall occur before galvanization. It shall not be permitted to weld or cut any galvanized members after galvanizing. Painting a galvanizing repair product over welds or field cuts shall not be permitted. If post-galvanized welding or cutting of members occurs, members shall be replaced at no cost to the Owner. If base plates are part of the design, it shall not be permitted for the top of the pier to be below grade and it shall not be permitted to grout under any base plates. If grout is installed under base plates, at no cost to the Owner the light poles shall be disconnected and lifted from the foundation so that the grout can be completely removed and the pole replaced and reconnected. The Contractor shall be responsible for monitoring for these conditions and shall be responsible for remediation at no cost to the Owner even if such conditions are noted by the Architect or Engineer during the Final Punchlist.

F. Soil Conditions: The design criteria for these specifications are based on soil design parameters as outlined in the geotechnical report. If a geotechnical report is not provided by the owner, the foundation design shall be based on soils that meet or exceed those of a Class 5 material as defined by 2018 IBC.
   1. It shall be the Contractor’s responsibility to notify the owner if soil conditions exist other than those on which the foundation design is based, or if the soil cannot be readily excavated. Contractor may issue a change order request / estimate for the owner’s approval / payment for additional costs associated with:
   2. Providing engineered foundation embedment design by a registered engineer in the State of Texas
   3. Additional materials required to achieve alternate foundation.
   4. Excavation and removal of materials other than normal soils, such as rock, caliche, etc.

G. Foundation Drawings: Project specific foundation drawings stamped by a registered engineer in the state where the project is located are required. The foundation drawings must list the moment, shear (horizontal) force, and axial (vertical) force at ground level for each pole.

1.07 FIELD CONDITIONS

A. Existing Conditions: See Section 00 3132 - Geotechnical Data

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 27 0000
COMMON COMMUNICATIONS REQUIREMENTS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. The requirements contained in this Section apply to all Sections of this Division.

1.02 SUMMARY

A. This section includes general design requirements, administration topics, and installation for communications systems.

B. Section Includes:
   1. Common terminology and requirements used throughout this Division.
   2. Identification and labeling.
   3. Firestop systems.
   4. Sleeves for raceways and cables.
   5. Grout.

1.03 PROJECT DESCRIPTION

A. The objective of this project is to provide complete communications systems installation including, but not limited to:
   1. Structured Cabling System:
      a. Optical Fiber Backbone Cabling
      b. Twisted Pair Copper Horizontal Data/Voice Cabling
      with attendant terminations, mounting equipment, power distribution, cable pathway and management systems, testing and other items/materials, as specified in drawings, these specifications, and contract documents.
   2. Intercommunications and Program (Paging) System: system head end equipment, amplifiers, system backbone cabling, speakers, and horizontal speaker cabling, with attendant terminations, mounting equipment, cable pathway and management systems, testing, and other items/materials as specified in drawings, these specifications, and contract documents.
   3. Audio-Video Systems and Equipment: projectors, flat panel displays, sound reinforcement systems for assembly spaces, and sound reinforcement systems for classrooms, along with all attendant terminations, mounting equipment, routing/switching/amplification/control equipment, cabling, and cable pathway and management systems, test and other items/materials, as specified in drawings, these specifications, and contract documents.

1.04 DEFINITIONS

AHJ: Authority(ies) Having Jurisdiction.

Architect: The Architect of Record for the project, if any.

Business Day: Monday thru Friday, excluding Holidays recognized by Federal, State and Local government.

CFCI: Contractor Furnished, Contractor Installed

Contract Documents: All documents pertinent to the quality and quantity of all work to be performed on the project. Includes, but not limited to, plans, specifications, addenda, instructions to bidders (both General and Sub-Contractors), unit prices, change orders, architect's supplemental instructions, etc.

Contractor: The General Contractor and/or Construction Manager, and any contractor or subcontractor performing any low-voltage communications work in the project, whether proposing/working independently or subcontracted under the.

Engineer: The Consulting Mechanical-Electrical Engineers either consulting to the Owner, Architect, other Engineers, etc.

Furnish: Deliver to the site in good condition.

Install: Install equipment furnished by others in complete working order.

OFCI: Owner Furnished, Contractor Installed

OFOI: Owner Furnished, Owner Installed

Provide: Furnish and install in complete working order.

1.05 GENERAL

A. The Instructions to Bidders, General and Special Conditions, and all other contract documents shall apply to the Contractor's work as well as to each of his Sub-Contractor's work. Each Contractor is directed to familiarize himself in detail with all documents pertinent to this Contract. In case of conflict between these General Provisions and the General and/or Special Conditions, the affected Contractor shall contact the Engineer for clarification and final determination.

B. Each Contractor shall be governed by any alternates, unit prices and addenda or other contract documents insofar as may affect the work or services.

C. The work included in this division consists of the furnishing of all labor, equipment, transportation, supplies, material and appurtenances and performing all operations necessary for the satisfactory installation of the complete and operating Communications System(s) indicated and/or specified in the Contract Documents.

D. Any materials, labor, equipment or services not mentioned specifically herein which may be necessary to complete or perfect any part of the Communications Systems in a substantial manner, in compliance with the requirements stated, implied or intended in the drawings and/or specifications, shall be included as part of this Contract.

E. The Contractor shall give written notice of any materials or apparatus believed inadequate or unsuitable; in violation of laws, ordinances, rules or regulations of authorities having jurisdiction; and any necessary items of work omitted a minimum of ten days prior to bid. In the absence of such written notice and by the act of submitting his bid, it shall be understood that the Contractor has included the cost of all required items in his bid, and that he will be responsible for the approved satisfactory functioning of the entire system without extra compensation.

F. It is not the intent of this section of the specifications (or the remainder of the contract documents) to make any specific Contractor, other than the Contractor holding the prime agreement, responsible to the Owner, Architect and Engineer. All transactions such as submittal of shop drawings, claims for extra costs, requests for equipment or materials substitution, shall be routed through the Contractor to the Architect (if applicable), then to the Engineer.

G. This section of the Specifications or the arrangement of the Contract Documents shall not be construed as an attempt to arbitrarily assign responsibility of work, material, equipment or services to a particular Contractor or Sub-Contractor. Unless stated otherwise, the subdivision and assignment of work under the various sections shall be the responsibility of the Contractor holding the prime contract.

H. It is the intent of this Contract to deliver to the Owner a new and complete project once work is complete. Although plans and specifications are complete to the extent possible, it shall be the responsibility of the Contractors involved to remove and/or relocate or re-attach any existing or new systems which interfere with new equipment or materials required for the complete installation without additional cost to the Owner.

I. In general, and to the extent possible, all work shall be accomplished without interruption of facility operations. The Contractor shall advise the Architect, Owner and Engineer in writing at least one week prior to the deliberate interruption of any services. The Owner shall be advised of the exact time that interruption will occur and the length of time the interruption will last. Failure to comply with this requirement may result in complete work stoppage by the Contractors involved until a complete schedule of interruptions can be developed.

J. Whenever utilities are interrupted, either deliberately or accidentally, the Contractor shall work continuously to restore said service. The Contractor shall provide tools, materials, skilled journeymen of his own and other trades as necessary, premium time as needed and coordination with all applicable utilities, including payment of utility company charges (if any), all without requests for extra compensation to the Owner, except where otherwise provided for in the contract for the work.

1.06 DRAWINGS AND SPECIFICATIONS

A. The drawings are diagrammatic only and indicate the general arrangement of the systems and are to be followed insofar as possible. If deviations from the layouts are necessitated by field conditions, detailed layouts of the proposed departures shall be submitted to the Engineer for approval before proceeding with the work.

B. The drawings and specifications are intended to supplement each other. No Contractor shall take advantage of conflict between them, or between parts of either. This also includes potential conflicts with regards to equipment and material model numbers, part numbers, etc. and respective description and/or performance. Should this condition exist, the Contractor shall request a clarification not less than 10 days prior to the submission of the proposal so that the condition may be clarified by Addendum. In the event that such a condition arises after work is started, the interpretation of the Engineer shall be the determining factor. In all instances, unless modified in writing and agreed upon by all parties thereto, the Contract to accomplish the work shall be binding on the affected Contractor.

C. The drawings and specifications shall be considered to be cooperative and complimentary and anything appearing in the specifications which may not be indicated on the drawings or conversely, shall be considered as part of the Contract and must be executed the same as though indicated by both.

D. Contractor shall make all necessary and required measurements in the field and shall be responsible for correct fitting. The work shall be coordinated with all other branches of work in such a manner as to cause a minimum of conflict or delay.

E. The Engineer shall reserve the right to make adjustments in location of conduit, j-hooks, devices, etc. where such adjustments are in the interest of concealing work or presenting a better appearance. Unless a formal proposal request is issued, this work shall be performed without additional cost to the Owner.

F. Each Contractor shall evaluate ceiling heights called for on Architectural Plans. Where the location of Communications equipment may interfere with ceiling heights, the Contractor shall call this to the attention of the Engineer in writing prior to making the installation. Any such changes shall be anticipated and requested sufficiently in advance so as to not cause extra work on the part of the Contractor or unduly delay the work.

G. Should conflict or overlap (duplication) of work between the various trades become evident, this shall be called to the attention of the Engineer. In such event neither trade shall assume to be relieved of the work which is specified under his branch until instructions in writing are received from the Engineer.

H. The Drawings are intended to show the approximate locations of equipment, materials, devices, etc. Dimensions given in figures on the drawings shall take precedence over scaled dimensions and all dimensions, whether given in figures or scaled, shall be verified in the field to ensure no conflict with other work. In case of conflict between small- and large-scale drawings, the larger scale drawings shall take precedence.

I. Where on the Drawings a portion of the work is drawn out and the remainder is indicated in outline, or not indicated at all, the parts drawn out shall apply to all other like portions of the work. Where ornamentation or other detail is indicated by starting only, such detail shall be continued throughout the courses or parts in which it occurs and shall also apply to all other similar parts of the work, unless otherwise indicated.

J. Details not usually shown or specified, but necessary for the proper installation and operation of systems, equipment, materials, etc., shall be included in the work without additional cost to the Owner, the same as if herein specified or indicated.

K. Where on the Drawings or Addenda the word ‘typical’ is used, it shall mean that the work method or means indicated as typical for a condition shall be repeated in each instance where that condition occurs, whether indicated or not.

1.07 SUBSTITUTION PROCEDURES

A. Comply with provisions of Division 01 Section “Substitution Procedures”.

B. Substitution may be considered when a product becomes unavailable through no fault of the Contractor.

C. If an alternate material is proposed that is equal to or exceeds specified requirements, Contractor shall provide manufacturers’ specifications in writing for Owner approval prior to purchase and installation.

D. Document each request with complete data substantiating compliance of proposed substitution with Contract Documents.

E. Substitutions of material by the Contractor shall be in writing complete with written manufacturers’ specifications. The material substituted shall not void, alter or change manufacturers’ structured cabling system warranty.
   1. The Contractor shall provide a complete cabling infrastructure according to these written specifications and drawings.
   2. The Contractor shall respond to these changes with a complete material list, including pricing, labor, and taxes in writing presented to the Owner for approval.
   3. The Contractor shall not proceed with additional scope of work without a signed approval by the Owner.
   4. Owner will not pay for additional work performed by the Contractor without signed approval of these changes.

F. Substitutions will not be considered when they are indicated or implied on shop drawing or product data submittals, without separate written request, or when acceptance will require revision to the Contract Documents.

G. The Owner will be the final judge of acceptability, with review by Engineer and the distribution of the acceptance by the Architect.
   1. No substitute shall be ordered, installed or utilized without the Architect’s prior written verification of acceptance from the Owner.

1.08 REFERENCES

A. The publications listed below form a part of this specification. The publications are referred to in the text by basic designation only.

B. Specific reference in specifications to codes, rules, regulations, standards, manufacturer's instructions, or requirements of regulatory agencies shall mean reference to the latest printed edition of each in effect at the date of contract.

C. Design, manufacture, test, and install data distribution systems per manufacturer's requirements and in accordance with NFPA 70, state codes, local codes, requirements of authorities having jurisdiction, and particularly the following specifications or standards:
   1. ANSI/TIA-568-C: Commercial Building Telecommunications Wiring Standard.
      a. ANSI/TIA-568-C.0: "Generic Telecommunications Cabling for Customer Premises", and its published addenda.
      b. ANSI/TIA-568-C.1: "Commercial Building Telecommunications Cabling Standard", and its published addenda.
      c. ANSI/TIA-568-C.2: "Balanced Twisted-Pair Telecommunication Cabling and Components Standard", and its published addenda.
      d. ANSI/TIA-568-C.3: "Optical Fiber Cabling Components Standard", and its published addenda.
   2. ANSI/TIA-569-B: "Commercial Building Standard for Telecommunications Pathways and Spaces", and its published addenda.
   3. ANSI/TIA-606-A: "Administration Standard for Commercial Telecommunications Infrastructure".
   4. ANSI/TIA-606-B: "Administration Standard for the Telecommunications Infrastructure of Commercial Buildings", and its published addenda.
   5. ANSI-J-STD-607-B: "Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications", and its published addenda.
   6. ANSI/TIA-942: "Telecommunications Infrastructure Standard for Data Centers", and its published addenda.
   7. BICSI Telecommunications Distribution Methods Manual (TDMM)
   8. Local, county, state and federal regulations and codes in effect as of date of installation
   9. Equipment of foreign manufacture must meet U.S. codes and standards.

1.09 QUALITY ASSURANCE

A. Regulatory Requirements
   1. Contractor shall supply all city, county, and state telecommunication cabling permits required by appropriate governing agency.
   2. Contractor shall be state-licensed and/or bonded as required for telecommunications/low voltage cabling systems.

B. Certifications
   1. Contractor shall submit an up-to-date and valid certification verifying qualifications of the Contractor and installers to perform the work specified herein at time of bid submission.
   2. Contractor shall have a complete working knowledge of low voltage cabling applications such as, but not limited to data, voice and video network systems.
   3. Contracting firm shall have installed similar-sized systems in at least ten (10) other projects in the last five (5) years prior to this bid and be regularly engaged in the business of installation of the types of systems specified in this document.
      a. Certification shall include, but not be limited to, items such as name and location of project contacts and numbers, total square footage, total number of cables/drops, types of media, etc.
   4. Contractor shall provide certificates for the appropriate insurance coverage as defined in contract documents.
   5. All installer personnel that will be assigned to this project shall be listed in the qualification questionnaire document.

6. 80% shall have a minimum of three (3) years' experience in the installation of the types of systems, equipment, and cables specified in this document prior to this bid.
    a. Any personnel substitutions shall be noted in writing to Owner prior to commencement of work.
7. Contractor shall submit evidence of compliance with these requirements prior to beginning work on the project.
8. Cabling installers shall be trained and certified by the cable manufacturer for telecommunication cabling installations and maintenance of said materials.
9. Maintain current status with the warranting manufacturer, including all training requirements, for the duration of the cable infrastructure project. Staff each installation crew with the appropriate number of trained personnel, in accordance with their manufacturer/warranty contract agreement, to support the lifetime system warranty requirements. After installation, submit all documentation to support the warranty in accordance with the manufacturer's warranty requirements, including test results, and to apply for said warranty on behalf of the customer. The system warranty will cover the components and labor associated with the repair/replacement of any failed link as a result of a defective product when a valid warranty claim is submitted within the warranty period.

C. Administrative Requirements and Coordination requirements
1. Coordinate work of this section with Owner's telephone system specifications, workstations, equipment suppliers, and installers.
2. Coordinate installation work with other crafts (examples include ceiling grid contractors, HVAC and sheet metal contractors, etc) to resolve procedures and installation placement for cable trays and cable bundle pathways.
    a. The goal of this coordination will be to establish priority pathways for critical data/voice network cable infrastructure, materials, associated hardware, as well as mitigate delays to the project and to allow service access for communications and HVAC components.
    b. Damage by Contractor to the craft work of others will be remedied at the Contractor's expense in a timely manner.
3. Exchange information and agree on details of equipment arrangements and installation interfaces.
    a. Record agreements reached in meetings and distribute record to other participants, Owner and telecommunication consultant.
4. Adjust arrangement and locations of distribution frames, patch panels, and cross-connect blocks in equipment rooms and racks to accommodate and optimize arrangement and space requirements of any service provider equipment, telephone system, and LAN equipment.
    a. Tasks shall be coordinated with Owner or his representative, owner's telecommunication utility provider(s) as applicable, and other trades' installation representatives.
5. When requested by Owner or Owner's representative, furnish extra materials that match specified products and that are factory packaged with protective covering for storage and identified with labels describing contents.

D. Common Requirements for Material Quality: Materials, equipment and devices shall be new and of the quality specified and shall be free from defects at the time of installation. Materials, equipment and devices damaged in shipment or otherwise damaged or found defective prior to acceptance by the Owner shall be replaced with new materials, equipment or devices identical with those damaged, unless approved otherwise by the Owner in writing.

E. Common Requirements for Code Compliance: In case where differences occur between building codes, state laws, local ordinances, industry standards, utility company regulations and the Contract Documents, the most stringent shall govern. Perform the following:
1. Promptly notify the Architect in writing of any such difference.

2. Obtain approval from Architect before proceeding with the Work.
3. Should the Contractor perform any work that knowingly does not comply with local codes, laws and ordinances, industry standards, or other governing regulations; the Work shall be corrected at no cost to the Owner.

F. Common Requirements for Compliance with AHJ Instructions: In cases where the Authority Having Jurisdiction requires deviations from the requirements of the Contract Documents, perform the following:
1. Promptly notify the Architect in writing of any such difference.
2. Obtain approval from Architect before proceeding with the Work.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Coordination with delivery companies, drivers, site address, and contact person(s) will be the responsibility of the Contractor.

B. Contractor requirements:
1. Be responsible for prompt material deliveries to meet contracted completion date.
2. Coordinate deliveries and submittals with the General Contractor to ensure a timely installation.
3. No equipment materials shall be delivered to the job site more than three weeks prior to the commencement of its installation.
4. Equipment shall be delivered in original packages with labels intact and identification clearly marked.
5. Equipment shall not be damaged in any way and shall comply with manufacturer's operating specifications.
6. Equipment and components shall be protected from the weather, humidity, temperature variations, dirt, dust, or other contaminants.
   a. Equipment damaged prior to system acceptance shall be replaced at no cost to the Owner.
7. Contractor shall be responsible for all handling and control of equipment. Contractor is liable for any material loss due to delivery and storage problems.

C. Owner/General Contractor shall supply a list of security requirements for Contractor to follow.

1.11 PROJECT/SITE CONDITIONS

A. After completing system installation, including outlet fittings and devices, inspect exposed finish. Contractor will remove burrs, dirt, and construction debris.
1. If applicable, the Contractor will repair damaged finishes, including chips, scratches, and abrasions.

B. Contractor shall provide daily a clean work environment, free from trash/rubbish accumulated during and after cabling installation.

C. Contractor shall keep all liquids (drinks, sodas, etc.) off finished floors, carpets, and tiles.
1. If any liquid or other detriment (cuts, soils, stains, etc.) damages the above finishes, Contractor shall provide professional services to clean or repair scratched/soiled finishes, at Contractor's expense.

1.12 COORDINATION

A. In describing various materials, equipment and devices, in general each item may be described singularly, even though there may be a multiplicity of identical items. Also, where the description is general in nature, the exact sizes, duties, space arrangements, and other requirements must be obtained by reference to other portions of Contract Documents.

B. Space allocations for materials, equipment and devices have been made on the basis of present and known future requirements and the dimensions of items of equipment or devices of a particular manufacturer. Verify that all materials, equipment and devices proposed for use on this Project are within the constraints of the allocated space.

C. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.

D. Coordinate location of access panels and doors for electrical items that are behind finished surfaces or otherwise concealed. Access doors and panels are specified in Division 08 Section "Access Doors and Frames."

E. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Firestopping" and in this Section.

F. Roof-Mounted Equipment: Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 07 Section "Roof Accessories."

1.13 MAINTENANCE

A. Support Availability: The Contractor shall commit to make available local support for the product and system during the Warranty or Extended Warranty periods.

PART 2 PRODUCTS

2.01 IDENTIFICATION (LABELING) SYSTEM

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Brady
   2. Brother
   3. Dymo
   4. Hellerman-Tyton

2.02 FIRESTOP SYSTEMS

A. Refer to Division 07 Section "Firestopping" for additional requirements.

B. General:
   1. Provide through-penetration firestop systems that are compatible with one another, with the substrates forming openings, and with the items penetrating through-penetration firestop systems, under conditions of service and application, as demonstrated by through-penetration firestop system manufacturer based on testing and field experience.
   2. Provide components for each through-penetration firestop system that are needed to install fill materials. Use only components specified by the firestopping manufacturer and approved by the qualified testing agency for the designated fire-resistance-rated systems.

C. Manufacturers: Subject to compliance with requirements and with through-penetration firestop systems listed in Volume 2 of the UL Fire Resistance Directory, provide products by Specified Technologies, Inc. (STI) or Engineer approved equal.

D. Materials:
   1. Firestop Sealants: Single component latex formulations that upon cure do not re-emulsify during exposure to moisture, the following products are acceptable:
      a. STI SpecSeal Series SSS Sealant.
      b. STI SpecSeal Series LCI Sealant.
   2. Firestop Putty: Intumescent, non-hardening, water resistant putties containing no solvents, inorganic fibers or silicone compounds, the following products are acceptable:
      a. STI SpecSeal Series SSP Putty.

3. Firestop Pillows: Re-enterable, non-curing, mineral fiber core encapsulated on six sides with intumescent coating contained in a flame retardant poly bag, the following products are acceptable:
   a. STI SpecSeal Series SSB Pillows.
4. Fire-Rated Cable Grommet: Molded, two-piece grommet with an integral fire and smoke sealing foam membrane for sealing individual cable penetrations through framed wall assemblies. Grommet snaps together around cable and locks tightly into the wall. The following products are acceptable:
   a. STI EZ-Firestop Grommets.
5. Fire-Rated Cable Pathways: Device modules comprised of steel pathway with self-adjusting intumescent foam pads allowing 0 to 100 percent cable fill, the following products are acceptable:
   a. STI EZ-PATH Fire Rated Pathway.

2.03 SLEEVES FOR RACEWAYS AND CABLES

A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, with burrs removed and insulating bushing fittings on ends.

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.

2.04 GROUT

A. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, nonmetallic aggregate grout, noncorrosive, non-staining, mixed with water to consistency suitable for application and a 30-minute working time.

PART 3 EXECUTION

3.01 STRUCTURED CABLING SYSTEM INSTALLERS

A. The Contractor shall be a certified Manufacturer's Authorized Installer and provide an end-to-end product warranty, adhere to the industry standard engineering, installation and testing procedures and utilize the authorized manufacturer components and distribution channels in provisioning this project. Contractor must be Belden certified to furnish a Belden 25-year manufacturer's warranty.

B. Provide and pay for all labor, supervision, tools, equipment, test equipment, tests and services to provide and install a complete inside and outside plant fiber and copper infrastructure system. Pay all required sales, gross receipts, and other taxes.

C. Furnish all labor, supervision, tooling, miscellaneous mounting hardware and consumables for each cabling system installed. Maintain current status with the warranting manufacturer, including all training requirements, for the duration of the cable infrastructure project. Staff each installation crew with the appropriate number of trained personnel, in accordance with the manufacturer/warranty contract agreement to support the lifetime system warranty requirements.

D. After installation, submit all documentation to support the warranty in accordance with the manufacturer's warranty requirements, including test results, and to apply for said warranty on behalf of the Owner. The system warranty will cover the components and labor associated with the repair/replacement of any failed link as a result of a defective product when a valid warranty claim is submitted within the warranty period.

E. Establish a single point of contact (POC) with the Owner who will be responsible for reporting progress and updating the Owner's technical representative with issues that the Owner must address to facilitate the cabling system installation. POC shall provide daily written reports to the Owner's technical representative detailing progress. Requests for access to limited access or restricted areas shall be made three days prior to the required access. Information critical to the completion of the task or project shall be communicated to the Owner's technical representative as the requirement becomes known. Casual information shall be passed during the scheduled progress report.

F. Maintain the Owner's facility in a neat and orderly manner during the installation of the communications cabling system. The Owner's facilities shall be maintained in broom clean condition at the completion of work each day. At the completion of work in each area, perform a final cleaning of debris prior to moving the installation crew to the next work area.

G. All members of the installation team shall be certified by the Structured Cabling Manufacturer System Performance Warranty provider as having completed the necessary training to complete their part of the installation and capable of an installation that falls under manufacturer's guidelines necessary to obtain the Manufacturer's System Performance Warranty.

H. A BICSI RCDD shall supervise and approve all on-site work as a recognized member of the Contractor's installation team. All installation team members must demonstrate knowledge and compliance with all BICSI, TIA, UL, and NEC methods, standards and codes.

3.02 STRUCTURED CABLING SYSTEM INSTALLATION

A. Allowable Cable Bend Radius and Pull Tension:
   1. In general, communications cable cannot tolerate sharp bends or excessive pull tension during installation.
   2. Refer to cable manufacturer's bend radius recommendations for the maximum allowable limits.
   3. After installation, exposed cable and other surfaces must be cleaned free of lubricant residue. Use only lubricants specifically designed for cable installation.

B. Pull Strings:
   1. Horizontal cable requirements
      a. Provide pull strings in all new conduits, including all conduits with cable installed as part of this contract.
      b. Pull string shall have a rated average breaking strength of 200 lbs.
      c. Data and video cables can be pulled in tandem with pull strings.
      d. During pulling sessions, pull strings must move freely to prevent cable jacket/cable damage.

C. Conduit Fill: Reference manufacturer's Design Installation Guidelines manual, BICSI TDMM, and NEC. The most stringent applicable code or standard shall apply.

D. All material and equipment as provided should be the standard Commercial-Off-The-Shelf (COTS) products of a manufacturer engaged in the manufacturing of such products.
   1. All material and equipment shall be typical commercial designs that comply with the requirements specified.
   2. All material and equipment shall be readily available through manufacturers and/or distributors.

E. All equipment shall be standard catalogued items of the manufacturer and shall be supplied complete with any optional items required for proper installation.

F. Coordinate the features of materials and equipment so they form an integrated system. Match components and interconnections for optimum future performance and backward compatibility.

G. Expansion Capability: Unless otherwise indicated, provide spare conductor pairs in cables, positions in patch panels, cross connects, and terminal strips, and space in cable pathways and backboard layouts to accommodate 20% future increase in campus distribution and active workstations.

H. Backward Compatibility: The provided solution shall be backward compatible with lower category ratings such that if higher category components are used with lower category components, the basic link and channel measures shall meet or exceed the lower channel's specified parameters.

I. Component Compliance: The provided solution's components shall each meet the minimum transmission specifications listed herein such that no individual component will be less than specifications for permanent link and channel, regardless of the fact that tests for link and channel ultimately meet required specifications.

J. In the event of a breach of the representations and warranties contained herein, the Contractor, at their own expense, shall take all measures necessary to make the cabling system work and comply with the applicable manufacturer written technical recommendations and standards.

K. Owner's technical representative will make periodic inspection of the project in progress. One inspection will be performed at the conclusion of cable pulling, prior to closing of the false ceiling to inspect the method of cable routing and support and the firestopping of penetrations. A second inspection will be performed at completion of cable termination to validate that cables were dressed and terminated in accordance with the ANSI/TIA-568-C standards for jacket removal and pair untwist, compliance with manufacturer's minimum bend radius, and that cable ends are dressed neatly and orderly.

3.03 EXAMINATION

A. Field Measurements
   1. Verify dimensions in areas of installation by field measurements before fabrication and indicate measurements on shop drawings.
   2. Coordinate fabrication schedule with construction progress to avoid delaying the work.

B. Established Dimensions
   1. Where field measurements cannot be made without delaying the work, establish dimensions and proceed with fabricating units without field measurements.
   2. Coordinate supports, adjacent construction, and fixture locations to ensure actual dimensions correspond to established dimensions.

3.04 PREPARATION

A. Contractor's RCDD shall review, approve and stamp all Shop Drawings, Submittal Documents, Coordination Drawings and As Built Drawings.

B. Pre-Installation Inspection:
   1. Contractor shall visually inspect all cables, cable reels, and shipping cartons to detect possible cable damage incurred during shipping and transport.
   2. Visibly damaged goods are not acceptable and shall be replaced by the Contractor at no additional cost to the Owner.

3.05 LABELING

A. Cable labels: Self-adhesive vinyl or vinyl-cloth wraparound tape markers, machine printed with alphanumeric cable designations.

B. Flat-surface labels: Self-adhesive vinyl or vinyl-cloth labels, machine printed with alphanumeric cable designations.

C. Provide transparent plastic label holders, and 4-pair marked colored labels.

D. Install colored labels according to the type of field as per ANSI/TIA 606-A color code designations.

E. Use ANSI/TIA 606-A: “designation strip color-code guidelines for voice, data, cross- connect, riser, and backbone fields”

F. Provide self-adhesive, color-coded, identification marker on ceiling grid directly below any device requiring an IP-connection above the ceiling. Ceiling marker to be Seton L12723 or equivalent. Division 27 related devices should utilize a yellow identification marker on the ceiling grid.

3.06 CODES, RULES, PERMITS, FEES, INSPECTIONS, REGULATION, ETC.

A. Contractor shall give all necessary notices, obtain and pay for all permits, government sales taxes, fees, inspections and other costs, including all utility connections, meters, meter settings, extensions, etc. in connection with his work.

B. Contractor shall file all necessary plans, utility easement requests and drawings, survey information on line locations, load calculations, etc. prepare all documents and obtain all necessary approvals of all utility and governmental departments having jurisdiction; obtain all certificates of inspection for his work and deliver same to the Engineer before request for acceptance and final payment for the work.

C. Ignorance of Codes, Rules, Regulations, Laws, etc. shall not render the Contractor irresponsible for compliance. The Contractor shall be versed in all Codes, Rules and Regulations pertinent to the work prior to submission of a proposal.

D. Contractor shall include in the work, without extra cost, any labor, materials, services, apparatus and drawings in order to comply with all applicable laws, ordinances, rules and regulations, whether or not indicated or specified.

E. Where minimum code requirements are exceeded in the Design, the Design shall govern.

F. Ensure that the work is accomplished in accordance with the OSHA Standards and any other applicable government requirements.

G. All work relating to the handicapped shall be in accord with regulations currently enforced by the Authority Having Jurisdiction.

H. Where conflict arises between any code and the plans and/or specifications, the code shall apply except in the instance where the plans and specifications exceed the requirements of the code. Any changes required as a result of these conflicts shall be brought to the attention of the Engineer at least ten working days prior to bid date, otherwise the Contractor shall make the required changes at his own expense. The provisions of the codes constitute minimum standards for wiring methods, materials, equipment and construction and compliance therewith will be required for all electrical work, except where the drawings and specifications require better materials, equipment, and construction than these minimum standards, in which case the drawings and specifications shall be the minimum standards.

3.07 CUTTING AND PATCHING

A. Unless otherwise indicated or specified, each Contractor shall provide cutting and patching necessary to install the work specified in this Division. Patching shall match adjacent surfaces to the satisfaction of the Engineer and shall be in accord with the Architect's standards for such work, as applicable.

B. Each Contractor shall be responsible for all openings, sleeves, trenches, etc. that he may require in floors, roofs, ceilings, walls, etc. and shall coordinate all such work with the General Contractor and all other trades. Contractor shall coordinate with the General Contractor any openings which he is to provide before submitting a bid proposal in order to avoid conflict and disagreement during construction. Improperly located openings shall be reworked at the expense of the responsible Contractor.

C. Each Contractor shall plan his work ahead and shall place sleeves, frames or forms through all walls, floors and ceilings during the initial construction, where it is necessary for conduit, conductors, wireways, etc. to go through; however, when this is not done, this Contractor shall do all cutting and patching as well as reinforcement required for the installation of his work, or he shall pay other trades for doing this work when so directed by the Engineer. Any damage caused to the buildings by the workmen of the responsible Contractor must be corrected or rectified by him at his own expense.

D. Cut holes in casework, equipment panels, etc. (if any), as required to pass pipes in and out.

E. Notify other trades in due time where openings of chases in new concrete or masonry are required. Set all concrete inserts and sleeves for work. Failing to do this, cut openings for work and patch same as required at own expense.

F. Openings in slabs and walls shall be cut with core drill. Hammer devices will not be permitted. Edges of trenches and large openings shall be scribe cut with a masonry saw.

G. No structural members shall be cut without the approval of the Structural Engineer and all such cutting shall be done in a manner directed by him.

H. Each Contractor shall be responsible for properly shoring, bracing, supporting, etc. any existing and/or new construction to guard against cracking, settling, collapsing, displacing or weakening while openings are being made. Any damage occurring to the existing and/or new structures, due to failure to exercise proper precautions or due to action of the elements, shall be promptly and properly made good to the satisfaction of the Engineer.

I. All work improperly done or not done at all as required by the Communications trades in this section will be performed by the General Contractor at the direction of the Contractor whose work is affected. The cost of this work shall be paid for by the Contractor responsible.

3.08 SLEEVES AND PLATES

A. Provide and locate all sleeves and inserts required for work before the floors and walls are built, or be responsible for the cost of cutting and patching required where sleeves and inserts were not installed, or where incorrectly located. Each Contractor shall do all drilling required for the installation of his hangers. Drilling of anchor holes may be prohibited in post-tensioned concrete construction, in which case the Contractor shall request approved methods from the Architect and shall carefully coordinate setting of inserts, etc., with the Structural Engineer and/or Architect.

B. Galvanized steel sleeves shall be provided for all communications conduit passing thru concrete floor slabs and concrete, masonry, tile and gypsum wall construction.

C. Cast iron sleeves shall be installed through all walls where pipe enters the building below grade. Sleeves shall be flush with each face of the wall and shall be sufficiently larger than the entering pipe to permit thorough caulking with lead and oakum between pipe and sleeve for waterproofing.

D. In all cases, sleeves shall be at least two pipe sizes larger than nominal pipe diameter.

E. Where conduit motion due to expansion and contraction will occur, make sleeves of sufficient diameter to permit free movement of pipe. Check floor and wall construction finishes to determine proper length of sleeves for various locations; make actual lengths to suit the following:
   1. Terminate sleeves flush with walls, partitions and ceiling.
   2. In areas where pipes are concealed, as in chases, terminate sleeves flush with floor.
   3. In all areas where pipes are exposed, extend sleeves ½ inch above finished floor, except in rooms having floor drains, where sleeves shall be extended 3/4 inches above floor.

F. Sleeves shall be constructed of 24-gauge galvanized sheet steel with lock seam joints for all sleeves set in concrete floor slabs terminating flush with the floor. All other sleeves shall be constructed of galvanized steel pipe unless otherwise indicated on the drawings.

G. Fasten sleeves securely in floors, walls, so that they will not become displaced when concrete is poured or when other construction occurs around them. Take precautions to prevent concrete, plaster or other materials being forced into the space between pipe and sleeve during construction. Fire and smoke stop all sleeves in a manner approved by the local authority having jurisdiction or per prevailing codes.

H. Sleeves passing through exterior wall (none are permitted thru roof) or where there is a possibility of water leakage and damage shall be caulked water tight for horizontal sleeves and flashed and counter-flashed with lead (4 lb.) or copper and soldered to the piping, lapped over sleeve and properly weather sealed. All roof penetrations shall be made inside mechanical equipment curbs.

I. All rectangular or special shaped openings in plaster, stucco or similar materials including gypsum board shall be framed by means of plaster frames, casing beads, wood or metal angle members as required. The intent of this requirements is to provide smooth even termination of wall, floor and ceiling finishes as well as to provide a fastening means for lighting fixtures, panels, etc. Lintels shall be provided where indicated over all openings in bearing walls, etc.

3.09 WEATHERPROOFING

A. Where any work pierces waterproofing, including waterproof concrete, the method of installation shall be as approved by the Architect and/or Engineer before work is done. Furnish all necessary sleeves, caulking and flashing required to make openings absolutely watertight.

B. Wherever work penetrates roofing, it shall be done in a manner that will not diminish or void the roofing guarantee or warranty in any way. Coordinate all such work with the roofing installer.

3.10 FIRESTOPPING

A. Refer to Division 07 Section “Firestopping” for additional requirements.

B. Preparation:
   1. Examination of Conditions: Examine areas and conditions under which work is to be performed and identify conditions detrimental to proper or timely completion.
   2. Surfaces to which firestop materials will be applied shall be free of dirt, grease, oil, scale, rust, release agents, water repellents, and any other substances that may inhibit optimum adhesion.
   3. Provide masking and temporary covering to prevent soiling of adjacent surfaces by firestopping materials.
   4. Do not proceed until unsatisfactory conditions have been corrected.

C. Through-Penetration Firestop System Installation:
   1. Install through-penetration firestop systems in accordance with the conditions of testing and classification as specified in the published design.
   2. Comply with manufacturer’s instructions for installation of through-penetration firestop systems products.
   3. Seal all openings or voids made by penetrations to ensure an air and water resistant seal.
   4. Protect materials from damage on surfaces subjected to traffic.

D. Do not penetrate rated fire walls, ceilings or floors with conduit, cable, wireway or other raceway system unless all penetrations are protected in a code compliant manner which maintains the fire-rating of the assembly. Firestop all openings made in walls, chases, ceilings and floors. Patch all openings around conduit, wireway, etc., with appropriate type material to provide needed fire rating at fire walls, ceilings and floors. Fire proofing materials and method of application shall be approved by the local authority having jurisdiction.

E. Apply firestopping to penetrations of fire-rated floor and wall assemblies for communications installations to restore original fire-resistance rating of assembly.

F. Apply putty pads to boxes located in fire-rated wall assemblies in which a horizontal distance of greater than 24” between boxes is not maintained.

G. Install and seal penetrations (conduit, sleeves, slots, chases) into or through fire-rated barriers created by or made for or on the behalf of the Contractor to prevent the passage of smoke, fire, toxic gas, or water through the penetrations.

H. Coordinate firestopping procedures and materials with General Contractor.

I. Solutions and shop drawings/submittals for firestop materials and systems shall be presented to the General Contractor for written approval of materials/systems prior to purchase and installation.

J. Following the pathway of others through compliant and non-compliant penetrations does not remove the requirement to maintain code-compliant firestopping.

K. Supply Owner with training manuals with instructions on methods of adding or removing cabling to/from firestopped sleeves and chases.

L. Provide manufacturer recommended material for rated protection for any given barrier.

M. Laminate and permanently affix adjacent to chases the following information:
   1. Manufacturer of firestop system
   2. Date of installation/repair.
   3. Part and model numbers of system and all components
   4. Name and phone numbers of local distributor and manufacturer’s corporate headquarters

N. The material chosen shall be distinctively colored to be clearly distinguishable from other materials, adhere to itself, and maintain the characteristics for which it is designed to allow for the removal and/or addition of communication cables without the necessity of drilling holes in the material.

3.11 TESTING

A. Upon completion of the communications infrastructure systems, including all pathways and grounding, the Contractor shall test the system.
   1. Cables and termination modules shall be affixed, mounted or installed to the designed/specified permanent location prior to testing.
   2. Any removal and reinstallation of any component in a circuit, including faceplates, shall require retesting of that circuit and any other disturbed or affected circuits.
   3. Cable/jack shall be affixed, mounted or installed to the designed/specified permanent location prior to testing.
      a. Any removal and reinstallation of any component in the circuit shall require retesting of that circuit.
   4. Approved instruments, apparatus, services, and qualified personnel shall be utilized.
   5. If tests fail, Contractor shall correct as required to produce a legitimate passing test.
   6. Manipulation of tester parameters on a failing test in order to achieve a passing test is unacceptable.
   7. If the Contractor is found to have manipulated or falsified any failing test result to show a “PASS” for any reason (without written notice and prior approval of the Owner), the Contractor shall be required to employ a Third-Party Testing Agent selected by the Owner to retest the complete cable plant and shall be required to pay all costs associated with this retesting.

B. These specifications will be strictly enforced.

1. The Contractor must verify that the requirements of the specifications are fully met through testing with an approved tester (rated for testing parameters listed elsewhere), and documentation as specified below.
2. This includes confirmation of requirements by demonstration, testing and inspection. Demonstration shall be provided at final walk-through in soft copy and printed test data.

C. Notification of the likelihood of a cable exceeding standardized lengths must be made prior to installation of the cable.
1. Without contractor's prior written notice and written approval by the Owner, testing that shows some or all pairs of cable not meeting specifications, shall be replaced at Contractor's expense (including respective connectors).
2. With the Owner's written approval, the over-length cable(s) shall be excluded from requirements to pass standardized tests and shall be explicitly identified.

D. Testing is still required for non-compliant cabling.
1. The tests shall be for wire-mapping, opens, cable-pair shorts, and shorts-to- ground.
2. The test results must be within acceptable tolerances and shall be submitted with the Owner's acceptance document.

E. Contractor will complete all work and documentation according to manufacturer guidelines to ensure manufacturer's warranty remains in effect.
1. Contractor shall obtain certificates from manufacturer attesting to warranty being in effect and include certificates with other deliverables due at the completion of the project.

F. Owner reserves the right to be present during any or all testing.

3.12 SCAFFOLDING, RIGGING AND HOISTING

A. Furnish all scaffolding, rigging, hoisting, and services necessary for erection and delivery into the premises of any equipment and apparatus furnished. Remove same from premises when no longer required in strict accordance with OSHA Guidelines.

3.13 OPTION TO RELOCATE DEVICES

A. The location of voice and data outlets and other similar devices along with their associated connections may be relocated at the Owner's option, at no additional cost to the Owner, to a point within 10 feet of their present location provided the Contractor is notified prior to rough-in or installation.

3.14 CLEANING

A. Work areas will be kept in a broom clean condition throughout the duration of the installation process.

B. Remove all unnecessary tools and equipment, unused materials, packing materials, and debris from each area where Work has been completed unless designated for storage.

C. The Contractor will damp clean all surfaces prior to final acceptance by Owner.

D. After completion of all work and before final acceptance of the work, thoroughly clean all equipment and materials and remove all foreign matter such as grease, dirt, plaster, labels, stickers, etc., from the exterior of equipment, fixtures and all other associated or adjacent fabrication.

3.15 ACCEPTANCE

A. Once all work has been completed, test documentation has been submitted, and Owner is satisfied that all work is in accordance with contract documents, the Owner shall notify Contractor in writing of formal acceptance of the system.

B. Contractor must warrant in writing that 100% of the installation meets the requirements specified herein (Standards Compliance & Test Requirements).

C. Acceptance shall be subject to completion of all work, successful post-installation testing which yields 100% PASS rating, and receipt of full documentation soft and hard copies as describe herein.

3.16 INDEMNIFICATION

A. The Contractor shall hold harmless and indemnify the Engineer, employees, officers, agents and consultants from all claims, loss, damage, actions, causes of actions, expense and/or liability resulting from, brought for, or on account of any personal injury or property damage received or sustained by any person, persons, (including third parties), or any property growing out of, occurring, or attributable to any work performed under or related to this contract, resulting in whole or in part from the negligence of the Contractor, any subcontractor, any employee, agent or representative.

3.17 HAZARDOUS MATERIALS

A. Any worker, occupant, visitor, inspector, etc., who encounters any material of whose content they are not certain shall promptly report the existence and location of that material to the Contractor and/or Owner. The Contractor shall, as a part of his work, insure that his workers are aware of this potential and what they are to do in the event of suspicion. He shall also keep uninformed persons from the premises during construction. Furthermore, the Contractor shall insure that no one comes near to or in contact with any such material or fumes therefrom until its content can be ascertained to be non-hazardous.

B. CMTA, Inc., Consulting Engineers, have no expertise in the determination of the presence of hazardous materials. Therefore, no attempt has been made by them to identify the existence or location of any such material. Furthermore, CMTA nor any affiliate thereof will neither offer nor make any recommendations relative to the removal, handling or disposal of such material.

C. If the work interfaces, connects or relates in any way with or to existing components which contain or bear any hazardous material, asbestos being one, then, it shall be the Contractor's sole responsibility to contact the Owner and so advise him immediately.

D. The Contractor by execution of the contract for any work and/or by the accomplishment of any work thereby agrees to bring no claim relative to hazardous materials for negligence, breach of contract, indemnity, or any other such item against CMTA, its principals, employees, agents or consultants. Also, the Contractor further agrees to defend, indemnify and hold CMTA, its principals, employees, agents and consultants, harmless from any such related claims which may be brought by any subcontractors, suppliers or any other third parties.

END OF SECTION

SECTION 27 0503
COMMUNICATIONS SHOP DRAWINGS AND SUBMITTALS

PART 1 GENERAL

1.01 SHOP DRAWINGS

A. Each Contractor shall submit to the Architect and/or Engineer, within thirty days after the date of the Contract, sets of shop drawings and/or manufacturer's descriptive literature (coordinate exact quantity with architectural specifications) on all equipment required for the fulfillment of his contract. Each shop drawing and/or manufacturer's descriptive literature shall have proper notation indicated on it and shall be clearly referenced per the specifications and/or schedules, etc., so that the Architect and/or Engineer may readily determine the particular item the Contractor proposes to furnish. All data and information scheduled, noted or specified by hand shall be noted in color red on the submittals.

B. The Contractor shall make any corrections or changes required and shall resubmit for final review as requested. Review of such drawings, descriptive literature and/or schedules shall not relieve the Contractor from responsibility for deviation from drawings or specifications unless they have, in writing, directed the reviewer's attention to such deviations at the time of submission of drawings, literature and manuals; nor shall it relieve them from responsibility for errors or omissions of any nature in shop drawings, literature and manuals. The term "as specified" will not be accepted.

C. If the Contractor fails to comply with the requirements set forth above, the Architect and/or Engineer shall have the option of selecting any or all items listed in the specifications or on the drawings, and the Contractor will be required to provide all materials in accordance with this list.

D. Review of shop drawings by the Engineer applies only to conformance with the design concept of the project and general compliance with the information given in the contract documents. In all cases, the installing Contractor alone shall be responsible for furnishing the proper quantity of equipment and/or materials required, for seeing that all equipment fits the available space in a satisfactory manner and that piping, electrical and all other connections are suitably located.

E. The Engineer's review of shop drawings, schedules, product data or other required submittal data shall not relieve the Contractor from responsibility for the adaptability of the equipment or materials to the project, compliance with applicable codes, rules, regulations, information that pertains to fabrication and installation, dimensions and quantities, electrical characteristics, and coordination of the work with all other trades involved in this project.

F. No cutting, fitting, rough-in, connections, etc., shall be accomplished until reviewed equipment shop drawings are in the hands of the Contractors concerned. It shall be each Contractor's responsibility to obtain reviewed shop drawings and to make all connections, etc. in the neatest and most workmanlike manner possible. Each Contractor shall coordinate with all the other Contractors having any connections, roughing-in, etc., to the equipment, to make certain proper fit, space coordination, voltage and phase relationships are accomplished.

G. In accord with the provisions specified hereinbefore, shop drawings, descriptive literature and schedules shall be submitted on each of the following indicated items as well as any equipment or systems deemed necessary by the Engineer:
   1. Raceways:
      a. Cable tray and each type of cable tray fitting.
      b. J-hook assembly.
   2. Structured Cabling:
      a. Backbone cabling.
      b. Horizontal cabling.
      c. Patch cords.
      d. Patch panels.

e. Racks and cable management.

3. Devices:
   a. Data/voice/video wallplates, each by type.
   b. Any special items not listed above.
4. Systems: Each system submittal is to be complete with legible cutsheets for all devices, equipment, special wiring, etc. Also, provide scale building layout drawings that indicate device placement, wiring, etc. Refer to the specific system's specification for additional submittal requirements where required.
   a. Data/Voice Network.
   b. Audio Video Systems and Equipment.
   c. Classroom Audio Video System.
   d. Intercommunications and Program Systems.
5. Miscellaneous
   a. Control panel assemblies.
   b. Non-standard junction/pullboxes.
   c. Floor plan and riser drawings that show the location of all communication devices and systems.
   d. Floor plan and riser drawings that show the location of all low-voltage devices and systems.

H. Specification Compliance Certification: Where this Section and other Sections of this Division require Specification Compliance Certification to be submitted, comply with the following:
   1. Prepare a line-by-line Specification Compliance Certification by marking up a copy of the Contract Document specification section in the left margin. Accompany the markup with a written report explaining all items that are not marked with “Compliance”. Submit line-by-line markup, written report of deviations and alternates and a cover letter certified by Manufacturer or Installer that prepared the Specification Compliance Certification. Use the following key for preparing the line-by-line markup.
      a. “C” for Compliance: By noting the term "compliance" or "C" in the margin, it shall be understood that the manufacturer is in full compliance with the item specified and will provide exactly the same with no deviations.
      b. “D” for Deviation: By noting the term "deviation" or "D" in the margin, it shall be understood that the manufacturer prefers to provide a different component in lieu of that specified.
      c. “A” for Alternate: By noting the term "alternate" or "A" in the margin, it shall be understood that the manufacturer proposes to provide the same operating function but prefers to do it in a different manner.
      d. “N/A” for Not Applicable: By noting the term “not applicable” or “N/A” in the margin, it shall be understood that the specified item is not applicable to the project.

1.02 SPECIAL WRENCHES, TOOLS AND KEYS

A. Each Contractor shall provide, along with the equipment provided, any special wrenches or tools necessary to dismantle or service equipment or appliances installed by him. Wrenches shall include necessary keys, handles and operators for valves, switches, etc. and keys to alarm pull boxes, panels, etc. At least two of any such special wrench, keys, etc. shall be turned over to the Architect prior to completion of the project. Obtain a receipt that this has been accomplished and forward a copy to the Engineer.

1.03 MAINTENANCE AND OPERATION MANUALS

A. Upon Substantial Completion of the project, deliver to the Engineer (in addition to the required Shop Drawings) one complete copy and one digital copy of operation and maintenance instructions and parts lists for all equipment provided. At a minimum, these documents shall include the following:

1. The operation and maintenance document directory should provide easy access and be well organized and clearly identified.
2. Emergency information should be immediately available during emergencies and should include emergency and staff and/or agency notification procedures.
3. The maintenance and operating manual should contain the following information:
    a. General Building Information and Description.
    b. Technical Information:
        1) System description.
        2) Operating routines and procedures.
        3) Special procedures.
        4) Basic troubleshooting.
    c. Equipment Data Sheets:
        1) Operating and nameplate data.
        2) Warranty.
        3) Addresses and phone numbers indicating where parts may be purchased.
    d. Maintenance Program Information:
        1) Manufacturer's installation, operation, and maintenance instructions.
        2) Spare parts information.
        3) Preventative maintenance actions.
        4) Schedule of actions.
        5) Action description.
        6) History.

PART 2 PRODUCTS (NOT APPLICABLE)

PART 3 EXECUTION (NOT APPLICABLE)

END OF SECTION

SECTION 27 0529
HANGERS AND SUPPORTS FOR COMMUNICATIONS SYSTEMS

PART 2 PRODUCTS

1.01 SUPPORT AND ATTACHMENT COMPONENTS

A. General Requirements:
   1. Comply with the following. Where requirements differ, comply with most stringent.
      a. TIA-569.
      b. NFPA 70.
      c. Requirements of authorities having jurisdiction.
   2. Provide required hangers, supports, anchors, fasteners, fittings, accessories, and hardware as necessary for complete installation of communications work.
   3. Provide products listed, classified, and labeled as suitable for purpose intended, where applicable.
   4. Where support and attachment component types and sizes are not indicated, select in accordance with manufacturer's application criteria as required for load to be supported with minimum safety factor of _____. Include consideration for vibration, equipment operation, and shock loads where applicable.
   5. Do not use products for applications other than as permitted by NFPA 70 and product listing.
   6. Steel Components: Use corrosion-resistant materials suitable for environment where installed.
      a. Zinc-Plated Steel: Electroplated in accordance with ASTM B633.
      b. Galvanized Steel: Hot-dip galvanized after fabrication in accordance with ASTM A123/A123M or ASTM A153/A153M.

B. Conduit Supports: Straps and clamps suitable for conduit to be supported.
   1. Conduit Straps: One-hole or two-hole type; steel or malleable iron.
   2. Conduit Clamps: Bolted type unless otherwise indicated.

C. Outlet Box Supports: Hangers and brackets suitable for boxes to be supported.

D. Metal Channel/Strut Framing Systems:
   1. Description: Factory-fabricated, continuous-slot, metal channel/strut and associated fittings, accessories, and hardware required for field assembly of supports.
   2. Comply with MFMA-4.

E. Hanger Rods: Threaded, zinc-plated steel unless otherwise indicated.

F. Anchors and Fasteners:
   1. Unless otherwise indicated and where not otherwise restricted, use anchor and fastener types indicated for specified applications.

END OF SECTION

SECTION 27 1100
COMMUNICATIONS EQUIPMENT ROOM FITTINGS

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Backboards.
   2. Boxes, enclosures, and cabinets.
   3. Cable trays.
   4. Power strips.
   5. Uninterruptible Power Supplie

B. Related Requirements:
   1. Division 26 Section “Raceways and Boxes for Electrical Systems” for backbox and device boxes for communication outlets.
   2. Division 26 Section "Pathways for Communications Systems" for j-hooks, boxes, conduits, and accessories.
   3. Division 27 Section "Communications Optical Fiber Backbone Cabling" for optical-fiber data cabling associated with system panels and devices.
   4. Division 27 Section "Communications Copper Horizontal Cabling" for copper data cabling associated with system panels and devices.

C. DEFINITIONS
   1. Access Provider: An operator that provides a circuit path or facility between the service provider and user. An access provider can also be a service provider.
   2. BICSI: Building Industry Consulting Service International.
   3. RCDD: Registered communications distribution designer.
   4. Service Provider: The operator of a telecommunications transmission service delivered through access provider facilities.
   5. SBB: Telecommunications Secondary Bonding Busbar.
   6. PBB: Telecommunications Primary Bonding Busbar.
   7. UON: Unless otherwise noted

1.02 ACTION SUBMITTALS

A. Submit product data and shop drawings in accordance with Division 01 and Division 27 Section “Communications Shop Drawings and Submittals” for products specified under PART 2 - PRODUCTS.

B. Specification Compliance Certification: Submit a Specification Compliance Certification in accordance with Division 27 Section “Communications Shop Drawings and Submittals”.

C. Product Data: For each type of product.
   1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for equipment racks and cabinets.
   2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
   3. Include data indicating dimensions and finishes for each type of cable tray indicated.

D. Shop Drawings: For communications equipment room fittings. Include plans, elevations, sections, details, and attachments to other work.
   1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   2. Equipment Racks and Cabinets: Include workspace requirements and access for cable connections.

3. Grounding: Indicate location of grounding bus bar and its mounting detail showing standoff insulators and wall mounting brackets.
4. Cable tray layout, showing cable tray route to scale, with relationship between the tray and adjacent structural, electrical, and mechanical elements. Include the following:
   a. Vertical and horizontal offsets and transitions.
   b. Clearances for access above and to sides of cable trays.
   c. Vertical elevation of cable trays above the floor or bottom of ceiling structure.
   d. Load calculations to show dead and live loads as not exceeding manufacturer's rating for tray and its support elements.

1.03 INFORMATIONAL SUBMITTALS

A. Field quality control reports.

1.04 QUALITY ASSURANCE

A. Refer to Quality Assurance information in Division 27 Section "Scope of the Communications Work" for additional information.

B. Installer Qualifications: Cabling installer must have personnel certified by BICSI on staff.
   1. Layout Responsibility: Preparation of Shop Drawings shall be under direct supervision of RCDD.
   2. Installation Supervision: Installation shall be under direct supervision of Installer 2, Copper or Fiber, who shall be present at all times when Work of this Section is performed at Project site.
   3. Field Inspector: Currently registered by BICSI as RCDD to perform the on-site inspection.

PART 2 PRODUCTS

2.01 BACKBOARDS

A. Backboards: Plywood, fire-retardant treated, 3/4 by 48 by 96 inches. Comply with requirements for plywood backing panels specified in Division 06 Section "Rough Carpentry."

B. Backboard Paint: Light-colored fire-retardant paint.

2.02 BOXES, ENCLOSURES, AND CABINETS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Crouse-Hinds, an Eaton business.
   2. Hoffman; a brand of Pentair Equipment Protection.
   3. Hubbell Incorporated; Wiring Device-Kellems.
   4. O-Z/Gedney; a brand of Emerson Industrial Automation.
   5. Thomas & Betts Corporation; A Member of the ABB Group.

B. General Requirements for Boxes, Enclosures, and Cabinets:
   1. Boxes, enclosures, and cabinets shall be listed and labeled for intended location and use.
   2. Sheet Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.
   3. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.
   4. Box extensions used to accommodate new building finishes shall be of same material as recessed box.
   5. Device Box Dimensions: 4 inches square by 2-1/8 inches deep, UON.

C. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250, Type 1 with continuous-hinge cover with flush latch unless otherwise indicated.
   1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
   2. Interior Panels: Steel; all sides finished with manufacturer's standard enamel.

2.03 GENERAL REQUIREMENTS FOR CABLE TRAYS

A. Cable Trays and Accessories: Identified as defined in NFPA 70 and marked for intended location, application, and grounding.

B. Source Limitations: Obtain cable trays and components from single manufacturer.

C. Sizes and Configurations: See Drawings for specific requirements for types, materials, sizes, and configurations.

D. Structural Performance: See articles for individual cable tray types for specific values for the following parameters:
   1. Uniform Load Distribution: Capable of supporting a uniformly distributed load on the indicated support span when supported as a simple span and tested according to NEMA VE 1.
   2. Concentrated Load: A load applied at midpoint of span and centerline of tray.
   3. Load and Safety Factors: Applicable to both side rails and rung capacities.

2.04 LADDER CABLE TRAY

A. Manufacturer: Subject to compliance with requirements, provide products by one of the following:
   1. B-Lline.
   2. Belden.
   3. Chatsworth Products, Inc. (CPI).

B. Description:
   1. Configuration: Two longitudinal side rails with transverse rungs swaged or welded to side rails, complying with NEMA VE 1.
   2. Width: 12 inches unless otherwise indicated on Drawings.
   3. Straight Section Lengths: 10 feet, except where shorter lengths are required to facilitate tray assembly.
   4. Rung Spacing: 12 inches o.c.
   5. Radius-Fitting Rung Spacing: 9 inches at center of tray's width.
   6. Minimum Cable-Bearing Surface for Rungs: 7/8-inch width with radius edges.
   7. No portion of the rungs shall protrude below the bottom plane of side rails.
   8. Structural Performance of Each Rung: Capable of supporting a maximum cable load, with a safety factor of 1.5, plus a 200-lb concentrated load, when tested according to NEMA VE 1.
   9. Fitting Minimum Radius: 24 inches.
   10. Splicing Assemblies: Bolted type using serrated flange locknuts.
   11. Splice-Plate Capacity: Splices located within support span shall not diminish rated loading capacity of cable tray.

C. Materials and Finishes:
   1. Steel:
      a. Straight Section and Fitting Side Rails and Rungs: Steel complies with the minimum mechanical properties of ASTM A 1011/A 1011M, SS, Grade 33.
      b. Steel Tray Splice Plates: ASTM A 1011/A 1011M, HSLAS, Grade 50, Class 1.
      c. Fasteners: Steel complies with the minimum mechanical properties of ASTM A 510/A 510M, Grade 1008.
      d. Finish: Epoxy-resin paint.
         1) Epoxy-Resin Prime Coat: Cold-curing epoxy primer, MPI# 101.
         2) Epoxy-Resin Topcoat: Epoxy, cold-cured gloss, MPI# 77.
         3) Hardware: Stainless steel, Type 316, ASTM F 593 and ASTM F 594.

D. Basis-of-Design Chatsworth Components:

Description	Part Number
Chatsworth 12” Ladder Rack	10250-712
Wall to Rack Ladder Kit	11911-712
Wall Angle kit	11421-712
Wall Triangular Support	11312-12
Rack to Runway	10595-712
Cable Runway Elevation Kit	10506-702
Butt Splice	11301-701
Junction-Splice	11302-701
Cable Runway Radius drop	12100-712
End cap	10642-001

2.05 CABLE TRAY ACCESSORIES

A. Fittings: Tees, crosses, risers, elbows, and other fittings as indicated, of same materials and finishes as cable tray.

B. Barrier Strips: Same materials and finishes as for cable tray.

C. Cable tray supports and connectors, including bonding jumpers, as recommended by cable tray manufacturer.

2.06 POWER DISTRIBUTION UNITS AND POWER STRIPS

A. Comply with requirements in Division 27 Section "Communications Racks, Frames, and Enclosures."

B. Common Physical Characteristics:
   1. Rack mounting, with accessory brackets and/or flanges as noted.
   2. Housing: Aluminum.
   3. Finish: Black powder coat to match rack hardware.

C. Vertical PDUs
   1. Product: Subject to requirements, provide Chatsworth #E0-1002-C or Engineer approved equal. Provide PDU offset brackets for each PDU installed.
   2. Circuit and Outlet Configuration
      a. Inlet cord: 30A, 120V AC NEMA L5-30P.
      b. Two (2) 20A 5kAIC circuit breakers
      c. Twenty-four (24) 20A, 120V AC, NEMA 5-20R receptacles in two (2) breaker groups.
   3. Listings and labeling
   4. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
      a. Comply with UL/CUL/IEC 62368.
      b. Breaker(s) listed UL 489.

2.07 UNINTERRUPTIBLE POWER SUPPLIES

A. Common Physical Characteristics:
   1. Rack mounting, with accessory brackets or flanges as needed for mounting. Refer to Division 27 Section "Communications Racks, Frames, and Enclosures" for rack product data
   2. Steel or aluminum enclosure with black powdercoat finish

B. Uninterruptible Power Supply, 3kVA Size w/ Network Management Card
   1. Product: Subject to requirements, provide APC #SMT3000RM2UC or Engineer approved equal.

2. Network Management Card w/ Environmental Monitoring: Subject to requirements provide APC #AP9641 UPS Network Management Card 3 with Environmental Monitoring. Provide 1 card for each UPS.
3. Circuit and Outlet Configuration:
   a. Inlet cord: 30A, 120V AC NEMA L5-30P.
   b. Two (2) 20A, 120V AC, NEMA 5-20R receptacles
   c. Six (6) 15A, 120V AC, NEMA 5-15R receptacles.
4. Electrical Characteristics:
   a. UPS Topology: Line Interactive
   b. Output Characteristics: Sine Wave, 50/60 Hz +/- 3 Hz synchronized to mains
   c. Max Configurable Power: 2700 W, 2880 VA
   d. Transfer Time: 6ms typical, 10ms maximum
5. Physical Characteristics:
   a. 19-inch rack mountable, 2 RU
   b. Weight: 97.62 lb
6. Warranty: Provide 3-yr extended warranty service pack, APC #WBEXTWAR3YR-SP-04.

PART 3 EXECUTION

3.01 ENTRANCE FACILITIES

A. Contact telecommunications service provider and arrange for installation of demarcation point, protected entrance terminals, and a housing when so directed by service provider.

B. Comply with requirements in Division 26 Section "Pathways for Communications Systems" for materials and installation requirements for underground pathways.

3.02 INSTALLATION

A. Comply with NECA 1.

B. Comply with BICSI's "Telecommunications Distribution Methods Manual" for layout of communications equipment spaces.

C. Comply with BICSI's "Information Technology Systems Installation Methods Manual" for installation of equipment in communications equipment spaces.

D. Bundle, lace, and train conductors and cables to terminal points without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.

E. Coordinate layout and installation of communications equipment in tracks and in room. Coordinate service entrance configuration with service provider.
   1. Meet jointly with systems providers, equipment suppliers, and Owner to exchange information and agree on details of equipment configurations and installation interfaces.
   2. Record agreements reached in meetings and distribute them to other participants.
   3. Adjust configurations and locations of distribution frames, cross-connects, and patch panels in equipment rooms to accommodate and optimize configurations and space requirements of communications equipment.
   4. Adjust configurations and locations of equipment with distribution frames, cross-connects, and patch panels of cabling systems of other communications, electronic safety and security, and related systems that share space in equipment room.

F. Coordinate location of power raceways and receptacles with locations of communications equipment requiring electrical power to operate.

G. Vertical PDUs:
   1. Provide two (2) vertical PDUs in MDF.
   2. Provide one (1) vertical PDU in each IDF.
   3. Mount units on back of rack with offset bracket.

H. Uninterruptible Power Supplies with Network Management Cards (UPS):Provide two (2) 3kVA size Uninterruptible Power Supplies with Network Management Card in MDF.
   1. Provide two (2) 3kVA size UPSes in MDF.
   2. Provide one (1) 3kVA size UPS in each IDF.
   3. Mount units at bottom of rack.

I. Backboards:
   1. Install from 6 inches to 8 feet, 6 inches above finished floor. If plywood is fire rated, ensure that fire-rating stamp is visible after installation.
   2. Paint all sides of backboard with two coats of paint, leaving fire rating stamp visible. Comply with requirements in Division 09 Section "Interior Painting" for painting backboards.
   3. Comply with requirements for backboard installation in BICSI's "Information Technology Systems Installation Methods Manual" and TIA-569-D.

3.03 CABLE TRAY INSTALLATION

A. Install cable trays according to NEMA VE 2.

B. Install cable trays as a complete system, including fasteners, hold-down clips, support systems, barrier strips, adjustable horizontal and vertical splice plates, elbows, reducers, tees, crosses, cable dropouts, adapters, covers, and bonding.

C. Install cable trays so that the tray is accessible for cable installation and all splices are accessible for inspection and adjustment.

D. Remove burrs and sharp edges from cable trays.

E. Fasten cable tray supports to building structure.

F. Place supports so that spans do not exceed maximum spans on schedules and provide clearances shown on Drawings. Install intermediate supports when cable weight exceeds the load-carrying capacity of the tray rungs.

G. Construct supports from channel members, threaded rods, and other appurtenances furnished by cable tray manufacturer. Arrange supports in trapeze or wall-bracket form as required by application.

H. Support tray assembly to prevent twisting from eccentric loading.

I. Locate and install supports according to NEMA VE 2. Do not install more than one cable tray splice between supports.

J. Make connections to equipment with flanged fittings fastened to cable trays and to equipment. Support cable trays independent of fittings. Do not carry weight of cable trays on equipment enclosure.

K. Install expansion connectors where cable trays cross building expansion joints and in cable tray runs that exceed dimensions recommended in NEMA VE 2. Space connectors and set gaps according to applicable standard.

L. Make changes in direction and elevation using manufacturer's recommended fittings.

M. Make cable tray connections using manufacturer's recommended fittings.

N. Seal penetrations through fire and smoke barriers. Comply with requirements in Division 07 Section "Penetration Firestopping."

O. Install capped metal sleeves for future cables through firestop-sealed cable tray penetrations of fire and smoke barriers.

P. Install cable trays with enough workspace to permit access for installing cables.

Q. Install barriers to separate cables of different systems, such as power, communications, and data processing; or of different insulation levels, such as 600, 5000, and 15 000 V.

R. Install warning signs in visible locations on or near cable trays after cable tray installation.

3.04 CABLE TRAY GROUNDING

A. Ground cable trays according to NFPA 70 unless additional grounding is specified. Comply with requirements in Division 26 Section "Grounding and Bonding."

B. Cable trays shall be bonded together with splice plates listed for grounding purposes or with listed bonding jumpers.

C. When using epoxy- or powder-coat painted cable trays as a grounding conductor, completely remove coating at all splice contact points or ground connector attachment. After completing splice-to-grounding bolt attachment, repair the coated surfaces with coating materials recommended by cable tray manufacturer.

D. Bond cable trays to power source for cables contained within with bonding conductors sized according to NFPA 70, Article 250.122, "Size of Equipment Grounding Conductors."

3.05 CABLE INSTALLATION

A. Install cables only when each cable tray run has been completed and inspected.

B. Fasten cables on horizontal runs with cable clamps or cable ties according to NEMA VE 2. Tighten clamps only enough to secure the cable, without indenting the cable jacket. Install cable ties with a tool that includes an automatic pressure-limiting device.

C. Fasten cables on vertical runs to cable trays every 18 inches.

D. Fasten and support cables that pass from one cable tray to another or drop from cable trays to equipment enclosures. Fasten cables to the cable tray at the point of exit and support cables independent of the enclosure. The cable length between cable trays or between cable tray and enclosure shall be no more than 72 inches.

3.06 FIRESTOPPING

A. Comply with requirements in Division 07 Section "Firestopping."

B. Comply with requirements in Division 27 Section “Common Communications Requirements.”

C. Comply with TIA-569-D, Annex A, "Firestopping."

D. Comply with BICSI's "Information Technology Systems Installation Methods Manual," "Firestopping Practices" Ch.

3.07 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:
   1. After installing cable trays and after electrical circuitry has been energized, survey for compliance with requirements.
   2. Visually inspect cable insulation for damage. Correct sharp corners, protuberances in cable trays, vibrations, and thermal expansion and contraction conditions, which may cause or have caused damage.
   3. Verify that the number, size, and voltage of cables in cable trays do not exceed that permitted by NFPA 70. Verify that communications or data-processing circuits are separated from power circuits by barriers or are installed in separate cable trays.
   4. Verify that there are no intruding items such as pipes, hangers, or other equipment in the cable tray.
   5. Remove dust deposits, industrial process materials, trash of any description, and any blockage of tray ventilation.
   6. Visually inspect each cable tray joint and each ground connection for mechanical continuity. Check bolted connections between sections for corrosion. Clean and retorque in suspect areas.
   7. Check for improperly sized or installed bonding jumpers.

8. Check for missing, incorrect, or damaged bolts, bolt heads, or nuts. When found, replace with specified hardware.
9. Perform visual and mechanical checks for adequacy of cable tray grounding; verify that all takeoff raceways are bonded to cable trays. Test entire cable tray system for continuity. Maximum allowable resistance is 1 ohm.

B. Prepare test and inspection reports.

3.08 PROTECTION

A. Protect installed cable trays and cables.
1. Install temporary protection for cables in open trays to safeguard exposed cables against falling objects or debris during construction. Temporary protection for cables and cable tray can be constructed of wood or metal materials and shall remain in place until the risk of damage is over.
2. Repair damage to paint finishes with matching touchup coating recommended by cable tray manufacturer.

END OF SECTION

SECTION 27 1116
COMMUNICATIONS RACKS, FRAMES, AND ENCLOSURES

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:
   1. 19-inch, 2-post network equipment racks.
   2. 19-inch, wall-mounted enclosed cabinet network equipment racks.
   3. Vertical cable management assemblies.
   4. Horizontal cable management assemblies.
   5. Cross-connect fields / patch panels.
   6. Grounding.
   7. Labeling.

B. Related Requirements:
   1. Division 26 Section "Grounding and Bonding" for PBBs and SBBs.
   2. Division 26 Section "Pathways for Communications Systems" for j-hooks and conduit.
   3. Division 27 Section "Communications Equipment Room Fittings" for backboards, cable trays, cable tray accessories, power strips, UPSes, and accessories.
   4. Division 27 Section "Communications Optical Fiber Backbone Cabling" for optical-fiber data cabling associated with system panels and devices.
   5. Division 27 Section "Communications Copper Horizontal Cabling" for copper data cabling associated with system panels and devices.

1.02 DEFINITIONS

A. BICSI: Building Industry Consulting Service International.
   1. RCDD: Registered communications distribution designer, a BICSI credential.

B. LAN: Local area network.

C. Cross-Connect: A facility enabling the termination of cable elements and their interconnection or cross-connection.
   1. Main Cross-Connect (MC):Central cross-connect for backbone cabling to the ICs and HCs. Frequently co-located with the EF.
   2. Horizontal Cross-Connect (HC): Cross-connect facility providing backbone cabling termination and distribution for Horizontal Cabling.
   3. Intermediate Cross-Connect (IC): Cross-connect facility providing intermediate-level backbone cabling distribution.

D. Entry-Facility (EF): The facility where service cabling from telecom access providers or campus OSP distribution terminates, also known as the Demarcation Point or Demarc.

E. Equipment Room (ER): An environmentally controlled centralized space for telecommunications equipment. Frequently co-located with the MC or IC.

F. PBB: Primary Bonding Busbar.

G. SBB: Secondary Bonding Busbar.

H. Telecommunications Enclosure (TE): A self-contained enclosure that provides a secure location for connection between backbone and horizontal infrastructure.

I. Telecommunications Room (TR): A room (or space) that provides an environmentally suitable and secure location for the connection between backbone and horizontal infrastructure.

1.03 CABINETS, RACKS, FRAMES, AND ENCLOSURES DESCRIPTION:

A. The ER (MDF) and TRs (IDFs) shall house racks, cross-connect fields for backbone and horizontal cabling, and required cable routing hardware.

B. The ER (MDF) shall be equipped with 2-post 19-inch racks as shown on drawings.

C. Each typical TR (IDF) shall be equipped with 2-post 19-inch racks as shown on drawings.

D. Each TE (Wall-rack IDF) shall be installed within a wall-mounted enclosed cabinet.

E. Racks and cabinets shall be placed as shown on the drawings, and/or located in a manner that will allow a minimum of 3 feet of clearance from the front and 3 feet from the rear mounting surfaces and on one side.

F. Vertical cable management shall be provided along both sides of all two-post racks. Refer to drawings for layouts.

G. Horizontal cable management shall be provided within all equipment racks.

1.04 ACTION SUBMITTALS

A. Submit product data and shop drawings in accordance with Division 01 and Division 27 Section “Communications Shop Drawings and Submittals” for products specified under PART 2 - PRODUCTS.

B. Specification Compliance Certification: Submit a Specification Compliance Certification in accordance with Division 27 Section “Communications Shop Drawings and Submittals”.

C. Product Data: For each type of product.
   1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for equipment racks and cabinets.
   2. Include rated capacities, operating characteristics, electrical characteristics, certifications, standards compliance, and furnished specialties and accessories.

D. Shop Drawings: For communications racks, frames, and enclosures. Include plans, elevations, sections, details, and attachments to other work.
   1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   2. Equipment Racks and Cabinets: Include workspace requirements and access for cable connections.
   3. Grounding: Indicate location of each bonding busbar on plans. Provide a mounting detail showing standoff insulators and wall-mounting brackets.

1.05 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer, qualified layout technician, installation supervisor, and field inspector.

1.06 QUALITY ASSURANCE

A. Refer to Quality Assurance information in Division 27 Section “Scope of the Communications Work” for additional information.

B. Installer Qualifications: Cabling installer must have personnel certified by BICSI on staff.
   1. Layout Responsibility: Preparation of Shop Drawings shall be under direct supervision of RCDD.
   2. Installation Supervision: Installation shall be under direct supervision of Installer 2, Copper or Fiber, who shall be present at all times when Work of this Section is performed at Project site.
   3. Field Inspector: Currently registered by BICSI as RCDD to perform on-site inspection.

PART 2 PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. UL listed.

B. RoHS compliant.

C. 19-inch rack width shall comply with EIA/ECIA 310-E, 19-inch nominal panel width with an opening of 17.72-inches between rails and mounting hardware

2.02 MANUFACTURERS

A. Subject to requirements, provide products manufactured by the following:
   1. Chatsworth Products, Inc. (CPI)
   2. Commscope
   3. NVent-Hoffman
   4. Others by Prior Engineer Approval.

2.03 19-INCH, TWO-POST NETWORK EQUIPMENT RACKS

A. Description: Freestanding, modular 19-Inch two-post racks with threaded (#12-24) rails designed for mounting telecommunications equipment.

B. Approved Products: Subject to compliance with requirements, provide:
   1. Chatsworth Products, Inc. (CPI) #55053-703.

C. Appearance and Finishes:
   1. Finish: Manufacturer's standard, baked-polyester powder coat. Color: Black.
   2. Rack Units Marked and Numbered in contrasting color.

D. Physical Characteristics:
   1. Overall Dimensions: 84"H x 20.3"W x 15"D (including mounting flanges).
   2. Upright Channel Depth: 3inches
   3. Load Rating: 1000 lb. of equipment.
   4. Equipment space: 45RU
   5. Universal hole pattern, 5/8" - 5/8" - 1/2" vertical spacing.
   6. Grounding/bonding lug inside side channel with prepared bare metal attachment point.
   7. Base shall have a minimum of four mounting holes for permanent attachment to floor.
   8. Top shall have provisions for attaching to cable tray or ceiling.
   9. Self-leveling.

2.04 19-INCH, WALL-MOUNTED ENCLOSED CABINET NETWORK EQUIPMENT RACKS

A. Description: Wall-mounted, floor-supported, enclosed modular 19-Inch racks with square hole rails designed for mounting telecommunications equipment, locking front door, and swing-out rear access.

B. Approved Products: Subject to compliance with requirements, provide:
   1. Chatsworth Products, Inc. (CPI) #13492-772

C. Appearance and Finishes:
   1. Finish: Manufacturer's standard, baked-polyester powder coat. Color: Black.
   2. Rack Units Marked and Numbered in contrasting color.

D. Physical Characteristics:
   1. Overall Dimensions: 72"H x 27.3"W x 24"D (including mounting flanges).
   2. Steel construction
   3. Load Rating: 1000 lb. of equipment, open or closed.
   4. Equipment space: 40RU
   5. Universal hole pattern, 5/8" - 5/8" - 1/2" vertical spacing.
   6. Prepared grounding/bonding provisions inside enclosure.
   7. Wheeled base for support of equipment load.

2.05 VERTICAL CABLE MANAGEMENT:

A. Description: 10" wide double-sided metal-channel vertical cable managers with front door.

B. Approved Products: Subject to compliance with requirements, provide:
   1. NVent-Hoffman #DV10D7.

C. Physical Characteristics:Metal, with integral wire retaining fingers.
   1. 10-inch wide aluminum channel (all managers on project to be 10-inch).
   2. Flexible composite cable management fingers.
   3. Double-sided finger-type cable management configuration type.
   4. Front door with access from right or left and 180 degree swing.

D. Appearance and Finishes:Baked-polyester powder coat finish.
   1. Finish: Manufacturer's standard, baked-polyester powder coat. Color: Black

E. All two-post equipment racks shall be augmented with vertical cable management hardware, both front and rear, to properly dress cables and patch cords.

2.06 HORIZONTAL CABLE MANAGEMENT:

A. Description: 2RU double-sided composite horizontal cable managers with front and back covers.

B. Approved Products: Subject to compliance with requirements, provide:
   1. NVent-Hoffman #DCHD2.

C. Physical Characteristics
   1. Composite construction.
   2. Flexible composite cable management fingers.
   3. Removable hinged covers open to both top and bottom.
   4. Pass-thru holes for routing cable between front and back of rack.

D. All equipment racks shall be augmented with horizontal cable management hardware, both front and rear, to properly dress cables and patch cords.

E. Horizontal cable management shall be provided between each network switch and patch panel.

2.07 CATEGORY 6 AND CATEGORY 6A PATCH PANELS:

A. Description: Termination for copper horizontal cabling shall consist of Category 6 patch panels with the following characteristics:
   1. Circuit board type terminal construction.
   2. Medium density (1RU, 24-port and 2RU, 48 port) flat front configuration
   3. Data patch panels: 48-port.
   4. Other applications patch panels: 24-port.
   5. Terminated in T568B configuration.

B. Category 6 Products: Subject to compliance with requirements, provide:
   1. Commscope #UNP-6-DM-1U-24 (760180042) (1RU 24-Port)
   2. Commscope #UNP-6-DM-2U-48 (760180059) (2RU 48-Port)

C. Category 6A Products: Subject to compliance with requirements, provide:
   1. Commscope #UNP-6A-DM-1U-24 (760162800) (1RU 24-Port)
   2. Commscope #UNP-6A-DM-2U-48 (760162818) (2RU 48-Port)

D. Each panel shall be black in color with individual ports numbered sequentially, from left to right, top to bottom. All ports shall be labeled 01-48, below the port.

E. An additional label area shall be provided immediately above each port to allow for room number labeling at each port.

F. Each port in the panel shall have 8 conductors present configured to 8P8C standard pin-out T568B.

G. A set of 48 ports shall be given a panel letter, starting with panel A.

H. The panel letter shall be labeled on the left of flat patch panels in large font, with the closet name listed above it.

I. A rack number is not necessary. Panels on additional racks shall continue panel lettering of previous rack.

J. A separate patch panel shall be provided for IP based video surveillance cameras.

K. Separate Category 6A patch panels shall be provided for wireless access point drops.

2.08 FIBER OPTIC PATCH PANELS

A. Description: Rack- and/or wall- mounted enclosures providing protection for terminated backbone fiber and cross-connection cabling.

B. Approved Products: Subject to compliance with requirements, provide:
   1. Commscope #EPX-2U-PNL-ENC-FX (760251047) (2U Fixed Enclosure)
   2. Commscope #EPX-4U-PNL-ENC (760251049) (4U Sliding Enclosure)
   3. Commscope #WB2-EMT-BK-2P-PNL (760248905) (Wall Enclosure)

C. Physical Characteristics:
   1. Housings shall be manufactured using 16-gauge aluminum or equivalent for structural integrity and shall be finished with a wrinkled black powder coat for durability. All fasteners shall be black-chromate to match the housing.
   2. The unit shall have guides that allow a transition and segregation point for jumpers exiting the sides of the housing.
   3. 4RU panels shall be sliding configuration tray with a metal door.
   4. 2RU panels shall have a fixed tray with a metal door.
   5. Wall-mount panels shall have (2) separate compartments, one for backbone terminations and one for patch cables. Each compartment shall have a door.

D. Functional Characteristics:
   1. Each connector shall be held by a duplex coupler snap-in adapter plate. Adapter plates shall be installed into rack-mount fiber optic enclosure. Refer to
   2. Enclosures shall be designed to protect against bend radius violations.
   3. Enclosures shall ensure that cable routing paths for all fibers are clear and cable congestion is minimized.
   4. The unit shall be modular with separate splicing, connector and jumper management housings available.
   5. The rack-mounted housings shall meet the requirements of TIA/EIA-568-A and UL V-0.
   6. The connector housings shall have a labeling scheme that complies with TIA/EIA-606.

2.09 COMMUNICATIONS TERMINATION BLOCKS

A. Termination block fields shall be mounted on 4’ x 8’ x .75” virgin fire retardant plywood, unless otherwise noted in Drawings, and shall be on the opposite side of the room from the room entrance. Backbone termination fields shall be mounted to the left of the horizontal voice fields. Conduits with 4” minimum diameter shall be used in all telecommunications rooms. Conduits for data backbone shall be located adjacent to the racks and conduits for voice shall be located adjacent to the voice termination fields. Provide required ladder and wall-mount management rings to properly support and dress cables from conduits to racks and frames.

2.10 LABELING

A. Comply with TIA/EIA-606-A and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

B. Labeling software shall be able to produce complex unique identifiers of up to 12 independent segments. Labeling software shall be capable of inserting symbols and any standard true type font as well as capable of saving individual build information and fine-tuning print adjustments.

PART 3 EXECUTION

3.01 INSTALLATION

A. Comply with NECA 1.

B. Comply with BICSI TDMM for layout of communications equipment spaces and BICSI ITSIMM for installation of communications equipment spaces.

C. Install all systems in accordance with manufacturer's printed instructions.

D. Frames shall be oriented so that backbone frames are located on the left and horizontal frames are located on the right of the termination field when facing the frame assembly.

E. Horizontal data terminations shall be contained in 19" x 84" racks. All equipment racks shall be augmented with horizontal and vertical cable management hardware, both front and rear, to properly dress horizontal cables and patch cables.

F. Each patch panel shall be separated vertically on the rack by a 1U (for 1U patch panels) or 2U (for 2U patch panels) horizontal cable management panel.

G. Patch panels and fiber enclosures shall be mounted in floor standing equipment racks or cabinets. Installation should follow the recommendations listed in ANSI/TIA-942 "Telecommunications Infrastructure Standard for Data Centers" specification.

H. Bundle, lace, and train conductors and cables to terminal points without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.

I. Coordinate layout and installation of communications equipment in racks and room. Coordinate service entrance configuration with service provider.
   1. Meet jointly with system providers, equipment suppliers, and Owner to exchange information and agree on details of equipment configurations and installation interfaces.
   2. Record agreements reached in meetings and distribute them to other participants.
   3. Adjust configurations and locations of distribution frames, cross-connects, and patch panels in equipment spaces to accommodate and optimize configuration and space requirements of telecommunications equipment.
   4. Adjust configurations and locations of equipment with distribution frames, cross-connects, and patch panels of cabling systems of other communications, electronic safety and security, and related systems that share space in equipment room.

J. Coordinate location of power raceways and receptacles with locations of communications equipment requiring electrical power to operate.

K. Floor-mounted racks shall be placed in a manner that will allow a minimum of 3 feet of clearance from the front and rear mounting surfaces and on one side. If the mounting rail of the rack is placed against a wall, the mounting rail shall be no closer than 6 inches to the wall to allow room for vertical management. Where there is more than one rack, the racks shall be ganged with vertical management hardware to provide cable management. Ganged rack frames will be placed in a manner that will allow a minimum of 3 feet of clearance from the front and rear mounting surfaces and on one side of the ganged assembly.

3.02 GROUNDING

A. Comply with requirements in Division 26 Section "Grounding and Bonding" for grounding conductors and connectors.

B. Comply with NECA/BICSI 607.

C. Install grounding according to BICSI ITSIMM, "Bonding, Grounding (Earthing) and Electrical Protection" Chapter.

D. Locate SBB to minimize length of bonding conductors. Fasten to wall, allowing at least 2 inches of clearance behind SBB. Connect SBB with a minimum No. 2 AWG grounding electrode conductor from SBB to suitable electrical building ground. Connect rack ground bar kit to near SBB or the PBB.
   1. Bond the shield of shielded cable to patch panel, and bond patch panel to SBB or PBB.

3.03 IDENTIFICATION

A. Coordinate system components, wiring, and cabling complying with TIA/EIA-606-A.

B. Comply with requirements in Division 09 Section "Painting" for painting backboards. For fire-resistant plywood, do not paint over manufacturer's label.

C. Paint and label colors for equipment identification shall comply with TIA/EIA-606-A for Class 2 level of administration.

D. Label patch panels in each telecommunications room to match those on the corresponding data outlets. All labels shall correspond to as-builts and to final test reports.

E. Labels shall be machine printed. Font type shall be 3/16 inch in height.

F. Labeling system shall clearly identify all components of the system: racks, cables, panels, and outlets.

G. Labeling system shall designate the cable origin and destination and a unique identifier for each cable within the system. Racks and patch panels shall be labeled to identify the location within the cabling system infrastructure.

H. The following nomenclature shall be used when labeling data outlets:
   1. Example Data Port: M-A01
      a. M – ‘M’ for MDF, ‘I1’ for IDF#1, ‘I2’ for IDF#2, etc.
      b. A – Data cables patch panel origin
      c. 01 – Outlet cable number

I. All labeling shall be recorded on the as-built drawings and all test documents shall reflect the appropriate labeling scheme.

J. All labels shall incorporate room numbers from the final Owner’s room numbering scheme. Coordinate with Owner to obtain final room numbers prior to applying labels.

END OF SECTION

SECTION 27 1323
COMMUNICATIONS OPTICAL FIBER BACKBONE CABLING

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:
   1. 9/125 micrometer single-mode optical fiber cable, plenum rated (OS2).
   2. Optical fiber cable connecting hardware, patch panels, and cross-connects.
   3. Cabling identification products.

B. Related Requirements:
   1. Division 26 Section "Grounding and Bonding" for Grounding and Bonding Busbars.
   2. Division 26 Section "Pathways for Communications Systems" for j-hooks and conduit.
   3. Division 27 Section "Communications Racks, Frames, and Enclosures" for fiber patch enclosures.

1.02 DEFINITIONS

A. BICSI: Building Industry Consulting Service International.
   1. RCDD: Registered Communications Distribution Designer, a BICSI credential.

B. Cross-Connect: A facility enabling the termination of cable elements and their interconnection or cross-connection.
   1. Main Cross-Connect (MC):Central cross-connect for backbone cabling to the ICs and HCs. Frequently co-located with the EF.
   2. Horizontal Cross-Connect (HC): Cross-connect facility providing backbone cabling termination and distribution for Horizontal Cabling.

C. Entry-Facility (EF): The facility where service cabling from telecom access providers or campus OSP distribution terminates, also known as the Demarcation Point or Demarc.

D. Equipment Room (ER): An environmentally controlled centralized space for telecommunications equipment. Frequently co-located with the MC or IC.

E. Telecommunications Enclosure (TE): A self-contained enclosure that provides a secure location for connection between backbone and horizontal infrastructure.

F. Telecommunications Room (TR): A room (or space) that provides an environmentally suitable and secure location for the connection between backbone and horizontal infrastructure.

1.03 OPTICAL FIBER BACKBONE CABLING DESCRIPTION

A. Fiber cabling from EF to MC shall be OS2 single-mode indoor optical fiber cable with interlocking armored plenum outer jacket.

B. Intrabuilding Backbone cabling from MC to each HC shall be OS2 single-mode indoor (or hybrid indoor/outdoor, as appropriate) optical fiber cable with interlocking armored plenum outer jacket.

C. Backbone cabling from MC to each outbuilding HC shall be OS2 single-mode hybrid indoor/outdoor optical fiber cable with non-metallic plenum outer jacket.

D. Optical fiber backbone cabling system shall provide connections between the communications MC and the EF, HC(s), and ERs in the telecommunications cabling system structure in a star topology.

E. Cabling system consists of backbone cables, cross-connects, mechanical terminations, and patch cords or jumpers used for backbone-to-backbone cross-connection and/or backbone-to-equipment interconnection.

F. Backbone cabling cross-connects may be located in TRs, TEs, ERs and/or at EFs. Bridged taps and splitters shall not be used as part of backbone cabling.

1.04 ACTION SUBMITTALS

A. Submit product data and shop drawings in accordance with Division 01 and Division 27 Section “Communications Shop Drawings and Submittals” for products specified under PART 2 - PRODUCTS.

B. Specification Compliance Certification: Submit a Specification Compliance Certification in accordance with Division 27 Section “Communications Shop Drawings and Submittals”.

C. Product Data: For each type of product.

D. Shop Drawings: Reviewed and stamped by RCDD.
   1. System Labeling Schedules: Electronic copy of labeling schedules, in software and format selected by Owner.
   2. Cabling administration drawings and printouts.
   3. Plan and Elevation views, including the following:
      a. Building floor plan(s) showing:
         1) Telecommunication room/space locations.
         2) Telecommunications pathways locations.
      b. Enlarged plans of each ER and TR showing equipment rack layout and rack IDs.
      c. Rack elevations showing physical location and IDs of cross-connects and patch panels.
   4. Backbone cabling system schematic, indicating cable types and counts to be provided for each connection.

E. Optical fiber cable testing plan.

1.05 INFORMATIONAL SUBMITTALS

A. Qualification Data: For RCDD, Installer, installation supervisor, and field inspector.

B. Product Certificates: For each type of product.

C. Source quality-control reports.

1.06 CLOSEOUT SUBMITTALS

A. Maintenance Data: For optical fiber cable, splices, and connectors to include in maintenance manuals.

B. Field test and observation reports from a qualified independent inspecting and testing agency indicating and interpreting test results relative to a compliance with performance requirements of the installed system.
   1. Test data within each section shall be presented in the sequence listed in the administration records. The test equipment name, manufacturer, model number, and last calibration date will also be provided at the end of the document. The test document shall detail the test method used and the specific settings of the equipment during the test.
   2. When repairs and re-tests are performed, the problem and corrective action taken shall be noted, and both the failed and passed test data shall be submitted.

1.07 QUALITY ASSURANCE

A. Refer to Quality Assurance information in Division 27 Section “Scope of the Communications Work” for additional information.

B. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.
   1. Installer, as a business entity, shall be an authorized distributor and designated representative of the equipment manufacturer, with full extended warranty privileges. The Installer shall have been actively engaged in the business of selling, installing, and servicing commercial building commercial cable systems for a period of at least 5 years.

a. Recently formed companies are acceptable only if specific pre-approval is requested and granted by the Architect/Engineer, based on experience of key personnel, current and complete projects, and all licensing requirements are met 10 working days prior to the contract proposal date.

2. Installer shall have an office within 150 miles of the job site, staffed with trained technicians who are qualified and licensed to supervise the installation, to be responsible that the system is installed as submitted, to conduct system start up and perform a 100 percent operational audit of all installed devices, to instruct the Owner's representatives in the proper operation of the system, and to provide service throughout the warranty period. The contractor shall be capable of dispatching technicians to repair a system within six hours of a service request.
3. Installer shall employ factory-trained technicians capable of supporting the maintenance of the system. No contract employees are allowed unless they have been to the factory service school within the last 18 months. A certificate of this training shall be provided with the Installer's submittal.
4. Layout Responsibility: Preparation of Shop Drawings by an RCDD.
5. Installation Supervision: Installation shall be under the direct supervision of Level 2 Installer, who shall be present at all times when Work of this Section is performed at Project site.
6. Testing Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.
7. Maintain current status with the warranting manufacturer, including all training requirements, for the duration of the cable infrastructure project. Staff each installation crew with the appropriate number of trained personnel, in accordance with their manufacturer/warranty contract agreement, to support the lifetime system warranty requirements. After installation, submit all documentation to support the warranty in accordance with the manufacturer's warranty requirements, including test results, and to apply for said warranty on behalf of the Owner.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Test cables upon receipt at Project site.
   1. Test optical fiber cable to determine the continuity of the strand end to end. Use optical fiber flashlight or optical loss test set.
   2. Test optical fiber cable while on reels. Use an optical time domain reflectometer to verify the cable length and locate cable defects, splices, and connector, including the loss value of each. Retain test data and include the record in maintenance data.

1.09 PROJECT CONDITIONS

A. Environmental Limitations: Do not deliver or install cables and connecting materials until wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

1.10 COORDINATION

A. Coordinate layout and installation of telecommunications pathways and cabling with Owner's telecommunications and LAN equipment and service suppliers.

1.11 WARRANTY

A. The selected system installer shall be factory certified by the manufacturer and shall provide an end-to-end performance warranty of not less than twenty-five (25) years for modifications to the system. The cabling contractor shall provide certification documentation. The performance warranty shall be issued by the manufacturer.

B. The warranty shall cover all fiber optic cabling installed under this contract, with testing in accordance with the manufacturer's requirements.
   1. Single-mode fiber shall be tested in accordance with ANSI/TIA/EIA-526-7 Method B.

C. The warranty shall stipulate that all products used in this installation meet the prescribed mechanical and transmission specifications for such products as described in ISO/IEC 11801, ANSI/TIA/EIA-568-A, or EN 50173. Quality and workmanship evaluation shall be solely by the Owner and designated representatives.
   1. Upon completion of the project, the Owner's technical representative will perform a final inspection of the installed cabling system with the Contractor's project foreman. The final inspection will be performed to validate that all horizontal and backbone cables were installed as defined in the Drawings, and that the installation meets the aesthetic expectations of the customer.
   2. Upon receipt of the test documentation, the Owner reserves the right to perform spot testing of a representative sample of the cabling system to validate test results provided in the test document. Owner testing will use the same method employed by the Contractor, and minor variations will be allowed to account for differences in test equipment and test variability. If significant discrepancies are found, the contractor will be notified for resolution.
   3. During the three-week period between final inspection and delivery of the test and as-built documentation, the customer will activate the cabling system. Owner will validate operation of the cabling system during this period.
   4. Completion of the installation, in-progress and final inspections, receipt of the test, receipt of the as-built documentation, and successful performance of the system for a two-week period will constitute acceptance of the system.

PART 2 PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. General Performance: Backbone cabling system shall comply with transmission standards in TIA-568-C.1, when tested according to test procedures of this standard.

B. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
   1. Flame-Spread Index: 25 or less.
   2. Smoke-Developed Index: 50 or less.

C. Telecommunications Pathways and Spaces: Comply with TIA-569-D.

D. Grounding: Comply with TIA-607-B.

2.02 MANUFACTURERS

A. Subject to requirements, provide products manufactured by the following:
   1. CommScope
   2. Others by Prior Engineer Approval.

2.03 9/125 MICROMETER, SINGLE-MODE, INDOOR PLENUM OPTICAL FIBER CABLE (OS2)

A. Description: Single mode, 9/125-micrometer, tight buffered optical fiber cable with plenum rated jacket.

B. Armored Cable: Subject to compliance with requirements, provide:
   1. Commscope #P-012-DZ-8W-FSUYL (760127803)

C. Part numbers provided above are for 12-strand cable; refer to structured cabling riser for strand counts. Provide Manufacturer's direct replacement if the specified product is discontinued.

D. Standards:
   1. Comply with TIA-492CAAB for detailed specifications.
   2. Comply with TIA-568-C.3 for performance specifications.
   3. Comply with ICEA S-83-596 for mechanical properties.

E. Construction:
   1. Jacket Color: Yellow.
   2. Cable cordage jacket, fiber, unit, and group color shall be according to TIA-598-D.
   3. Imprinted with fiber count, fiber type, and aggregate length at regular intervals not to exceed 40 inches.
   4. Armored cable shall be aluminum armored type.

F. Maximum Attenuation: 0.7 dB/km at 1310 nm; 0.7 dB/km at 1550 nm.

G. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444, UL 1651, and NFPA 70 for the following types:
   1. Plenum Rated, Armored (Conductive): Type OFCP

2.04 9/125 MICROMETER, SINGLE-MODE, HYBRID INDOOR/OUTDOOR PLENUM OPTICAL FIBER CABLE (OS2)

A. Description: Single mode, 9/125-micrometer, tight buffered interlocking armor optical fiber cable with plenum-rated indoor/outdoor hybrid jacket.

B. Armored Cable: Subject to compliance with requirements, provide:
   1. Commscope #P-012-OZ-8W-FSUBK (760134924)

C. Non-Armored Cable: Subject to compliance with requirements, provide:
   1. Commscope #P-012-OD-8W-FSUBK (760037192)

D. Inner Duct: For each non-armored cable, provide 1" innerduct throughout the entire run, rated for the space in which it is installed.

E. Part numbers provided above are for 6-strand cable; refer to structured cabling riser for strand counts. Provide Manufacturer's direct replacement if the specified product is discontinued.

F. Standards
   1. Comply with TIA-492CAAB for detailed specifications.
   2. Comply with TIA-568-C.3 for performance specifications.
   3. Comply with ICEA S-104-696 for mechanical properties.

G. Construction
   1. Jacket Color: Black.
   2. Cable cordage jacket, fiber, unit, and group color shall be according to TIA-598-D.
   3. Imprinted with fiber count, fiber type, and aggregate length at regular intervals not to exceed 40 inches.
   4. Non-Armored cable shall contain no metallic elements.

H. Maximum Attenuation: 0.7 dB/km at 1310 nm; 0.7 dB/km at 1550 nm.

I. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444, UL 1651, and NFPA 70 for the following types:
   1. Plenum Rated (Non-conductive): Type OFNP

2.05 OPTICAL FIBER CABLE HARDWARE

A. Standards:
   1. Comply with Fiber Optic Connector Intermateability Standard (FOCIS) specifications of the TIA-604 series.
   2. Comply with TIA-568-C.3.

B. Jack Assemblies (Commscope):
   1. Adapter panel with (6) ganged female-female duplex LC connectors.
   2. Designed to install in Commscope LGX/1000 format patch panels.
   3. Approved Products:
      a. Commscope #760067165 or equivalent.

C. Plugs and Plug Assemblies (Commscope):
   1. Male; color-coded modular telecommunications connector designed for termination of a single optical fiber cable.
   2. Insertion loss not more than 0.25 dB.
   3. Marked to indicate transmission performance.
   4. Approved Products:
      a. Commscope LC Single-Mode #SFC-LCF-09-8X (760117895).

D. Connector Type: Type LC complying with TIA-604-10.

E. Cross-Connects and Patch Panels: Modular panels housing multiple-numbered, duplex cable connectors.
   1. Number of Connectors per Field: One for each fiber of cable or cables assigned to field, plus spares and blank positions adequate to suit specified expansion criteria.

F. Patch Cords:
   1. Factory-made, fiber optic cable assemblies using duplex cable.
   2. Patch cord assemblies shall be LC to LC, 3-meter length.

2.06 GROUNDING

A. Comply with requirements in Division 26 Section "Grounding and Bonding" for grounding conductors and connectors.

B. Comply with TIA-607-B and NECA/BICSI-607.

2.07 INNER DUCT

A. Description: Corrugated non-metallic flexible raceway for separation and protection of fiber optic cabling.

B. Corrugated tubing, size as noted. Color Orange U.O.N.

C. Factory pre-installed pull tape.

D. Approved manufacturers:
   1. Carlon
   2. Dura-line

E. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 910, and NFPA 70, rated for use in environmental air handling plenum.

2.08 IDENTIFICATION PRODUCTS

A. Comply with TIA/EIA-606-A and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

B. Labeling software shall be able to produce complex unique identifiers of up to 12 independent segments. Labeling software shall be capable of inserting symbols and any standard true type font as well as capable of saving individual build information and fine-tuning print adjustments.

2.09 SOURCE QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to evaluate cables.

B. Factory test single mode optical fiber cables according to TIA-526-7B and TIA-568-C.3

C. Cable will be considered defective if it does not pass tests and inspections and must be replaced.

D. Prepare test and inspection reports.

PART 3 EXECUTION

3.01 ENTRANCE FACILITIES

A. Coordinate backbone cabling with the protectors and demarcation point provided by communications service provider.

3.02 INSTALLATION OF PATHWAYS

A. Comply with requirements of demarcation point, cabinets, and racks specified in Division 27 Section “Communications Racks, Frames, and Enclosures.”

B. Comply with Division 26 Section “Pathways for Communications Systems.”

C. Drawings indicate general arrangement of pathways and fittings.

3.03 WIRING METHODS

A. Wiring Method: Install cables in raceways and cable trays except within consoles, cabinets, desks, and counters. Conceal raceway and cables except in unfinished spaces.
   1. Comply with requirements for pathways specified in Division 26 Section "Pathways for Communications Systems."

B. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

C. Wiring within Enclosures: Bundle, lace, and train cables within enclosures. Connect to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.

D. Non-armored fiber optic cabling shall be installed in inner duct, u.o.n.

3.04 INSTALLATION OF OPTICAL FIBER BACKBONE CABLES

A. Comply with NECA 1, NECA 301, and NECA/BICSI 568.

B. General Requirements for Optical Fiber Cabling Installation:
   1. Comply with TIA-568-C.1 and TIA-568-C.3.
   2. Comply with BICSI ITSIMM, Ch. 6, "Cable Termination Practices."
   3. Terminate all cables; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.
   4. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
   5. Install lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommended by manufacturer.
   6. Bundle, lace, and train cable to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIMM, "Cabling Termination Practices" Chapter. Use lacing bars and distribution spools.
   7. 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.
   8. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.
   9. In the communications equipment room, provide a 10-foot-long service loop on each end of cable.
   10. Pulling Cable: Comply with BICSI ITSIMM, Ch. 4, "Pulling Cable." Monitor cable pull tensions.
   11. Cable may be terminated on connecting hardware that is rack or cabinet mounted.

12. Backbone cables shall be installed separately from horizontal distribution cables. Where cables are housed in conduits, the backbone and horizontal cables shall be installed in separate conduits.
13. Where cables are installed in air return plenums, the backbone cable shall be installed in conduit to provide protection of cable. Backbone cables shall be installed in separate conduits from horizontal distribution cables.
14. Cable shall be installed in innerduct from fiber patch panels to plenum entrances. Innerduct shall not be installed in plenum ceilings unless it is UL approved plenum rated. Plenum rated cable shall be installed in conduit or UL approved plenum rated innerduct in all plenum ceilings.
15. Inside plant cables above four fibers shall support a minimum bend radius of 10 times the cable diameter under no tensile load and 20 times the cable diameter under tensile loading to the cable's rated limit.

C. Open-Cable Installation:
1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
2. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.
3. Where backbone cables and distribution cables are installed in a cable tray or j-hooks, backbone cables shall be installed first and bundled separately from the horizontal distribution cables.

D. Group connecting hardware for cables into separate logical fields.

E. Terminations: Terminations shall be performed by manufacturer-trained and certified technicians. Terminations shall be made in a controlled environment. Contractor may choose to have cables assembled off-site, although testing must be completed with the cable in its final installed condition.

F. Warning Tags: At each location where fiber cable is exposed to human intrusion, it shall be clearly marked with waring tags. These tags shall be yellow or orange in color and shall contain the warning: "CAUTION FIBER OPTIC CABLE". The text shall be permanent, black, block characters, and at least 3/16-inch high. A warning tag shall be permanently affixed to each exposed cable or bundle of cables at intervals of not less than five (5) feet. Any section of exposed cable that is less than five (5) feet in length shall have at least one warning tag affixed to it.

3.05 FIRESTOPPING

A. Comply with requirements in Division 07 Section "Firestopping."

B. Comply with requirements in Division 27 Section "Common Communications Requirements."

C. Comply with TIA-569-D, Annex A, "Firestopping."

D. Comply with BICSI ITSIMM, "Firestopping" Chapter.

3.06 GROUNDING

A. Install grounding according to BICSI ITSIMM, "Grounding (Earthing), Bonding, and Electrical Protection" Chapter.

B. Locate grounding bus bar to minimize the length of bonding conductors. Fasten to wall allowing at least 2-inch clearance behind the grounding bus bar. Connect grounding bus bar with a minimum No. 2 AWG grounding electrode conductor from grounding bus bar to suitable electrical building ground.

C. Bond metallic equipment to the grounding bus bar, using not smaller than No. 6 AWG equipment grounding conductor.

D. Bond conductive cable armor to the telecom grounding system per ANSI-J-STD-607 and NEC.

3.07 IDENTIFICATION

A. Identify system components, wiring, and cabling complying with TIA/EIA-606-A. Comply with requirements for identification specified in the OSDM Communication and Network Systems Telecommunications Standards. The identification scheme will be provided by the Owner.

B. Cable Schedule: Install in a prominent location in each equipment room and wiring closet. List incoming and outgoing cables and their designations, origins, and destinations. Protect with rigid frame and clear plastic cover. Furnish an electronic copy of final comprehensive schedules for Project.

C. Cabling Administration Drawings: Show building floor plans with cabling administration-point labeling. Identify labeling convention and show labels for telecommunications closets, backbone pathways and cables, entrance pathways and cables, terminal hardware and positions, horizontal cables, work areas and workstation terminal positions, grounding buses and pathways, and equipment grounding conductors. Follow convention of TIA/EIA-606-A. Furnish electronic record of all drawings, in software and format selected by Owner.

D. Cable and Wire Identification:
   1. Label each cable within 4 inches of each termination and tap, where it is accessible in a cabinet or junction or outlet box, and elsewhere as indicated.
   2. Exposed Cables and Cables in Cable Trays and J-hooks: Label each cable at intervals not exceeding 15 feet.
   3. Label each unit and field within distribution racks and frames.
   4. Identification within Connector Fields in Equipment Rooms and Wiring Closets: Label each connector and each discrete unit of cable-terminating and connecting hardware. Where similar jacks and plugs are used for both voice and data communication cabling, use a different color for jacks and plugs of each service.
   5. Labeling shall note cable type, run designation, “Tx” for transmit fiber connectors, and “Rx” for the receive fiber connectors.
   6. Cable labels shall not be obscured from view.

E. Labels shall be preprinted or computer-printed type with printing area and font color that contrasts with cable jacket color but still complies with requirements in TIA/EIA 606-A, for the following:
   1. Flexible vinyl or polyester that flexes as cables are bent.
   2. Labels shall be machine printed. Type shall be 3/16 inch in height.

F. Labeling system shall designate the cable origin and destination and a unique identifier for each cable within the system. Racks and patch panels shall be labeled to identify the location within the cabling system infrastructure.

G. All labeling shall be recorded on the as-built drawings and all test documents shall reflect the appropriate labeling scheme.

H. All labels shall incorporate room numbers from the final Owner’s room numbering scheme. Coordinate with Owner to obtain final room numbers prior to applying labels.

3.08 FIELD QUALITY CONTROL

A. Perform tests and inspections with the assistance of a factory-authorized service representative

B. Tests and Inspections:
   1. Visually inspect optical fiber 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.
   2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.

3. Optical Fiber Cable Tests:
    a. Test instruments shall meet or exceed applicable requirements in TIA-568-C.1. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
    b. Testing device for fiber optic cables shall be a high quality OTDR (Optical Time-Domain Reflectometer) equipped with a printer. The printed data shall show, in addition to any summary information, the complete test trace and all relevant scale settings. The OTDR must have the capability to take measurements from bare fiber strands as well as SC connector terminations.
    c. All fiber optic cable shall be tested on the reel before installation to ensure that is meets the specifications outlined herein.
    d. After installation, test each fiber strand in accordance with the EIA 455-171 Method D procedures (bi-directional testing) at both 850 and 1300 nm for multimode and 1310nm and 1550nm for single-mode. A form shall be completed for each cable showing data recorded for each strand including length, total segment (end-to-end) loss (dB) and connector losses (dB) at each end. In addition, the printed data strip for each strand shall be attached to the form. Patch cables shall also be tested.
    e. Single-mode fibers shall have a maximum attenuation of 1.0 dB/km at 1310 nm and 1.0 db/km at 1550 nm
    f. Multimode fibers shall have a maximum attenuation of 3.5 dB/km at 850 nm and 1.5 dB/km at 1300 nm.
    g. Acceptable fiber optic connector loss shall not exceed 0.75 dB per mated pair. The Contractor is responsible for obtaining minimum loss in fiber connections and polishing per manufacturer's specifications.

C. Data for each measurement shall be documented. Data for submittals shall be printed in a summary report that is formatted similar to Table 10.1 in BICSI TDMM, or transferred from the instrument to the computer, saved as text files, and printed and submitted.

D. Remove and replace cabling where test results indicate that it does not comply with specified requirements.

E. End-to-end cabling will be considered defective if it does not pass tests and inspections.

F. Any cable damaged or exceeding recommended installation parameters during installation shall be replaced prior to final acceptance at no cost to the Owner.

G. OTDR shots shall be provided for each strand of fiber completely installed and terminated.

H. Prepare test and inspection reports.

3.09 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to site in manufacturer's original, unopened, protective containers and packaging, with labels clearly identifying product name and manufacturer.
    1. Store materials in secure, clean, and dry area indoors in accordance with manufacturer's instructions.
    2. Protect materials and finish from damage and moisture during handling and installation.

END OF SECTION

SECTION 27 1513
COMMUNICATIONS COPPER HORIZONTAL CABLING

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Category 6 twisted pair cable.
   2. Twisted pair cable hardware, including plugs and jacks.
   3. Cabling identification products.
   4. Grounding provisions for twisted pair cable.
   5. Source quality control requirements for twisted pair cable.

1.02 DEFINITIONS

A. BICSI: Building Industry Consulting Service International.

B. Cross-Connect: A facility enabling the termination of cable elements and their interconnection or cross-connection.

C. EMI: Electromagnetic interference.

D. FTP: Shielded twisted pair.

E. F/FTP: Overall foil screened cable with foil screened twisted pair.

F. F/UTP: Overall foil screened cable with unscreened twisted pair.

G. IDC: Insulation displacement connector.

H. LAN: Local area network.

I. Jack: Commonly called an "outlet," it is the fixed, female connector.

J. Plug: Commonly called a "connector," it is the removable, male telecommunications connector.

K. RCDD: Registered Communications Distribution Designer.

L. Screen: A metallic layer, either a foil or braid, placed around a pair or group of conductors.

M. Shield: A metallic layer, either a foil or braid, placed around a pair or group of conductors.

N. S/FTP: Overall braid screened cable with foil screened twisted pair.

O. S/UTP: Overall braid screened cable with unscreened twisted pairs.

P. UTP: Unscreened (unshielded) twisted pair.

1.03 COPPER HORIZONTAL CABLING DESCRIPTION

A. Horizontal cabling for data circuits shall be Category 6, 24 AWG, 4-pair UTP, UL/NEC CMP rated and independently verified for compliance.

B. Horizontal cable cabling system shall provide interconnections between Distributor A, Distributor B, or Distributor C, and the equipment outlet, otherwise known as "Cabling Subsystem 1," in the telecommunications cabling system structure. Cabling system consists of horizontal cables, intermediate and main cross-connects, mechanical terminations, and patch cords or jumpers used for horizontal-to-horizontal cross-connection.
   1. TIA-568-C.1 requires that a minimum of two equipment outlets be installed for each work area.
   2. Horizontal cabling shall contain no more than one transition point or consolidation point between the horizontal cross-connect and the telecommunications equipment outlet.
   3. Bridged taps and splices shall not be installed in the horizontal cabling.

C. A work area is approximately 100 sq. ft. and includes the components that extend from the equipment outlets to the station equipment.

D. The maximum allowable horizontal cable length is 275 feet. This maximum allowable length does not include an allowance for the length of 16 feet to the workstation equipment or in the horizontal cross-connect.

E. The horizontal cabling shall extend from each designated data outlet to the nearest IDF or the MDF in a star topology.

1.04 ACTION SUBMITTALS

A. Submit product data and shop drawings in accordance with Division 01 and Division 27 Section “Communications Shop Drawings and Submittals” for products specified under PART 2 - PRODUCTS.

B. Specification Compliance Certification: Submit a Specification Compliance Certification in accordance with Division 27 Section “Communications Shop Drawings and Submittals”.

C. Product Data: For each type of product.

D. Shop Drawings: Reviewed and stamped by RCDD.
   1. System Labeling Schedules: Electronic copy of labeling schedules, in software and format selected by Owner.
   2. Cabling administration Drawings and printouts.
   3. Wiring diagrams and installation details of telecommunications equipment, to show location and layout of telecommunications equipment, including the following:
      a. Telecommunications rooms plans and elevations.
      b. Telecommunications pathways.
      c. Telecommunications system access points.
      d. Telecommunications grounding system.
      e. Telecommunications conductor drop locations.
      f. Typical telecommunications details.
      g. Mechanical, electrical, and plumbing systems.

E. Twisted pair cable testing plan.

1.05 INFORMATIONAL SUBMITTALS

A. Qualification Data: For RCDD, Installer, installation supervisor, and field inspector.

B. Product Certificates: For each type of product.

C. Source quality-control reports.

D. Field quality-control reports.

1.06 CLOSEOUT SUBMITTALS

A. Maintenance Data: For splices and connectors to include in maintenance manuals.

B. Software and Firmware Operational Documentation:
   1. Software operating and upgrade manuals.
   2. Program Software Backup: On USB media or compact disk, complete with data files.
   3. Device address list.
   4. Printout of software application and graphic screens.

C. Field test and observation reports from a qualified independent inspecting and testing agency indicating and interpreting test results relative to a compliance with performance requirements of the installed system.
   1. Test data within each section shall be presented in the sequence listed in the administration records. The test equipment name, manufacturer, model number, and last calibration date will also be provided at the end of the document. The test document shall detail the test method used and the specific settings of the equipment during the test.

2. When repairs and re-tests are performed, the problem and corrective action taken shall be noted, and both the failed and passed test data shall be submitted.

1.07 QUALITY ASSURANCE

A. Refer to Quality Assurance information in Division 27 Section “Scope of the Communications Work” for additional information.

B. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.
   1. Installer, as a business entity, shall be an authorized distributor and designated representative of the equipment manufacturer, with full extended warranty privileges. The Installer shall have been actively engaged in the business of selling, installing, and servicing commercial building commercial cable systems for a period of at least 5 years.
      a. Recently formed companies are acceptable only if specific pre-approval is requested and granted by the Architect/Engineer, based on experience of key personnel, current and complete projects, and all licensing requirements are met 10 working days prior to the contract proposal date.
   2. Installer shall have an office within 150 miles of the job site, staffed with trained technicians who are qualified and licensed to supervise the installation, to be responsible that the system is installed as submitted, to conduct system start up and perform a 100 percent operational audit of all installed devices, to instruct the Owner’s representatives in the proper operation of the system, and to provide service throughout the warranty period. The contractor shall be capable of dispatching technicians to repair a system within six hours of a service request.
   3. Installer shall employ factory-trained technicians capable of supporting the maintenance of the system. No contract employees are allowed unless they have been to the factory service school within the last 18 months. A certificate of this training shall be provided with the Installer’s submittal.
   4. Layout Responsibility: Preparation of Shop Drawings by an RCDD.
   5. Installation Supervision: Installation shall be under the direct supervision of Level 2 Installer, who shall be present at all times when Work of this Section is performed at Project site.
   6. Testing Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.
   7. Maintain current status with the warranting manufacturer, including all training requirements, for the duration of the cable infrastructure project. Staff each installation crew with the appropriate number of trained personnel, in accordance with their manufacturer/warranty contract agreement, to support the lifetime system warranty requirements. After installation, submit all documentation to support the warranty in accordance with the manufacturer’s warranty requirements, including test results, and to apply for said warranty on behalf of the Owner.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Test cables upon receipt at Project site.
   1. Test each pair of twisted pair cable for open and short circuits.

1.09 PROJECT CONDITIONS

A. Environmental Limitations: Do not deliver or install cables and connecting materials until wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

1.10 COORDINATION

A. Coordinate layout and installation of telecommunications pathways and cabling with Owner's telecommunications and LAN equipment and service suppliers.

1.11 WARRANTY

A. The selected system installer shall be factory certified by the manufacturer and shall provide an end-to-end performance warranty of not less than twenty-five (25) years for modifications to the system. The cabling contractor shall provide certification documentation. The performance warranty shall be issued by the manufacturer and shall warrant that all Category 6+ cable links have been tested bi-directionally (end-to-end) using a Level 2 tester, per TSB-67, and that all test results conform to the most current TIA/EIA-568-A and/or TSB-67 link values.

B. The warranty shall stipulate that all products used in this installation meet the prescribed mechanical and transmission specifications for such products as described in ISO/IEC 11801, ANSI/TIA/EIA-568-A, or EN 50173. Quality and workmanship evaluation shall be solely by the Owner and designated representatives.
   1. Upon completion of the project, the Owner's technical representative will perform a final inspection of the installed cabling system with the Contractor's project foreman. The final inspection will be performed to validate that all horizontal and backbone cables were installed as defined in the Drawings, and that the installation meets the aesthetic expectations of the customer.
   2. Upon receipt of the test documentation, the Owner reserves the right to perform spot testing of a representative sample of the cabling system to validate test results provided in the test document. Owner testing will use the same method employed by the Contractor, and minor variations will be allowed to account for differences in test equipment and test variability. If significant discrepancies are found, the contractor will be notified for resolution.
   3. During the three-week period between final inspection and delivery of the test and as-built documentation, the customer will activate the cabling system. Owner will validate operation of the cabling system during this period.
   4. Completion of the installation, in-progress and final inspections, receipt of the test, receipt of the as-built documentation, and successful performance of the system for a two-week period will constitute acceptance of the system.

PART 2 PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. General Performance: Horizontal cabling system shall comply with transmission standards in TIA-568-C.1, when tested according to test procedures of this standard.

B. Telecommunications Pathways and Spaces: Comply with TIA-569-D.

C. Grounding: Comply with TIA-607-B.

2.02 GENERAL CABLE CHARACTERISTICS

A. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with the applicable standard and NFPA 70 for the following types:
   1. Communications, Plenum Rated: Type CMP complying with UL 1685.

B. Surface-Burning Characteristics: Comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
   1. Flame-Spread Index: 25 or less.
   2. Smoke-Developed Index: 50 or less.

C. RoHS compliant.

2.03 COLOR CODES

A. The following color code applies to products specified under this section:

	Permanent Link Cabling Jacket	Cabling Hardware	TR Patch Cords	Workstation Patch Cords
Data Outlets	Blue	Blue	Blue	Blue
Voice Outlets	Blue	White	White	White
Wireless Access Points	Yellow	Yellow	Yellow	Yellow
IP Cameras	Green	Green	Green	Green
IP Access Control	Violet	Violet	Violet	Violet
Fire Alarm	Red	Red	Red	Red

B. Note: Permanent link cabling jacket for indoor/outdoor cabling to be black. Hardware and patch cords to be color coded as noted above.

2.04 CATEGORY 6A TWISTED PAIR CABLE

A. Description: Four-pair, balanced twisted-pair cable with internal separator, certified to meet transmission characteristics of Category 6A cable at frequencies up to 500MHz.

B. Indoor Cabling Product: Subject to requirements, provide Commscope #CS44P series cabling.

C. Indoor/Outdoor Cabling Product: Subject to requirements, provide Commscope #CS44P-IO series cabling.

D. Physical Characteristics:
1. Conductor Gauge: 23 AWG
2. Nominal Outside Diameter: 0.285 in
3. Separator type: Bisector
4. Shielding/Screening: None (UTP)
5. Environmental Rating: Plenum (CMP)
6. Jacket Color: Color code by application per color code article in this section.

E. Performance Characteristics:
1. Characteristic impedance: 100-ohm.
2. Operating Frequency: 500MHz
3. Transmission Standards: ANSI/TIA-568.2-D, ISO/IEC 11801 Class E_A
4. Remote Power: IEEE 802.3bt compliant when installed according to TIA TSB-184-A

2.05 CATEGORY 6 TWISTED PAIR CABLE

A. Description: Four-pair, balanced-twisted pair cable, with internal spline, certified to meet transmission characteristics of Category 6 cable at frequencies up to 250MHz.

B. Indoor Cabling Product: Subject to requirements, provide Commscope #CS37P series cabling.

C. Indoor/Outdoor Cabling Product: Subject to requirements, provide Commscope #CS34P-IO series cabling.

D. Physical Characteristics:
1. Conductor Gauge: 23 AWG
2. Nominal Outside Diameter: 0.222 in
3. Separator Type: Isolator
4. Shielding/Screening: None (UTP)
5. Environmental Rating: Plenum (CMP)
6. Jacket Color: Color code by application per color code article in this section.

E. Performance Characteristics:
1. Characteristic Impedance: 100-ohm.
2. Operating Frequency: 400MHz
3. Transmission Standards: ANSI/TIA-568.2-D, ISO/IEC 11801 Class E
4. Remote Power: IEEE 802.3bt compliant when installed according to TIA TSB-184-A

2.06 TWISTED PAIR CABLE HARDWARE

A. Description: Hardware designed to connect, splice, and terminate twisted pair copper communications cable.

B. Manufacturer: Subject to compliance with requirements, provide products by the following:
   1. Commscope (Unless otherwise noted)
   2. Semtron (Faceplates)

C. General Requirements for Twisted Pair Cable Hardware:
   1. Comply with the performance requirements of Category 6A or Category 6, as applicable to the specified cabling.
   2. Comply with ANSI/TIA-568-2.D, IDC type, with modules designed for punch-down caps or tools.
   3. Cables shall be terminated with connecting hardware of same category or higher.

D. Source Limitations: Obtain twisted pair cable hardware from same manufacturer as twisted pair cable, from single source.

E. Patch Cables: Factory-made, four-pair cables; terminated with an 8P8C modular plug at each end.
   1. Patch cables shall have bend-relief-compliant boots and color-coded icons to ensure performance.
   2. Cable assemblies shall meet the performance requirements of ANSI/TIA-568-2.D
   3. Cable assemblies shall utilize the color scheme defined above.
   4. Provide one (1) 10-foot workstation/device patch cable and one (1) 6-foot distribution frame patch cable per installed data or telephone jack indicated on plans.
   5. For wireless access points, provide one (1) 10-foot Category 6A workstation/device patch cable and one (1) 6-foot Category 6A distribution frame patch cable per installed WAP drop indicated on plans.
   6. For IP video surveillance cameras, provide a one (1) 10-foot workstation/device patch cable and one (1) 6-foot distribution frame patch cable per installed data or telephone jack indicated on plans.

F. Plugs and Plug Assemblies:
   1. Male; eight-position; color-coded modular telecommunications connector designed for termination of a single four-pair, 100-ohm, unshielded or shielded twisted pair cable.
   2. Standard: Comply with TIA-568-2.D.
   3. Marked to indicate transmission performance.

G. Jacks and Jack Assemblies:
   1. Female; eight-position; modular using connectors designed for termination of a single four-pair, 100-ohm, unshielded or shielded twisted pair cable.
   2. Insulation displacement connectors (IDC) shall be capable of terminating 22-24 AWG solid or 24 AWG stranded conductors. The insulation displacement contacts shall be paired with additional space between pairs to improve crosstalk performance.
   3. Designed to snap-in to a patch panel or faceplate.
   4. Standard: Comply with TIA-568-2.D requirements.
   5. Marked to indicate transmission performance.
   6. Jacks installed in faceplates shall match the color of the cable per the type of system as defined above.
   7. The number next to data symbol on Drawings indicates the quantity of data lines/jacks at that location, duplex outlets are not numbered. One jack shall be provided at the end of each cable run.

H. Faceplate: Each data or telephone jack shall be terminated and mounted in a suitable faceplate for all wall, enclosure, millwork, floor box, modular furniture, etc. locations.

1. Four-port, vertical single gang faceplates designed to mount to single gang wall boxes. Faceplate shall match manufacturer for jacks at all locations. Provide blank insert covers for unused station ports.
2. Above ceiling should have a two-port plenum surface box.
3. Faceplate:
   a. Provide stainless steel plates for use with snap-in jacks. Jacks shall be held flat to plane of faceplate.
   b. Plates shall accommodate any combination of twisted pair, optical fiber, and coaxial work area cords.
   c. Plates shall include label positions.
   d. Plates shall complying with general faceplate requirements in Division 26 Section "Wiring Devices."
   e. Product: Subject to requirements, provide Semtron #1FM-(4)0E-AMP-LAB
4. Wall Telephone Station Jack:
   a. Provide a Stainless steel wall plate for use with one (1) snap-in jack, with telephone wall set mounting studs and without label position(s).
   b. Product: Subject to requirements, provide Semtron #1FM-OE-AMP-PHONE

I. Legend:
1. Machine printed, in the field, using adhesive-tape label.
2. Snap-in, clear-label covers and machine-printed paper inserts.

2.07 IDENTIFICATION PRODUCTS

A. Comply with TIA/EIA-606-A and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

B. Labeling software shall be able to produce complex unique identifiers of up to 12 independent segments. Labeling software shall be capable of inserting symbols and any standard true type font as well as capable of saving individual build information and fine-tuning print adjustments.

2.08 GROUNDING

A. Comply with requirements in Division 26 Section "Grounding and Bonding" for grounding conductors and connectors.

B. Comply with TIA-607-B.

2.09 SOURCE QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to evaluate cables.

B. Factory test cables on reels according to TIA-568-C.1.

C. Factory test twisted pair cables according to TIA-568-2.D.

D. Cable will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

PART 3 EXECUTION

3.01 WIRING METHODS

A. Wiring Method: Install cables in raceways, cable trays, and J-hooks, except within consoles, cabinets, desks, and counters. Conceal raceway and cables, except in unfinished spaces.
1. Install plenum cable in environmental air spaces, including plenum ceilings.
2. Comply with requirements for raceways and boxes specified in Division 26 Section "Pathways for Communications Systems."

B. Wiring within Enclosures: Bundle, lace, and train cables within enclosures. Connect to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools. Install conductors parallel with or at right angles to sides and back of enclosure.

3.02 INSTALLATION OF PATHWAYS

A. Comply with requirements for demarcation point, cabinets, racks, and cable trays specified in Division 27 Section "Communications Equipment Room Fittings."

B. Comply with Division 26 Section "Pathways for Communications Systems."

C. Drawings indicate general arrangement of pathways and fittings.

3.03 INSTALLATION OF TWISTED-PAIR HORIZONTAL CABLES

A. Comply with NECA 1 and NECA/BICSI 568.

B. General Requirements for Cabling:
   1. Comply with TIA-568-C.0, TIA-568-C.1, and TIA-568-2.D.
   2. Comply with BICSI's "Information Transport Systems Installation Methods Manual (ITSIMM), Ch. 5, "Copper Structured Cabling Systems," "Cable Termination Practices" Section.
   3. Cable pathways, conduit, and cable support systems shall be complete with bushings, deburred, cleaned, and secure prior to installation of cable.
   4. Cables shall be dressed and terminated in accordance with the recommendations in ANSI/TIA-568-C standard, manufacturer’s recommendations, and/or best industry practices.
   5. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels. Cable jacket shall be maintained as close as possible to the termination point.
   6. Do not untwist twisted pair cables more than 1/4 inch from the point of termination to maintain cable geometry.
   7. Cables shall be neatly bundled and dressed to their respective panels.
   8. Each panel shall be fed by an individual bundle separated and dressed back to the point of cable entrance into the rack.
   9. Consolidation points may be used only for making a direct connection to equipment outlets:
      a. Do not use consolidation point as a cross-connect point, as a patch connection, or for direct connection to workstation equipment.
      b. Locate consolidation points for twisted-pair cables at least 49 feet from communications equipment room.
   10. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
   11. Install lacing bars to restrain cables, prevent straining connections, and prevent bending cables to smaller radii than minimums recommended by manufacturer.
   12. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI Information Transport Systems Installation Methods Manual, Ch. 5, "Copper Structured Cabling Systems," "Cable Termination Practices" Section. Use lacing bars and distribution spools.
   13. 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.
   14. Cold-Weather Installation: Bring cable to room temperature before de-reeling. Heat lamps shall not be used for heating.

15. Service Loops:
    a. Provide 10-foot-long service loop on MDF/IDF end of all cabling.
    b. Provide 3-foot-long service loop at workstation end of all Data/Voice drops.
    c. Provide 10-foot-long service loop at all camera drops with a mod plug on the end.
    d. Provide 10-foot-long service loop at all WAP drops.
16. Pulling Cable: Comply with BICSI Information Transport Systems Installation Methods Manual, Ch. 5, "Copper Structured Cabling Systems," "Pulling and Installing Cable" Section. Monitor cable pull tensions. The cable's minimum bend radius of 4 times the cable diameter and maximum pulling tension of 25 lbs shall not be exceeded.
17. Horizontal distribution cables shall be bundled in groups of not greater than 40 cables.

C. Open-Cable Installation:
1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
2. Suspend twisted pair cabling, not in a wireway or pathway, a minimum of 8 inches above ceilings by cable supports not more than 48inches apart. At no point shall cables rest on acoustic ceiling grids or tiles. All communications cable shall be supported from the building structure and bundled.
3. The cable support system shall provide a protective pathway to eliminate stress that could damage the cabling. The cable shall not be crushed, deformed, skinned, crimped, twisted, or formed into tight radius bends that could compromise the integrity of the cabling.
4. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.
5. Cables shall not be attached to ceiling grid or lighting support wires.
6. Where light support for drop cable legs is required, install clips to support the cabling.
7. Cables shall be installed above fire sprinkler piping and shall not be attached to the system or any ancillary equipment or hardware.
8. Cabling system and support hardware shall be installed so that it does not obscure any valves, fire alarm conduit, boxes, or other control devices.

D. Cable in Conduit Installation:
1. Communications cables shall be run in conduits, where stubs are provided, from wall or floor jacks to accessible areas above finished ceilings. Conduit shall be required only within walls and concealed spaces to provide access.
2. Provide bushings to protect the cable from damage for conduit ends, box openings, and passage through metal studs.

E. Group connecting hardware for cables into separate logical fields.

F. Separation from EMI Sources:
1. Comply with recommendations from BICSI's "Telecommunications Distribution Methods Manual" and TIA-569-D for separating unshielded copper communication cable from potential EMI sources, including electrical power lines and equipment.
2. Separation between communications cables in grounded metallic raceways, power lines, and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:
    a. Electrical Equipment Rating Less Than 2 kVA: No requirement.
    b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches.
    c. Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches.
3. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches.
4. Do not route any data cable within two feet of any light fixture, HVAC unit, service access area, electric panel, or any device containing a motor or transformer.

3.04 WALL MOUNT FLAT SCREEN DISPLAY LOCATIONS

A. Provide a Category 6+ non-keyed RJ-45 data jack on the wall as required and Category 6+ cable to nearest MDF/IDF patch panel.

3.05 INTERIOR WIRELESS ACCESS POINT JACK LOCATIONS

A. Provide a surface mount housing “biscuit block” for two jacks with label window, blank module, Category 6+ non-keyed RF-45 data jack, and Category 6+ cable to nearest MDF/IDF patch panel.

B. For drop ceiling mounting locations, provide a surface mount housing to be mounted to a ceiling tile support bridge Atlas Sound model 81-4 or equivalent concealed above the finished ceiling.

C. For open structure mounting locations, provide a Wiremold/Legrand model WAPBRKT overhead device bracket with removable cover. The bracket shall be constructed of galvanized steel with a large capacity device compartment: 12-3/4" long x 9-1/2” wide x 3-1/8” deep. The bracket shall be securely attached to the overhead building structure by the included strap hardware or by an all thread rod.

D. Label the cable run designator(s) in a visible location on brackets/housings/enclosures and on the ceiling grid bar at jack locations that are concealed above a drop ceiling.

3.06 INTERIOR CAMERA JACK LOCATIONS

A. Provide a surface mount housing “biscuit block” for two jacks with label window, blank module, Category 6+ non-keyed RJ-45 data jack, and Category 6+ cable to nearest MDF/IDF patch panel.

B. For drop ceiling mounting locations, provide a surface mount housing to be mounted to a ceiling tile support bridge Atlas Sound model 81-4 or equivalent concealed above the finished ceiling.

C. For open structure mounting locations, provide a Wiremold/Legrand model WAPBRKT overhead device bracket with removable cover. The bracket shall be constructed of galvanized steel with a large capacity device compartment: 12-3/4" long x 9-1/2” wide x 3-1/8” deep. The bracket shall be securely attached to the overhead building structure by the included strap hardware or by an all thread rod.

3.07 EXTERIOR CAMERA JACK LOCATIONS

A. Provide a data jack surface mounted inside the building on the wall in a concealed and accessible location at least 12-inches above the finished ceiling. Surface mount housing shall be a “biscuit block” for two jacks with label window, blank module, Category 6+ non-keyed RF-45 data jack, and Category 6+ cable to nearest MDF/IDF patch panel.

B. Adjacent to jack provide a 3/4-inch rigid threaded conduit stub passing through the exterior wall with a temporary threaded pipe-cap exposed, making the stub ready to thread-in to the device weather proof backbox/enclosure.

3.08 FIRESTOPPING

A. Comply with requirements in Division 07 Section "Firestopping."

B. Comply with requirements in Division 27 Section “Common Communications Requirements.”

C. Comply with TIA-569-D, Annex A, "Firestopping."

D. Comply with "Firestopping Systems" Article in BISCI's "Telecommunications Distribution Methods Manual."

3.09 GROUNDING

A. Install grounding according to the "Grounding, Bonding, and Electrical Protection" chapter in BICSI's "Telecommunications Distribution Methods Manual."

B. Comply with TIA-607-B and NECA/BICSI-607.

C. Locate grounding bus bar to minimize the length of bonding conductors. Fasten to wall, allowing at least a 2-inch clearance behind the grounding bus bar. Connect grounding bus bar to suitable electrical building ground, using a minimum No. 4 AWG grounding electrode conductor.

D. Bond metallic equipment to the grounding bus bar, using not smaller than a No. 6 AWG equipment grounding conductor.

3.10 IDENTIFICATION

A. Identify system components, wiring, and cabling complying with TIA/EIA-606-A. Each patch panel jack, wall plate jack, terminal cabinet connector, and both ends of each cable run shall be labeled with a cable scheme run designator machine printed labels.

B. Cable Schedule: Install in a prominent location in each equipment room and wiring closet. List incoming and outgoing cables and their designations, origins, and destinations. Protect with rigid frame and clear plastic cover. Furnish an electronic copy of final comprehensive schedules for Project.

C. Cabling Administration Drawings: Show building floor plans with cabling administration-point labeling. Identify labeling convention and show labels for telecommunications closets, terminal hardware and positions, horizontal cables, work areas and workstation terminal positions, grounding buses and pathways, and equipment grounding conductors.

D. Cable and Wire Identification:
   1. Cables shall be identified by a self-adhesive label.
   2. Label each cable within 4 inches of each termination and tap, where it is accessible in a cabinet or junction or outlet box, and elsewhere as indicated.
   3. Each cable shall be clearly labeled on the cable jacket behind the patch panel at a location that can be viewed without removing the bundle support ties.
   4. A cable label shall be applied to the cable behind the faceplate on a section of cable that can be accessed by removing the coverplate.
   5. Cable labels shall not be obscured from view.
   6. Exposed Cables and Cables in Cable Trays and Wire Troughs: Label each cable at intervals not exceeding 15 feet.
   7. Label each terminal strip, and screw terminal in each cabinet, rack, or panel.
      a. Individually number wiring conductors connected to terminal strips, and identify each cable or wiring group, extended from a panel or cabinet to a building-mounted device, with the name and number of a particular device.
      b. Label each unit and field within distribution racks and frames.
   8. Identification within Connector Fields in Equipment Rooms and Wiring Closets: Label each connector and each discrete unit of cable-terminating and -connecting hardware. Where similar jacks and plugs are used for both voice and data communication cabling, use a different color for jacks and plugs of each service.

E. Provide self-adhesive, color-coded, identification marker on ceiling grid directly below any device requiring an IP-connection above the ceiling. Ceiling marker to be Seton L12723 or equivalent. Division 27 related devices should utilize a yellow identification marker on the ceiling grid.

F. Labels shall be preprinted or computer-printed type, with a printing area and font color that contrast with cable jacket color but still comply with TIA-606-B requirements for the following:
   1. Cables use flexible vinyl or polyester that flexes as cables are bent.
   2. Labels shall be machine printed. Type shall be 3/16 inch in height.

G. Labeling system shall designate the cable origin and destination and a unique identifier for each cable within the system. Racks and patch panels shall be labeled to identify the location within the cabling system infrastructure.

H. All labeling shall be recorded on the as-built drawings and all test documents shall reflect the appropriate labeling scheme.

I. All labels shall incorporate room numbers from the final Owner's room numbering scheme. Coordinate with Owner to obtain final room numbers prior to applying labels.

3.11 FIELD QUALITY CONTROL

A. Perform tests and inspections with the assistance of a factory-authorized service representative.

B. Tests and Inspections:
   1. 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.
   2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
   3. Test twisted pair cabling for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination but not cross-connection. All UTP cabling shall be certified to meet and/or exceed the specifications as set forth for Category 6-CLASS E/D Permanent Link Testing. Testing shall meet TIA/EIA TSB-95 for Category 6.
      a. Test instruments shall meet or exceed applicable requirements in TIA-568-2.D. Perform tests with a tester that complies with performance requirements in "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
   4. Certifications shall include the following parameters for each pair of each cable installed:
      a. Characteristic Impedance 100 Ohm +/- 15%.
      b. Wire map (pin to pin connectivity).
      c. Permanent Link, station cable from patch panel to jack, should not exceed 295 feet (Channel length not to exceed 328 feet).
      d. Detect split pairs and number of pairs present, 4 pairs required.
      e. Attenuation <21.3 dB @ 100 MHz, < 35.9 dB @ 250 MHz.
      f. Return Loss < 26.8 dB @ 100 MHz, < 20.5 dB @ 250 MHz.
      g. NEXT > 39.9 dB @ 100 MHz, > 33.1 dB @ 250 MHz.
      h. PS NEXT > 37.1 dB @ 100 MHz, > 30.2 dB @ 250 MHz.
      i. ELFEXT > 23.3 dB @ 100 MHz, > 15.3 dB @ 250 MHz.
      j. PS ELFEXT > 20.3 dB @ 100 MHz, > 12.3 dB @ 250 MHz.
      k. ACR > 18.6 dB @ 100 MHz, > -2.8 dB @ 250 MHz.
      l. PS ACR > 15.8 dB @ 100 MHz, > -5.7 dB @ 250 MHz.

C. Data for each measurement shall be documented. Data for submittals shall be printed in a summary report that is formatted similarly to Table 10.1 in BICSI's "Telecommunications Distribution Methods Manual," or shall be transferred from the instrument to the computer, saved as text files, printed, and submitted.

D. Remove and replace cabling where test results indicate that they do not comply with specified requirements.

E. End-to-end cabling will be considered defective if it does not pass tests and inspections.

F. Any cable damaged or exceeding recommended installation parameters during installation shall be replaced prior to final acceptance at no cost to the Owner.

G. Prepare test and inspection reports.

3.12 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to site in manufacturer's original, unopened, protective containers and packaging, with labels clearly identifying product name and manufacturer.
   1. Store materials in secure, clean, and dry area indoors in accordance with manufacturer's instructions.
   2. Protect materials and finish from damage and moisture during handling and installation.

END OF SECTION

SECTION 27 4116.00
INTEGRATED AUDIO-VIDEO SYSTEMS AND EQUIPMENT - COMMON REQUIREMENTS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

B. Refer to all of the Contract Documents, including but not limited to the E- and T- series sheets, for installation locations and quantities of devices described herein.

1.02 SUMMARY

A. Section includes:
   1. Common requirements for audio-video systems as described in the corresponding sections and on drawings, including:
      a. Conference Room AV
      b. Large Group Instruction (LGI) AV
      c. Classroom AV
      d. Sports Field AV
      e. Dance Room AV

B. Reference Project drawings for particular locations, quantities, and coordination with other trades.

C. Related Requirements:
   1. Installation shall comply with all applicable codes and standards in effect at the job site and as indicated in the Drawings and Specifications
   2. Division 26 Section "Raceways and Boxes for Electrical Systems" for boxes and raceways.
   3. Division 27 Section “Grounding and Bonding for Communications Systems” for grounding and bonding requirements at head end equipment racks, frames, and enclosures.
   4. Division 27 Section “Audio-Video Cabling and Accessories” for system cabling and accessories and related procedures and standards.

1.03 DEFINITIONS

A. Acronyms and Abbreviations
   1. Assistive Listening System
   2. American Wire Gauge
   3. High-Definition Multimedia Interface standard
   4. Standard for distributing high-definition video and audio signals over standard twisted pair cabling
   5. Infrared
   6. Personal Computer
   7. Radio frequency
   8. Serial data interface per TIA-232
   9. Serial data interface per TIA/EIA-422
   10. Serial data interface per TIA/EIA-485
   11. Teaching Display
   12. Teacher Desk Station
   13. Universal Serial Bus cable and connector standard

B. Major System Components include but are not limited to the items described as such in the Part 2 article names, including:

1. Display(s),
2. Loudspeaker(s),
3. Amplifier(s),
4. Signal switching and processing equipment,
5. Signal source equipment including media player(s), microphone(s), and camera(s),
6. Powered signal extender(s),
7. RF Transmitting and Receiving equipment and Antenna(s)
8. Control system processor(s) and interface(s)

1.04 PREINSTALLATION MEETINGS

A. The successful Contractor shall attend a mandatory pre-construction meeting with individuals deemed necessary by the Owner's representative prior to the start of the work. Conduct conference at Project site.

1.05 ACTION SUBMITTALS

A. Submit product data and shop drawings in accordance with Division 01 and Division 27 Section "Communications Shop Drawings and Submittals" for products specified under PART 2 - PRODUCTS.

B. Specification Compliance Certification: Submit a Specification Compliance Certification in accordance with Division 27 Section "Communications Shop Drawings and Submittals".

C. Product Data as follows:
   1. Bill-of-materials with part number listing of all system components, cabling, and accessories
   2. Datasheets for each type of cabling to be provided
   3. Short-form datasheets (not full user manuals—please save those for the O&M manual!) providing part numbers and basic physical and performance specifications of each Major System Component (as defined above)
   4. Datasheets for mounting hardware including load capacities

D. Shop Drawings:
   1. Floor plans and/or reflected ceiling plans showing the physical locations of devices for each system.
   2. Diagrams for power, signal, and control wiring for each type of system
   3. Rack elevations

1.06 INFORMATIONAL SUBMITTALS

A. Qualification Data: For installer/integrator, qualified layout technician, installation supervisor, and field inspector.

1.07 CLOSEOUT SUBMITTALS

A. Hardware Operational Documentation:
   1. User manuals, preferably in electronic form, for each Major System Component (as defined in 1.5(B) above).

B. Software and Firmware Operational Documentation:
   1. Software operating and upgrade manuals.
   2. Program Software Backup: On compact disk or USB flash drive, complete with data files.
   3. Device address list.

1.08 QUALITY ASSURANCE

A. Installer Qualifications:

1. The proposing contractor and the installing contractor must be the same company. No subcontractor to the proposing audio-video contractor will be allowed for any portion of the audio-video scope of work.
2. The projector system installer shall meet all applicable regulations of the State of Texas and Department of Labor insofar as they apply to this type of system. The bidder shall be a firm normally employed in the audio-video industry and shall provide a reference list of five (5) projects of comparable size or larger and contact names confirming successful completion.
3. The bidder shall have an authorized service center within 75 miles of the project's location for the brand of equipment that is submitted for bid. The Owner reserves the right to perform an onsite inspection.
4. The bidder must produce a letter from the manufacturer guaranteeing the delivery of all the equipment outlined in the specification herein.

B. Standards: All work shall be performed in accordance with the latest revisions of the following standards and codes:
1. NFPA 70 – National Electrical Code.
2. Local Codes and Amendments.

C. Other References:
1. EIA/TIA-569 Commercial Building Standard for Telecommunication Pathways and Spaces.
2. TIA/EIA-606 The Administration Standard for the Telecommunications Infrastructure of Commercial Buildings.
3. TIA/EIA-607 Commercial Building Grounding and Bonding Requirements for Telecommunications.

1.09 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to repair or replace components of AV system(s) that fail in materials or workmanship within one year, or period specified in products section.

B. Special Warranty: Installer agrees to repair AV System(s) and/or replace components, cabling, etc. that fail in materials or workmanship within specified warranty period.
1. Special Warranty Period: One year from date of Substantial Completion.

PART 2 PRODUCTS

2.01 GENERAL

A. Incidental and Miscellaneous Appurtenances: Contractor shall include in his bid and provide all incidental and/or miscellaneous appurtenances, including but not limited to power supplies, expansion cards, brackets, etc. as required for a complete and operational system with all functionalities specified herein, whether or not such appurtenances are identified herein.

B. Materials: Materials shall be as listed or shall be approved equivalent products of other manufacturers meeting the intent and quality level of the TIA/EIA specifications.

C. All products shall be new and brought to the job site in the original manufacturer's packaging.

D. Electrical components (including innerduct) shall bear NRTL and FCC listings as required by applicable law.

2.02 CONFERENCE ROOM AV

A. Refer to section 274116.23 for products and procedures specific to this scope.

2.03 LGI AV

A. Refer to section 274116.50 for products and procedures specific to this scope.

2.04 CLASSROOM AV

A. Refer to section 274116.51 for products and procedures specific to this scope.

2.05 SPORTS FIELD AV

A. Refer to section 274116.65 for products and procedures specific to this scope.

2.06 DANCE ROOM AV

A. Refer to section 274116.71 for products and procedures specific to this scope.

2.07 ACCESSORIES

A. I/O Plates: Provide Input/Output Plates per the basis of design indicated on drawings. Subject to requirements, provide plates by Penn Elcom, RDL, Whirlwind, or approved equals.

B. Connectors: Provide connectors at Input/Output Plates per the basis of design indicated on drawings. Subject to requirements, provide connectors by Leviton, Neutrik, or approved equals.

PART 3 EXECUTION

3.01 PREPARATION

A. Furnish in a timely fashion all floor boxes, back boxes, and other specialty enclosures and appurtenances which are to be installed by other trades.

3.02 GENERAL EQUIPMENT INSTALLATION

A. Comply with NECA 1.

B. Furnish cabling, plates, and labor necessary for the complete installation of the AV System architectural infrastructure, in full accordance with the recommendations of the equipment manufacturers and the requirements of the drawings and specifications.

C. Refer to division 27 section AUDIO-VIDEO CABLING AND ACCESSORIES for detailed requirements and standards applicable to cabling.

D. Equipment shall be fixed firmly in place with proper types of mounting hardware. Equipment affixed to the building structure shall be self-supporting with a safety factor not less than three U.O.N.

3.03 SEQUENCED RACK POWER CONNECTIONS

A. Connect the following equipment to constant (non-sequenced) power: Network Switches, Rack Lighting, Control System Processors & Interfaces

B. Connect equipment to power sequencer steps as follows:
   1. Audio DSPs, Video Switchers, and Processors (where applicable)
   2. Powered extenders, Wireless Microphones, Media Players, Assistive Listening
   3. Power Amplifiers, Powered Loudspeakers

C. Exact sequence may vary according to equipment requirements, but in general, amplifiers should turn on last and turn off first to avoid speaker damage from switching transients

3.04 IDENTIFICATION

A. Label each cable at both ends using machine-printed adhesive or heat shrink labels.

B. Labels shall include identifying information corresponding to cabling diagram provided in shop drawing and Operator Manual submittals.

3.05 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months from date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

3.06 SOFTWARE SERVICE AGREEMENT

A. Technical Support: Beginning at Substantial Completion, service agreement shall include software support for not less than two years.

3.07 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain units. Separate training shall be provided for each type of system installed.

END OF SECTION

SECTION 27 4116.28
INTEGRATED AUDIO-VIDEO SYSTEMS AND EQUIPMENT FOR CONFERENCE ROOMS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Installation of owner-furnished flat panel displays and display mounts
   2. Provide audio-video infrastructure as described herein and on drawings, including:
      a. Cabling and plates
      b. Other infrastructure and accessories appurtenant to the AV functions of the room

B. Reference Project drawings for locations, quantities, and coordination with other trades.

C. Related Requirements:
   1. Division 27 Section "Integrated Audio-Video Systems and Equipment - Common Requirements for common requirement applicable to all AV systems.
   2. Division 27 Section “Audio-Video Cabling and Accessories” for system cabling and accessories and related procedures and standards.

PART 2 PRODUCTS

2.01 MAJOR SYSTEM COMPONENTS: HDBASET & AV-OVER-IP SIGNAL EXTENDERS

A. HDBaseT Transmitter/Receiver Pair, Wall Plate Transmitter Type: (F1)
   1. Transmitter and receiver device shall permit HDCP-compliant transport of 4k60, 4:2:0 HDMI video from input location to destination over twisted pair cabling.
   2. Device shall be US 1-gang wall plate form factor.
   3. Devices shall receive power via HDBaseT output.
   4. Basis-of-Design Product: Subject to compliance with requirements, provide Liberty #DL-1H1A-WPKT-W or comparable product by one of the following:
      a. Aten
      b. Atlona
      c. Crestron
      d. Extron
      e. Kramer
      f. Liberty AV

PART 3 EXECUTION

3.01 OFCI DEVICE INSTALLATION

A. Install flat panel displays and display mounts provided by owner at display location shown on plans.

END OF SECTION

SECTION 27 4116.50
INTEGRATED AUDIO-VIDEO SYSTEMS AND EQUIPMENT FOR LGI

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Provide complete instructional audio-video systems as described herein and on drawings, including:
      a. Ceiling-mounted projector display systems
      b. Display mounts
      c. Local sound and Voice Enhancement systems
      d. Integrated touch screen control hardware and software appurtenant to the above
      e. Cabling, plates, and other infrastructure appurtenant to the above

B. Reference Project drawings for locations, quantities, and coordination with other trades.

C. Related Requirements:
   1. Division 27 Section "Integrated Audio-Video Systems and Equipment - Common Requirements for common requirement applicable to all AV systems.
   2. Division 27 Section “Audio-Video Cabling and Accessories” for system cabling and accessories and related procedures and standards.

PART 2 PRODUCTS

2.01 MAJOR SYSTEM COMPONENTS: DISPLAYS

A. Projector, LGI: (VP-L1)
   1. Provide 7,000 Lumen Video Projector with 20000-hour maintenance free laser-phosphor light source, standard lens, and WUXGA minimum native resolution.
   2. Basis-of-Design Product: Subject to compliance with requirements, provide Epson #Powerlite L730U or comparable product by one of the following:
      a. Epson
      b. NEC
      c. Panasonic
   3. Basis-of-Design Mount: Subject to compliance with requirements, provide Chief #RPMAUW plus mounting column, structural attachment bracket(s), and ceiling escutcheon, or comparable product by one of the following:
      a. Peerless Mounts
      b. Projector Manufacturer

2.02 MAJOR SYSTEM COMPONENTS: LOUDSPEAKERS

A. LGI Speakers: (SL).
   1. Ceiling-mounted high-output distributed loudspeaker with 6” cone LF, coaxial HF, and integral 70V transformer.
   2. Tap at 68W.
   3. Basis-of-Design Product: Subject to compliance with requirements, provide JBL #Control 226C/T or comparable product by one of the following:
      a. Community
      b. Electro-Voice (EV)
      c. QSC
      d. Tannoy
      e. Yamaha

2.03 MAJOR SYSTEM COMPONENTS: AMPLIFIERS

A. Audio Power Amp, LGI (AMP-L1)
   1. Amp shall provide two channels of amplification for 70V speaker zones, with 300W per channel
   2. Amp shall include auxiliary contacts for power-down on fire alarm.
   3. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
      a. Ashly
      b. Lab Gruppen
      c. QSC
      d. Yamaha

2.04 MAJOR SYSTEM COMPONENTS: SIGNAL SWITCHING AND PROCESSING

A. Audio DSP: (DSP-L)
   1. DSP shall facilitate mixing and routing of audio
   2. DSP shall include ethernet and RS232 control
   3. Provide extra I/O break-in/breakouts to facilitate input/output configuration indicated on one-line diagram.
   4. Basis-of-Design Product: Subject to compliance with requirements, provide BSS #BLU-100 or comparable product by one of the following:
      a. Crestron
      b. Extron
      c. Kramer
      d. QSC

B. Video Presentation Switcher / Audio Demux: (VSD-L1)
   1. Switcher shall accept HDBaseT and HDMI sources and provide means to scale and switch video signals from its inputs to HDBaseT and HDMI outputs.
   2. Switcher shall provide de-multiplexed audio output from the presently selected video to the DSP.
   3. Switcher shall accept RS-232 control
   4. Basis-of-Design Product: Subject to compliance with requirements, provide Kramer #VP-440H2 or comparable product by one of the following:
      a. AMX
      b. Aten
      c. Atlona
      d. Crestron
      e. Extron
      f. Intelix
      g. Key Digital

2.05 MAJOR SYSTEM COMPONENTS: SIGNAL SOURCES

A. Network Media/CD/Bluetooth Audio Player (MP-L1)
   1. Minimum Supported media sources: CD, USB, Bluetooth
   2. Minimum Supported Bluetooth profiles: A2DP and/or AVRCP.
   3. Features:
      a. Tempo control for playback.
      b. Web-browser based network control.
      c. Infrared remote.
   4. Player shall be rack-mountable, 1U form factor.

5. Basis-of-Design Product: Subject to compliance with requirements, provide Denon DN-700CB or comparable product.

2.06 MAJOR SYSTEM COMPONENTS: HDBASET & AV-OVER-IP SIGNAL EXTENDERS

A. HDBaseT Transmitter, Wall Plate Type: (VTX-L1)
   1. Transmitter device shall permit HDCP-compliant transport of 4k60, 4:2:0 HDMI video from input location to destination over twisted pair cabling.
   2. Device shall be US 1-gang wall plate form factor.
   3. Devices shall receive power via HDBaseT output.
   4. Basis-of-Design Product: Subject to compliance with requirements, provide Kramer #WP-789T or comparable product by one of the following:
      a. Aten
      b. Atlona
      c. Crestron
      d. Extron
      e. Kramer
      f. Liberty AV

2.07 MAJOR SYSTEM COMPONENTS: RF TRANSMITTERS, RECEIVERS, AND ANTENNAS

A. Wireless Microphone Systems: (WMRX-L1, WMRX-L2, WMRX-L3)
   1. Provide UHF wireless microphone transmitter/receiver pair
   2. Provide rechargeable battery for each transmitter.
   3. Provide 2-space charging dock for each room.
   4. LGI shall have two beltpack transmitters with lavalier and one handheld transmitter.
   5. Dance shall have one beltpack transmitter with headset.
   6. Basis-of-Design Product: Subject to compliance with requirements, provide (2) Shure #QLXD24/SM58 (handheld kit), and (1) #QLXD14/85 (lav kit), or comparable product by one of the following:
      a. Audio Technica 3000 Series
      b. Sennheiser EW-D Series

B. Wireless Microphone Antenna Distribution: (WMAD-L1)
   1. Provide 4-way antenna distribution system for distribution of antenna signal to LGI mic receivers.
   2. Basis-of-Design Product: Subject to compliance with requirements, provide Shure #UA844+SWB or comparable product by one of the following:
      a. RFVenue
      b. Sennheiser

C. Wireless Microphone Architectural Remote Antenna
   1. Provide dual-feed Architectural diversity antenna for UHF wireless microphones.
   2. Color of antenna to be white
   3. Basis-of-Design Product: Subject to compliance with requirements, provide RFVenue #D-ARC

D. Assistive Listening: (TAS-TX)
   1. Unit shall provide compliant assistive listening service for accessibility via FM beltpack packaged with unit or via wifi transmission to mobile app
   2. Connect network to owner data network for streaming of accessible audio.
   3. Basis-of-Design Product: Subject to compliance with requirements, provide Williams #FM 558 Pro or approved equal.

2.08 MAJOR SYSTEM COMPONENTS: CONTROL SYSTEM PROCESSOR & INTERFACES

A. Control Processor: (CP-L1)
   1. Processor shall facilitate custom, integrated control programming for control of all AV system devices, integration with lighting and shade controls, etc. in space
   2. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
      a. Crestron
      b. Extron
      c. Kramer
      d. QSC

B. 7” Touch Screen Control: (CT-L1)
   1. 7” Recessed Mount Programmable Touch Screen Controller with Custom Graphical Interface
   2. LGI touchscreen to mount on wall near input plate as noted.
   3. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
      a. Crestron
      b. Extron
      c. Kramer
      d. QSC

C. AV Control Network Switch, 5-port (NSW-L1):
   1. Provide 5-port, Unmanaged Gigabit network switch for AV Control Network
   2. Switch to be PoE+ (802.3at) enabled, 83W total power budget.
   3. Subject to requirements, provide product indicated on drawings or comparable product manufactured by one of the following:
      a. Aruba
      b. Cisco
      c. Crestron
      d. Extreme Networks
      e. Netgear

2.09 ACCESSORIES

A. I/O Plates: Provide Input/Output Plates per the basis of design indicated on drawings. Subject to requirements, provide plates by Penn Elcom, RDL, Whirlwind, or approved equals.

B. Connectors: Provide connectors at Input/Output Plates per the basis of design indicated on drawings. Subject to requirements, provide connectors by Leviton, Neutrik, or approved equals.

PART 3 EXECUTION

3.01 SEQUENCED RACK POWER CONNECTIONS

A. Connect the following equipment to constant (non-sequenced) power: Network Switches, Rack Lighting, Control System Processors & Interfaces

B. Connect equipment to power sequencer steps as follows:
   1. Audio DSPs, Video Switchers, and Processors (where applicable)
   2. Powered extenders, Wireless Microphones, Media Players, Assistive Listening
   3. Power Amplifiers, Powered Loudspeakers

C. Exact sequence may vary according to equipment requirements, but in general, amplifiers should turn on last and turn off first to avoid speaker damage from switching transients

3.02 FIELD QUALITY CONTROL & SYSTEM STARTUP

A. Initial Testing and Pre-Startup Testing:
   1. Perform field-survey of site RF conditions for use in startup of wireless microphones and other RF systems
   2. Test speaker zone wiring with an Audio Impedance Tester after speaker installation and prior to connecting and powering on amplifiers to check for shorts, opens, and overload conditions.

B. Startup Service.
   1. Connect power as described above.
   2. Complete equipment installation and startup checks according to manufacturer's written instructions.
   3. Set up peak limiters on each DSP output to amplifiers for loudspeaker protection.
   4. Set coordinated radio channels on wireless microphone systems, assistive listening systems, etc. using RF survey data collected in pre-startup and mic manufacturer’s frequency coordination software.
   5. Verify each wired AV signal path passes signal.
   6. Set equalization curves and delays on loudspeakers as needed to deliver clear intelligible audio to occupants.
   7. Update firmware and software on all installed equipment to latest available version
   8. Load control system program into control processors and verify all control functions operate correctly. Set limits (or coordinate with system supplier to set limits) on projection screens, shade controls, etc.

C. Prepare test and inspection reports.

3.03 FINAL ACCEPTANCE TESTING WITH OWNER

A. Upon completion of initial tests and delivery of all documents, diagrams, and project record drawings, notify the Architect in writing that the installation has been completed in accordance with the requirements of the specification and is ready for inspection by representatives of the Owner.
   a. Acceptance testing will include operation by the Owner of each major system and other components (i.e., microphones, consoles, racks, loudspeakers, etc.) deemed necessary. Contractor will assist as necessary in this testing.
   b. In the event the need for further adjustments or work becomes evident during acceptance testing, the Contractor will continue his work until system is acceptable at no additional cost to the Owner.

B. Contractor shall provide a Final Acceptance Test record document signed by both the Contractor and the Owner or designated Owner’s Representative establishing the “In Warranty” date. The warranty period will not commence until the Final Acceptance Test is completed.

C. Be prepared to verify the performance of any portion of the installation by demonstration, listening and viewing test, and instrumented measurements. Make additional adjustments within the scope of work and which are deemed necessary by the Owner because of the acceptance test.

3.04 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months from date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

3.05 SOFTWARE SERVICE AGREEMENT

A. Technical Support: Beginning at Substantial Completion, service agreement shall include software support for not less than two years.

3.06 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain units.

END OF SECTION

SECTION 27 4116.51
INTEGRATED AUDIO-VIDEO SYSTEMS AND EQUIPMENT FOR CLASSROOMS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Installation of owner-furnished flat panel displays and display mounts.
   2. Provide complete instructional audio-video systems as described herein and on drawings, including:
      a. Local sound and Voice Enhancement systems
      b. Cabling and plates
      c. Other infrastructure appurtenant to the above

B. Reference Project drawings for locations, quantities, and coordination with other trades.

C. Related Requirements:
   1. Division 27 Section "Integrated Audio-Video Systems and Equipment - Common Requirements for common requirement applicable to all AV systems.
   2. Division 27 Section “Audio-Video Cabling and Accessories” for system cabling and accessories and related procedures and standards.

PART 2 PRODUCTS

2.01 MAJOR SYSTEM COMPONENTS: HDBASET & AV-OVER-IP SIGNAL EXTENDERS

A. HDBaseT Transmitter/Receiver Pair, Wall Plate Type Transmitter, with USB: (TS)
   1. Transmitter device shall permit HDCP-compliant transport of 4k60, 4:2:0 HDMI video from input location to destination over twisted pair cabling.
   2. Device shall be US 1-gang wall plate form factor.
   3. Transmitter shall receive power via HDBaseT output.
   4. System shall include USB extender
   5. Basis-of-Design Product: Subject to compliance with requirements, provide Liberty #DL-1H1A1U or comparable product by one of the following:
      a. Aten
      b. Atlona
      c. Crestron
      d. Extron
      e. Kramer
      f. Liberty AV

2.02 MAJOR SYSTEM COMPONENTS: VOICE ENHANCEMENT SYSTEM COMPONENTS

A. Typical Classroom Voice Enhancement System: (TA)
   1. Description: Provide complete packaged classroom voice enhancement solution with integral loudspeaker in plenum-rated ceiling box.
   2. System amplifier and processing equipment shall be housed in ceiling plenum box
   3. Where multiple 'TA's are shown in a room, they shall be interconnected to function as a single system per manufacturer instructions.
   4. Connect teaching display analog output with 3.5mm input on 'TA's.
   5. Set up / pair microphone accessories per manufacturer instructions.
   6. Products: Subject to compliance with requirements provide the following for each classroom where one or more 'TA's is indicated:
      a. Lightspeed Topcat (#TCN) In-ceiling Classroom Audio System. For rooms with multiple 'TA' devices shown, provide the quantity indicated.
      b. Lightspeed Flexmike (#FMN) Pendant-Style RF wireless teacher microphone

c. Lightspeed Sharemike (#SMN) Handheld RF wireless studend microphone
d. Lightspeed microphone cradle charger(s) with space for all microphones provided.

2.03 ACCESSORIES

A. I/O Plates: Provide Input/Output Plates per the basis of design indicated on drawings. Subject to requirements, provide plates by Penn Elcom, RDL, Whirlwind, or approved equals.

B. Connectors: Provide connectors at Input/Output Plates per the basis of design indicated on drawings. Subject to requirements, provide connectors by Leviton, Neutrik, or approved equals.

PART 3 EXECUTION

3.01 OFCI DEVICE INSTALLATION

A. Install flat panel displays and display mounts provided by owner at display location shown on plans.

END OF SECTION

SECTION 27 4116.65
INTEGRATED AUDIO-VIDEO SYSTEMS AND EQUIPMENT FOR SPORTS FIELDS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Provide complete instructional audio-video systems as described herein and on drawings, including:
      a. Local sound systems
      b. Integrated control hardware and programming
      c. Cabling and platesother infrastructure appurtenant to the above
      d. Other infrastructure appurtenant to the above

B. Reference Project drawings for locations, quantities, and coordination with other trades.

C. Related Requirements:
   1. Division 27 Section "Integrated Audio-Video Systems and Equipment - Common Requirements for common requirement applicable to all AV systems.
   2. Division 27 Section “Audio-Video Cabling and Accessories” for system cabling and accessories and related procedures and standards.

PART 2 PRODUCTS

2.01 MAJOR SYSTEM COMPONENTS: LOUDSPEAKERS

A. Press-Box Mounted Speakers: (SP).
   1. Press-box mounted, high-output loudspeaker with 12” cone LF, coaxial HF, and integral 70V transformer.
   2. Speakers to be weather resistant, rated for installation outdoors.
   3. Provide compete with yoke and hard for mounting to press box.
   4. Connect to amp in low-impedance configuration per manufacturer instructions..
   5. Basis-of-Design Product: Subject to compliance with requirements, provide Community R.25-94z or comparable product by one of the following:
      a. Electro-Voice (EV)
      b. JBL
      c. Others by Engineer Approval.

2.02 MAJOR SYSTEM COMPONENTS: AMPLIFIERS

A. Audio Power Amp, Large Zones (AMP-Px).
   1. Amp shall provide two channels of amplification, with 600W nominal per channel
   2. Basis-of-Design Product: Subject to compliance with requirements, provide Crown #DCi2|600 or comparable product by one of the following:
      a. Ashly
      b. Lab Gruppen
      c. QSC
      d. Yamaha

2.03 MAJOR SYSTEM COMPONENTS: SIGNAL SWITCHING AND PROCESSING

A. Audio DSP: (DSP-Px)
   1. DSP shall facilitate mixing and routing of audio
   2. DSP shall include ethernet and RS232 control
   3. Provide extra I/O break-in/breakouts to facilitate input/output configuration indicated on one-line diagram.

4. Basis-of-Design Product: Subject to compliance with requirements, provide BSS #BLU-100 or comparable product by one of the following:
   a. Crestron
   b. Extron
   c. Kramer
   d. QSC

2.04 MAJOR SYSTEM COMPONENTS: SIGNAL SOURCES

A. Network Media/CD/Bluetooth Audio Player (MP-L1, MP-D1)
   1. Minimum Supported media sources: CD, USB, Bluetooth
   2. Minimum Supported Bluetooth profiles: A2DP and/or AVRCP.
   3. Features:
      a. Tempo control for playback.
      b. Web-browser based network controlnfrared remote.
      c. nfrared remote.
   4. Player shall be rack-mountable, 1U form factor.
   5. Basis-of-Design Product: Subject to compliance with requirements, provide Denon DN-700CB or comparable product.

2.05 MAJOR SYSTEM COMPONENTS: RF TRANSMITTERS, RECEIVERS, AND ANTENNAS

A. Wireless Microphone Systems: (WMRX-Px)
   1. Provide UHF wireless microphone transmitter/receiver pair
   2. Provide rechargeable battery for each transmitter.
   3. Provide 2-space charging dock for each room.
   4. LGI shall have two beltpack transmitters with lavalier and one handheld transmitter.
   5. Dance shall have one beltpack transmitter with headset.
   6. Basis-of-Design Product: Subject to compliance with requirements, provide Shure #QLXD24/SM58 (handheld kit), #QLXD14/85 (lav kit), one of each type per pressbox, or comparable product by one of the following:
      a. Audio Technica 3000 Series
      b. Sennheiser EW-D Series

B. Wireless Microphone Antenna Distribution: (WMAD-1)
   1. Provide RF splitter and bias tees for connection of antennas to sound system per manufacturer instructions. Mount antennas on front of rack.

2.06 MAJOR SYSTEM COMPONENTS: CONTROL SYSTEM PROCESSOR & INTERFACES

A. Control Panel: (CP-Px):
   1. Provide network-connected remote for DSP. Unit shall be PoE powered and programmed to control volume, and source selection on DSP.
   2. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by DSP manufacturer.

B. AV Control Network Switch, 5-port (NSW-L1, NSW-D1):
   1. Provide 5-port, Unmanaged Gigabit network switch for AV Control Network
   2. Switch to be PoE+ (802.3at) enabled, 83W total power budget.
   3. Subject to requirements, provide product indicated on drawings or comparable product manufactured by one of the following:
      a. Aruba
      b. Cisco
      c. Crestron
      d. Extreme Networks

e. Netgear

2.07 ACCESSORIES

A. I/O Plates: Provide Input/Output Plates per the basis of design indicated on drawings. Subject to requirements, provide plates by Penn Elcom, RDL, Whirlwind, or approved equals.

B. Connectors: Provide connectors at Input/Output Plates per the basis of design indicated on drawings. Subject to requirements, provide connectors by Leviton, Neutrik, or approved equals.

PART 3 EXECUTION

3.01 EXTERIOR INSTALLATION REQUIREMENTS

A. In addition to general installation requirements, the following shall apply to sports field systems:
   1. Weather seal penetrations through building exterior walls using silicone sealant or similar.
   2. Caulk or seal around top and sides of all plates, speaker brackets, etc. installed on building exterior

B. The following modifications to the general installation requirements shall apply to sports field systems:
   1. In lieu of plenum-rated cabling, provide cabling rated for exterior damp location use. Cabling shall be UV and weather resistant.

3.02 SEQUENCED RACK POWER CONNECTIONS

A. Connect the following equipment to constant (non-sequenced) power: Network Switches, Rack Lighting, Control System Processors & Interfaces

B. Connect equipment to power sequencer steps as follows:
   1. Audio DSPs, Video Switchers, and Processors (where applicable)
   2. Powered extenders, Wireless Microphones, Media Players, Assistive Listening
   3. Power Amplifiers, Powered Loudspeakers

C. Exact sequence may vary according to equipment requirements, but in general, amplifiers should turn on last and turn off first to avoid speaker damage from switching transients

3.03 FIELD QUALITY CONTROL & SYSTEM STARTUP

A. Initial Testing and Pre-Startup Testing:
   1. Perform field-survey of site RF conditions for use in startup of wireless microphones and other RF systems
   2. Test speaker zone wiring with an Audio Impedance Tester after speaker installation and prior to connecting and powering on amplifiers to check for shorts, opens, and overload conditions.

B. Startup Service.
   1. Connect power as described above.
   2. Complete equipment installation and startup checks according to manufacturer's written instructions.
   3. Set up peak limiters on each DSP output to amplifiers for loudspeaker protection.
   4. Set coordinated radio channels on wireless microphone systems, assistive listening systems, etc. using RF survey data collected in pre-startup and mic manufacturer’s frequency coordination software.
   5. Verify each wired AV signal path passes signal.
   6. Set equalization curves and delays on loudspeakers as needed to deliver clear intelligible audio to occupants.
   7. Update firmware and software on all installed equipment to latest available version

8. Load control system program into control processors and verify all control functions operate correctly. Set limits (or coordinate with system supplier to set limits) on projection screens, shade controls, etc.

C. Prepare test and inspection reports.

3.04 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months from date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

3.05 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain units.

END OF SECTION

SECTION 27 4116.71
INTEGRATED AUDIO-VIDEO SYSTEMS AND EQUIPMENT FOR DANCE REHEARSAL ROOM

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Provide complete instructional audio-video systems as described herein and on drawings, including:
      a. Local sound systems
      b. Integrated touch screen control hardware and software.
      c. Cabling and plates.
      d. Other infrastructure appurtenant to the above.

B. Reference Project drawings for locations, quantities, and coordination with other trades.

C. Related Requirements:
   1. Division 27 Section "Integrated Audio-Video Systems and Equipment - Common Requirements for common requirement applicable to all AV systems.
   2. Division 27 Section “Audio-Video Cabling and Accessories” for system cabling and accessories and related procedures and standards.

PART 2 PRODUCTS

2.01 MAJOR SYSTEM COMPONENTS: LOUDSPEAKERS

A. Dance Gym Speakers: (SG).
   1. Ceiling-mounted high-output distributed loudspeaker with 12” cone LF, coaxial HF, and integral 70V transformer.
   2. Provide compete with back can and clamps for mounting to exposed structure.
   3. Connect speakers to amp in low impedance configuration, two speakers per channel.
   4. Basis-of-Design Product: Subject to compliance with requirements, provide JBL #Control 322C or comparable product by one of the following:
      a. Community
      b. Electro-Voice (EV)
      c. Tannoy

2.02 MAJOR SYSTEM COMPONENTS: AMPLIFIERS

A. Audio Power Amp, Large Zones (AMP-D1).
   1. Amp shall provide four channels of amplification, with 600W per channel
   2. Amp shall include auxiliary contacts for power-down on fire alarm.
   3. Basis-of-Design Product: Subject to compliance with requirements, provide Crown #DCi4|600 or comparable product by one of the following:
      a. Ashly
      b. Lab Gruppen
      c. QSC
      d. Yamaha

2.03 MAJOR SYSTEM COMPONENTS: SIGNAL SWITCHING AND PROCESSING

A. Audio DSP: (DSP-D)
   1. DSP shall facilitate mixing and routing of audio
   2. DSP shall include ethernet and RS232 control
   3. Provide extra I/O break-in/breakouts to facilitate input/output configuration indicated on one-line diagram.

4. Basis-of-Design Product: Subject to compliance with requirements, provide BSS #BLU-100 or comparable product by one of the following:
   a. Crestron
   b. Extron
   c. Kramer
   d. QSC

2.04 MAJOR SYSTEM COMPONENTS: SIGNAL SOURCES

A. Network Media/CD/Bluetooth Audio Player (MP-L1, MP-D1)
   1. Minimum Supported media sources: CD, USB, Bluetooth
   2. Minimum Supported Bluetooth profiles: A2DP and/or AVRCP.
   3. Features:
      a. Tempo control for playback.
      b. Web-browser based network controlnfrared remote.
      c. nfrared remote.
   4. Player shall be rack-mountable, 1U form factor.
   5. Basis-of-Design Product: Subject to compliance with requirements, provide Denon DN-700CB or comparable product.

2.05 MAJOR SYSTEM COMPONENTS: RF TRANSMITTERS, RECEIVERS, AND ANTENNAS

A. Wireless Microphone Systems: (WMRX-D1)
   1. Provide UHF wireless microphone transmitter/receiver pair
   2. Provide rechargeable battery for each transmitter.
   3. Provide 2-space charging dock for each room.
   4. LGI shall have two beltpack transmitters with lavalier and one handheld transmitter.
   5. Dance shall have one beltpack transmitter with headset.
   6. Basis-of-Design Product: Subject to compliance with requirements, provide Shure #QLXD24/SM58 (handheld kit), #QLXD14/85 (lav kit), and #QLXD14/SM35 (headset kit), or comparable product by one of the following:
      a. Audio Technica 3000 Series
      b. Sennheiser EW-D Series

2.06 MAJOR SYSTEM COMPONENTS: CONTROL SYSTEM PROCESSOR & INTERFACES

A. Control Processor: (CP-2)
   1. Processor shall facilitate custom, integrated control programming for control of all AV system devices, integration with lighting and shade controls, etc. in space
   2. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
      a. Crestron
      b. Extron
      c. Kramer
      d. QSC

B. 7” Touch Screen Control: (CT-D1)
   1. 7” Recessed Mount Programmable Touch Screen Controller with Custom Graphical Interface
   2. LGI touchscreen to mount on wall near input plate as noted.
   3. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
      a. Crestron
      b. Extron

c. Kramer
d. QSC

C. AV Control Network Switch, 5-port (NSW-D1):
1. Provide 5-port, Unmanaged Gigabit network switch for AV Control Network
2. Switch to be PoE+ (802.3at) enabled, 83W total power budget.
3. Subject to requirements, provide product indicated on drawings or comparable product manufactured by one of the following:
a. Aruba
b. Cisco
c. Crestron
d. Extreme Networks
e. Netgear

2.07 ACCESSORIES

A. I/O Plates: Provide Input/Output Plates per the basis of design indicated on drawings. Subject to requirements, provide plates by Penn Elcom, RDL, Whirlwind, or approved equals.

B. Connectors: Provide connectors at Input/Output Plates per the basis of design indicated on drawings. Subject to requirements, provide connectors by Leviton, Neutrik, or approved equals.

PART 3 EXECUTION

3.01 SEQUENCED RACK POWER CONNECTIONS

A. Connect the following equipment to constant (non-sequenced) power: Network Switches, Rack Lighting, Control System Processors & Interfaces

B. Connect equipment to power sequencer steps as follows:
1. Audio DSPs, Video Switchers, and Processors (where applicable)
2. Powered extenders, Wireless Microphones, Media Players, Assistive Listening
3. Power Amplifiers, Powered Loudspeakers

C. Exact sequence may vary according to equipment requirements, but in general, amplifiers should turn on last and turn off first to avoid speaker damage from switching transients

3.02 FIELD QUALITY CONTROL & SYSTEM STARTUP

A. Initial Testing and Pre-Startup Testing:
1. Perform field-survey of site RF conditions for use in startup of wireless microphones and other RF systems
2. Test speaker zone wiring with an Audio Impedance Tester after speaker installation and prior to connecting and powering on amplifiers to check for shorts, opens, and overload conditions.

B. Startup Service.
1. Connect power as described above.
2. Complete equipment installation and startup checks according to manufacturer's written instructions.
3. Set up peak limiters on each DSP output to amplifiers for loudspeaker protection.
4. Set coordinated radio channels on wireless microphone systems, assistive listening systems, etc. using RF survey data collected in pre-startup and mic manufacturer’s frequency coordination software.
5. Verify each wired AV signal path passes signal.
6. Set equalization curves and delays on loudspeakers as needed to deliver clear intelligible audio to occupants.
7. Update firmware and software on all installed equipment to latest available version

8. Load control system program into control processors and verify all control functions operate correctly. Set limits (or coordinate with system supplier to set limits) on projection screens, shade controls, etc.

C. Prepare test and inspection reports.

3.03 FINAL ACCEPTANCE TESTING WITH OWNER

A. Upon completion of initial tests and delivery of all documents, diagrams, and project record drawings, notify the Architect in writing that the installation has been completed in accordance with the requirements of the specification and is ready for inspection by representatives of the Owner.
   a. Acceptance testing will include operation by the Owner of each major system and other components (i.e., microphones, consoles, racks, loudspeakers, etc.) deemed necessary. Contractor will assist as necessary in this testing.
   b. In the event the need for further adjustments or work becomes evident during acceptance testing, the Contractor will continue his work until system is acceptable at no additional cost to the Owner.

B. Contractor shall provide a Final Acceptance Test record document signed by both the Contractor and the Owner or designated Owner's Representative establishing the "In Warranty" date. The warranty period will not commence until the Final Acceptance Test is completed.

C. Be prepared to verify the performance of any portion of the installation by demonstration, listening and viewing test, and instrumented measurements. Make additional adjustments within the scope of work and which are deemed necessary by the Owner because of the acceptance test.

3.04 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months from date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

3.05 SOFTWARE SERVICE AGREEMENT

A. Technical Support: Beginning at Substantial Completion, service agreement shall include software support for not less than two years.

3.06 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain units.

END OF SECTION

SECTION 27 4116

INTEGRATED AUDIO/VIDEO SYSTEMS AND EQUIPMENT

PART 1 - GENERAL

1.01 SUMMARY

A. Integrated Audio-Video Systems and Equipment as part of the Work.

1.02 RELATED DOCUMENTS

A. General provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections apply to this section.

B. Reference the Project Manual for related specification sections.

C. Reference the Project Drawings for additional information.

1.03 SECTION INCLUDES

A. Project instructions for the Contractor and System description details

B. System product description

C. Project completion instructions for the Contractor

1.04 RESPONSIBILITY

A. Responsibilities include, but are not limited to, the following items:

1. Provide materials, equipment, transportation, and labor necessary for a fully working, tested, and calibrated system. Supply accessories and minor equipment items (such as, but not limited to, power strips, adapters, connectors, mounting hardware, etc.) needed for a complete system, even if not specifically mentioned in these Specifications. Notify the Architect of any discrepancies in part numbers or quantities before bid. Failing to provide such notification, supply items and quantities according to the intent of the Specification and Drawings, without claim for additional payment.
2. Specifications and drawings are complementary. Work called for by one is binding as if called for by both. Any discrepancies between specifications and drawings shall be brought to the attention of the Architect for clarification during the bidding period. No allowance shall subsequently be made to the Contractor by reason of his failure to have brought said discrepancies to the attention of the Architect.
3. Execute work in accordance with the National Electrical Code (NEC), the National Electrical Safety Code, the Occupational Safety and Health Act (OSHA), applicable State and Local codes, ordinances, regulations, authority having jurisdiction (AHJ), and manufacturer's recommendations. If a conflict develops between the contract documents and the appropriate codes and is reported to the Architect prior to bid opening, the Architect will prepare the necessary clarification. Where a conflict is reported after contract award, propose a resolution of the conflict and, upon approval, perform Work.
4. Required licenses, insurance and permits including payment of charges and fees
5. Verification of dimensions and conditions at the job site.
6. Coordinate location and installation of equipment with other building elements.
7. Preparation of submittal information
8. Pick-up of Owner Furnished Equipment (OFE) and incorporation into project if applicable.
9. Development and implementation of control system software code and control panel layouts, which will become the property of the Owner
10. Final tests and adjustments, written report, and documentation

11. Instruction of operating personnel
12. Provision of manuals
13. Maintenance services and warranty.

1.05 REFERENCES

A. Published specification standards, tests or recommended methods of trade, industry or governmental organizations apply to Work in this section where cited below:
   1. American National Safety Institute (ANSI)
   2. American Society of Testing and Materials (ASTM)
   3. Electronics Industries Association (EIA)
   4. Federal Communications Commission (FCC)
   5. National Electrical Manufacturer's Association (NEMA)
   6. National Electrical Code (NEC)
   7. Underwriters Laboratories (UL)
   8. Occupational Safety and Health Administration (OSHA)
   9. Society of Motion Picture and Television Engineers (SMPTE)
   10. Building Industry Consulting Service International (BICSI)
   11. Davis and Davis, Sound System Engineering (3rd Edition) (SSE), Howard W. Sams, 2006
   12. Giddings, Audio System Design and Installation (ASDI), Howard W. Sams, 2013
   13. AV Installation Handbook Second Edition: The Best Practices for Quality Audiovisual Systems, Infocomm (AVIH), 2009

1.06 DEFINITIONS

A. In addition to those Definitions of Division1, the following list of terms as used in this specification shall be defined as follows:
   1. Furnish - To purchase, procure, acquire, and deliver complete with related accessories.
   2. Install – To set in place, join, attach, link, set up or otherwise connect together and test until complete before turning over to the Owner, all parts, items, or equipment supplied by Contractor.
   3. Provide – To furnish and install.

1.07 DESCRIPTIONS & REQUIREMENTS

A. The following is intended to further describe the Work and clarify design intent and is not an exhaustive description of the systems.

B. Auditorium
   1. Sound and Intercommunications Systems
      a. The audio system will provide audio support for theatrical and musical productions, video presentation, and general assembly.
      b. The main audio reinforcement system shall be comprised of a digital mixing console at the front-of-house (FOH) control position, as well as a left-center-right (LCR) loudspeaker above the stage facing the audience. A subwoofer array will be placed behind the center grouping of loudspeakers. Loudspeakers located on both sides of the auditorium will provide surround audio effects. Smaller Front-Fill loudspeakers will be recessed into the stage apron for audience members sitting too close to the stage to benefit from the loudspeakers overhead. Connections shall be provided on the stage and apron for additional input and output expansion to the audio system as necessary. Portable loudspeakers shall be provided to augment the audio system

as needed. Consultant will provide review options for various levels of complexity and cost for the main control console as part of the design process.

c. A BOH (Back-of-House) system shall be comprised of a distributed audio system, with loudspeakers in the dressing rooms, lobby, and related adjacencies. Audio source will be controlled thru the DSP at the FOH control position.

d. Sixteen (16) channels of wireless microphone receivers will be provided along with handheld, lavaliere, headset transmitters, rechargeable batteries including a spare battery for each channel. Microphone inputs from stage panels will be soft-patchable to any channel and will be controlled by the digital console. Microphone inputs will also be located above the stage at the center of the proscenium opening, and above the audience at the ceiling level. These inputs will be used for suspending microphones above the stage and audience, respectively. The system will also include an assortment of wired microphones, stands, and cables. These microphones shall be a mixture of dynamic, condenser, and specialty microphone kits for instruments and vocals.

e. Additional program sources at the FOH control position shall include a media recorder/player for recording and playback of program material, a media player for playback only, and a USB multi-channel sound card to facilitate computer audio playback and recording.

f. An assistive listening system will also be provided to accommodate the hearing impaired and must operate on FCC approved frequencies. The transmitting unit will be located in the amplifier rack and the antenna will be located at a remote location suitable to provide full coverage to the auditorium. Portable receivers will allow the users to be seated anywhere within the auditorium and will be equipped with a variety of listening devices including ear speakers, lightweight headsets, and inductive coil loops. Receivers are to be provided in configuration and quantity to meet current ADA standards.

g. A simple presentation audio sub-system, controlled from the stage manager's position (SMP) located at the side of the stage, will allow operation for less complex events without the use of the large mixing console at the FOH control position. This system shall include an analog mixer, two (2) channels of wireless microphones, a dedicated media player/recorder, and stereo auxiliary inputs. System presets will allow users to switch between the presentation system and the main control system.

h. The amplifier rack, located remotely in a dedicated room, will house the power amplifiers, digital signal processor (DSP), assistive listening transmitter, and other miscellaneous equipment. Signal feeds for the DSP will be supplied from the digital mixing console and the stage manager's analog mixer.

i. A production intercom system shall be provided to facilitate communication between the auditorium and supporting spaces. Intercom receptacles will be provided in these spaces for production staff use. The intercom system will be an independent four (4) channel system and the main station will be located in the amplifier rack. Intercom receptacles for belt-pack units will be located at the stage panels. Headset stations will be located in the FOH control position. Remote intercom stations will be located in the dressing rooms, as well as at selected catwalk locations. Paging will be possible into the performers' areas from the SMP equipment rack as determined in more detailed programming. Each zone will act independently, and the page signal will be preceded by a single chime tone activated by the page microphone push-to-talk button.

j. A power sequencing system will control the sequence in which the system's power is turned on and off. The system power will be controlled from both the FOH control position and the SMP equipment rack.

k. The Auditorium system will mute in case of a fire alarm and remain muted for the duration of the alarm. When the alarm condition has ended the system is to revert to the standard system configuration. This feature is to be implemented using control ports linked to system presets within the DSP system.

2. AV Presentation Systems
   a. The AV presentation system in the auditorium will include two side screens for projected display of video sources. The display will utilize a projection screen that is a fixed frame style and mounted directly to the wall.
   b. Provide two video projectors to enable display of video sources.
   c. All sources being shown through the AV system should be distributed from a rack-mounted matrix switcher. All sources have both video and audio components. Sources currently planned are:
      1) Video inputs from the Stage Manager's Rack
      2) Video inputs from the Front of House Rack.
      3) A video input from the center stage floor box.
      4) A video input from a stage wall plate
      5) Wireless Presentation System
      6) Blu-ray Player at FOH and SMP racks.
   d. Control of the AV presentation system (Projector power, screen up/down, source selection, etc.) should be simple and intuitive. Color touch screen control panels will be provided for use; one at the stage managers position one inside the control room, and one in the amp rack.
3. Video Monitoring
   a. A video monitoring system will allow a video image of on-stage events to be seen by individuals near the stage manager's position backstage, opposite stage position, dressing rooms, music rooms and lobby.
   b. Image capture shall be done with a camera mounted on the back wall of the Auditorium for capture of presentation or program. Camera shall be statically set on a wide shot view of stage area. The camera feed shall be sent to monitors in the following locations:
      1) Lobby – two wall-mounted monitors
      2) Green Room – one wall-mounted monitor
      3) Stage Right Position – one wall-mounted monitor
      4) Make Up Rooms – one wall-mounted monitor per space
4. Production AV Infrastructure
   a. A network of AV tie line connections will be located around the Auditorium that will allow AV signals to be sent to any other tie line locations within the Auditorium. These tie lines will allow multiple projectors to provide scenic backgrounds for theatrical productions or live video mapping throughout the Auditorium.
   b. Tie line connections will terminate in an equipment rack panel that serves as a patch bay. A loose equipment schedule is provided to include necessary components for temporary setup of theatrical video mapping.
   c. Two projectors will be provided for an edge blended rear projection setup to project theatrical scenery on the cyclorama. The edge blend from the projectors should be no less than 20% to allow a smooth transition of one large image approx. 18ft tall x 50ft wide. Field verification of all mounting locations, heights and projector lens

requirements will be necessary for this rear projected edge blended setup to be successful.

C. Black Box Theatre

1. A portable, rolling audio equipment rack will house the mixing console, source playback and processing equipment. The source equipment includes two CD players for effects and source playback. A dual channel wireless microphone system will be located in the portable rack. Additionally, there are auxiliary inputs located in a rack panel for connection of microphones or other playback sources like an MP3 player. Input/output panels for connection of this portable rack are located at two positions within the black box theater space adjacent to the lighting console connections.
2. Floor level input panels at multiple locations on the walls will provide for direct connection to the system. These panels will provide microphone inputs and also receptacles for four channels of effect speakers that are controlled from the mixing console.
3. The house or effects speaker arrangement provides portable speakers to use in any configuration. Yoke style brackets with pipe clamps are provided on all speakers to facilitate positioning them from the rigging grid. As noted above, the floor level input panels will also have speaker connections that will allow additional speakers to be used with or built into staging and props. Amplification is located in a separate rack in an adjacent storage room.
4. A wireless, single channel, radio frequency hearing assist system provides coverage to the audience area for those with hearing difficulty and must operate on FCC approved frequencies. The transmitting unit will be located in the amplifier rack and the antenna will be located at the lighting grid level. Portable receivers will allow the users to be seating anywhere within the black box theater and will be equipped with a variety of listening devices including, ear speakers, lightweight headsets, and inductive coil loops. Provide receivers to meet current ADA requirements.
5. Intercom receptacles are provided at multiple locations around the Black Box Theater. The intercom is a single-channel system feeding the control and floor positions as well as speaker stations in the adjacent dressing rooms.
6. A power sequencing system will control the sequence in which the system's power is turned on and off. The system power will be controlled from the teacher's office adjacent to the Black Box Theater.
7. The Black Box Theater system will mute in case of a fire alarm and remain muted for the duration of the alarm. When the alarm condition has ended the system is to revert back to the standard system configuration. This feature is to be implemented through the use of a maintained fire alarm closure forcing the power sequencing system to off.

D. Band Room

1. AV Presentation System
    a. Provide a video projector to enable display of video sources
    b. Provide a motorized front projection screen that can be raised when not in use.
    c. Screen aspect ratio shall be a 16:9 widescreen format to accommodate high-definition programming.
    d. Video projector shall be no less than 6,000 ASNI lumens to produce a bright enough image.
    e. Resolution of the video projector shall be at least 1920 X 1080.
    f. All sources shown on the video wall shall be distributed from a rack-mounted matrix switcher located in the equipment rack. Sources are:
        1) Blu-ray Player

2) HDMI Inputs at equipment rack
3) HDMI Input at the wall plate location near the teaching position
4) Wireless Presentation

g. Provide control of the AV presentation system (Display power, source selection, Blu-ray transport controls, etc.). Controls should be simple and intuitive and be accomplished through a color touch panel mounted in the equipment rack.

2. Audio Sources
   a. Provide a rack mounted multi-media player for music playback.
   b. Provide a rack mounted digital multi-media recorder for music recording.
   c. Provide wired and wireless media connectivity.
   d. Provide a line input connection at the front of the room for Owner provided metronome.
   e. Provide cabling and equipment accessories.
3. Processing and Amplification
   a. Provide DSP amplification for room loudspeakers.
   b. Provide a rack mounted mixer for control of audio sources.
4. Loudspeakers
   a. Provide wall mounted speakers at the front of the room for music playback.
   b. Provide wall mounted speakers at the back of the room for metronome playback.
5. Equipment Housing
   a. Provide a permanent wall mounted equipment rack for housing of rack mounted equipment.
   b. Equipment rack to be located near the director for quick access to operable equipment.
6. Life Safety
   a. Provide a contact closure from the life safety system
   b. System to mute upon contact closure and remain muted during the alarm.
   c. System to continue previous operation when alarm has ended.

E. Choir Room
1. AV Presentation System
   a. Provide a video projector to enable display of video sources
   b. Provide a motorized front projection screen that can be raised when not in use.
   c. Screen aspect ratio shall be a 16:9 widescreen format to accommodate high-definition programming.
   d. Video projector shall be no less than 6,000 ASNI lumens to produce a bright enough image.
   e. Resolution of the video projector shall be at least 1920 X 1080.
   f. All sources shown on the video projector shall be distributed from a rack-mounted matrix switcher located in the equipment rack. Sources are:
      1) Blu-ray Player
      2) HDMI Inputs at equipment rack
      3) HDMI Input at the wall plate location near the teaching position
      4) Wireless Presentation

g. Provide control of the AV presentation system (Projector power, screen up/down, source selection, Blu-ray transport controls, etc.). Controls should be simple and intuitive and be accomplished through a color touch panel mounted in the equipment rack.

2. Audio Sources
   a. Provide a rack mounted multi-media player for music playback.
   b. Provide a rack mounted digital multi-media recorder for music recording.
   c. Provide wired and wireless media connectivity.
   d. Provide a line input connection at the front of the room for Owner provided metronome.
   e. Provide cabling and equipment accessories.
3. Processing and Amplification
   a. Provide DSP amplification for room loudspeakers.
   b. Provide a rack mounted mixer for control of audio sources.
4. Loudspeakers
   a. Provide wall mounted speakers at the front of the room for music playback.
5. Equipment Housing
   a. Provide a permanent wall mounted equipment rack for housing of rack mounted equipment.
   b. Equipment rack to be located near the director for quick access to operable equipment.
6. Life Safety
   a. Provide a contact closure from the life safety system.
   b. System to mute upon contact closure and remain muted during the alarm.
   c. System to continue previous operation when alarm has ended.

F. Orchestra Room
1. AV Presentation System
   a. Provide a video projector to enable display of video sources
   b. Provide a motorized front projection screen that can be raised when not in use.
   c. Screen aspect ratio shall be a 16:9 widescreen format to accommodate high-definition programming.
   d. Video projector shall be no less than 6,000 ASNI lumens to produce a bright enough image.
   e. Resolution of the video projector shall be at least 1920 X 1080.
   f. All sources shown on the video projector shall be distributed from a rack-mounted matrix switcher located in the equipment rack. Sources are:
      1) Blu-ray Player
      2) HDMI Inputs at equipment rack
      3) HDMI Input at the wall plate location near the teaching position
      4) Wireless Presentation
   g. Provide control of the AV presentation system (Projector power, screen up/down, source selection, Blu-ray transport controls, etc.). Controls should be simple and intuitive and be accomplished through a color touch panel mounted in the equipment rack.

2. Audio Sources
    a. Provide a rack mounted multi-media player for music playback.
    b. Provide a rack mounted digital multi-media recorder for music recording.
    c. Provide wired and wireless media connectivity.
    d. Provide a line input connection at the front of the room for Owner provided metronome.
    e. Provide cabling and equipment accessories.
3. Processing and Amplification
    a. Provide DSP amplification for room loudspeakers.
    b. Provide a rack mounted mixer for control of audio sources.
4. Loudspeakers
    a. Provide wall mounted speakers at the front of the room for music playback.
    b. Provide wall mounted speakers at the back of the room for metronome playback.
5. Equipment Housing
    a. Provide a permanent wall mounted equipment rack for housing of rack mounted equipment.
    b. Equipment rack to be located near the director for quick access to operable equipment.
6. Life Safety
    a. Provide a contact closure from the life safety system.
    b. System to mute upon contact closure and remain muted during the alarm.
    c. System to continue previous operation when alarm has ended.

1.08 SUBMITTALS

A. Provide submittals in accordance with Conditions of the Contract and Division 1, Submittal Procedures section unless otherwise indicated.

B. Submittals shall contain sufficient information to describe the Work to be performed. Reviewed shop drawings are to be used for final coordination and construction.

C. Shop drawings must be original work produced by the Contractor responsible for performing the work defined in this specification. Scanning, photographic copying, materially copying, or any other reproducing the contents of the drawings or specifications contained within the Contract Documents will be marked as unacceptable and not reviewed for any content. No claim shall be made for delay, undue burden, or additional costs for the effort to produce shop drawings, schedules, and equipment lists addressing this specification or the overall project manual.

D. Supplementary submittal requirements:
    1. Provide the following in one electronic submission for review within thirty days of issuance of Notice to Proceed (NTP) and prior to commencement of Work:
        a. Complete schedule of submittals.
        b. Chronological schedule of Work in bar chart form.
        c. Product Data Sheets:
            1) Provide a complete table of contents with the following information:
            2) Project title.

3) Submittal number. In the case of a resubmittal, use the original submittal number immediately followed by the suffix “R” immediately followed by a unique number and be numbered in consecutive order.

4) Date of submission.

5) Provide a list of and Manufacturer's data sheets on products to be incorporated with the Work. Arrange data sheets in the same order they appear in this specification. Where a data sheet shows more than one product, indicate the model being proposed with an arrow or other appropriate symbol.

6) Submit manufacturer’s product literature for each type of firestop material to be used. Literature shall include documentation of UL classifications or approved third party testing. Manufacturer’s name and number for each part shall be included. Submit drawings of through penetrations, which include the system to be utilized for the firestopping application. Drawing shall indicate construction of wall or floor assembly; size, number and material of penetrating items; firestop system designation; required F-rating, T-rating and remarks.

7) Upon Owners and/or Consultant’s request provide (3) three copies of the submittals. Bind submittal in titled three ring D style binders sized for 150 per cent of the material. Maximum size: three-inch spine. Use multiple volumes as required. Separate major grouping with labeled binder tabs.

8) Submissions that do not follow the format and configuration described above will be returned without review.

d. Shop Drawings:

1) Functional Diagrams/Schematics:

a) Detailed wiring diagrams showing interconnection of components and products, wiring and cabling diagrams depicting cable types and designators, and device designators for each system. Provide connector designations and terminal strip identification, along with color codes for cables connecting to these devices. Give each component a unique designator and use this designator consistently throughout the project.

2) Coordination Drawings:

a) Prepare and submit a set of coordination drawings showing major elements, components, and devices of the audio and video system in relationship with other building components. Prepare drawings to an accurate scale of 1/8”=1’-0” or larger on suitable sized media.

b) Prepare floor plans, reflected ceiling plans, elevations, sections, and details to conclusively coordinate and integrate all equipment. Indicate locations where space is limited, and where sequencing and coordination of installations is of importance to the efficient flow of the Work including but not necessarily limited to the following:

(1) Equipment housings

(2) Ceiling and wall mounted devices

(3) Raceways

(4) Cabling

e. Equipment: Location of equipment within racks, consoles, or on tables, with dimensions; wire routing and cabling within housings; AC power outlet and terminal strip locations.

f. Patch panel(s): Layouts and designation (labeling) strips, including color schemes.

g. Full fabrication details of any custom enclosures and millwork indicating size, material, finish and openings for equipment.

h. Structural rigging and mounting details:

1) Loudspeaker rigging, suspension, and mounting detail drawings shall be signed and sealed by a professional engineer licensed to practice in the state in which the project is located. The signed and sealed drawings noted above to include the following:

a) Analysis of all components in the load path and attachment method to building structure for suspended loudspeakers.

b) Attachment method for mounting brackets at ceilings, walls, or other building features.

c) Detail the product manufacturer, part numbers, and load capacity of the hardware fittings and materials selected for suspended or mounted loudspeakers.

d) A copy of the design calculations.

e) Secondary steel required for attachment to the building structure.

f) Custom brackets, mounts, suspension grids or trusses, loudspeaker cabinet frames, or loudspeaker brackets.

g) Loudspeaker brackets or mounts provided by the specific loudspeaker manufacturer being installed that do not include traceability data.

2) Risk analysis data as referenced in Part 3.2, F

3) Stamping Engineer post-installation sign-off as described in Part 3.2, F

4) Proof of ETCP certification for on-site rigging crew.

i. Projector, loudspeaker, camera mounting details, include hardware types and load capacity.

j. Fabricated Plates and Panels

1) Provide complete drawings on custom fabricated plates or panels. Drawings shall include dimensioned locations of components, component types, engraving information, plate material and color, and bill of material.

k. Labeling

1) Equipment and cabling labeling scheme. Include font sizes and styles, explanation of scheme, and designator schedule.

l. Schedules

1) Wiring schedule showing source and destination of wiring and indicating which wiring is in conduit. Junction box schedule showing type of box, size, mounting and location. Include this information with remainder of wiring diagrams.

m. Control System Software

1) Provide electronic copies of proposed control system user interfaces within sixty (60) days of issuance of Notice to Proceed (NTP).

n. IP Addresses

1) Coordinated with the venue IT Administrator, provide a list of IP addresses, by device, used in the project.

o. Consultant’s project documents in electronic format will not be supplied to the Contractor for their use as part of submittals.

p. Detail drawings executed at an appropriate scale, but not smaller than 1/8 inch = 1’–0”.

q. Submissions that do not follow the format and configuration described above will be returned without review.

r. Any other pertinent data which is necessary to provide the Work.

2. Control System Software:

a. Provide electronic copies of proposed control system user interfaces within sixty (60) days of issuance of Notice to Proceed (NTP).

E. Resubmission requirements:

1. Make all requested corrections or change in submittals required. Resubmit for review until no exceptions are taken.

2. Indicate all changes that have been made other than those requested.

1.09 CONTRACT CLOSE-OUT DOCUMENTS:

A. Provide submittals in accordance with Conditions of the Contract and Division 1, Submittal Procedures section unless otherwise indicated, after substantial completion but prior to final observation:

B. Supplementary submittal requirements:

1. Provide the following in one electronic submission for review.

a. Equipment Manuals:

1) Manufacturer's owner/instruction manual for each type of Product by manufacturer and model or part number unless specified otherwise herein

2) Supply manufacturer’s serial numbers for each Product

3) For custom circuits or modifications, a description of the purpose, capabilities, and operation of each item

4) Separately bind list by manufacturer and model or part number of Products incorporated within the Work, arranged in alpha numeric order. When applicable, bind Manufacturer's warranty statements separately.

b. Test Reports: Recorded findings of Commissioning.

c. Signed copy of turn over equipment to Owner including quantity, make and model.

d. Copy of any program or hardware setup files.

e. System Operation and Instructions: Prepare a complete and typical procedure for the operation of the equipment as a system, organized by subsystem or activity.

1) This procedure should describe the operation of system capabilities.

2) Assume the intended reader of the manual to be technically inexperienced but unfamiliar with the components and the facility.

f. Service Information, including service phone number(s) and hours; service schedule; description of products recommended or provided for maintenance purposes, and instructions for the proper use of these products.

g. Any other pertinent data generated during the Project or required for future service.

h. Within three (3) weeks of final observation, submit the following in one electronic submission for review. Upon Owners and/or Consultant’s request provide (3) three copies of the following:

1) Record drawings: Final rendition of Shop Drawings depicting what is actually incorporated within the Work.

2) Hardcopy full size set of Record drawings.

3) Three (3) compact disc or DVD’s containing Record drawings in AutoCAD editable DWG format and Adobe PDF format. Resolution to be sufficient to

permit Owner's technicians to be able to clearly read all notes and text on screen.

4) One set of signed proof-of-training documents.

2. Submittal Format:

a. Record Drawings: Drawings executed at an appropriate scale, but not smaller than 1/8 inch = 1'–0".

b. Segregate documents into separate binders containing data relevant to operational, maintenance, and warranty issues. Appropriately duplicate data within the separate bindings when it will reasonably clarify procedures, e.g., operational data in maintenance binding.

c. Bind Project Record Manual in titled three ring D style binders sized for 150 per cent of the material. Maximum size: three inch spine. Use multiple volumes as required. Separate major grouping with labeled binder tabs.

C. Resubmission requirements:

1. Make all requested corrections or change in submittals required. Resubmit for review until no exceptions are taken.

2. Indicate all changes that have been made other than those requested.

1.10 CUSTOM SOFTWARE

A. Introduction:

1. Proprietary software provided for the Technical Systems shall be subject to this software license between the Contractor and the Owner as an essential element of the system as defined in the system specification and associated documents, drawings and agreement.

2. Contractor shall agree that 3rd party proprietary software provided with the system shall be subject to this agreement.

3. Contractor and Owner agree that this software license is deemed to be part of, and subject to, the terms of the Agreement applicable to both parties; and shall supersede any standard manufacturer or Contractor's standard license agreement.

4. Proprietary software shall be defined to include, but not be limited to, device and system specific software and firmware designed to run on conventional computer based operating platforms as well as all micro-processor based hardware used to program, setup, or operate the system or its components.

5. For sake of this agreement, MS Windows® shall not be considered "proprietary" software, unless a non-public version of Windows® or any of its components are critical to the operation of the system in which case it shall be deemed proprietary.

B. License Grant and Ownership:

1. Contractor hereby grants to Owner a perpetual, non-exclusive, site license to all software for Customer's use in connection with the establishment, use, maintenance and modification of the system implemented by Contractor. Software shall mean executable object code of software programs and the patches, scripts, modifications, enhancements, designs, concepts or other materials that constitute the software programs necessary for the proper function and operation of the system as delivered by the Contractor and accepted by the Owner.

2. Except as expressly set forth in this agreement, Contractor shall at all times own all intellectual property rights in the software. Any and all licenses, product warranties or service contracts provided by third parties in connection with any software, hardware or other software or services provided in the system shall be delivered to Owner for the sole benefit of Owner.

3. Owner may supply to Contractor or allow the Contractor to use certain proprietary information, including service marks, logos, graphics, software, documents and business information and plans that have been authored or pre-owned by Contractor. All such intellectual property shall remain the exclusive property of Owner and shall not be used by Contractor for any purposes other than those associated with delivery of the system.

C. Copies, Modifications, and Use:

1. Source code shall be available to Owner for a period of not less than 10 years.
2. Owner may make copies of the software for archival purposes and as required for modifications to the system. All copies and distribution of the software shall remain within the direct control of Owner and its representatives.
3. Owner may make modifications to the source code version of the software, if and only if the results of all such modifications are applied solely to the system. In no way does this Software License confer any right for Owner to license, sublicense, sell, or otherwise authorize the use of the software, whether in executable form, source code or otherwise, by any third parties.
4. All express or implied warranties relating to the software shall be deemed null and void in case of any modification to the software made by any party other than Contractor.

D. Warranties and Representations:

1. Contractor represents and warrants to Owner that:
   a. It has all necessary rights and authority to execute and deliver this Software License and perform its obligations hereunder and to grant the rights granted under this Software License to Owner;
   b. The goods and services provided by contractor under this Software License, including the software and all intellectual property provided hereunder, are original to Contractor or its subcontractors or partners; and
   c. The software, as delivered as part of the system, will not infringe or otherwise violate the rights of any third party, or violate any applicable law, rule or regulation.
2. Contractor further represents and warrants that, throughout the System Warranty Period, the executable object code of software and the system will perform substantially in accordance with the System Specifications and Agreement. If the software fails to perform as specified and accepted all remedies are pursuant to the policies set forth in the Specification and in the Agreement. No warranty of any type or nature is provided for the source code version of the software which is delivered as is.
3. Except as expressly stated in this Agreement, there are no warranties, express or implied, including, but not limited to, the implied warranties of fitness for a particular purpose, of merchantability, or warranty of no infringement of third party intellectual property rights.

1.11 QUALITY ASSURANCE

A. Qualifications: Contractor to be experienced in the provision of systems similar in complexity to those required for this project, and meet the requirements listed below. Provide documentation at the time of bid to support these qualifications:

1. Form of corporation.
2. No less than three years' experience with equipment and systems of the specified types.
3. Experience with at least three comparable scale projects within the last three years.
4. Be a franchised dealer and service facility for the manufacturer's products furnished.
5. Maintain a fully staffed and equipped service facility with full-time field technicians.
6. Have at least one supervisory on-site employee who has completed and has been certified CTS-I by Infocomm.

7. Supervision of all rigging by an ETCP certified rigger for all work associated with suspension or mounting of overhead equipment.
8. Adequate plant capacity and equipment to complete the Work.
9. Adequate staff with commensurate technical experience.
10. Suitable financial status (i.e., bonding and materials purchase capacity) to meet the obligations of the Work.
11. Adequate regional service organization to meet warranty response requirements of the Project.
12. Provide listing with appropriate explanation regarding the status of Contractor's resolved or unresolved legal disputes within the last six calendar years.
13. Provide listing with appropriate explanation regarding any projects within the last 3 years where the Contractor has failed to meet construction schedules due to Contractor's cause.
14. Completed current version of the AIA Contractor's Qualification Form.

B. Subcontractors: at the time of bid, the Contractor shall provide a list of structural, electrical, sound, or any other subcontractors intended to do the Work, or are being retained as local service providers throughout the warranty period. Subcontractors shall be appropriately state licensed in their specialty and must provide the same qualification documents as the Contractor.

C. Work: Perform Work in compliance with the applicable standards listed herein and governing codes and regulations of the authorities having jurisdiction and the Contract Documents.
1. Drawings and specification requirements govern where they exceed Code and Regulation requirements.
2. Where requirements between governing Codes and Regulations vary, the more restrictive provision applies.
3. Nothing in the Contract Documents grants authority or permission to disregard or violate any legal requirements.

D. Coordinate exact location and installation of equipment, power, grounding, and raceway requirements with the Architect.

1.12 DELIVERY, STORAGE & HANDLING

A. Ship Products in its original container, to prevent damaging or entrance of foreign matter.

B. Handling and shipping in accordance with Manufacturer's recommendation.

C. Provide protective covering during construction of all installed devices, to prevent damaging or entrance of foreign matter.

D. Replace at no expense to Owner, Products damaged during storage, handling or the course of construction.

1.13 PROJECT CONDITIONS

A. Verify conditions on the job site applicable to this work. Notify Architect in writing of discrepancies, conflicts, or omissions promptly upon discovery.

B. The Drawings diagrammatically show cabling and arrangements of equipment fitting the space available without interference. If conditions exist which make it impossible to install work as shown, recommend solutions and/or submit drawings to Architect for approval, showing how the work may be installed.

1.14 WARRANTY

A. Warrant labor and equipment for one year following the date of substantial completion to be free of defects and deficiencies, and to conform to the drawings and specifications as to kind,

quality, function, and characteristics. Repair or replace defects occurring in labor or equipment within the Warranty period without charge.

B. This warranty is in addition to any specific warranties issued by manufacturers for greater periods of time.

C. Within the warranty period, answer service calls within twenty four (24) hours during normal working hours and correct the deficiency within forty eight (48) hours.

D. Provide Owner with the name and telephone number of the person to call for service. This information to be part of Project Closeout Documents.

E. Thirty days prior to the end of the warranty period provide a complete checkout of all system components. Repair or replace any defective equipment discovered during the testing. Correct any defects in wiring or other functional problems reported by Owner. Warranty replacement and service of equipment shall not apply to Owner furnished equipment (OFE). Coordinate observation visit with the Owner.

PART 2 - PRODUCTS

2.01 GENERAL

A. Products quantity is as required. If a quantity is given, provide at least the given amount. Some product listed may not be required to fulfill the obligations of the Work.

B. Equipment and materials shall be new and conform to applicable UL or ANSI provisions.

C. Regardless of the length or completeness of the descriptive paragraph herein, provide Products complying with the specified manufacturer's published specifications.

D. Remove or blank out all manufacturers’ names, logos, or other symbols from loudspeakers or other objects placed in view of the public. If logos are removable, remove and repaint to the color of the adjacent surface and reattach.

E. Take care during installation to prevent scratches, dents, chips, etc.

2.02 ACCEPTABLE MANUFACTURERS

A. Model numbers and manufacturers included in this specification are listed as a standard of function, performance, and quality.

B. Refer to General and Supplementary Conditions and Division 1 Specification Sections for equipment substitution procedure.

C. If a specified product has been discontinued by a manufacturer, provide the replacement model (as certified by the manufacturer) at no additional cost.

D. Where required provide manufacturer’s rack mount adapter or one manufactured by Middle Atlantic or Winstead unless specified elsewhere.

2.03 MICROPHONES AND ACCESSORIES

A. Single Wireless Microphone System (WRLS Type 1):

1. Receiver Type: Digital Wireless System with automatic switching diversity reception with XLR type audio output connectors.
2. Indicators: LED signal strength meters for battery, RF and audio levels.
3. Frequency: Coordinate with FCC and local requirements.
4. Antennas: Rear mount passive antennas for the frequency spectrum chosen.
5. 1-RU Rack mountable.
6. Acceptable product to include:
    a. Shure ULXD4 Diversity Receiver

B. Dual Wireless Microphone System (WRLS Type 2):

1. Receiver Type: Digital Wireless System with automatic switching diversity reception with XLR type audio output connectors.
2. Indicators: LED signal strength meters for battery, RF and audio levels.
3. Frequency: Coordinate with FCC and local requirements.
4. Antennas: Rear mount passive antennas for the frequency spectrum chosen.
5. 1-RU Rack mountable.
6. Acceptable product to include:
    a. Shure ULXD4D Diversity Receiver

C. Wireless Microphone System (WRLS, Type 3)
1. Not Specified

D. Quad Wireless Microphone System (WRLS Type 4):
1. Receiver Type: Digital Wireless System with automatic switching diversity reception with XLR type audio output connectors.
2. Indicators: LED signal strength meters for battery, RF and audio levels.
3. Frequency: Coordinate with FCC and local requirements.
4. Antennas: Rear mount passive antennas for the frequency spectrum chosen.
5. 1-RU Rack mountable.
6. Acceptable product:
    a. Shure ULXD4Q Diversity Receiver

E. Wireless Antenna Splitter (ANT SPLIT, Type 1)
1. 4-Way active antenna splitter
2. Acceptable Product:
    a. Shure UA844+SWB

F. Wireless Antenna (ANT-MA)
1. Directional antenna
2. Wide band
3. Provide any additional signal amplification recommended by manufacturer
4. Acceptable Product:
    a. Shure UA874US
        1) Shure UA834 (as needed)

G. Bodypack Wireless Microphone (Type 1)
1. Theatrical headset/lapel mic
2. Acceptable Product to Include:
    a. Shure ULXD1 Bodypack Transmitter
    b. Shure SB900B Lithium Ion Battery
    c. Shure MX150B/C-TQG Cardioid Lavalier Microphone
    d. Shure MX153 Headset Microphone (coordinate color with Owner)

H. Handheld Wireless Microphone (Type 1)
1. Acceptable Product to Include:
2. Shure ULXD2/B87A Handheld Transmitter
    a. Shure SB900A Lithium Ion Battery

I. Wireless Microphone Charge Base (Type 1)
   1. 2 Port Wireless Microphone Charging Dock
   2. Acceptable Product
      a. Shure SBC200-US Battery Charger Base

J. Wireless Microphone Charge Base (Type 2)
   1. 8 Port Wireless Microphone Charging Dock
   2. Acceptable Product
      a. Shure SBC800-US Battery Charger Base

K. Drum Microphone Package: (Type 1)
   1. 7-piece kit to include:
   2. Large diaphragm kick drum mic
   3. Snare drum mic
   4. Rack & Floor tom mics
   5. Overhead mics
   6. Mounts for all mics
   7. Acceptable Product:
      a. Audix DP7
      b. Shure:
         1) Shure Beta 52A (Quantity: 1)
         2) Shure Beta 56A (Quantity: 3)
         3) Shure SM81 (Quantity: 3)
   8. Approved Equivalent

L. Piano Microphone Package: (Type 1)
   1. Dual element condenser microphone
   2. Acceptable Product:
      a. Audix SCX25A
      b. Shure Beta 181
      c. Approved Equivalent

M. Vocal Microphone: (Type 1)
   1. Handheld dynamic cardioid pattern
   2. Acceptable Product:
      a. Audix OM6
      b. Shure Beta58a
      c. Approved Equivalent

N. Switched Vocal Microphone: (Type 1)
   1. Handheld dynamic cardioid pattern
   2. ON/Off Switch integrated
   3. Acceptable Product:
      a. SM58S
      b. Approved Equivalent

O. Instrument Microphone: (Type 1)

1. Dynamic cardioid pattern
2. Acceptable Product:
    a. Audix D4
    b. Shure Beta57a
    c. Approved Equivalent

P. Instrument Microphone: (Type 2)
1. Condenser cardioid pickup pattern
2. Acceptable Product:
    a. Audix f9
    b. Shure SM81
    c. Approved Equivalent

Q. Instrument Microphone: (Type 3)
1. Boundary style condenser
2. Acceptable Product:
    a. Audix ADX60
    b. Shure Beta91a
    c. Approved Equivalent

R. Choir Microphone: (Type 1)
1. Hanging condenser
2. HyperCardioid pattern
3. Acceptable Product:
    a. Audix ADX40HC
    b. Shure MX202B/S

S. Talkback Microphone (Type 1)
1. Goose neck condenser microphone
2. Cardioid pattern
3. Acceptable Product:
    a. Shure MX418/C

T. Podium Microphone (Type 1)
1. Goose neck condenser microphone
2. Cardioid pattern
3. Acceptable Product:
    a. Shure MX412/C

U. Suspended Microphone: (Type 1)
1. Dual mic for stereo configuration
2. Phantom powered
3. Acceptable Product:
    a. Audix ADX40 with CPSADXC cardioid capsule
    b. Shure MX202B/C
    c. Approved Equivalent

V. Proscenium Microphone (Type 1):

1. Small diaphragm condenser.
2. Studio pair.
3. Acceptable Product
    a. Shure KSM 137/SL Stereo

W. Panel Mount Microphone (Type 1)
1. Panel mount with threaded body
2. Flush-mount boundary layer microphone
3. Acceptable Product:
    a. AKG C562CM

X. Microphone Switch (MIC SWITCH, Type 1)
1. Push to talk
2. Table top
3. Acceptable Product:
    a. ProCo SAS2
    b. Approved Equivalent

Y. Microphone Stands and Mounting Hardware:
1. Provide the following items:
    a. TYPE 1: Round-base floor stands, Black
        1) Atlas MS-10CE w / PB11XEB
        2) Approved Equivalent
    b. TYPE 2: Heavy Duty floor stand, Black
        1) Atlas SB11WE
        2) Approved Equivalent
    c. TYPE 3: Boom Arm Short, Black
        1) Atlas PB11XEB
        2) Approved Equivalent
    d. TYPE 4: Boom Arm Long, Black
        1) AtlasPB21XEB
        2) Approved Equivalent
    e. TYPE 5: Table Top stand, Black
        1) Atlas SMS2B
        2) Approved Equivalent

2.04 INPUT SOURCES

A. Media Player (MDP, Type 1):
1. Analog inputs and outputs: RCA unbalanced.
2. Digital input and output: S/PDIF.
3. 1-U Rack Mountable.
4. AMFM Tuner
5. Bluetooth Receiver
6. USB & Aux input
7. RS-232 Control

8. Wireless Remote Control.
9. Acceptable Product:
    a. Tascam SS-R250N
        1) Tascam IF-DA2

B. Media Recorder (MDR, Type 1):
1. Analog inputs and outputs: RCA unbalanced, Balanced XLR
2. Digital input and output: S/PDIF, AES/EBU, Dante.
3. Media Format: SD, USB, CD
4. File Formats: CD, MP3, WAV
5. Stereo Record and Playback
6. Ethernet connectivity
7. 1-U Rack Mountable.
8. Wired Remote Control.
9. Acceptable product:
    a. Tascam SS-CDR250N
        1) Tascam RC-SS150
        2) Tascam IF-DA2

C. Media Recorder (MDR, Type 2):
1. Analog inputs and outputs: RCA unbalanced, Balanced XLR
2. Digital input and output: S/PDIF, AES/EBU
3. Media Format: SD, USB, CD
4. File Formats: CD, MP3, WAV
5. Stereo Record and Playback
6. Ethernet connectivity
7. 1-U Rack Mountable.
8. Wired Remote Control.
9. Acceptable product:
    a. Tascam SS-CDR250N

D. Portable Device Interface (IRACK, Type 1):
1. Stereo RCA inputs
2. Stereo 3.5mm input
3. Ground/lift switch
4. Acceptable Product:
    a. ProCo iRack

E. Mono DI Box (Type 1):
1. Inputs for unbalanced line sources
2. Inputs shall be via ¼” receptacles
3. Line and mic level outputs
4. Ground lift switch
5. Acceptable Product:
    a. Whirlwind DIRECTOR

b. Radial ProDI
c. Approved Equivalent

F. Stereo DI Box (Type 1):
1. Inputs for stereo/dual mono unbalanced line sources
2. Inputs shall be via ¼", RCA, 3.5mm receptacles
3. Line and mic level outputs
4. Ground lift switch
5. Acceptable Product:
a. Whirlwind DIRECT2
b. Radial ProAV2
c. Approved Equivalent

G. Stereo Computer DI Box (Type 1):
1. Inputs for stereo/dual mono unbalanced line sources
2. Inputs shall be via ¼", RCA, 3.5mm receptacles
3. Line and mic level outputs
4. Ground lift switch
5. Acceptable Product:
a. Whirlwind PC-DI
b. Radial JPC
c. Approved Equivalent

H. Stereo Computer USB DI Box (Type 1):
1. Inputs shall be via USB receptacle
2. Mic level outputs
3. Acceptable Product:
a. Whirlwind PC-USB
b. Radial USB-Pro
c. Approved Equivalent

I. USB Sound Card (USB AUD, Type 1)
1. Minimum 2 Chanel in/out
2. Operating System Level driver
3. Rackmount kit
4. Balanced in/out
5. Acceptable Product:
a. Henry Engineering USB MatchBox II
b. Approved Equivalent

J. Chime Tone Generator (CHIME, Type 1)
1. Minimum of four signal types: pulsed alarm tone, slow whoop, chime, and steady tone.
2. Operates on 12 - 48VDC, positive or negative ground.
3. Continuous or two-burst tone.
4. Activation by external contact closure.
5. Built-in precedence over interconnected program source.

6. Provide power supply as required.
7. Acceptable product:
    a. RDL FP-CH8

K. Bluetooth Receiver (BTRX, BTIO, Type 1)
1. Input: Bluetooth
2. Output: balanced analog audio.
3. Provides long distance distribution of Bluetooth audio using Cat6 cable.
4. Powered from receiver in rack.
5. Does not support automatically pairing.
6. Customizable Bluetooth name.
7. Coordinate finish with Architect
8. Acceptable Product to Include:
    a. QSC BT1 (BTRX)
    b. QSC AXPio (BTIO)

L. Line Input (LI, Type 1)
1. Decora mounted
2. Stereo RCA jacks
3. Stereo 3.5mm jack
4. Balanced stereo outputs
5. Coordinate finish with Architect
6. Acceptable Product:
    a. RDL DS-CIJ3D

M. Analog Stereo to S/PDIF Converter (CONV, Type 1)
1. Inputs: 2x balanced analog, 2x unbalanced analog
2. Outputs: 1x AE3
3. Acceptable Product:
    a. RDL HR-ADC1
    b. Approved Equivalent

2.05 MIXERS

A. Reinforcement Console (MIXER, Type 1):
1. Digital audio mixing surface
2. Customizable motorized faders
3. Touch screen LCD
4. Local Analog and Digital IO
5. Digital Audio Network compatibility
6. Expansion Card Slots
7. Set virtual inputs/output labels to match connector labeling
8. Acceptable Product:
    a. Allen & Heath C3500

B. Stage Rack I/O (MIX IO, Type 1):
1. Analog and Digital I/O

2. 44.1kHz, 48kHz, 88.2kHz, 96kHz sampling
3. Digital Audio Network compatibility
4. Expandable IO
5. Recessed Rack Mounted
6. Acceptable Product:
    a. Allen & Heath CDM series
        1) Allen & Heath Dante 64x64

C. Portable Expander (MIX IO, Type 2)
1. Portable digital audio expander.
2. 16 balanced inputs
3. 8 balanced outputs
4. Acceptable Product:
    a. Allen & Heath DX168

D. Mixer Controller (Type 1)
1. To be used with Allen & Heath D-Live series mixing products.
2. 8 Fader expansion unit
3. Programmable soft keys
4. PoE powered + Local Power
5. Acceptable Product:
    a. Allen & Heath IP8

E. Mixer Controller (Type 2)
1. Touchscreen wireless controller
2. 9.7 inch display
3. Acceptable Product to Include:
    a. Apple iPad Air (or current version)
    b. Otterbox Latch II
    c. Otterbox Defender Series

F. Mixer (MIXER, Type 2):
1. 6 input rack mount mixer
2. 3 stereo line inputs
3. Stereo line output
4. Mono line output
5. Frequency response: +1 dB, 20 Hz to 20 kHz
6. Hum & Noise generation: -91 dBu
7. Input configuration: 2kΩ input, XLR-3, RCA, Phoenix
8. Acceptable Product:
    a. TOA M-633D

G. Mixer (MIXER, Type 3):
1. 16 input digital rackmount mixer
2. 8 outputs
3. 48 channels

4. 36 mix busses
5. USB audio input/output.
6. Rack Mountable.
7. Acceptable product:
    a. Allen & Heath SQ-5
        1) SKB 1SKB-RE-SQ5

H. Mixer (MIXER, Type 4)
1. 2 mic/5 stereo line inputs.
2. 3 stereo zone outputs
3. Rack Mountable.
4. Acceptable product:
    a. Tascam MZ-223

I. Microphone Preamp (PRE, Type 1):
1. Two input, two output microphone pre-amplifier
2. +48 volt phantom power.
3. Gain variable from 20-60dB.
4. Chassis Mountable.
5. Acceptable Product:
    a. RDL HR-MP2

2.06 DIGITAL SIGNAL PROCESSORS

A. Digital Signal Processing System (DSP)
1. Provide independent DSP processing for each system as detailed on the AV drawings.
2. The DSP system and control software shall be operational 30 days prior to the first use of the installed system.
3. Function: Provide all signal processing and control required for the system(s). Devices required include, but are not limited to; mixer, matrix router, crossover, high and low pass filters, delay, compression, 6-band parametric equalizer, limiter, ducker, signal delay, and external control.
4. Unit to be configured with a minimum quantity of inputs and outputs as shown within the AV drawings, including control port requirements.
5. Signal flow and routing to be fully user configurable.
6. Unit to permit hardwire connection of external switches for recalling presets.
7. Unit to permit remote networked control via dedicated devices.
8. Access to external user-adjustable controls shall be restricted.
9. Manufacturer Software:
    a. Provide 12 months of on-site software upgrades from date of final acceptance.
10. DSP Software Setup:
    a. Provide site specific configuration and programming for the DSP software.
    b. Coordinate user interface, software functionality, and menu screens with Architect's Consultant. Reference submittal requirements.
    c. Provide ongoing software upgrades and maintenance for 12 months from date of final acceptance.

d. Reference Part 3.4 System Programing in this specification for additional programming details.

11. Where DSP and Amplifiers are used in the same system, use processing and amplification products of the same platform.
12. Acceptable product:
    a. DSP Type 1:
        1) QSC Q-Sys Core 110f
    b. DSP Type 2
        1) QSC Q-Sys Core 8 Flex
    c. DSP IO, Type 1:
        1) QSC IO FRAME
            a) QSC CIML4
            b) QSC COL4
    d. DSP IO, Type 2:
        1) QSC IO-8 FLEX

2.07 POWER AMPLIFIERS

A. General:
1. Two, Four, or Eight channel power amplifier with the EIA standard RS-490 power rating at 1% THD into 70-volt constant voltage load or 8-ohm load as applicable.
2. Provide protection of circuit components in the event of input over-drive, output overload, or short circuits.
3. Frequency response: ±1 dB, 20 Hz to 20 kHz with less than 1 per cent THD at rated output.
4. Input impedance: 10k ohm balanced.
5. Output regulation: 2 dB from no load to full load conditions.
6. Noise generation: at least 85 dB below rated output with input shorted.

B. Acceptable products:
1. Type 1:
    a. QSC CX-Q 2K4
    b. LEA
    c. Linea
    d. Powersoft
2. Type 2:
    a. QSC CX-Q 4K series
    b. LEA
    c. Linea
    d. Powersoft
3. Type 3:
    a. QSC CX-Q 8K series
    b. LEA
    c. Linea
    d. Powersoft

4. Type 4:
    a. QSC CX-Q 8K4 (two channels driven)
    b. LEA
    c. Linea
    d. Powersoft
5. Type 5
    a. QSC CXD 4.2 (CXD 4.5 for 70V applications)
    b. LEA
    c. Linea
    d. Powersoft
6. Type 6
    a. QSC CXD 4.3
    b. LEA
    c. Linea
    d. Powersoft
7. Type 7
    a. QSC CXD 4.5
    b. LEA
    c. Linea
    d. Powersoft
8. Type 8
    a. QSC CX168
    b. LEA
    c. Linea
    d. Powersoft

2.08 LOUDSPEAKERS

A. Speaker (Type 1)
1. Type: Surface mounted loudspeaker
2. Configuration: 12-inch two-way loudspeaker
3. Frequency Range: 50 Hz – 25 kHz
4. Power: 600W @ 8 ohms
5. Coverage: 90 x 55-degree
6. Acceptable Product:
    a. QSC AD-S12

B. Speaker (Type 2)
1. Type: High output full-range coaxial loudspeaker
2. Configuration: 15 inch driver with 4 inch compression driver
3. Frequency Range: 54 Hz – 20 kHz
4. Power: 800W @ 8 ohms
5. Coverage: 90 x 60 degree
6. Max SPL: 138 dB

7. Acceptable Product
    a. Fulcrum CCX1596

C. Speaker (Type 3)
1. Type: Surface mounted column speaker
2. Configuration: column speaker
3. Frequency Range: 60 Hz – 20 kHz
4. Power: 1000W @ 8 ohms
5. Max SPL: 114 dB
6. Settings: Broad, Music
7. Acceptable Product
    a. JBL CBT 70J-1

D. Speaker (Type 4)
1. Type: Surface mounted subwoofer
2. Configuration: (2) 18-inch subwoofer
3. Frequency Range: 24 Hz – 152 Hz
4. Power: 2400W @ 8 ohms
5. Max SPL: 141 dB
6. Acceptable Product:
    a. Fulcrum Sub218

E. Speaker (Type 5)
1. Type: Surface mounted loudspeaker
2. Configuration: 8-inch two-way loudspeaker
3. Frequency Range: 62 Hz – 16 kHz
4. Taps: 60W / 30W / 15W / 7.5W @ 70V
5. Coverage: 100 X 100 degree
6. Acceptable Product:
    a. JBL Control 28-1
        1) JBL MTC-28UB-1

F. Speaker (Type 6)

G. Speaker (Type 10)
1. Type: full-range loudspeaker
2. Configuration: single 10 inch driver with 2.5 inch compression driver
3. Frequency Range: 68 Hz – 20 kHz
4. Power: 600w
5. Coverage: 85 degree
6. Max SPL: 126 dB
7. Acceptable Product
    a. QSC E110
        1) Include Yoke Mount & Cheeseborough style clamp

H. Speaker (Type 12)
1. Type: High output full-range coaxial loudspeaker

2. Configuration: dual 15 inch driver with 4 inch compression driver
3. Frequency Range: 42 Hz – 20 kHz
4. Power: LF 700 @ 8 Ω, HF/LF 400 W @ 8 Ω
5. Coverage: 90 x 60 degree
6. Max SPL: 134 dB
7. Acceptable Product
    a. Fulcrum DX1526

I. Speaker (Type 13)
1. Type: Surface mounted subwoofer
2. Configuration: (2) 18-inch subwoofer
3. Frequency Range: 24 Hz – 152 Hz
4. Power: 2400W @ 8 ohms
5. Max SPL: 141 dB
6. Acceptable Product:
    a. Fulcrum Sub218

J. Speaker (Type 14)
1. Type: Full-range subcardioid coaxial loudspeaker
2. Configuration: 12-inch coaxial driver with 3 inch compression driver
3. Frequency Response: 71 Hz – 20 kHz
4. Power: 400W @ 8 ohms
5. Coverage: 120 x 60 degree
6. Acceptable Product:
    a. Fulcrum CCX1226
        1) Fulcrum YK-CX12

K. Speaker (Type 15)
1. Type: Full-range subcardioid coaxial loudspeaker
2. Configuration: 12-inch coaxial driver with 3 inch compression driver
3. Frequency Response: 71 Hz – 20 kHz
4. Power: 400W @ 8 ohms
5. Coverage: 120 x 60 degree
6. Acceptable Product:
    a. Fulcrum CCX1226
        1) Fulcrum YK-CX12

L. Speaker (Type 17)
1. Type: Full-range flush mounted loudspeaker
2. Configuration: Two 3.5-inch drivers with 6 inch ribbon driver
3. Frequency Response: 140 Hz – 20 kHz
4. Power: 150W @ 16 ohms
5. Coverage: 120 x 50 degree
6. Acceptable Product:
    a. Innovox HLA Stage Lip

1) Innovox HLA Stage Lip In Wall Assembly

M. Speaker (Type 18)
1. Type: Surface mounted column speaker
2. Configuration: column speaker
3. Frequency Range: 60 Hz – 20 kHz
4. Power: 1000W @ 8 ohms
5. Max SPL: 114 dB
6. Settings: Broad, Music
7. Acceptable Product
a. JBL CBT 70J-1

N. Speaker (Type 19)
1. Type: Compact surface mount two-way, full-range loudspeaker
2. Configuration: 12-inch woofer, 90° x 50° horn
3. Frequency Response: 62Hz – 19kHz
4. Power: 600W program @ 8Ω
5. Sensitivity: 95dB (1W/1m)
6. Acceptable Product:
a. JBL PRX412M

O. Speaker (Type 30)
1. Type: Powered speaker
2. Configuration: 12-inch woofer, 90° x 50° horn
3. Frequency Range: 60 Hz – 20 kHz
4. Power: 1000W @ 8 ohms
5. Max SPL: 114 dB
6. Acceptable Product
a. QSC K12.2

2.09 LOUDSPEAKER HARDWARE AND SUPPORT STRUCTURE

A. All rigging truss modules, slings and hardware to meet a minimum of one of the following standards.
1. ASME B30.26
2. ASME B30.9
3. OSHA 1910.184
4. OSHA 1926.251
5. UL 1480 31.3

B. Custom Loudspeaker Rigging
1. For indoor practice field speaker clusters
2. Provide rigging drawings in accordance with Part 1 of this specification
3. Coordinate all rigging attachments with structure
4. Acceptable Manufacturer
a. Polar Focus
b. Adaptive Technologies

C. Loudspeaker Poles
   1. Provide turnkey installation of mounting pole
   2. Auxiliary bracket mounted at top of pole to allow loudspeaker manufacturer yoke bracket to attach
   3. Reference drawings for heights
   4. Provide all parts, materials and labors required for pole installation
   5. Provide ground and lightning protection per NEC requirements
   6. Acceptable Manufacturer:
      a. Musco Sports-Pole with one position coupling (Contact Rick Van Dusseldorp (1-800-825-6020)

D. Shoulder Type Machinery Eye Bolts:
   1. Forged Steel - Quenched and Tempered.
   2. Fatigue rated at 1-1/2 times the Working Load Limit at 20,000 cycles.
   3. Product to meet or exceed all the requirements of ASME B30.26 including identification, ductility, design factor, proof load and temperature requirements.
   4. Select size of product based working load limits required.
   5. Acceptable product:
      a. Crosby Group S-279 / M-279 Series

E. Forged Eye Nuts:
   1. Forged Steel - Quenched and Tempered.
   2. Tapped with standard UNC class 2 threads after galvanizing.
   3. Product to meet or exceed all the requirements of ASME B30.26 including identification, ductility, design factor, proof load and temperature requirements.
   4. Select size of product based working load limits required.
   5. Acceptable product:
      a. Crosby Group G-400 Series

F. Anchor Shackles:
   1. Forged - Quenched and Tempered, with alloy pin.

G. Working Load Limit permanently shown on every shackle.

H. Hot Dip galvanized or Self-Colored.

I. Product to meet the performance requirements of Federal Specification RR-C-271D Type IVA, Grade A, Class1.

J. Select size of product based working load limits required.

K. Provide all screw pin type shackles with mouse wire.

L. Acceptable product:
   1. Crosby Group G-213 / S-213 Series Round Pin
   2. Crosby Group G-209 / S-209 Series Screw Pin

M. Turnbuckles:
   1. Acceptable turnbuckle assembly combinations include: Eye and Eye, Jaw and Jaw, Jaw and Eye.
   2. End fittings are Quenched and Tempered, bodies heat treated by normalizing.
   3. Hot Dip galvanized.

4. Product to meet or exceed all the requirements of ASME B30.26 including identification, ductility, design factor, proof load and temperature requirements.
5. Product to meet the performance requirements of Federal Specifications FF-T-791b, Type 1 Form 1 - CLASS 4, and ASTM F-1145.
6. Select size of product based working load limits required.
7. All end fittings to be moused to the body with mousing cable.
8. Acceptable product:
    a. Crosby Group HG-226 Series, Eye and Eye
    b. Crosby Group HG-227 Series, Jaw and Eye
    c. Crosby Group HG-228 Series, Jaw and Jaw

N. Wire Rope Thimble:
1. Product to meet the performance requirements of Federal Specification FF-T-276b Type II.
2. Hot Dip galvanized.
3. Select size of product based wire rope size required for suspended load.
4. Acceptable product:
    a. Crosby Group G-411 Series

O. Wire Rope:
1. Strands: 7 x 19 Utility Cable.
2. Type: Galvanized.
3. Select size of product based working load limits required.
4. Acceptable product:
    a. Wire Rope Corporation of America (WRCA)

P. Wire Rope Sleeves:
1. Type: Copper Duplex.
2. Select size of product based wire rope size required for suspended load.
3. Acceptable product:
    a. Wire Rope Corporation of America (WRCA) SW-740 Series

2.10 ASSISTIVE LISTENING

A. ALS Transmitter (ALT, Type 1):
1. Configuration: Single-channel.
2. Frequency: 216 MHz.
3. Audio Input: Balanced, mic or line level, 3-pin XLR.
4. Provide power supply.
5. Provide 1-RU rack mount bracket.
6. Remote mounted antenna (ANT-HA)
7. Acceptable product to include:
    a. Listen Technologies LS-71-216
    b. Listen Technologies LA-124 for device/panel mounted antennas

B. ALS Receiver (Type 1):
1. Configuration: Single channel.
2. Frequency: 216 MHz.

3. Frequency agile to adjust various systems.
4. Receivers to be frequency adjustable for use in all venues.
5. Include an individual price for owner to purchase additional receivers.
6. Acceptable product:
    a. Listen LR-4200-216 Receiver
    b. Listen LA-401 Ear Speaker
    c. Listen LA-402 Headset
    d. Listen LA-430 Neck Loop

2.11 PRODUCTION INTERCOM

A. Master Station (ICMS, Type 1):
1. Four channel main station.
2. Separate short circuit protection for each channel
3. External program feed to either or both channels.
4. Call signal buttons for each channel.
5. Global “Remote Mic Kill”
6. 2RU height unit
7. Acceptable Product:
    a. Clear Com MS-704

B. Remote Station (ICRS, Type 1):
1. Four channel remote station.
2. Separate short circuit protection for each channel
3. External program feed to either or both channels.
4. Call signal buttons for each channel.
5. Global “Remote Mic Kill”
6. 2RU height unit
7. Acceptable Product:
    a. Clear Com RM-704

C. Intercom Power Supply (ICPS, Type 1)
1. Two channel power supply
2. Separate short circuit protection for each channel
3. External program feed to either or both channels.
4. 1RU height unit
5. Acceptable Product:
    a. Clear Com PS-702

D. Intercom System Interface (ICI, Type 1)
1. Combines channels from two intercom systems
2. ClearCom/RTS interface capable
3. Acceptable Product:
    a. Clear Com TW-12C
4. Intercom Combiner (ICC, Type 1)
5. Channel A+B combine

6. 3 pin single channel input
7. 3 pin two channel output
8. Acceptable Product:
    a. Clear Com TWC-703

E. Wall Stations (ICS, Type 1):
1. One channel speaker station
2. Flush mount internal microphone.
3. Visual and audible call signaling.
4. Mounts in four gang junction box
5. Acceptable Product:
    a. Clear Com KB-701

F. Wall Stations (ICS, Type 2):
1. Two channel speaker station
2. Flush mount internal microphone.
3. Visual and audible call signaling.
4. Mounts in four gang junction box
5. Acceptable Product:
    a. Clear Com KB-702

G. Wall Stations (ICHS, Type 1)
1. Two channel headset/handset station
2. Push to talk with channel selection
3. Acceptable Product to include:
    a. Clear Com HB-702
    b. Clear Com HS-6

H. Belt Unit (Type 1)
1. Two channel station
2. Volume control
3. Mic on/off button
4. Call signal button.
5. Sidetone adjust.
6. Three pin configuration with loop thru.
7. Acceptable Product to include:
    a. Clear Com RS-703

I. Headset (Type 1)
1. Single earpiece unit.
2. Noise cancelling microphone.
3. Flexible boom arm with 300-degree rotation.
4. Acceptable Products:
    a. Clear Com CC-300

J. Headset (Type 2)
1. Dual earpiece unit.

2. Noise cancelling microphone.
3. Flexible boom arm with 300-degree rotation.
4. Acceptable Products:
    a. Clear Com CC-400

K. Handset (Type 1)
1. Telephone style hand set
2. Push to talk button
3. Acceptable Product:
    a. Clear Com HS-6

L. Call Signal Flasher (Type 1)
1. LED light source
2. Visual and Audible alert
3. Volume/Brightness control
4. Acceptable Product:
    a. Clear Com FL-7

2.12 PROJECTION SCREENS

A. Wall Mounted Fixed Frame Projection Screen, (PS, Type 1)
1. General: Provide manufacturer's standard units consisting of screen and other components as required for a complete installation.
2. Provide rigging and mounting hardware as required.
3. Comply with the following requirements for the viewing surface:
    a. HD Progressive 1.1 surface material
    b. Aspect Ratio: 16:9
    c. Reference AV Projection Screen Schedule in AV drawing set for size.
4. Acceptable Product:
    a. Da-Lite Da-Snap

B. Wall Mounted Electric Projection Screen (PS, Type 2)
1. General: Provide manufacturer's standard units consisting of screen and other components as required for a complete installation.
2. Provide rigging and mounting hardware as required.
3. Low voltage controller
4. Comply with the following requirements for the viewing surface:
    a. Tab tensioned screen
    b. HD Progressive 1.1 surface material
    c. Aspect Ratio: 16:9
    d. Install screen as required to locate bottom of image 4’-0” AFF.
    e. Reference AV Projection Screen Schedule in AV drawing set for size.
5. Acceptable Product:
    a. Da-Lite Tensioned Contour Electrol Series

2.13 VIDEO PROJECTORS

A. Video Projector (PROJ, Type 1)

1. Laser WUXGA 3LCD Projector
2. Native Resolution: WUXGA (1920 x 1200) w/ 4K Enhancement Technology
3. Brightness 16,000 lumens
4. Control Communication RS-232C / LAN
5. Field verify throw distance to determine the appropriate lens
6. Provide required lens
7. Acceptable Product to include:
    a. Epson EB-PU2216B w/ Chief WMA2S, VCTUB, CMS003

B. Video Projector (PROJ, Type 2)
    a. Not Used.

C. Video Projector (PROJ, Type 3)
1. Laser WUXGA 3LCD Projector
2. Native Resolution: WUXGA (1920 x 1200) w/ 4K Enhancement Technology
3. Brightness 6,000 lumens
4. Control Communication RS-232C / LAN
5. Field verify throw distance to determine the appropriate lens
6. Provide required lens
7. Acceptable Product to include:
    a. Epson EB-PU1006W

2.14 VIDEO DISPLAYS

A. 55” LCD Monitor (MON, Type 1):
1. 55” Diagonal
2. Resolution 3,840 x 2,160 (4K UHD)
3. Brightness: 500cd/m2
4. RS232 controllable
5. 10W + 10W Speakers
6. Acceptable Product:
    a. LG 55UH5F with Chief LTM1U

B. 65” LCD Monitor (MON, Type 2):
1. 65” Diagonal
2. Resolution 3,840 x 2,160 (4K UHD)
3. Brightness: 500cd/m2
4. RS232 controllable
5. 10W + 10W Speakers
6. Acceptable Product:
    a. LG 65UH5F

2.15 AV SOURCES

A. PTZ Camera (CAM, Type 1):
1. Horizontal field of view 74° (wide) to 4.8° (tele) at 20x
2. 12x optical zoom
3. 1.67x digital zoom

4. Simultaneous HDBaseT, HDMI and IP Streaming
5. Power, video and control over a single Cat-5e cable up to 230 ft. (70m), or over a Cat-6 cable up to 328 ft. (100m)
6. Acceptable Product:
    a. Vaddio RoboShot 20 UHD OneLink Bridge System (999-9950-200W)

B. Wireless Presentation System (WPS, Type 1)
1. Wirelessly Share Content from mobile devices
2. Supports MS Windows, OSX as well as Apple and Android smartphones and tablets
3. Up to 4 Users Screen Collaboration
4. AirPlay & Miracast support
5. Wireless: Dual band 802.11ac 2 2 MIMO
6. Streaming Video Support: 4K (4096 x 2160), HD (1920 1080), SD (1280 720)
7. Output: HDMI 2.0 for HDMI1 with Audio (8-channel 7.1 surround sound), HDMI 1.4 for HDMI2 with Audio (8-channel 7.1 surround sound), Stereo output
8. Input: HDMI 1.4b (HDCP not supported)
9. Power Input: PoE+ or DC 12V @ 2A max
10. PSU Gen3 Power Supply included
11. 5 Year Subscription
12. Acceptable Product:
    a. Mersive Solstice Pod Gen 3 Small Group Edition Enterprise, SP-8100-E5

C. Blu-ray Player (BR, Type 1):
1. Plays Blu-Ray, DVD, and CD formats
2. Full HD 1080p
3. HDMI Output
4. XLR Balanced Output
5. RS-232C and IP control capability
6. Acceptable Product:
    a. Tascam BD-MP1

2.16 VIDEO PROCESSORS

A. Matrox Graphics Expansion Module (MGE, Type 1):
1. Converts Display Port to Dual DVI Outputs
2. Active Converter
3. USB Control
4. Acceptable Product:
    a. Matrox DUAL Head 2GO Digital ME/SE verify which version ME or SE is required based upon Owner Furnished PC

2.17 VIDEO SWITCHERS

A. Audio/Video Presentation Switcher (DMPS, Type 1):
1. 10x8 4K matrix switcher, scaler, audio DSP with AEC, audio power amplifier, and control processor.
2. Four DTP inputs
3. Six HDMI inputs

4. Four HDMI outputs
5. Four independently scaled DTP outputs
6. Integrated DTP inputs and outputs support transmission of video, control, and audio up to 330 feet (100 meters) over a shielded CATx cable
7. 3RU height
8. Acceptable Product:
    a. Extron DTP CrossPoint 108 4K IPCP Q MA 70 (60-1381-93)

B. Audio/Video Presentation Switcher (DMPS, Type 2):
1. Eight input seamless presentation switcher with control processor
2. Two DTP inputs
3. Five HDMI inputs
4. One DTP output with one mirrored HDMI output
5. Integrated DTP2 extension supports transmission of video, audio, and control up to 330 feet (100 meters) over a shielded CATx cable
6. 2RU height
7. Acceptable Product:
    a. Extron IN1808 IPCP Q MA 70 (60-1615-93)

2.18 TRANSMITTERS/RECEIVERS

A. DTP Transmitter Wall Plate (DMTX, Type 1):
1. Single HDMI input
2. Decorator-Style Wall Plate
3. Transmits HDMI up to 330 feet over a shielded CATx cable
4. Coordinate color with architect.
5. Acceptable Product:
    a. Extron DTP T HWP 4K 331 D, Black (60-1421-52)
    b. Extron DTP T HWP 4K 331 D, White (60-1421-53)

B. DTP Transmitter (DMTX, Type 2):
1. Four HDMI inputs
2. Transmits HDMI up to 330 feet over a shielded CATx cable
3. Acceptable Product:
    a. Extron DTP2 T 204 (60-1626-52)

C. DTP Transmitter (DMTX, Type 3):
1. Single HDMI input
2. Transmits HDMI up to 330 feet over a shielded CATx cable
3. Coordinate color with architect.
4. Acceptable Product:
    a. Extron DTP HDMI 4K 330 Tx (60-1331-12)

D. DTP Receiver (DMRX, Type 1):
1. Receives HDMI up to 330 feet over a shielded CATx cable
2. Acceptable Product:
    a. Extron DTP HDMI 4K 330 Rx (60-1331-13)

E. DM Distribution Amplifier (DMDA, Type 1):
   1. Distributes HDMI plus control and analog audio up to 330 feet (100 meters) over shielded CATx cable
   2. Includes 1 HDMI loop output.
   3. Eight DTP 330 twisted pair outputs on RJ-45
   4. Acceptable Product:
      a. Extron DTP HD DA8 4K 330 (60-1438-51)

2.19 AV NETWORK HARDWARE

A. Network Switch (AV SWITCH, Type 1)
   1. Managed
   2. Gigabit switch
   3. PoE+
   4. Streaming compatible
   5. Acceptable Product:
      a. Pakedge SX Series
      b. Luxul AMS Series
      c. QSC NS Gen-2 Series
      d. Approved Equivalent

2.20 CONTROL SYSTEM

A. Room Control System (RCS, Type 1)
   1. Control System Expansion Interface
   2. Eight digital I/O ports
   3. Eight relays
   4. Four 12V DC and four 24V DC ports
   5. PoE+ powered
   6. Acceptable Product:
      a. Extron IPL EXP RIO8 (60-1907-01)

2.21 USER INTERFACES

A. Touch Panel (TP, Type 1):
   1. Screen size: 10-inch diagonal
   2. Capacitive touch surface
   3. Resolution: 1280 x 800
   4. PoE powered
   5. Wall Mount
   6. Acceptable Product:
      a. Extron TLP Pro 1025M – Black (60-1566-02) w/Extron RM6 as required when rack mounted

B. Touch Panel (TP, Type 2):
   1. Screen size: 12.1-inch diagonal
   2. Capacitive touch surface
   3. Resolution: 1280 x 800

4. HDMI and XTP inputs
5. PoE+ powered
6. Tabletop
7. Acceptable Product:
    a. Extron TLP Pro 1225TG – Black (60-1788-02)

C. Touch Panel (TP, Type 3):
1. Screen size: 5-inch diagonal
2. Capacitive touch surface
3. Resolution: 800 x 480
4. PoE powered
5. Wall Mount
6. Acceptable Product:
    a. Extron TLP Pro 525M – Black (60-1561-02) w/Extron RM5 as required when rack mounted

2.22 POWER SYSTEMS

A. Power Sequencing
1. Power Sequencing system to be operated via low voltage button contact closures from either push buttons located on panels local to the event space or via a contact closure from a relative control system (DSP, Control Processor, etc.)
2. Devices to be sequenced “ON” in order of audio signal flow. Devices and equipment to be shut down in reverse order from “ON” sequence. Example “ON” order starting with:
    a. Source devices. (Media Players, Pre-amplifiers, etc.)
    b. Processing devices (DSP, Mixers, Video Switchers, etc.)
    c. Output devices (Amplifiers, Powered Speakers, etc.)
3. Devices not to be sequenced and to remain on for status and monitoring purposes to include but not limited to:
    a. Network switches and components.
    b. Equipment housing ventilation systems.
    c. Control system equipment responsible for providing control of Remote Power Sequencing system.
4. Coordinate wiring of high voltage components.

B. Power Sequencer (SEQ, Type 1)
1. 6 step sequencing
2. Low voltage contact closure
3. Configurable step delay
4. Acceptable Product:
    a. Middle Atlantic USC-6R

C. Switched Power Distribution (SEQ, Type 2)
1. Low voltage-controlled power sequencer
2. Rack mounted
3. 6 controlled outlets
4. 1 unswitched outlet

5. Acceptable Product:
    a. Middle Atlantic PDS-620R

D. Rack Power Distribution (RPD, Type 1)
1. Modular raceway power system.
2. Rack mountable vertical distribution.
3. Low voltage contact closures.
4. Coordinate wiring of high voltage components with electrical contractor.
5. Provide additional raceways if circuit count exceeds maximum raceway length
6. Acceptable Product to Include:
    a. Middle Atlantic MPR-xA
    b. Middle Atlantic RLM-20A (Switched Module, as needed)
    c. Middle Atlantic RLM-30A (Switched Module, as needed)
    d. Middle Atlantic M-20A (Un-switched Module, as needed)

E. Rack Power Distribution (RPD, Type 2)
1. Rack mountable vertical distribution.
2. Used for additional outlets where needed.
3. Size strip to number of required outlets.
4. Acceptable Product:
    a. Middle Atlantic PDT Series
    b. Middle Atlantic PD Slim Series

F. Switched Power Distribution (SW POWER, Type 1)
1. Low voltage-controlled power distribution
2. Rack mounted
3. 3 controlled duplexes
4. 1 unswitched duplex
5. Acceptable Product:
    a. Middle Atlantic PDC-915R-6

G. Power Protection with Lights (POWER/LIGHT):
1. 20 Amp power system.
2. Eight switched AC outlets.
3. Remote power turn on.
4. Acceptable product:
    a. Furman Sound PL-PRO C
    b. Approved Equivalent

H. Power Protection with Lights (POWER/LIGHT):
1. For small or portable rack applications
2. 15 Amp power system.
3. Eight switched AC outlets.
4. Acceptable product:
    a. Furman Sound PL-8C
    b. Approved Equivalent

I. Rackmount Uninterruptible Power Supply (UPS)
   1. Provide UPS systems to maintain power to all networking and processing equipment, including digital audio mixer systems and recording equipment
   2. UPS's shall be on-line style with sufficient battery reserve to operate for 15 minutes. Size each UPS unit for 25% additional capacity.
   3. Rack mountable.
   4. Acceptable product:
      a. Middle Atlantic Select Series UPS
      b. APC Easy UPS Series

J. Free Standing Uninterruptible Power Supply
   1. Provide UPS systems to maintain power to all networking and processing equipment, including control room equipment.
   2. UPS's shall be on-line style with sufficient battery reserve to operate for 15 minutes. Size each UPS unit for 25% additional capacity.
   3. Free Standing
   4. Acceptable product:
      a. APC Back UPS PRO Series

K. Approved Equivalent
   1. Power Supplies:
   2. As required.

2.23 EQUIPMENT HOUSING AND ACCESSORIES

A. General
   1. Refer to drawings for equipment rack sizes and additional notes.

B. Floor Pocket (FPG, FB):
   1. Cover: Floor pocket to have a hinged door of 6061-T6 machined aluminum, painted black. Top of cover to be flush with floor surface.
   2. Cable Access: Hinged door to have cable slots, which allow cables to be plugged-in to the receptacles with door in closed position.
   3. Back Box: 16-gauge galvanized steel with ¾" and 1" knockouts.
   4. Internal Brackets: Reference drawings for internal plate configuration.
   5. Provide with voltage barrier between high and low voltage areas.
   6. Acceptable product:
      a. Legrand RFB11 Series

C. Freestanding Equipment Rack (Type 1)
   1. Finish: Black powder coat
   2. Tapped 10-32 rack rails
   3. Provide side, top, and bottom panels
   4. Acceptable Product to Include:
      a. Middle Atlantic BGR series
      b. Middle Atlantic BGR-552FT-FC
      c. Middle Atlantic VFD series

D. Wall Mounted Equipment Rack (Type 1)

1. Finish: Textured black powder coat
2. Tapped 10-32 rack rails
3. Acceptable Product to Include:
    a. Middle Atlantic DWR series
    b. Middle Atlantic FAN2-DC-FC
    c. Middle Atlantic LVFD series

E. Floor-Supported Wall Rack (Type 1)
1. Finish: Black powder coat
2. Tapped 10-32 rack rails
3. Acceptable Product to Include:
    a. Middle Atlantic SR series
    b. Middle Atlantic FAN2-DC-FC
    c. Middle Atlantic LVFD series

F. Desk Mounted Equipment Rack (Type 1)
1. Finish: Black laminate
2. Tapped 10-32 rack rails
3. Acceptable Product:
    a. Middle Atlantic Slim 2 series

G. Rolltop Desk (Type 1)
1. Custom manufactured to specifications
2. Refer to drawings for dimensions
3. Coordinate finish with Architect
4. Lockable roll top lid
5. Acceptable Product:
    a. HSA Rolltop Desk – TBD

H. Portable Equipment Rack (Type 1)
1. Acceptable Product:
    a. Gator G-Tour GRC12x12

I. Rack Blanks (BLANK)
1. Flanged, aluminum panel.
2. Anodized finish.
3. Acceptable product:
    a. Middle Atlantic BL series

J. Rack Vents (VENT)
1. Flanged, aluminum panel.
2. Anodized finish.
3. Acceptable product:
    a. Middle Atlantic VTP series

K. Cable Management
1. Brush grommet panel
2. Acceptable Product:

a. Middle Atlantic BR series

L. Rack Drawers (DRAWER)
1. Blank anodized finish.
2. Acceptable product:
a. Middle Atlantic D series

M. Rack Mounted Sliding Shelf (SLIDING SHELF)
1. Finish: Black.
2. 1-RU rack mountable sizes.
3. Acceptable product to include:
a. Middle Atlantic SS

N. Equipment Rack Screws:
1. Install rack mounted equipment with black 10-32 star post security screws with flat nylon washers
2. Quantity as required
3. Provide one spare bit located in a clear plastic bag attached to the inside of each equipment rack in plain view
4. Acceptable Product:
a. Middle Atlantic HTX

O. Temperature Display (TD, Type 1)
1. 1RU/decora mount
2. Alarm out contact closure
3. Customizable over-temperature settings
4. LED display
5. Acceptable Product:
a. Middle Atlantic T1P

P.

2.24 PLATES AND PANELS

A. General
1. Provide plates and panels and as described in Drawings. Engrave as shown on Drawings. Other Plates and Panels may be required to satisfy the requirements of the Work.
2. Custom panels shall be 1/8-inch thick aluminum, standard EIA sizes, brushed, anodized finish unless otherwise noted. Brush in direction of aluminum grain only.
3. Plate finish shall be coordinated with the Owner. Plastic plates are not acceptable.
4. Panel, plate and label engraving shall be 1/8-inch block sans serif characters unless noted otherwise. On dark panels or pushbuttons, letters shall be white; on stainless steel or brushed natural aluminum pushbuttons, letters shall be black.

B. Custom and/or Engraved Panels:
1. Custom panels constructed of 1/8 inch brushed aluminum
2. Coordinate finishes with Owner
3. Acceptable Manufacturers:
a. EMG
b. RCI Custom

c. ProCo
d. Radial Engineering

2.25 CONNECTORS

A. XLR Panel mount Connectors
1. Provide panel mount XLR connectors with unified metal shell.
2. RF-Protector connectors.
3. Shell Color: Black.
4. Contacts: Silver.
5. Terminations: Solder.
6. Acceptable Product:
a. Male Connectors: Neutrik NC*MD-L-1-BAG Series
b. Female Connectors: Neutrik NC*FD-L-1-BAG Series

B. XLR Cable Connectors
1. Provide XLR cable connectors with die cast shell.
2. No-screw type assembly.
3. Chuck-type strain relief.
4. Shell Color: Black.
5. Contacts: Silver.
6. Terminations: Solder.
7. Acceptable Product:
a. Male Connectors: Neutrik NC*MX-BAG Series
b. Female Connectors: Neutrik NC*FX-BAG Series

C. RCA Panel Mount Connectors
1. Provide panel mount RCA connectors with unified metal shell.
2. RF-Protector connectors.
3. Shell Color: Black.
4. Terminations: Solder.
5. Acceptable Product:
a. Neutrik NF2D series

D. 3.5mm Stereo Panel Mount Connectors
1. Provide panel mount 3.5mm connectors with unified metal shell.
2. RF-Protector connectors.
3. Shell Color: Black.
4. Terminations: Solder.
5. Acceptable Product:
a. Switchcraft EH35MMMSCB

E. BNC Cable Connectors
1. Provide cable mount BNC connectors.
2. Contacts: Brass or copper.
3. Terminations: Crimp.
4. Acceptable Product:

a. Kings
b. Amp
c. Amphenol
d. Canare
e. Liberty

F. HDMI Connectors
1. Provide panel mount HDMI feedthrough connectors
2. HDMI 2.0 compliant
3. Acceptable Product:
a. Neutrik NAHDMI-W

G. Ethercon CAT6 Panel Connectors
1. Provide panel mount Ethercon CAT6 connectors
2. Metal housing
3. Shielded
4. Acceptable Product:
a. Neutrik NE8FDY-C6-B

2.26 LOOSE CABLES

A. Microphone/Instrument Cables:
1. Cable properties:
a. Quad 24 gauge stranded with braided shield, flexible hard service jacket.
b. Color: Black
c. Each cable to be provided with a Velcro style tie wrap.
1) Minimum 5/8” width
2) Length appropriate to wrap minimum 1.5 times around a cable loop of 14-inch diameter.
3) Standard of performance:
a) Rip-Tie CABLEWRAP
2. Microphone Cable:
a. Type 06 – 6 foot, with Gray collar on connector
b. Type 25 – 25 foot, with Blue collar on connector
c. Type 50 – 50 foot, with Green collar on connector
d. Type 100 – 100 foot, with Red collar on connector
3. Instrument Cable
a. Type 6 - 6 foot, 1/4-1/4
b. Type 10 – 10 foot, 1/4-1/4
4. Acceptable cable:
a. Whirlwind MKQ series
b. Canare StarQuad
c. ProCo AmeriQuad

B. Microphone Snake (Type 1):
1. 6 Channel

2. Male to Female XLR connectors
3. Acceptable Product:
    a. WhirlwindUSA MS-6-0-NR-075
    b. Approved Equivalent

C. Intercom Cables:
1. Cable properties:
    a. Quad 24 gauge stranded with braided shield, flexible hard service jacket.
    b. Color: Black
    c. Each cable to be provided with a Velcro style tie wrap.
        1) Minimum 5/8” width
        2) Length appropriate to wrap minimum 1.5 times around a cable loop of 14-inch diameter.
        3) Standard of performance:
            a) Rip-Tie CABLEWRAP
2. Intercom Cable:
    a. Type 06 – 6 foot, with Gray collar on connector
    b. Type 25 – 25 foot, with Blue collar on connector
    c. Type 50 – 50 foot, with Green collar on connector
    d. Type 100 – 100 foot, with Red collar on connector
3. Acceptable cable:
    a. Whirlwind MKQ series
    b. Canare StarQuad
    c. ProCo AmeriQuad

D. Speaker Cables:
1. Cable properties:
    a. Color: Black,
    b. Connector: NL4 to NL4 or NL8 to NL8
    c. Wire: 12 gauge stranded, SJ jacket.
    d. Each cable to be provided with a Velcro style tie wrap.
        1) Minimum 1” width
        2) Length appropriate to wrap minimum 1.5 times around a cable loop of 14-18 inch diameter.
        3) Standard of performance:
            a) Rip-Tie CABLEWRAP
2. Speaker Cable:
    a. Type 06 – 6 foot, with Gray collar on connector
    b. Type 25 – 25 foot, with Blue collar on connector
    c. Type 50 – 50 foot, with Green collar on connector
    d. Type 100 – 100 foot, with Red collar on connector
3. Acceptable cable:
    a. Whirlwind SK5 series

b. Approved Equivalent

E. Ethernet Audio Cables:

1. Cable properties:
   a. Color: Black
   b. Neutrik Ethercon Connector
   c. Rugged Tactical Jacket
   d. Each cable to be provided with a Velcro style tie wrap.
      1) Minimum 5/8” width
      2) Length appropriate to wrap minimum 1.5 times around a cable loop of 14-inch diameter.
      3) Standard of performance:
         a) Rip-Tie CABLEWRAP
2. Ethernet Cable:
   a. Type 06 – 6 foot, with Gray collar on connector
   b. Type 25 – 20 foot, with Blue collar on connector
   c. Type 50 – 55 foot, with Green collar on connector
   d. Type 100 – 100 foot, with Red collar on connector
3. Acceptable cable:
   a. ProCo DuraCat
   b. Approved Equivalent

2.27 INSTALLED CABLES & WIRING

A. General

1. All electrical conductors installed under this contract, except where otherwise specified, shall be soft drawn annealed stranded copper having a conductivity of not less than 98% of pure copper, and meet appropriate ratings (e.g. CMR, CMP, etc.)
2. Cable shall carry appropriate fire rating (e.g. CMR, CMP, OFNR, OFNP, etc.) on jacket of cable.
3. Where cables are routed through cable tray, provide tray rated cable of equal specification.
4. Where speaker cables are run exposed through a return air plenum, provide plenum rated cable of equal specification.
5. Shielded cables located in raceways shall have aluminum foil shield with drain wire.

B. Microphone/Line Level Wire

1. Provide shielded 22 AWG cable.
2. Cable to be PVC jacketed.
3. Jacket color: black.
4. Acceptable Product:
   a. Belden 9451

C. Production Intercom Wire

1. 18 AWG shielded
2. Cable capacitance to be less than 17 pF/ft
3. Acceptable Product:

a. Belden 6340FT

D. Speaker Level Wire
   1. For applications less than 600W and/or 600 feet
   2. Provide 14 AWG cable.
   3. Cable to be CL3R or CL2P rated.
   4. Jacket color: gray.
   5. Acceptable Product:
      a. Belden 5100UE

E. Speaker Level Wire
   1. For applications less than 2400W and/or 1000 feet
   2. Provide 12 AWG cable.
   3. Cable to be CL3R or CL2P rated.
   4. Jacket color: gray.
   5. Acceptable Product:
      a. Belden 5000UE

F. Speaker Level Wire
   1. For applications more than 2400W and/or 1000 feet
   2. Provide 10 AWG cable.
   3. Cable to be CL3R or CL2P rated.
   4. Acceptable Product:
      a. Belden 5T00UP

G. Batten Mic Junction Box Cable (BMJ-DS/US)
   1. Custom cable assembly
   2. (2) Digital Media Cable (see below)
   3. (2) 14 gauge stranded twisted pair
   4. (4) 22 gauge stranded twisted pair with shield
   5. Include cheeseborough style clamp
   6. Rated for single point suspension
   7. Acceptable Manufacturer:
      a. EMG

H. Category Cable
   1. 23-gauge solid cable
   2. Category 6+ Enhanced
   3. 4 pair, UTP
   4. Acceptable Product
      a. Belden 2412F

I. Relay/Control Level Wire
   1. Provide unshielded 22 AWG cable.
   2. Cable to be CMR or CMP rated.
   3. Provide number of conductors where required.
   4. Acceptable Product:

a. Belden Cable

J. Wireless /Assisted Listening Antenna Cable
1. For applications less than 100 feet
2. 16-gauge, stranded center conductor
3. RG8/X
4. 95% braided shield
5. Acceptable Product:
a. Belden 9258

K. Wireless /Assisted Listening Antenna Cable
1. For applications between 100 and 400 feet
2. 10-gauge, stranded center conductor
3. RG8/U
4. 90% braided shield
5. Acceptable Product:
a. Belden 9913

L. HDMI Cable
1. Provide pre-molded cables in lengths as required
2. Acceptable Product:
a. Extron Ultra Series HDMI Cable
b. Comprehensive Microflex Pro AV/IT 18Gbps

M. Digital Media Cable
1. Shielded Twisted Pair Cable for XTP Systems and DTP Systems
2. Enables lossless distribution of 4K and Ultra HD video signals at distances of 330 ft (100 m) via XTP and DTP
3. CMR rated for non-plenum applications
4. CMP rated for plenum applications
5. Color: Black
6. Acceptable Product:
a. Extron XTP DTP 24
b. Extron XTP DTP 24P (where required)

2.28 BUTTONS, SWITCHES, & KNOBS

A. Illuminated momentary action
1. Match LED to source voltage.
2. Accepted Product:
a. EAO Series 31 snap action with multi chip LED light source

B. Volume Controls, 70 Volt (V)
1. Provide volume control sized for connected load of speaker zone.
2. Architect to select plate color.
3. Acceptable suppliers:
a. 10-Watt:
1) Atlas AT10 (DC)

b. 35-Watt:
1) Atlas AT35 (DC)
c. 100-Watt:
1) Atlas AT100 (DC)

2.29 MISCELLANEOUS

A. Desktop Light: (Type 1)
1. 12” LED gooseneck light
2. On/off switch
3. Weighted base
4. Acceptable Product:
a. Littlite LW-12-LED

B. Desktop Light: (Type 2)
1. 18” LED gooseneck light
2. On/off switch
3. Weighted base
4. Acceptable Product:
a. Littlite LW-18-LED

C. Headphones (Type 1):
1. Acceptable Product:
a. Sony MDR-7506
b. Shure SRH440
c. Approved Equivalent

D. Stationary Cabinet (Type 1)
1. Lockable
2. Steel construction
3. Dimensions: 36 x 18x 30
4. 1 adjustable shelf
5. Acceptable Product:
a. Tennsco 3018BK

E. Stationary Cabinet (Type 2)
1. Lockable
2. Steel construction
3. Dimensions: 36 x 18x 42
4. 2 adjustable shelves
5. Acceptable Product:
a. Tennsco 4218BK

F. Stationary Cabinet (Type 3)
1. Lockable
2. Steel construction
3. Dimensions: 36 x 18x 60
4. 4 adjustable shelves

5. Acceptable Product:
    a. Tennsco 6018DHBK

G. Stationary Cabinet (Type 4)
1. Lockable
2. Steel construction
3. Dimensions: 36 x 18x 72
4. 4 adjustable shelves
5. Acceptable Product:
    a. Tennsco 7218DLXBK

H. Mobile Cabinet: (Type 1) – Microphones / Accessories
1. Lockable
2. Steel construction
3. 4 Drawers
4. Large 6” casters
5. Acceptable Product:
    a. Westward 3401NVS-5PU-95W
    b. Approved Equivalent

I. Mobile Cabinet: (Type 2) - Speakers / Cables
1. Lockable
2. Steel mesh construction
3. Large 6” casters
4. Double doors
5. Acceptable Product:
    a. Grainger 9WMJ8
    b. Approved Equivalent

J. Control Booth Chair: TYPE 1
1. Adjustable height, arms, backrest
2. Mesh back and seat
3. Color: Gray
4. Acceptable Product:
    a. OpenPlan B1 Relax
    b. Include OpenPlan OPS-B-CHKIT-BOOST

K. Follow Spot Chair: TYPE 1
1. All wood construction
2. Height: 29”
3. Backless
4. Color: Natural or Black
5. Acceptable Product:
    a. Winsome 249-01-6514
    b. Approved Equivalent

PART 3 - EXECUTION

3.01 GENERAL

A. Coordinate incorporation of the Work specified herein with other project work so as to facilitate a cohesive final Products.

B. The installation recommendations contained within ASDI and Telecommunications Distribution Methods Manual are mandatory minimum standards and requirements.

C. Mount equipment and enclosures plumb and level.

D. Permanently installed equipment to be firmly and safely held in place. Design equipment supports to support loads imposed with a safety factor of at least five. Seismic bracing shall be installed on appropriate equipment where local codes require such installation.

E. Verify all locations of equipment in all rooms with Owner's Representative, Owner, and Consultant.

3.02 INSTALLATION

A. Installation of cable and wiring

1. Cabling and Wiring:

a. Install cable in a manner to adhere to manufacturer's specifications for maximum cable pulling tension, minimum bend radius, and restrictions.

b. Provide appropriate support at all horizontal-to-vertical transitions in order to keep the weight of the cable from degrading at the point of transition.

c. If a J-hook or trapeze system is used to support cable bundles, all horizontal cables shall be supported at a maximum of 48-inch (1.2 meter) intervals. At no point shall the cables rest on light fixtures, acoustic ceiling grids, panels, conduits, sprinkler pipe, water pipe and/or HVAC system ducting.

d. Horizontal distribution cables shall be bundled in groups of no more than 50 cables when being supported by J-Hook or trapeze systems. Cable bundle quantities in excess of 50 cables may cause deformation of the bottom cables within the bundle and degrade cable performance. An exception to this rule is when cable is installed in cable tray systems.

e. Cable shall be installed above fire-sprinkler systems and shall not be attached to the system or any ancillary equipment or hardware. The cable system and support hardware shall be installed so that it does not obscure any valves, fire alarm conduit, boxes, or other control devices

f. Cables shall not be attached to ceiling grid or lighting fixture wires. Where support for horizontal cable is required, install appropriate carriers to support the cabling.

g. Any cable damaged or exceeding recommended installation parameters during installation shall be replaced prior to final acceptance at no cost to the Owner.

h. Cables shall be identified by a self-adhesive machine label in accordance with the System Documentation Section of this specification and ANSI/TIA/EIA-606-A. The cable label shall be applied to the cable behind the faceplate on a section of cable that can be accessed by removing the cover plate.

i. Unshielded twisted pair cable shall be installed so that there are no bends smaller than four times the cable outside diameter at any point in the run and at the termination field.

j. Provide splice free wiring and cabling from origination to destination. Cables shall be installed in continuous lengths from origin to destination (no splices). Properly designed transition points, or consolidation points are not considered 'splice' points.

k. Make joints and connections with rosin-core 60/40 solder or with mechanical connectors specifically intended for the type and class of cable being used. Where spade lugs are used, crimp properly with ratchet type tool.

l. Take precaution to prevent and guard against electromagnetic and electrostatic hum. For line-level audio signal, float cable shield at one end. Shield not connected to be folded back over cable jacket and covered with heat-shrink tubing. Do not cut off unused shield.

m. Isolate cables and wires of different signals or different levels; and separate, organize, and route to restrict channel crosstalk or feedback oscillation in any amplifier section. Keep wiring separated into groups for microphone level circuits, line level circuits, loudspeaker circuits, and power circuits.

n. Connect cable to active components through XLR connections whenever multiple formats are available. Make connections to speaker transformers with properly sized closed end connectors crimped with factory approved ratchet type tool. Wire nut or "Scotchlock" connectors are not acceptable. Do not wrap audio cable splices or connections with adhesive backed tape.

o. Cover edges of cable and wire pass-through holes in chassis, housings, boxes, etc., with rubber grommets or Brady GRNY nylon grommetting.

p. Execute wiring in strict adherence to:

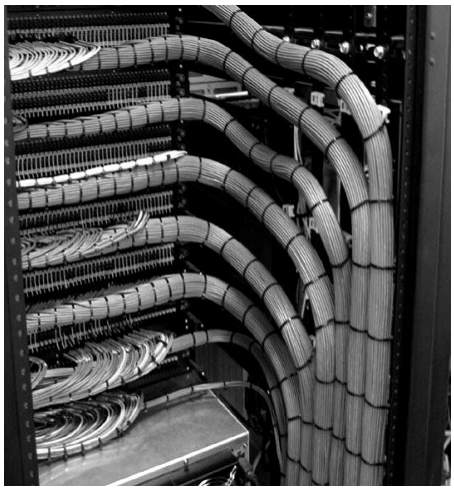
1) Phillip Giddings. Audio System Design and Installation. Indianapolis: Howard W. Sams & Co., 1990.

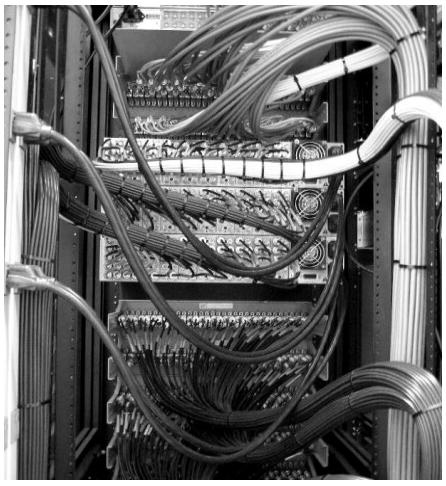
2) Don Davis and Carolyn Davis. Appendix II, Recommended Wiring Practices. Sound System Engineering, 2nd Edition. Indianapolis: Howard W. Sams & Co., 1989.

3) AV Installation Handbook Second Edition: The Best Practices for Quality Audiovisual Systems, Infocomm, 2009

2. Equipment Housing Cabling and Wiring:

a. Lace, tie, or harness wire or cable as required herein, and in accordance with accepted professional practice. Dress, lace or harness all wire or cable to prevent mechanical stress on electrical connections; no wire or cable shall be supported by a connection point. Install cable and wire neatly tied in manageable bundles with cable lengths cut to minimize excess cable slack but still allow for service and testing. Provide horizontal support bars if cable bundles sag. Reference photos below for standard of quality.





b. Provide adequate service loops so that equipment mounted on rack slides may be pulled fully out, to their locked position without straining cable.

c. Neatly bundle excess AC power cable from housing mounted equipment with plastic cable ties.

d. Provide plastic cable ties or Velcro straps to bundle cabling and wiring. Electrical tape and adhesive backed cable tie anchors are not acceptable.

e. Install with connections completely visible and labeled.

f. Provide termination resistors, if required, of 5 per cent tolerance; fully visible and not concealed.

B. Installation of connectors, plates & panels:

1. Install panel mounted connectors rigidly attached to panels, plumb and level.
2. Custom rack panels shall be 1/8 inch thick aluminum, standard EIA sizes, brushed black anodized finish (brushed in direction of aluminum grain only), unless otherwise noted.
3. Custom connector plates (speaker, microphone, etc.) are typically stainless steel, unless otherwise noted or specified. However, verify plate finish with Architect.
4. Install XLR type connectors in accordance with IEC-268 standard, with a wiring scheme of pin 2 hot (high), pin 3 (low), and pin 1 screen (shield).
5. Other Plates and Panels may be required to satisfy the requirements of the Work.

C. Installation power and grounding:

1. Coordinate final connection of power and ground wiring to housings.
2. Hardwire power wiring directly to internal AC receptacles to ensure uninterrupted operation.
3. Provide 3-conductor, isolated ground, 120 VAC outlets as required within each housing. Provide a minimum of two spare outlets in each rack.
4. Provide a copper ground buss top to bottom in each housing, insulated from the housing. Ground equipment chassis not having a three wire power cord to these busses using 6/32 nuts, bolts and lock-washers with No. 12 wire. Connect green ground wire from each AC outlet in housing to this buss bar.
5. Replace manufacturers supplied 18 gauge IEC power cords with UL listed 18 gauge pre-molded 6”, 12”, 18”, or 24”. Use minimum length required. No looped or cable tied IEC power cords will be permitted within the equipment rack.
6. Replace manufacturers supplied 14 gauge IEC power cords with UL listed 14 gauge pre-molded 18” or 36” for all equipment IEC capable. Use minimum length required and minimize looped or cable tied IEC power cords present in the equipment rack.

D. Installation of electronic equipment:

1. Take appropriate precautions against electrostatic discharge (ESD). Establish a personal ground before handling electronic equipment through the use of a grounded wrist wrap and/or an anti-static floor pad.
2. Take appropriate precautions to protect the equipment from damage during installation. Equipment to be installed free of damages, scratches, dents, etc.
3. Mount trim potentiometers, custom circuit cards, relays, and transformers (except large 70V units) in shielded enclosures, and mark their function and connections with engraved lamicoid labels.
4. Mount equipment plumb and level, firmly and safely held in place.

E. Installation of equipment housing:

1. Mount equipment in racks and consoles and fully wire and test before delivery to job site. If field conditions prevent prior assembly of racks, notify Owner in writing that racks will be fabricated on site and the reasons for the change.
2. Provide rear support for housing mounted equipment greater than 15 inches deep.
3. Provide blank panels to fill unused panel space within the equipment housing.
4. If Key door locks are required, key each housing type alike.
5. Looking at the rack from the rear, locate AC power and speaker wiring on the left; line level audio, video, and RF wiring on the right.
6. Provide shaft locks or security covers on non-user operated equipment having front panel controls. These panels are to be installed at the conclusion of testing.
7. If forced air active thermal management is used, provide ventilation blocking material on the front, sides, and rear of the equipment rack as needed. Reference Middle Atlantic Products “Controlling the Temperature Inside Equipment Racks”.
8. Panels or equipment mounted on the rear rack rails shall not block access to any front mounted components.
9. If equipment rack is not equipped with casters, provide two inch high wood base to isolate equipment rack from floor. Wood base should be capable of supporting the load.

F. Installation of loudspeakers:
   1. The Contractor is responsible for final design and engineering of loudspeaker rigging, attachments, brackets, and hoisting.
   2. Loudspeakers shall be mounted at the operating position in a safe, secure, and permanent manner.
   3. Provide custom rigging as needed.
   4. Suspension and Mounting:
      a. Static and dynamic equipment loads shall be suspended or mounted in compliance with the following ANSI/ESTA standards, using the latest available versions of the standards:
         1) ANSI E1.4-2-2021 Statically Suspended Rigging Systems
         2) ANSI E1.56-2018 Rigging Support Points
         3) ANSI E1.6-1-2021 Powered Hoist Systems
         4) ANSI E1.8-2012 Loudspeaker Enclosures Intended for Overhead Suspension
      b. Rigging, mounting, and support systems for overhead suspended loudspeakers shall be reviewed and certified by a registered Professional Engineer (PE), in the employ of the Contractor, licensed to practice in the State in which the project is located. Documentation shall be included as a submittal item. Once the systems are installed, the PE shall physically inspect, at the Contractor’s cost, the methods and means used to verify compliance with the original design.
   5. General Guidelines:
      a. Paint loudspeakers, supports, and related hardware color as directed by the Owner.
      b. The aiming direction of all loudspeakers shall be adjustable by no less than ±5 degrees horizontally and vertically.
      c. Loudspeakers are to be oriented parallel to their mounting surface unless otherwise noted.
      d. Provide a safety cable connected to a secondary location for each loudspeaker.
      e. All loudspeakers located in ceiling tiles shall be located in the center of the tile unless noted otherwise.

f. Paint loudspeakers to match surroundings. Confirm color selection with the Architect during the submittal phase.

g. Exterior loudspeaker cabinets shall be constructed of materials designed for permanent outdoor exposure conditions with a minimum IP 54 rating, and a minimum expected 10-year life span. Exterior and interior surfaces of the cabinets shall be protected from the effects of water, moisture, and humidity. The exterior surface shall also be protected from the effects of ultraviolet radiation to prevent fading and color change. The cabinets shall be shaped and oriented in a manner that minimizes the possibility of water pooling on any cabinet surface. Associated hardware shall be inherently non-corrosive, performing to the standards of 304 Stainless Steel or higher.

G. Installation of projectors:

1. Confirm distance of specified projection lens before mounting projector.
2. Projectors shall be mounted plumb and level at the operating position in a safe, secure and permanent manner.
3. All hardware required to locate the mount and projector at the required location shall be provided.
4. Projectors shall be mounted using tamper proof secure hardware.
5. Contractor may be required to adjust projection screen and lift upper and lower limit switches for projection screens and lifts specified elsewhere and not installed as part of this Contract.

H. Installation of flat panel monitors:

1. Confirm location before mounting.
2. Monitors shall be mounted plumb and level at the operating position in a safe, secure and permanent manner.
3. All hardware required to locate the mount and monitor at the required position shall be provided.
4. Locate monitor on the center line of the room unless noted otherwise.

I. Loose Equipment

1. Provide loose equipment as indicated on drawings.
2. Unpackage and assemble items.
3. Place items in designated storage or refer to Owner for direction on final location and storage of loose equipment.

3.03 FIRESTOP

A. A fire-stop system is comprised of the item or items penetrating the fire rated structure, the opening in the structure and the materials and assembly of the materials used to seal the penetrated structure. Fire-stop systems comprise an effective block for fire, smoke, heat, vapor and pressurized water stream.

B. All penetrations through fire-rated building structures (walls and floors) shall be sealed with an appropriate fire-stop system. This requirement applies to through penetrations (complete penetration) and membrane penetrations (through one side of a hollow fire rated structure). Any penetrating item i.e., riser slots and sleeves, cables, conduit, cable tray, and raceways, etc. shall be properly fire-stopped.

C. Fire-stop systems shall be reviewed by a Professional Engineer (PE) licensed to practice in the State in which the project is located. Stamped drawings showing the fire stop systems shall be included as a submittal item. Once the systems are installed, the engineer of record for the firestop system shall physically inspect the methods and means used to verify compliance with the original design.

D. A drawing showing the proposed fire-stop system, stamped/embossed by the PE shall be provided to the Owner's Technical Representative prior to installing the fire-stop system(s).

E. All fire-stop systems shall be installed in accordance with the manufacturer's recommendations and shall be completely installed and available for observation by the local authorities prior to cable system acceptance.

3.04 CONTROL SYSTEM PROGRAMMING

A. General

1. The following outlines basic control functions on a per system basis. Additional logic and programming may be required outside of detailed functions to complete the work.
2. Audio level controls
   a. Audio level controls to use UP/DOWN buttons to change audio levels in 1.5 dB increments (or closest translation by control system).
   b. Microphone and line level controls to operate between 0 and -24 dB.
   c. Audio outputs/zone output level controls to operate between 0 and -6 dB.
   d. Provide visual feedback of current level setting.
   e. Provide additional level control upstream of user-level control to set the maximum level for the zone.

B. Auditorium

1. Low voltage controls for AV control system
   a. Remote Power Sequencing
      1) Power Up: Triggered via touch panels.
         a) Control system to begin System Power Up Sequence. Sequence to be timed to trigger sequencing systems in accordance with the sequence specified in Part 2.22.A Power Sequencing Systems in this specification. During Sequence, Control System to flash the SYSTEM READY button located on touch panels until sequence is complete. Upon completion, Control System to indicate that the system is powered on and ready via solid color on SYSTEM READY buttons on all touch panels.
      2) Power Down: Triggered via touch panels.
         a) Control system to begin System Power Down Sequence. Sequence to be timed to trigger sequencing systems in accordance with the sequence specified in Part 2.22.A Power Sequencing Systems in this specification. During Sequence, Control System to flash the SYSTEM OFF button on the System touch panel until sequence is complete. Upon completion, Control System to indicate that the system is powered off by solid color on SYSTEM OFF button on System touch panel.
2. Low-voltage/network controls for DSP
   a. Page/Fire Alarm
      1) Triggered by the paging and/or fire alarm system, this preset to change the Source Matrix to source the paging/fire alarm system audio feed to the center channel of the main loudspeakers. Except for the Assisted Listening System, all recording and feeds outside the auditorium to mute and remain muted until the trigger has been released.
   b. Standby
      1) Triggered by AV Control System when system is powered on/off.
3. Functions triggered by AV Control System touch panel located in the Control Booth

a. System modes/presets:
   1) STANDBY: Audio DSP preset to mute all output capability of the system.
   2) EVENT: This preset to change Audio DSP Source Matrix to route the outputs of the digital mixing system to the main loudspeakers. All outputs of the DSP to be unmuted.
   3) REHEARSAL: This preset to change Audio DSP Source Matrix to route the outputs of the digital mixing system to the main loudspeakers. Feeds to the Lobby to be muted.
   4) PRESENTATION: This preset to change Source Matrix to route the outputs of the stage mixer to the main loudspeakers. All outputs of the DSP to be unmuted.

b. LOBBY VOLUME: Volume control for Lobby feed.

c. LOBBY MUTE: Mute control for Lobby feed.

4. DSP functions triggered by AV Control System touch panel located in ER-SMP
   a. System modes/presets:
      1) STANDBY: Audio DSP preset to mute all output capability of the system. This function to be disabled if system is currently in EVENT preset.
      2) PRESENTATION: This preset to change Source Matrix to route the outputs of the stage mixer to the main loudspeakers. All outputs of the DSP to be unmuted.
   b. LOBBY – CHIME: This button to trigger lobby chime. Button to flash while chime is active and end when chime has finished.
   c. LOBBY – CHIME/TALK: This momentary button to trigger lobby chime then unmute stage managers microphone. Button to flash while chime is active and return to depressed solid when chime has finished while user holds button. Stage managers microphone to mute and button to return to solid when user has released button.
   d. BOH – CHIME/TALK: This momentary button to trigger Back-of-House chime then unmute stage managers microphone. Button to flash while chime is active and return to depressed solid when chime has finished while user holds button to talk. Stage managers microphone to mute and button to return to solid when user has released button.
   e. INTERCOM LINK: This latching button to trigger control systems to actuate relays on the production intercom system to power intercom system combiners to link Black Box and Auditorium production intercom systems.

C. Transport Control
   1. Provide standard Stop, Play, Pause, Fast Forward and Rewind for each playback device and menu control for DVD players. Buttons should be arranged in a conventional fashion that will be familiar to the normal user.
   2. The selected control function should be displayed by showing the appropriate button “pressed”. It should remain this way until another function is selected.
   3. For devices that will go into a standby mode after a period of time, the control system shall sense this mode and restore normal operating mode once a transport function has been selected. This may require the use of current sensors to determine the state of the unit. No direct user action should be required at the playback device to restore the normal operating mode.

D. Screen/Shade Control

1. In addition to up-down functions, provide a Stop function to allow the movement to be halted. Once movement has been stopped, the up or down buttons should resume travel in the selected direction.
2. Control system shall not prevent screen/shade wall controls from being used as well.
3. Touch panel controls should be readily accessible to the user to permit direct control of shades or screen with having to navigate through multiple control pages.

E. Level Control
1. Objects requiring level adjustment such as volume or tone controls shall be through Up/Down buttons with a graphical representation of the actual level.
2. Increment of level change to be adjusted for reasonable range without the need to push the Up or Down buttons needlessly.

F. Standard Colors
1. Control functions shall be color coded to add clarity and show relationships between different groups of controls.
2. The color Red shall be reserved to indicate a fault or abnormal condition.
3. Green may be used to indicate normal operation, but may be used for standard control colors as well.
4. Similar controls should maintain the same color scheme across all control pages.
5. When a function is selected, the graphical depiction of that button should appear to be pressed and its color change to a darker shade of the regular button color.
6. Color schemes used for background and foreground objects should be selected to be complimentary and provide a consistent theme throughout the control pages.

G. Minimum Button Size and Placement
1. Minimum visual size of a button is 3/8” wide by 1/4” high.
2. Spacing between buttons should be no less than 1/16”.
3. Where buttons are immediately adjacent, the active selection area of the button should be reduced to 80% of the visual area of the button.

H. Button Actions
1. When a function on a control page is selected, that button or visual object associated with that function should change to reflect what has been chosen.
2. For functions that are momentary selections (i.e., VOL UP), the change of state is visible for as long as the button is being pressed.
3. For function that are maintained selections (i.e., PLAY), the change of state remains visible until another function is selected and resets the previous function.
4. The state change of a button or visible object should depict real-world objects as much as possible including the appearance of the button be pressed inward, change in shade of the original color, but not a change in hue.

I. Labels
1. Use of simple words or titles are preferred to indicate functionality, navigation and system status.
2. Use of stylish symbols should be avoided unless their identity is commonly recognized by the general public. Standard symbols for transport functions are acceptable.
3. Labels should be presented in a clear, sans serif type face that will remain legible on lower resolution touch panels.
4. Where physical buttons are present along the side of a touch panel, these buttons should be engraved and filled with a contrasting color.

J. Look & Feel
   1. Control pages should utilize a clean, elegant but stylish appearance.
   2. Use a common graphical template across all control pages for a consistent look.
   3. The touch screen layout should utilize graphical elements such as drop shadows, gradient fills and transparency to provide a pleasing overall appearance.
   4. Utilize graphical representations of floor plans to convey location information.
   5. Include company logos, icons or watermarks to portray the corporate identity.
   6. Provide clear navigation tools for moving between control pages.
   7. Each sub-page should have a “BACK” button to return to the previous page. This button should appear in the same location on each page.
   8. Provide a “HELP” button or icon on each user page to provide clear, non-technical instructions on how to use the functions available to regular users.

K. Security
   1. Provide password access to control pages not intended to be accessed by the general public.
   2. Unless otherwise noted, provide a minimum of three levels of access
      a. General User
      b. Non-Technical Employee
      c. AV Technician
   3. Segregate the control functions to only allow authorized individuals access to more sophisticated control pages.
   4. Provide a timeout feature to automatically return the control panel back to the default opening screen after 30 seconds of inactivity. After this reset, passwords must be reentered to return to a previous control page.

3.05 LABELING OF EQUIPMENT

A. Provide each terminal strip with a unique descriptor and a numerical designator for each terminal. Show terminal strip descriptor and designator on system schematic drawing.

B. Provide logical and legible cable and wiring label permanently affixed for easy identification.
   1. Labels on cables to be adhesive strip type covered with clear heat-shrink tubing. Factory stamped heat shrink tubing may be used in lieu of the adhesive strip style.
   2. Wiring designator to be an alpha-numeric code unique for each cable. Actual cable designation assignments to be determined by Contractor. Add cable designation codes to system schematic drawings.
   3. Locate the cable designator at the origination and destination of each circuit within 3 inches of the point of termination or connection. Provide cable designator on circuits with intermediate splice points with an additional suffix to indicate each segment.

3.06 ENGRAVING

A. Text font: 1/8 inch block sans serif characters unless noted otherwise.

B. On dark materials, provide white characters; on stainless steel or brushed natural aluminum plates, or light-colored materials, provide black characters.

C. Provide at least two lines of text with first line listing the general device name, e.g., amplifier. Second line to include schematic reference of the device, e.g., AMP-1.

D. Equipment label: black with white characters except where indicated.

3.07 COMMISSIONING

A. Prior to energizing or testing the system, ensure the following:

1. All products are installed in proper and safe manner according to manufacturer's instructions.
2. Insulation and shrink tubing are present were required.
3. Dust, debris, solder splatter, etc. is removed.
4. Cable is dressed, routed, and labeled; connections are consistent with regard to polarity.
5. Labeling has been provided.
6. Temporary facilities and utilities have been properly disconnected, removed and disposed of off-site.
7. Products are neat, clean and unmarred and parts securely attached.
8. Broken work, including glass, raised flooring and supports, ceiling tiles and supports, walls, doors, etc. have been replaced or properly repaired, and debris cleaned up and discarded.

B. Prior to energizing the System verify and perform the following tests and adjustments in compliance with applicable EIA standards.
   1. Electronic devices are properly grounded.
   2. Test each AC power receptacle with a circuit checker for proper hot, neutral and ground connections.
   3. Verify each individual component is operating properly.
   4. Verify each individual component's performance meets the manufacturer's published performance for this unit.
   5. Measure and record the DC resistance between the technical ground in any equipment rack or console and the main building ground. Resistance should be 0.15 ohms or less.

C. Speaker Circuit Verification Test
   1. Measure the impedance of each speaker line leaving the equipment racks.
   2. For constant voltage systems measure the impedance at 100 (or 250) Hz, 1 KHz and 8 (or 10) KHz of each line leaving the equipment rack with the line disconnected from the driving source. For band limited devices, use a frequency appropriate for the operating range of the transducer.
   3. When documenting the results of these tests, include the calculated impedance based on number of units on a line and the size and distance of the run. Correct any field readings that differ more than 20% from the calculated impedance.
   4. Include the results of the tests in the Project Record Manual.

D. Speaker Polarity Verification Test
   1. Use an electronic polarity checker, TEF-20, SYSID, SIM II, Smaart, or other similar device to test each loudspeaker. All speakers should have the same relative polarity.
   2. Follow manufacturer's recommendations in conducting the tests.
   3. Include the results of the tests in the Project Record Manual.

E. Audio Signal Paths
   1. Verify operation from each source device through all switching, amplification and distribution devices.

F. System Gain Adjustment
   1. Adjust each active device to have proper gain structure from the mixer output to the input of the amplifier.
   2. With all amplifiers turned off, connect a sine wave or pink noise generator to the input of the mixer. Using an RMS AC voltmeter with a dB scale, adjust the mixer to an output

between -10 and 0 dBu. Once the level has been established, it should remain unchanged throughout the test. All equalizers should be set flat for this test.

3. Follow the signal flow from the mixer to each subsequent component. Measure the input level and output level of each device at the point of connection to the device. The input level reading should differ no more than 0.25 dB from the level recorded for the preceding device. Diagnose and correct the wiring or equipment when any readings exceed this range.
4. Adjust the output of each component to achieve the proper output level.
5. Record the output levels of each device in the Project Record Manual.

G. Signal Delay Adjustment

1. Adjust the delay to each subsystem to ensure proper synchronization between the main speakers and delayed speakers.
2. Using a TEF 20, SYSID, Smaart, SIM II, or other acceptable time based measurement system, measure the arrival time of the distant signal and then measure the arrival of the local signal.
3. Based on the arrival times measured, adjust the delay applied to the local speakers to synchronize them with the distant speakers. Repeat the test to verify the delay has been set to within 1 ms of the arrival of the distant signal. Once the precise delay time has been determined, provide an additional 10 ms of Haas effect delay to maintain directional orientation toward the original sound source.
4. Continue to test and adjust each separate subsystem with a dedicated delay channel.
5. Provide hard-copy printout of each delay adjustment showing first the arrival times with no delay set and then the result after the delay has been adjusted. Record the settings of each delay in the Project Record Manual.

H. Remote Input Verification Test

1. Using a microphone or portable signal generator, connect to each microphone/line level receptacle throughout the facility.
2. Verify that the receptacle under test appears at the correct input and is operating properly.
3. In a similar manner, check all remote tielines and media related lines for correct wiring and labeling.

I. System Equalization

1. Using a RTA, TEF 20, SYSID, or SMAART, equalize all loudspeaker systems to provide a suitable frequency response as follows:
    a. Speech Reinforcement Systems: flat response from 125 Hz to 2.5 KHz, with 2 dB roll off above.
    b. Program Reproduction Systems: flat response from 65 Hz to 8 KHz, with 2 dB roll off above.
2. Verify system gain and amplifier levels.
3. Provide program levels of at least 85 dB and speech reinforcement levels of at least 70 dB in the seating area without objectionable distortion, buzzes, or rattles.
4. Provide hard copy printouts of the spectral response with the test data.

J. RFI and Parasitic Oscillation

1. With systems operating check to ensure that all systems are free from spurious oscillation and radio frequency interference in the absence of audio signal.

K. Buzzes, Rattles and other Distortions

1. Adjust the system for normal operating level in the space. Apply a slow sine wave sweep from 60 Hz to 3 KHz and listen carefully for buzzes, rattles and other objectionable distortions.
2. Correct the cause of the defect. If the cause is not from the system. Bring the cause to the attention of the GC, indicating cause and suggestive corrective actions.

L. Video Systems Test

1. Projected images and screen must be plumb with respect to ceiling line.

M. Video System Tests. Verify performance of all video equipment, components and systems, as specified herein.

1. Video (signal):
   a. S/N (peak to RMS), unweighted DC to 4.2 MHz: 55 dB minimum.
   b. Crosstalk, unweighted DC to 4.2 MHz: 45 dB minimum.
   c. Frequency Response: Within plus to minus 0.5 dB to 4.2 MHz.
   d. Line and Field Tilt: 2% maximum.
   e. Differential Gain: 2% maximum.
   f. Differential Phase: 2 degrees maximum.
   g. Frequency Response: DC to 4.2 MHz within plus or minus 0.5 dB.

N. Video Signal Paths

1. Verify operation from each source device through all switching, amplification and distribution devices.

O. Video Test Report shall include the following:

1. Test Failures and Notices
   a. Sink Device EDID Test – Open items or failures shall not be accepted.
   b. Cable Length Test – Open items or failures shall not be accepted.
   c. HDCP KSV Limitations – Limitations shall not be accepted.
   d. Cable Limitations - Limitations shall not be accepted.
   e. EDID Limitations - Limitations shall not be accepted.
   f. Cable Length Limits exceeded – Failing cables shall not be accepted.
2. Device Model Number, Serial Number, and Firmware Version for main chassis and each input and output card.
3. Device Model Number, Serial Number, and Firmware Version for connected transmitter and receiver devices.
4. EDID – Input Resolution and 3D support status for each input.
5. EDID – Supported Output Resolution and 3D support status for devices connected to each output.
6. EDID – Supported Audio formats for each input.
7. EDID – Supported Audio formats for devices connected to each output.

P. Control Systems

1. Verify operational functions of the control system and all interfaced devices.
2. Verify operational functionality of any wireless user devices.

3.08 CAT5E/CAT6 CABLE CERTIFICATION

A. General Field Test Requirements

1. All CAT5E/CAT6 cabling links installed as part of this scope shall be tested for the following, in accordance with the field test specifications defines in ANSI/TIA-568-C.2 “Commercial Balanced Twisted-Pair Telecommunications Cabling and Components Standard.” This document will be referred to as the “Category 5e Standard”:
    a. Wire Map
    b. Length
    c. Insertion Loss
    d. NEXT loss
    e. PS NEXT Loss
    f. ACR-F Loss
    g. PS ACR-F Loss
    h. Return Loss
    i. Propagation Loss
    j. Delay Skew
2. The installed twisted-pair horizontal links shall be tested from terminated end point to terminated end point for compliance with the “Permanent Link” performance specification as defined in the Category 5e Standard.
3. One hundred percent of the installed cabling links must pass the requirements of the Category 5e standard mentioned above and as further detailed in Section B below. Any failing link must be diagnosed and corrected. The corrective action shall be followed with a new test to prove that the corrected link meets the performance requirements. The final and passing result of the tests for all links shall be provided in the test results documentation in accordance with Section C below.
4. The test equipment (tester) shall comply with the accuracy requirements for level IIe field testers as defined in ANSI/TIA-1152. The tester including the appropriate interface adapter must meet the specified accuracy requirements. The accuracy requirements for the permanent link test configuration (baseline accuracy plus adapter contribution) are specified in Table 2 of ANSI/TIA-1152 (Table 2 in this TIA document also specifies the accuracy requirements for the channel configuration).
5. The RJ45 test plug shall fall within the values specified in ANSI/TIA-568-C Annex C for NEXT, FEXT and Return Loss.
6. The tester shall be within the calibration period recommended by the vendor in order to achieve the vendor-specified measurement accuracy.
7. The tester interface adapters must be of high quality and the cable shall not show any twisting or kinking resulting from coiling and storing of the tester interface adapters. In order to deliver optimum accuracy, preference is given to a permanent link interface adapter for the tester that can be calibrated to extend the reference plane of the Return Loss measurement to the permanent link interface. To ensure that normal handling on the job does not cause measurable Return Loss change, the adapter cord cable shall not be of twisted-pair construction.
8. The Pass or Fail condition of the link-under-test is determined by the results of the required individual tests (detailed in Section 4.2.2 of ANSI/TIA-1152). Any Fail result yields a Fail for the link-under-test. In order to achieve an overall Pass condition, the results for each individual test parameter must Pass.
9. A Pass or Fail result for each parameter is determined by comparing the measured values with the specifies test limits for that parameter.

B. Performance Test Parameters

1. The test parameters are defined by the Category 5e Standard. The test of each link shall contain all of the following parameters as detailed below. In order to pass the test, all measurements (at each frequency in the range from 1 MHz through 100 MHz) must meet or exceed the limit value determined in the above mentioned standard.
2. Wire Map - Shall report Pass if the wiring of each wire-pair from end to end is determined to be correct.
3. Length – The field tester shall be capable of measuring length of all pairs of a basic link or channel based on the propagation delay measurement and the average value for NVP. The physical length of the link shall be calculated using the pair with the shortest electrical delay. This length figure shall be reported and shall be used for making the Pass/Fail decision. The Pass/Fail criteria are based on the maximum length allowed for the Permanent Link configuration (90 meters – 295 feet) plus 10% to allow for the variation and uncertainty of NVP.
4. Insertion Loss (Attenuation) – Insertion Loss is a measure of signal loss in the permanent link or channel. The term “Attenuation” has been used to designate “Insertion Loss.” Insertion Loss shall be tested from 1 MHz through 100 MHz in maximum step size of 1 MHz. It is preferred to measure insertion loss at the same frequency intervals as NEXT loss in order to provide a more accurate calculation of the Attenuation-to-Crosstalk Ratio (ACR) parameter. Minimum test results documentation (summary results): Identify the worst wire pair (1 of 4 possible). The test results of the worst wire pair must show the highest attenuation value measured (worst case), the frequency at which the worst case value occurs, and the test limit value at this frequency.
5. NEXT Loss – Pair-to-pair near end crosstalk loss (abbreviated as NEXT loss) shall be tested for each wire pair combination from each end of the link (a total of 12 pair combinations).This parameter is to be measured from 1 through 100 MHz. NEXT Loss measures the crosstalk disturbance on a wire pair at the end from which the disturbance signal is transmitted (near-end) on the disturbing pair. The maximum step size for NEXT loss measurements shall not exceed the maximum step size defined in the Category 5e Standard as shown in Table 1. Minimum test results documentation (summary results): Identify the wire pair combination that exhibits the worst value of NEXT (worst case). NEXT is to be measured from each end of the link-under-test. These wire pair combinations must be identified for the tests performed from each end. Each reported case should include the frequency at which it occurs as well as the test limit value at this frequency.

   Table 1 – Maximum frequency step size as defined in ANSI/TIA-1152

Frequency Range (MHz)	Maximum Step size (MHz)
1 - 31.25	0.15
31.26 - 100	0.25

6. PS NEXT Loss – Power Sum NEXT Loss shall be evaluated and reported for each wire pair from both ends of the link under-test (a total of eight results). PS NEXT Loss captures the combined near-end crosstalk effect (statistical) on a wire pair when all other pairs actively transmit signals. Like NEXT this test parameter must be evaluated from 1 through 100 MHz and the step size may not exceed the maximum step size defined in the Category 5e Standard as shown in Table 1. Maximum test results documentation (summary results): Identify the wire pair that exhibits the worst-case margin and the wire pair that exhibits the worst value for PS next. These wire pairs must be identified for the tests performed from each end. Each reported case should include the frequency at which it occurs as well as the test limit value at this frequency.

7. ACR-F Loss, pair to pair – Attenuation Crosstalk Ratio Far-end is calculated from the pair-to-pair FEXT Loss. It shall be measured for each wire-pair combination from both ends of the link under-test. FEXT Loss measures the crosstalk disturbance on a wire pair at the opposite end (far-end) from which the transmitter emits the disturbing signal on the disturbing pair. FEXT is measured to compute ACR-F Loss that must be evaluated and reported in the test results. ACR-F measures the relative strength of the far-end crosstalk disturbance relative to the attenuated signal that arrives at the end of the link. This test yields 24 wire pair combinations. ACR-F is to be measured 1 through 100 MHz and the maximum step size for FEXT loss measurements shall not exceed the maximum step size defined as the standard as in Table 1. Minimum test results documentation (summary results): Identify the wire pair combination that exhibits the worst value for ACR-F. There wire pairs must be identified for the tests performed from each end. Each reported case should include the frequency at which it occurs as well as the test limit value at this frequency.
8. PS ACR-F Loss – Power Sum Attenuation Crosstalk Ratio Far-end is a calculated parameter that combines the effect of the FEXT disturbance from three wire pairs of the fourth one. This test yields eight wire-pair combinations. Each wire-pair is evaluated from 1 through 100 MHz in frequency increments that do not exceed the maximum step size defined in the standard as shown in Table 1. Minimum test results documentation (summary results): Identify the wire pair that exhibits the worst pair combinations must be identified for the tests performed from each end. Each reported case should include the frequency at which it occurs as well as the test limit value at this frequency.
9. Return Loss – Return Loss (RL) measures the total energy reflected on each wire pair. Return Loss is to be measured from both ends of the link-under-test for each wire pair. This parameter is also to be measured from 1 through 100 MHz in frequency increments that do not exceed the maximum step size defined in the Category 5e Standard as shown in Table 1. Minimum test results documentation (summary results): Identify the wire pair that exhibits the worst value of Return Loss. These wire pairs must be identified for the tests performed from each end. Each reported case should include the frequency at which it occurs as well as the test limit value at this frequency.
10. Propagation Delay – Propagation delay is the time required for the signal to travel from one of the links to the other. This measurement is to be performed for each of the four wire pairs. Minimum test results documentation (summary results): Identify the wire pair with the worst propagation delay. The report shall include the propagation delay value measured as well as the test limit value.
11. Delay Skew – [as defined in the Category 5e Standard; Section 6.2.19] This parameter shows the difference in propagation delay between the four wire pairs. The pair with the shortest propagation delay between the four wire pairs. The pair with the shortest propagation delay is the reference pair with a delay skew value of zero. Minimum test results documentation (summary results): Identify the wire pair with the worst-case propagation delay (the longest propagation delay). The report shall include the delay skew value measured as well as the test limit value.

C. Test Result Documentation

1. The test results/measurements shall be transferred into a Windows based database utility that allows for the maintenance, inspection, and archiving of these test records. A guarantee must be made that the measurement results are transferred to the PC unaltered, i.e., “as saved in the tester” at the end of each test and that these results cannot be modified at a later time.
2. The database for the completed job shall be stored and delivered on CD-ROM or DVD including the software tools required to view, inspect, and print any selection of test reports.

3. A paper copy of the test results shall be provided that lists all the links that have been tested with the following summary information:
    a. The identification of the link in accordance with the naming convention defined in the overall system documentation.
    b. The overall Pass/Fail evaluation of the link-under-test including the NEXT Headroom (overall worst case) number.
    c. The date and time the test results were saved in the memory of the tester.
4. General information to be provided in the electronic data base with the test results information for each link:
    a. The identification of the customer site as specified by the end-user.
    b. The identification of the link in accordance with the naming convention defined in the overall system documentation.
    c. The overall Pass/Fail evaluation of the link-under-test
    d. The name of the test limit selected to execute the stored test results
    e. The cable type and value of NVP used for length calculations
    f. The date and time the test results were saved in the memory of the tester
    g. The brand name, model, and serial number of the tester.
    h. The identification of the tester interface
    i. The revision of the tester software and the revision of the test limits database in the tester
    j. The test results information must contain information on each of the required test parameters that are listed in Section B and as further detailed below under paragraph C5.
5. For each of the frequency-dependent test parameters, the value measured at every frequency during the test is stored. The PC-resident database program must be able to process the stored results to display and print a color graph of the measured parameters. The PC-resident software must also provide a summary numeric format in which some critical information is provided numerically as defined by the summary results (minimum numeric test results documentation) as outlined above for each of the test parameters.
6. The detailed test results data to be provided in the electronic database must contain the following information:
    a. Length: Identify the wire-pair with the shortest electrical length, the value of the length rounded to the nearest 0.1 m330 and test limit value.
    b. Propagation delay: Identify the pair with the shortest propagation delay, the value measured in nanoseconds (ns) and the test limit value.
    c. Delay Skew: Identify the pair with the largest value for delay skew, the value measured in nanoseconds (ns) and the test limit value.
    d. Insertion Loss (Attenuation): Minimum test results documentation as explained in Section B for the worst pair.
    e. Return Loss: Minimum test results documentation as explained in Section B for the worst pair as measured from each end of the link.
    f. NEXT, ACR-F: Minimum test results documentation as explained in Section B for the worst pair combination as measured from each end of the link.
    g. PS NEXT and PS ACR-F: Minimum test results documentation as explained in Section B for the worst pair combination as measured from each end of the link.

3.09 FINAL OBSERVATION & TESTING

A. Upon completion of installation, initial adjustments, tests and measurements specified in Part 3, and submission and review of the results, a final observation and test will be performed by the Owner or Owner's representative no earlier than two weeks after receipt of the written results.

B. Provide a minimum of one (1) person for observation and testing familiar with aspects of the System to assist the Owner.

C. The process of testing the System may necessitate moving and adjusting certain components.

D. Testing includes operation of each major system and any other components deemed necessary. Perform tests and provide required test equipment, tools and material required to make any necessary repairs, corrections, or adjustments.

E. The following procedures will be performed on each System:

1. Observation of the methods and means employed to incorporate the System within the facility.
2. Verification of proper operation, from controlling devices to controlled devices.
3. Verification of proper adjustment, balance, and alignment of equipment for optimum quality and to meet the manufacturer's published specifications. Establish and mark normal settings for each level control, and appropriately record these settings within the Record Documents.
4. Other tests on equipment or systems deemed appropriate.

F. In the event the need for further adjustment or work becomes evident during testing, the Contractor is to continue his work until the System is acceptable at no addition to the contract price. If approval is delayed because of defective equipment, or failure of equipment or installation to meet the requirements of these specifications and any extension of the observation and testing period is required, the Contractor shall pay for additional time and expenses of the Owner at the standard rate in effect at that time.

3.10 TEST EQUIPMENT

A. Thirty days prior to start of testing, provide a list to the Owner of test equipment make, model numbers and calibration dates that will be used.

B. The following equipment shall be available on site for the entire test period through final system testing.

1. Sound Level Meter : ANSI S1.4-1971 Type S1A with digital or analog display. Meter to provide ranges of 40 to 120 dBA.
2. Pink Noise Source - Equal energy per octave bandwidth 20 Hz to 20,000 Hz, ±1 dB (long-term average) at 0 dBm output. Stability: ±2 dB per day.
3. Dual-trace oscilloscope - 100 MHz bandwidth, 1 mV/cm sensitivity.
4. Impedance Meter - Capable of testing audio lines at three frequencies, minimum, between 250 Hz and 5k Hz. Measurement Range: 1 ohm to 100 kohms.
5. Audio Oscillator: bandwidth 20 Hz to 20k Hz ±.5 dB at 0 dBm output. Output to be balanced. Oscillator to include adjustable output level over the range from –30 dBu to +10 dBu.
6. Multimeter - Measurement range, DC to 20k Hz, 100 mV to 300 V, 10 ma to 10 A, dB.
7. NTSC Test generator
8. Real time analyzer with LED or CRT display. The unit shall meet the filter requirements of ANSI S1.11 Class III for one third octave filters.
9. Video (analog) test generator capable of generating signal up to 1920 x 1200 with audio.
10. Video (digital) test generator capable of generating signal up to 1920 x 1200 with audio.
11. Ladders and scaffolding necessary to inspect elevated equipment, junction boxes, etc.

C. Provide three portable VHF or UHF business band radios for use during acceptance testing with transmission range sufficient to cover entire project. Include rechargeable batteries and recharger along with holster for wearing on belt. Radios to be available for duration of testing process, including any follow-up visits required prior to final acceptance.

3.11 INSTRUCTION OF OWNER PERSONNEL

A. Provide instruction to Owner designated personnel focusing on the use, operation and maintenance of the systems, scheduled as a minimum of two separate sessions, by an instructor fully knowledgeable and qualified in system operation. The System Reference Manuals should be complete and on site at the time of this instruction. Coordinate schedule of demonstration with Owner's Representative.

1. Area

a. 8 hours of instruction

B. Video record all training sessions and compile a training video to be provided to the Owner on DVD.

C. Provide sign in sheet to document the attendee's presence.

D. If Contractor is not properly equipped to conduct Owner training on particular equipment, arrange for factory representatives of the equipment to be present to provide training at no additional cost to the Owner.

3.12 CLEANUP AND REPAIR

A. Upon completion of the work, remove refuse and rubbish from and about the premises. Leave areas and equipment clean and in an operational state. Repair any damage caused to the premises by the installation of systems at no cost to the Owner.

END OF SECTION 27 4116

SECTION 27 4123
AUDIO-VIDEO CABLING AND ACCESSORIES

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes: Requirements for cabling and accessories for audio-video systems.

B. Related Requirements:
   1. Installation shall comply with all applicable codes and standards in effect at the job site and as indicated in the Drawings and Specifications
   2. Division 27 Section “Pathways for Communication Systems” for pathways and support for system cabling.

1.02 DEFINITIONS

A. Acronyms and Abbreviations
   1. Assistive Listening System
   2. American Wire Gauge
   3. Category 6 cable as defined in ANSI/TIA 568
   4. Category 6A cable as defined in ANSI/TIA 568
   5. Twisted-pair cabling with overall foil shield, without shielding of individual pairs within the cable.
   6. High-Definition Multimedia Interface standard
   7. Standard for distributing high-definition video and audio signals over standard twisted pair cabling
   8. Radio frequency
   9. Universal Serial Bus cable and connector standard
   10. Twisted-pair cabling without overall shield

1.03 ACTION SUBMITTALS

A. Product Data:
   1. Cabling product data shall be included in product data submittals for systems referencing this section.

1.04 QUALITY ASSURANCE

A. Installer Qualifications: All cabling for a given AV system (except data network drops provided by the structured cabling contractor) shall be provided by the same company providing the equipment for that AV system.

B. Standards: All work shall be performed in accordance with the latest revisions of the following standards and codes:
   1. NFPA 70 – National Electrical Code.
   2. Local Codes and Amendments.
   3. TIA/EIA-568-A Commercial Building Telecommunications Wiring Standard.
   4. EIA/TIA-569 Commercial Building Standard for Telecommunication Pathways and Spaces.
   5. TIA/EIA-606 The Administration Standard for the Telecommunications Infrastructure of Commercial Buildings.
   6. TIA/EIA TSB 67 Transmission Performance Specification for Field Testing of Unshielded Twisted-Pair Cabling Systems.
   7. ISO/IEC 1180 Generic Cabling Standard.
   8. EN 50173 Generic Cabling Standards for Customer Premises.

PART 2 PRODUCTS

2.01 GENERAL

A. Installation: The cabling shall be installed per requirements of the manufacturer and the Project Documents utilizing materials meeting all applicable TIA/EIA standards. The Contractor is responsible for providing all incidental and/or miscellaneous hardware not explicitly specified below as required for a complete and operational system.

B. Ratings: All products shall be new and brought to the job site in the original manufacturer's packaging. Electrical components (including innerduct) shall bear the Underwriter's Laboratories label. All communications cable shall bear flammability testing ratings as follows unless noted otherwise:
   1. Indoor Cable: CL2P, CL3P, or CMP Plenum Rated Communications Cable
   2. Outdoor Cable: CL2, CL3, CM UV & Water Resistant, and/or Indoor/Outdoor Plenum OSP Communications Cable

C. Fire Wall Sealant: Any penetration through firewalls (including those in sleeves) will be resealed with an Underwriter Laboratories (UL) approved assembly.

2.02 WIRE AND CABLE

A. Constant Voltage (70.7V) Loudspeaker Cable for Distributed Loudspeaker Systems: 2-Conductor Unshielded, 14 AWG minimum, bare conductors, rated CMP (plenum). Belden 6100UE or equal.

B. Mic/Line Level Analog Audio Cable: Individually shielded & twisted pairs (count as required for application), 22AWG tinned stranded conductors, rated CMP (plenum). Belden 9451 Series or equal.

C. HDBaseT and/or Video-Over-IP Cabling: Cat 6 UTP (unless otherwise noted), rated CMP (plenum). Refer to Section 27 06 10 Voice Data System. Provide typical Category 6 RJ-45 plug termination on both ends of cable in lieu of keystone jack terminations.

D. Point-to-point HDMI Cabling, non-plenum, 25 ft (7.6 m) or less: Provide high quality cable rated for in-wall installation and HDMI 2.0 minimum. C2G #2968x or equal.

E. Point-to-point HDMI Cabling, plenum, 25 ft (7.6 m) or less: Provide high quality cable rated for plenum installation and HDMI 2.0 minimum. C2G #4252x or equal.

F. Point-to-point HDMI Cabling, plenum, greater than 25 ft (7.6 m): Provide high quality active HDMI cable rated for plenum installation and 4k60Hz minimum: C2G #4145x or equal.

G. Wireless Microphone Antenna Cabling: Provide low-loss, plenum rated 50-ohm RG8 Coaxial Cable with 10AWG solid bare copper conductor. Belden 89913 or equal with Amphenol Connex 112563 or equal connector.

H. Assistive Listening System Antenna Cabling: Provide 75-ohm coaxial cable with 20AWG solid bare copper conductor. Belden 1370P or equal, with connectors as specified by manufacturer.

I. Other equipment control cables shall be stranded wire, appropriately shielded, of gauge and number of conductors required by the manufacturer for proper operation of the system or equipment item furnished.

J. Capacities and Characteristics:
   1. All wire and cables shall be new and unused.
   2. Indoor Wire which is not portable and is not installed within equipment racks or conduit shall be plenum-rated and meet all applicable codes

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine roughing-in for A/V system(s) to verify pathways and/or conduits are prepared and free of sharp edges and other conditions that may damage cable prior to cabling installation.

B. Inspect all cable prior to installation to verify that it is identified properly on the reel identification label, that it is of the proper gauge, containing the correct number of pairs, etc. Note any buckling of the jacket that would indicate potential problems. Damaged cable or any other components failing to meet specifications shall not be used in the installation.

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

3.02 GENERAL CABLING INSTALLATION

A. Comply with NECA 1.

B. Furnish cabling, plates, and labor necessary for the complete installation of the AV System(s) infrastructure, in full accordance with the recommendations of the equipment manufacturers and the requirements of the drawings and specifications.

C. Wiring Method: Install cables in raceways and cable trays except within consoles, cabinets, desks, and counters and except in accessible ceiling spaces and in gypsum board partitions where unenclosed wiring method may be used. Conceal raceway and cables except in unfinished spaces.
   1. Install plenum cable in environmental air spaces, including plenum ceilings.
   2. Comply with requirements for cable trays specified in Section 26 05 36 "Cable Trays for Electrical Systems."
   3. Comply with requirements for raceways and boxes specified in Section 26 05 33 "Raceways and Boxes for Electrical Systems."

D. Install cables parallel and perpendicular to building lines where possible.

E. Support cables in accordance with Division 27 Specification Section “Pathways for Communication systems”. Cables shall not be supported by ceilings, ductwork, piping, etc.

F. Cables shall be installed and routed in such a manner that they do not interfere with the operation of equipment or removal of ceiling tiles.

G. 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.

H. Testing: Contractor shall test all installed cabling shall be tested after installation and prior to owner acceptance to confirm cabling and terminations are good and passing signals as intended. Re-terminate or replace cabling which does not pass testing.

3.03 CABLE PULLING

A. Follow manufacturers’ recommendations for regulating temperature conditions of conductors prior to installation.

B. Exercise care in handling and installing cables to avoid damage. Carefully form cables in pull boxes, enclosures, etc. Form bends in cables larger than the minimum radii shown in the cable manufacturer's published data for minimum bends such that bends will not reduce the cable life.

C. Provide suitable installation equipment to prevent abrasion and cutting of conductors by raceways during the pulling of conductors.

D. The pulling of all wires and cable on this project shall be performed in strict compliance with applicable sections of the National Electrical Code. No conductor entering or leaving a cabinet or box shall be deflected in such a manner as to cause excess pressure on the conductor insulation. Conductors shall only be installed after insulating bushings are in place.

E. Maximum permissible pulling tensions, as recommended by the manufacturer for any given type of cable or wire installed shall not be exceeded. Utilize special remote readout equipment to ensure compliance.

F. Before any wire is pulled into any conduit, thoroughly swab the conduit to remove all foreign material and to permit the wire itself to be pulled into a clean, dry conduit.

G. Use manufacturer-approved pulling compound or lubricant where necessary, of non-conducting type. Compounds used must not deteriorate the conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.

3.04 IDENTIFICATION AND LABELING

A. Color-code cables according to Division 27 Section "Common Communications Requirements."

B. Provide self-adhesive vinyl or vinyl-cloth wraparound tape machine printed marker labels, at both ends of each cable. Utilize systematic alphanumeric designations to identify cables for easy troubleshooting. Document cable labeling in O&M manual.

END OF SECTION

SECTION 27 5123
INTERCOMMUNICATIONS AND PROGRAM SYSTEMS

PART 1 GENERAL

1.01 SUMMARY

A. Furnish and install a complete new intercommunication and program system for the facility as necessary. Furnish and install all equipment, accessories, and materials in accordance with the specifications and drawings to provide a complete communication system including public address paging and intercommunication functions as outlined below.
   1. A complete system includes items such as wiring, control consoles, and main distribution equipment as necessary.
   2. Integrate all components to provide a complete and functioning system.

B. Integrate the intercommunication and program system with the following systems:
   1. Owner’s Phone System.
   2. Access Control System Lockdown Sequence.
   3. Fire Alarm System

C. Intercom Features / Public Address Features: Provide system with the following minimum characteristics and features:
   1. System topology
      a. One-Way paging functionality.
      b. Individual intercom circuit for every classroom.
      c. Paging circuits to operate at 25 Volts.
      d. Connections to Owner's internal phone exchange and the public telephone system via SIP trunk.
   2. Differentiated Paging Function Types:
      a. All-call announcements and scheduled messages.
      b. Zone-specific announcements and scheduled messages.
      c. Emergency announcements with distinctive tones and/or pre-recorded messages.
   3. Time Control and Event Scheduler: Provide system with the following functions:
      a. Built-in Master Clock with unlimited events.
      b. 64 schedules.
      c. Weekly system event scheduler.
   4. Miscellaneous Features
      a. Ethernet LAN/WAN interface for district-wide all-calls and remote management.
      b. MapAssist Administrative Console with facility plan view.

D. Related Requirements:
   1. Division 27 Section "Communications Horizontal Cabling" for cabling used for voice and data circuits.
   2. Division 28 Section “Access Control Software and Database Management” for interface with emergency lockdown sequences.
   3. Division 28 Section "Digital Addressable Voice Evacuation Fire Alarm System" for interface with fire alarm system.

1.02 DEFINITIONS

A. FXO: Foreign eXchange Office.

B. Paging: Communication via audio messages relayed by a distributed speaker system.
   1. "One-Way", "Broadcast", or "Public Address" Paging: Audio message playback to one or more distributed locations or zones, without a means for the message source to hear return communication from the zones addressed.

C. SIP: Session Initiation Protocol, a standard protocol used in voice-over-IP telephone systems.

1.03 ACTION SUBMITTALS

A. Submit product data and shop drawings in accordance with Division 01 and Division 27 Section “Communications Shop Drawings and Submittals” for products specified under PART 2 - PRODUCTS.

B. Specification Compliance Certification: Submit a Specification Compliance Certification in accordance with Division 27 Section “Communications Shop Drawings and Submittals”.

C. Product Data:
   1. Complete system bill of materials.
   2. Brief specification documents ("cut sheets") for each type of product.

D. Shop Drawings: The installing contractor and/or equipment supplier shall provide complete and detailed shop drawings and include:
   1. Complete floor plan drawings locating all system devices.
   2. Overall system one-line diagram.
   3. Wiring and interconnection schematics.
   4. Detailed system operational description

1.04 INFORMATIONAL SUBMITTALS

A. Qualification Data for Installer. Refer to "Quality Assurance" article for qualification requirements.

1.05 CLOSEOUT SUBMITTALS

A. Start-up Testing Documentation: When requesting Owner Acceptance Testing, submit the following documentation from the Start-up Testing procedure:
   1. A record of speaker line testing indicating DC ground resistance and line-line impedance measurement for each speaker line.

B. Operation and Maintenance Manual: For intercommunications and program systems. Collect the information in an organized format including tabs and/or PDF bookmarks delineating each of the required sections below. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
   1. Record drawings including:
      a. Plans showing location of intercom system components including head-end equipment, speakers, and user interface devices.
      b. Record of speaker tap settings.
      c. Device address list.
   2. Operation and Maintenance Documentation including:
      a. Hardware and Software operating manuals.
      b. Maintenance Parts List & supplier contact information.
   3. System Maintenance and Warranty Documentation including:
      a. A copy of the manufacturer’s standard statement of warranty on system components.
      b. Installing contractor's statement of warranty on overall system and workmanship.
      c. Warranty contact information.

C. Program Software Backup: On USB media or compact disk, complete with data files.

1.06 QUALITY ASSURANCE

A. Installing Contractor Qualifications:
   1. Contractor shall be an established electronic communication systems installer with not less than 5 years history of designing and installing similar systems. Provide, upon request by Owner or Architect/Engineer, names and addresses of similar installations.
   2. Contractor shall be an authorized distributor in good standing for the equipment supplied, with full manufacturer's warranty privileges.

B. Installing Personnel Qualifications:
   1. Technicians performing work shall be trained in the basic principles and practices of low voltage systems installation and integration.
   2. Work shall be supervised by a technician trained and certified by the manufacturer to install the equipment supplied.

1.07 COORDINATION

A. It shall be the responsibility of the installing contractor to coordinate all requirements surrounding installation of the communication system with all other trades.

B. Pre-installation Meeting: Schedule a pre-installation meeting specifically for the Intercommunications and Program System with Owner and Architect.

1.08 WARRANTY

A. Manufacturer shall warranty components of the installed system against defects in material and workmanship for a period of not less than five (5) years from the date of installation.

B. Installing contractor shall warranty workmanship and system integration for a period of not less than one (1) year after final acceptance of the Work by the Owner.

C. Defects occurring in labor or materials within the one-year warranty are to be rectified by replacement or repair. Correct detects in material or workmanship with a minimum loss of operating time at no cost to Owner.

D. Onsite Service: This Contractor, within the warranty period, is required to answer all service calls and requests for information within a 24-hour period and repair or replace any faulty item within a 24-hour period, without charge, including parts and labor.

PART 2 PRODUCTS

2.01 PRODUCTS

A. Products: Subject to compliance with requirements, provide CareHawk #CH1000. Substitutions by written Owner approval only.

2.02 GENERAL SYSTEM REQUIREMENTS

A. The intercom system shall consist of one or more central equipment cabinet(s) with modular components as needed to implement the features described herein, administrative control stations (ACSs), and station equipment including loudspeaker assemblies.

B. Provide all associated material hardware, wiring, and options as described herein to provide a complete working system, which shall meet the specified requirements.

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

D. Weather-Resistant Equipment: Listed and labeled by an NRTL for duty outdoors or in damp locations.

2.03 CENTRAL CONTROL EQUIPMENT

A. The central control equipment shall be mounted in a wall-mounted equipment cabinet. See part number schedule for listing of components.

B. The central equipment shall consist of but not be limited to the following:
   1. Provide power supplies to deliver operating DC power for the circuitry contained within the central equipment housing and all administrative control stations (ACSs).
   2. Provide a central microprocessor unit containing system memory, components, and programming necessary to implement the features specified herein.
   3. Provide zone circuit boards and amplifier modules as required to meet the system requirements for intercom zones/paths.
   4. Provide a means to automatically activate a program source between class changes.

5. Provide network IP communications modules as needed to receive district wide mass notifications and permit remote management.
6. Provide enclosure for mounting equipment. Size enclosure(s) or rack(s) to accommodate all components, plus 20 percent spare expansion room for future additions.

C. Telephone Integrations
1. The system shall integrate to the facility phone system to allow any authorized telephone system extension to:
   a. Make paging announcements to any of the zones.
   b. Initiate system tones to any area of the facility.
   c. Distribute programs to any zones and zone monitor any area of the building.
2. Integration to the Owner's VoIP phone system will utilize SIP trunking .

2.04 ADMINISTRATIVE CONTROL STATION

A. Central office communications and control are achieved via the administrative control station or "admin phone". See part number schedule below.

B. 12-Digit Keypad Selector: Initiates commands for programming and operation.

C. Volume Control: Regulates incoming-call volume.

D. LED Annunciation: Identifies stations in use. LED remains on until call is answered.

E. Speaker Microphone: Transmits intercom voice signals when used via a voice-operated switch.

F. Hard Buttons: To transfer and place calls on hold.

G. Reset Control: Cancels call and resets system for next call.

H. LCD Graphical display.

2.05 MASTER CLOCK SYSTEM

A. The system shall contain an integral Master Clock and Programmer that shall be capable of performing the scheduled functions, bells, etc. See part number schedule below.

B. The system shall provide for automatic (without user input) clock correction for Daylight Savings Time, spring ahead/fall back.

C. The system shall provide for an editing and review routine to permit the user to change and edit time events, zones, and schedules.

2.06 AMPLIFIERS

A. Amplifiers and speaker lines provided shall operate on the constant voltage principle at 25 V.

B. System amplifier sizes and quantities shall be selected according to the initial tap settings specified in Part 3. The total amplifier load in each zone or enclosure shall not exceed 80-percent of capacity provided. See part number schedule below.

C. The amplifiers shall be capable of producing their rated power output at less than 1 percent THD.

D. The amplifiers shall be designed to operate on an AC line voltage of 115 VAC.

2.07 SPEAKERS

A. Lay-in Tile Ceiling-Recessed Speakers:
1. Provide 1'x2' nominal lay-in tile replacement recessed loudspeaker assemblies.
2. All speakers shall include 4 W integral transformer and rotary tap selector.
3. Provide front-mounted volume control in Classrooms, Offices, Conference Rooms, Teacher's Lounges, and Workrooms.
4. Contractor may utilize RJ45 or 8P8C connectors and Category 5e or Category 6 cabling.
5. Finish color to be White unless noted otherwise.

6. Basis-of-design product: Subject to requirements, provide Quam #System 5 series or comparable product by manufacturers listed below.

B. Interior Ceiling-Recessed Speakers, other than lay-in tile:
   1. Provide round, 12" diameter baffle recessed loudspeaker assemblies.
   2. All speakers shall include 5W integral transformer and back can.
   3. Provide speakers with appropriate mounting supports for application.
   4. Finish color to be White unless noted otherwise.
   5. Basis of design product: Subject to requirements, provide Quam #System 21 or #Solution 3, or comparable product by manufacturers listed below.

C. Interior Structure-Mount Speakers for areas with exposed structure:
   1. Provide round, 12" diameter baffle recessed loudspeaker assemblies.
   2. All speakers shall include 5 W integral transformer and back can.
   3. Provide speakers with appropriate mounting supports for application.
   4. Finish color to be White unless noted otherwise.
   5. Basis-of-design product: Subject to requirements, provide Quam #BB2, or comparable product by manufacturers listed below.

D. Interior Wall-Recessed Speakers:
   1. Provide square recessed backbox, with acoustic foam lining and conduit stub-up to nearby cabling pathway above accessible ceiling or bottom of structure. Coordinate backbox depths with other trades.
   2. Provide 8" diameter speaker with 5 W integral transformer.
   3. Provide 12" square baffle. Finish color to be White unless noted otherwise.
   4. Basis-of-design product: Subject to requirements, provide Quam #8C10PAX/TBLU + #BS8W + #ES-8(-6), or comparable products by manufacturers listed below.

E. Interior/Exterior Wall-Recessed Vandal-Resistant Paging Horn:
   1. Provide square recessed backbox, with acoustic foam lining and conduit stub-up to nearby cabling pathway above accessible ceiling or bottom of structure. Coordinate backbox depths with other trades.
   2. Provide 16 W compression-type re-entrant horn loudspeaker with vandal-resistant square stainless steel baffle and integral transformer. Baffle finish to be White unless noted otherwise.
   3. Basis-of-design product: Subject to requirements, provide Quam #H16/SVPS + #ES-8S, or comparable products by manufacturers listed below.

F. Exterior (Damp-location) Canopy Surface Mounted Vandal-Resistand Speaker:
   1. Provide square surface-mount backbox with conduit connections and matching square vandal-resistant baffle with security torx fasteners. Finish color to be White unless noted otherwise.
   2. Provide 8" diameter moisture-resistant loudspeaker with 5W integral transformer.
   3. Basis-of-design product: Subject to requirements, provide Quam #System 1VP or comparable products by manufacturers listed below.

G. Manufacturers: Subject to requirements, comparable products by the following manufacturers are acceptable in lieu of the bases of design specified above:
   1. AtlasIED
   2. Lowell
   3. Others by prior Engineer approval.

2.08 REMOTE VOLUME CONTROL DEVICES

A. Wall-Mounted Volume Control: 10-watt, stepped, recessed autotransformer volume control in US 1-gang form factor. Volume control shall have relay coil for public address (PA) emergency override of volume control. Provide Atlas Sound #AT-10PA or Quam #QC-10P. Equivalents from all acceptable manufacturers to be accepted.

B. Remote Source Output Volume Control: Rack-mounted in remote source rack. Provide line level volume control.

2.09 REMOTE MANAGEMENT

A. Remote Scheduling: Provide all necessary components to allow for remote scheduling of intercommunications and program system.

B. Troubleshooting: Provide all necessary components to allow for remote management of system settings and issue logs.

2.10 UPS BATTERY BACK-UP

A. Acceptable Manufacturers: Liebert, Best Power, APC, TrippLite.

B. Provide UPS battery back-up for the communications system to operate a minimum of 24 hours standby then 20 minutes of operation upon loss of power.

2.11 CONDUCTORS AND CABLES

A. Conductors: Jacketed, twisted pair and twisted multi-pair, un-tinned solid copper. Sizes as recommended by system manufacturer, but no smaller than No. 22 AWG. Increase wire sizes as needed to account for voltage drop in long cabling runs.

B. Insulation: Thermoplastic, not less than 1/32 inch thick.

C. Plenum Cable: Listed and labeled for plenum installation.

2.12 RACEWAYS

A. Intercommunication and Program System Raceways and Boxes: Comply with requirements in Division 26 Section "Pathways for Communications Systems."

B. Flexible metal conduit is prohibited.

2.13 EQUIPMENT PART NUMBER SCHEDULES: CAREHAWK CH1000

A. Central Control Equipment and Add-Ons

Equip. Name	Component Part Number	Description
CH1000 Central Cabinet (Wall Mount)	CC301	Central Controller Card
	MI100	Main Interface Card
	TC2	Telephone Interface Card
	AC1	Admin Interface Card (One per Admin Phone served)
	RAC2	Remote Audio Card
	DAF250D	300 Watt Class D Amplifier(s)
	IA5	Intercom Amplifier Card(s) (One per intercom path)
		5 volt / 12 Volt Power Supply
CH1000C Client Cabinet (Wall Mount)	CC301	Central Controller Card
	MI100C	Client Cabinet Main Interface Card
	RAC2	Remote Audio Card
	DAF250D	300 Watt Class D Amplifier(s)
	IA5	Intercom Amplifier Card(s) (One per intercom path)

Equip. Name	Component Part Number	Description
		5 Volt / 12 Volt Power Supply
Control Accessories	DAF250D	300 Watt Class D Amplifier(s) (Provide additional amps as needed to serve large speaker zones)
	SS16/SS32	16- and 32-port remote switching cards
	ACA16	Audible Call Assurance Card
	OC16	Output Contact Card
	AP1-B	Administrative Display Console (Admin Phone)
	AD2W16	16-Port Two-Wire Adapter
Telephone Accessories	VTM	VoIP Telephone Expansion Module
	VG4-G	4-port FXO Telephone Gateway
	VFS16-G/32-G	16- or 32-prt FXS Telephone Gateway
	DMS	District-wide Server
	DTM	District-wide Telephone Module
Other Optional Equipment	MPD100	Media Player (Digital Music Source)
	RK100	Rack Mount Kit
PC-Based Add-Ons	Assistant PC-Based Visual Console	
	VCCall PC-Based Call Switch	
	Tone Alerts PC-Based Tone Control	
	MapAssist Map-Based Administrative Phone & Calendar	

B. Port Equipment

Component Part Number	Description
STELVP-1	VoIP Classroom Telephone
STEL	Analog Classroom Telephone
CS100/CS35	Silicon Call-in Switch
CS45	Rocker-Style Call Switch with Privacy
CS25	Rocker-style Call Switch
CS20	Call Switch for 2-Wire Installations
CS-DCCK	2-Button (Safety Acknowledgment Blue Button)

PART 3 EXECUTION

3.01 WIRING METHODS

A. Wiring Method: Install cables in raceways and j-hooks except within consoles, cabinets, desks, and counters, and except in accessible ceiling spaces and in gypsum board partitions where unenclosed wiring method may be used. Conceal raceway and cables except in unfinished spaces.
   1. Install plenum cable in environmental air spaces, including plenum ceilings.
   2. Comply with requirements for raceways and boxes specified in Division 27 Section "Pathways for Communications Systems."

B. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

3.02 INSTALLATION OF RACEWAYS

A. Comply with requirements in Division 26 Section "Pathways for Communications Systems" for installation of conduits and wireways.

3.03 EQUIPMENT INSTALLATION

A. Locate equipment to accommodate millwork, fixtures, marker boards and other room equipment at no additional cost to the Owner.

B. Provide and install a PTT microphone in the front office. Coordinate location with architect.

C. Provide and install an Administrative Control Station at the following locations:
   1. Reception Desk
   2. Principal's Office.

D. General: Install new communication system components in accordance with the manufacturer's instructions.
   1. Terminate field wiring on wall-mounted cross connect blocks per manufacturer recommendations..
   2. Label cables and wiring logically, legibly, and permanently for ease of identification, using adhesive strip type labels.
   3. Provide integration of telephone system.
   4. Provide integration of EVACS fire alarm system override
   5. Provide integration of remote emergency pushbuttons.
   6. Furnish and install quantity of amps necessary to power all speakers as shown on the Drawings.

3.04 SPEAKER INSTALLATION:

A. Install new speaker types as indicated on the Drawings.

B. All speakers shall be supported from building structure at at least two points. Supports shall be independent of the work of other trades.

C. Speaker wattages shall be initially set based on the speaker type, mounting height, and area served. In general:
   1. Lay-in Speakers:
      a. Classrooms: 0.5 Watt.
      b. Typical corridors and other low-volume spaces: 1 Watt.
      c. High-volume (Ceiling > 12' AFF, < 20' AFF) spaces: 2 Watts
      d. Extra-high-volume (Ceiling > 20' AFF): 4 Watts
   2. Hard Deck Speakers:
      a. Bathrooms, locker rooms, & other low-volume spaces: 1.25 Watt.
      b. High volume (Ceiling > 12' AFF) spaces: 2.5 Watt.
   3. Exposed Structure Area Speakers: 2.5 Watt (U.O.N.)
   4. Interior Wall Recessed Speakers: 1.25 Watt (U.O.N.)
   5. Exterior Wall Recessed Speakers:
      a. Mounting Height ≥ 11' AFF: 4 Watt
      b. Other locations: 2 Watt
   6. Exterior Canopy Mounted Speakers:
      a. Mounting Height ≥ 11' AFF: 2.5 Watt
      b. Other locations: 1.25 Watt

D. Provide silicone sealant at all canopy penetrations at exterior canopies. At single-layer pre-fabricated metal canopy ("Avadeck" or similar), penetrate canopy only at upper flute.

E. Provide silicone sealant at top and sides of baffle at all exterior back box locations.

3.05 CABLING INSTALLATION:

A. Comply with NECA 1.

B. Return air plenum cable shall be used. Wherever cabling is run exposed, conduit shall be used to cover and protect wiring.

C. General Requirements:
   1. Terminate conductors; no cable shall contain unterminated elements. Make terminations only at outlets and terminals.
   2. Splices, Taps, and Terminations: Arrange on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures. Do not splice cable between termination, tap, or junction points.
   3. Secure and support cables at intervals not exceeding 60 inches and not more than 12 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
   4. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.
   5. Do not install bruised, kinked, scored, deformed, or abraded cable. Remove and discard cable if damaged during installation and replace it with new cable.
   6. Cold-Weather Installation: Bring cable to room temperature before de-reeling. Heat lamps shall not be used.

D. Open-Cable Installation:
   1. Install cabling with horizontal and vertical cable guides in telecommunication spaces with terminating hardware and interconnection equipment.
   2. Suspend cable not in a wireway or pathway a minimum of 8 inches above ceiling by cable supports not more than 60 inches apart.
   3. Cable shall not be run through structural members or be in contact with pipes, ducts, or other potentially damaging items.

E. Separation of Wires: Separate speaker-microphone, line-level, speaker-level, and power wiring runs. Install in separate raceways or, where exposed or in same enclosure, separate conductors at least 12 inches apart for speaker microphones and adjacent parallel power and telephone wiring. Separate other intercommunication equipment conductors as recommended by equipment manufacturer.

F. Cabling Topology: wire system to physical zones / audio points as indicated on the Drawings and as described below:
   1. Administration and office pods.
   2. Corridors of each floor of each classroom wing or other building unit (gym, CTE, fine arts, etc.) shall be wired as separate zones.
   3. Restrooms and locker rooms shall be zoned with the nearest corridor zone.
   4. Each individual room such as and not limited to classrooms, science labs, fine arts rooms, etc. shall be wired as individual zones.
   5. Dining
   6. Library
   7. Gyms
   8. Exterior paging speakers serving different exposures and functional areas (outside fine arts, outside CTE, exterior E side, etc.) shall be wired as separate zones.

G. Tag each circuit at each end and at each terminal with a separate tag indicating the area served.

3.06 GROUNDING

A. Ground cable shields and equipment to eliminate shock hazard and to minimize ground loops, common-mode returns, noise pickup, cross talk, and other impairments.

B. Signal Ground Terminal: Locate at main equipment cabinet. Isolate from power system and equipment grounding.

3.07 SYSTEM START-UP AND INITIAL TESTING

A. Assemble and mount head end equipment per manufacturer instructions

B. Using an audio impedance tester, measure impedance of each speaker zone to verify correct tap settings and detect wiring faults. Report test signal frequency and measured zone impedance / power draw on testing report.

C. Connect speaker zones to amplifier(s) per manufacturer's instructions.

D. Program system telephone card to function with Owner's telephone system per owner preferences and manufacturer instructions.

E. Initial Testing and Adjustment: After connection to Owner's program source and telephone systems, test individual zone and all-call pages from each source. Adjust speaker volume controls, speaker tap settings, and gain staging to meet the following criteria
   1. Volume levels of program source, microphone(s), and paging from phones are balanced appropriately (e.g.: volume of bell tones should not be much louder or quieter than spoken paging messages).
   2. Sound produced by system is free from noise and distortion.
   3. Overall volume levels in spaces are sufficiently loud to ensure paging message intelligibility, and not so loud as to cause occupant discomfort.

F. Inspection: Verify that units and controls are properly labeled and interconnecting wires and terminals are identified. Prepare a list of final tap settings of paging and independent room speaker-line matching transformers.

G. Prepare test and inspection reports.

3.08 SYSTEM PROGRAMMING

A. Programming: Fully brief Owner on available programming options. Record Owner's decisions and set up initial system program. Prepare a written record of decisions, implementation methodology, and final results.
   1. Interface with access control lockdown sequence to provide emergency message and/or tone throughout the entire building during a lockdown event. Refer to access conrol system specification for lockdown sequence.
   2. Install floor plan drawings and configure building maps for user interface.
   3. Assign audio points to logical zones per Owner's preferences.

3.09 ACCEPTANCE BY OWNER

A. Upon completion of initial tests and delivery of all documents, diagrams, and project record drawings, notify the Architect in writing that the installation has been completed in accordance with the requirements of the specification and is ready for equalization and inspection by representatives of the Owner.

B. Acceptance testing will include operation by the Owner of each major system and other components (i.e. microphones, consoles, racks, loudspeakers, etc.) deemed necessary. Contractor will assist as necessary in this testing.

C. In the event the need for further adjustments or work becomes evident during acceptance testing, the Contractor will continue his work until system is acceptable at no additional cost to the Owner.

D. Contractor shall provide a Final Acceptance Test record document signed by both the Contractor and the Owner or designated Owner's Representative establishing the "In Warranty" date. The warranty period will not commence until the Final Acceptance Test is completed.

E. Be prepared to verify the performance of any portion of the installation by demonstration, listening and viewing test, and instrumented measurements. Make additional adjustments within the scope of work and which are deemed necessary by the Owner because of the acceptance test.

3.10 DEMONSTRATION AND TRAINING

A. Engage a factory-authorized service representative to train Owner's personnel to adjust, operate, and maintain the intercommunications and program systems.
   1. Train Owner's maintenance personnel on programming equipment for starting up and shutting down, troubleshooting, servicing, and maintaining the system and equipment.
   2. Provide and implement a complete and comprehensive staff training program for all administrators, facility staff members, and teachers. This mandatory training program will provide school staff a complete understanding of how to utilize and properly operate all functions.
   3. Provide 8 hours, 4 hours on each of two days, of instruction to the Owner designated user and maintenance personnel on the use and operation of the system. Instructing personnel shall be a competent engineer or technician familiar with the installed system. Instruction times shall be arranged by the Owner.

B. All staff development training is to be coordinated through the owner’s designated representative. As training sessions are completed, the trainer will provide the school’s administrative staff and school district’s staff a document listing all of the staff and faculty members who attended, received, and completed the training program.

3.11 POST-OCCUPANCY ADJUSTMENT

A. On-Site Assistance: Engage a factory-authorized service representative to provide on-site assistance in adjusting sound levels, resetting transformer taps, and adjusting controls to meet occupancy conditions.

B. Occupancy Adjustments: When requested within 12 months from date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

END OF SECTION

SECTION 28 0000
COMMON ELECTRONIC SAFETY AND SECURITY REQUIREMENTS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

B. The requirements contained in this Section apply to all Sections of this Division.

1.02 SUMMARY

A. This section includes general design requirements, administration topics, and installation for communications systems.

B. Section Includes:
   1. Common terminology and requirements used throughout this Division.
   2. Identification and labeling.
   3. Firestop systems.
   4. Sleeves for raceways and cables.
   5. Grout.

1.03 SYSTEM DESCRIPTION

A. The objective of this project is to provide complete communications systems installation including, but not limited to:
   1. Emergency Responder Radio Antenna System
   2. Access Control System.
   3. Intrusion Detection System.
   4. Video Surveillance System
   5. Digital Addressable Voice Evacuation Fire Alarm System.

1.04 STRUCTURED CABLING SYSTEM SCOPE OF WORK

A. Refer to Division 27 Sections for more information on the low-voltage structured cabling system infrastructure required for this project.

1.05 GENERAL

A. The Instructions to Bidders, General and Special Conditions, and all other contract documents shall apply to the Contractor's work as well as to each of his Sub-Contractor's work. Each Contractor is directed to familiarize himself in detail with all documents pertinent to this Contract. In case of conflict between these General Provisions and the General and/or Special Conditions, the affected Contractor shall contact the Engineer for clarification and final determination.

B. Each Contractor shall be governed by any alternates, unit prices and addenda or other contract documents insofar as may affect the work or services.

C. The Work included in this Division consists of the furnishing of all labor, equipment, transportation, supplies, material and appurtenances and performing all operations necessary for the satisfactory installation of the complete and operating Communications System(s) indicated and/or specified in the Contract Documents.

D. Any materials, labor, equipment or services not mentioned specifically herein which may be necessary to complete or perfect any part of the Communications Systems in a substantial manner, in compliance with the requirements stated, implied or intended in the drawings and/or specifications, shall be included as part of this Contract.

E. The Contractor shall give written notice of any materials or apparatus believed inadequate or unsuitable; in violation of laws, ordinances, rules or regulations of authorities having jurisdiction; and any necessary items of work omitted a minimum of ten days prior to bid. In the absence of such written notice and by the act of submitting his bid, it shall be understood that the Contractor has included the cost of all required items in his bid, and that he will be responsible for the approved satisfactory functioning of the entire system without extra compensation.

F. It is not the intent of this Section of the Specifications (or the remainder of the Contract Documents) to make any specific Contractor, other than the Contractor holding the prime agreement, responsible to the Owner, Architect and Engineer. All transactions such as submittal of shop drawings, claims for extra costs, requests for equipment or materials substitution, shall be routed through the Contractor to the Architect (if applicable), then to the Engineer.

G. This Section of the Specifications or the arrangement of the Contract Documents shall not be construed as an attempt to arbitrarily assign responsibility of work, material, equipment or services to a particular Contractor or Sub-Contractor. Unless stated otherwise, the subdivision and assignment of work under the various sections shall be the responsibility of the Contractor holding the prime contract.

H. It is the intent of this Contract to deliver to the Owner a new and complete project once work is complete. Although plans and specifications are complete to the extent possible, it shall be the responsibility of the Contractors involved to remove and/or relocate or re-attach any existing or new systems which interfere with new equipment or materials required for the complete installation without additional cost to the Owner.

I. In general, and to the extent possible, all work shall be accomplished without interruption of facility operations. The Contractor shall advise the Architect, Owner and Engineer in writing at least one week prior to the deliberate interruption of any services. The Owner shall be advised of the exact time that interruption will occur and the length of time the interruption will last. Failure to comply with this requirement may result in complete work stoppage by the Contractors involved until a complete schedule of interruptions can be developed.

J. Whenever utilities are interrupted, either deliberately or accidentally, the Contractor shall work continuously to restore said service. The Contractor shall provide tools, materials, skilled journeymen of his own and other trades as necessary, premium time as needed and coordination with all applicable utilities, including payment of utility company charges (if any), all without requests for extra compensation to the Owner, except where otherwise provided for in the contract for the work.

1.06 DEFINITIONS

A. AHJ: Authorities Having Jurisdiction.

B. Architect: The Architect of Record for the project, if any.

C. Where this Section and other Sections of this Division use the term “Business Day” it shall mean Monday thru Friday, excluding Holidays recognized by Federal, State and Local government.

D. Contract Documents: All documents pertinent to the quality and quantity of all work to be performed on the project. Includes, but not limited to, plans, specifications, addenda, instructions to bidders (both General and Sub-Contractors), unit prices, shop drawings, field orders, change orders, cost breakdowns, construction manager’s assignments, architect’s supplemental instructions, periodical payment requests, etc.

1. Note: Any reference within these specifications to a specific entity, i.e. “Electrical Contractor” is not to be construed as an attempt to limit or define the scope of work for that entity or assign work to a specific trade or contracting entity. Such assignments of responsibility are the responsibility of the Contractor or Construction Manager holding the prime contract, unless otherwise provided herein.

E. Contractor: Any Contractor whether proposing or working independently or under the supervision of a General Contractor and/or Construction Manager and who installs any type of low-voltage communications work (Electrical, Low Voltage, Fire Alarm, etc.) or, the General Contractor.

F. Engineer: The Consulting Mechanical-Electrical Engineers either consulting to the Owner, Architect, other Engineers, etc.

G. ESS: Electronic Safety and Security

H. Furnish: Deliver to the site in good condition.

I. Install: Install equipment furnished by others in complete working order.

J. Provide: Furnish and install in complete working order.

K. RS-232: TIA standard for asynchronous serial data communications between terminal devices.

L. RS-485: TIA standard for multipoint communications using two twisted-pairs.

M. TCP/IP: Transport control protocol/Internet protocol incorporated into Microsoft Windows.

1.07 DRAWINGS AND SPECIFICATIONS

A. The Drawings are diagrammatic only and indicate the general arrangement of the systems and are to be followed insofar as possible. If deviations from the layouts are necessitated by field conditions, detailed layouts of the proposed departures shall be submitted to the Engineer for approval before proceeding with the work.

B. The Drawings and Specifications are intended to supplement each other. No Contractor shall take advantage of conflict between them, or between parts of either. This also includes potential conflicts with regards to equipment and material model numbers, part numbers, etc. and respective description and/or performance. Should this condition exist, the Contractor shall request a clarification not less than 10 days prior to the submission of the proposal so that the condition may be clarified by Addendum. In the event that such a condition arises after work is started, the interpretation of the Engineer shall be the determining factor. In all instances, unless modified in writing and agreed upon by all parties thereto, the Contract to accomplish the work shall be binding on the affected Contractor.

C. The Drawings and Specifications shall be considered to be cooperative and complimentary and anything appearing in the specifications which may not be indicated on the drawings or conversely, shall be considered as part of the Contract and must be executed the same as though indicated by both.

D. Contractor shall make all necessary and required measurements in the field and shall be responsible for correct fitting. The work shall be coordinated with all other branches of work in such a manner as to cause a minimum of conflict or delay.

E. The Engineer shall reserve the right to make adjustments in location of conduit, j-hooks, devices, etc. where such adjustments are in the interest of concealing work or presenting a better appearance. Unless a formal proposal request is issued, this work shall be performed without additional cost to the Owner.

F. Each Contractor shall evaluate ceiling heights called for on Architectural Plans. Where the location of Communications equipment may interfere with ceiling heights, the Contractor shall call this to the attention of the Engineer in writing prior to making the installation. Any such changes shall be anticipated and requested sufficiently in advance so as to not cause extra work on the part of the Contractor or unduly delay the work.

G. Should conflict or overlap (duplication) of work between the various trades become evident, this shall be called to the attention of the Engineer. In such event neither trade shall assume to be relieved of the work which is specified under his branch until instructions in writing are received from the Engineer.

H. The Drawings are intended to show the approximate locations of equipment, materials, devices, etc. Dimensions given in figures on the drawings shall take precedence over scaled dimensions and all dimensions, whether given in figures or scaled, shall be verified in the field to ensure no conflict with other work. In case of conflict between small- and large-scale drawings, the larger scale drawings shall take precedence.

I. Where on the Drawings a portion of the work is drawn out and the remainder is indicated in outline, or not indicated at all, the parts drawn out shall apply to all other like portions of the work. Where ornamentation or other detail is indicated by starting only, such detail shall be continued throughout the courses or parts in which it occurs and shall also apply to all other similar parts of the work, unless otherwise indicated.

J. Details not usually shown or specified, but necessary for the proper installation and operation of systems, equipment, materials, etc., shall be included in the work without additional cost to the Owner, the same as if herein specified or indicated.

K. Where on the Drawings or Addenda the word “typical” is used, it shall mean that the work method or means indicated as typical shall be repeated in and each time it occurs whether indicated or not.

1.08 SUBSTITUTION PROCEDURES

A. Comply with provisions of Division 01 Section “Substitution Procedures”.

B. Substitution may be considered when a product becomes unavailable through no fault of the Contractor.

C. If an alternate material is proposed that is equal to or exceeds specified requirements, Contractor shall provide manufacturers’ specifications in writing for Owner approval prior to purchase and installation.

D. Document each request with complete data substantiating compliance of proposed substitution with Contract Documents.

E. Substitutions of material by the Contractor shall be in writing complete with written manufacturers’ specifications. The material substituted shall not void, alter or change manufacturers’ structured cabling system warranty.

F. Substitutions will not be considered when they are indicated or implied on shop drawing or product data submittals, without separate written request, or when acceptance will require revision to the Contract Documents.

G. The Owner will be the final judge of acceptability, with review by Engineer and the distribution of the acceptance by the Architect.
   1. No substitute shall be ordered, installed or utilized without the Architect’s prior written verification of acceptance from the Owner.

1.09 QUALITY ASSURANCE

A. Regulatory Requirements

1. Contractor shall supply all city, county, and state telecommunication cabling permits required by appropriate governing agency.
2. Contractor shall be state-licensed and/or bonded as required for low voltage structured cabling systems.

B. Certifications
1. Contractor shall submit an up-to-date and valid certification verifying qualifications of the Contractor and installers to perform the work specified herein at time of bid submission.
2. Contractor shall have a complete working knowledge of low voltage cabling applications such as, but not limited to data, voice and video network systems.
3. Contracting firm shall have installed similar-sized systems in at least ten (10) other projects in the last five (5) years prior to this bid and be regularly engaged in the business of installation of the types of systems specified in this document.
    a. Certification shall include, but not be limited to, items such as name and location of project contacts and numbers, total square footage, total number of cables/drops, types of media, etc.
4. Contractor shall provide certificates for the appropriate insurance coverage as defined in contract documents.
5. All installer personnel that will be assigned to this project shall be listed in the qualification questionnaire document.
6. 80% shall have a minimum of three (3) years' experience in the installation of the types of systems, equipment, and cables specified in this document prior to this bid.
    a. Any personnel substitutions shall be noted in writing to Owner prior to commencement of work.
7. Contractor shall submit evidence of compliance with these requirements prior to beginning work on the project.
8. Cabling installers shall be trained and certified by the cable manufacturer for telecommunication cabling installations and maintenance of said materials.
9. Maintain current status with the warranting manufacturer, including all training requirements, for the duration of the cable infrastructure project. Staff each installation crew with the appropriate number of trained personnel, in accordance with their manufacturer/warranty contract agreement, to support the lifetime system warranty requirements. After installation, submit all documentation to support the warranty in accordance with the manufacturer's warranty requirements, including test results, and to apply for said warranty on behalf of the customer. The system warranty will cover the components and labor associated with the repair/replacement of any failed link as a result of a defective product when a valid warranty claim is submitted within the warranty period.

C. Administrative Requirements and Coordination requirements
1. Coordinate work of this section with Owner's telephone system specifications, workstations, equipment suppliers, and installers.
2. Coordinate installation work with other crafts (examples include ceiling grid contractors, HVAC and sheet metal contractors, etc) to resolve procedures and installation placement for cable trays and cable bundle pathways.
    a. The goal of this coordination will be to establish priority pathways for critical data/voice network cable infrastructure, materials, associated hardware, as well as mitigate delays to the project and to allow service access for communications and HVAC components.
    b. Damage by Contractor to the craft work of others will be remedied at the Contractor's expense in a timely manner.
3. Exchange information and agree on details of equipment arrangements and installation interfaces.

a. Record agreements reached in meetings and distribute record to other participants, Owner and telecommunication consultant.

4. Adjust arrangement and locations of distribution frames, patch panels, and cross-connect blocks in equipment rooms and racks to accommodate and optimize arrangement and space requirements of any service provider equipment, telephone system, and LAN equipment.
   a. Tasks shall be coordinated with Owner or his representative, and other trades' installation representatives.
5. When requested by Owner or Owner's representative, furnish extra materials that match specified products and that are factory packaged with protective covering for storage and identified with labels describing contents.

D. Common Requirements for Material Quality: Materials, equipment and devices shall be new and of the quality specified and shall be free from defects at the time of installation. Materials, equipment and devices damaged in shipment or otherwise damaged or found defective prior to acceptance by the Owner shall be replaced with new materials, equipment or devices identical with those damaged, unless approved otherwise by the Owner in writing.

E. Common Requirements for Code Compliance: In case where differences occur between building codes, state laws, local ordinances, industry standards, utility company regulations and the Contract Documents, the most stringent shall govern. Perform the following:
1. Promptly notify the Architect in writing of any such difference.
2. Obtain approval from Architect before proceeding with the Work.
3. Should the Contractor perform any work that knowingly does not comply with local codes, laws and ordinances, industry standards, or other governing regulations; the Work shall be corrected at no cost to the Owner.

F. Common Requirements for Compliance with AHJ Instructions: In cases where the Authority Having Jurisdiction requires deviations from the requirements of the Contract Documents, perform the following:
1. Promptly notify the Architect in writing of any such difference.
2. Obtain approval from Architect before proceeding with the Work.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Coordination with delivery companies, drivers, site address, and contact person(s) will be the responsibility of the Contractor.

B. Contractor requirements:
1. Be responsible for prompt material deliveries to meet contracted completion date.
2. Coordinate deliveries and submittals with the General Contractor to ensure a timely installation.
3. No equipment materials shall be delivered to the job site more than three weeks prior to the commencement of its installation.
4. Equipment shall be delivered in original packages with labels intact and identification clearly marked.
5. Equipment shall not be damaged in any way and shall comply with manufacturer's operating specifications.
6. Equipment and components shall be protected from the weather, humidity, temperature variations, dirt, dust, or other contaminants.
   a. Equipment damaged prior to system acceptance shall be replaced at no cost to the Owner.
7. Contractor shall be responsible for all handling and control of equipment. Contractor is liable for any material loss due to delivery and storage problems.

C. Owner/General Contractor shall supply a list of security requirements for Contractor to follow.

1.11 PROJECT/SITE CONDITIONS

A. After completing system installation, including outlet fittings and devices, inspect exposed finish. Contractor will remove burrs, dirt, and construction debris.
   1. If applicable, the Contractor will repair damaged finishes, including chips, scratches, and abrasions.

B. Contractor shall provide daily a clean work environment, free from trash/rubbish accumulated during and after cabling installation.

C. Contractor shall keep all liquids (drinks, sodas, etc.) off finished floors, carpets, and tiles.
   1. If any liquid or other detriment (cuts, soils, stains, etc.) damages the above finishes, Contractor shall provide professional services to clean or repair scratched/soiled finishes, at Contractor's expense.

1.12 COORDINATION

A. In describing various materials, equipment and devices, in general each item may be described singularly, even though there may be a multiplicity of identical items. Also, where the description is general in nature, the exact sizes, duties, space arrangements, and other requirements must be obtained by reference to other portions of Contract Documents.

B. Space allocations for materials, equipment and devices have been made on the basis of present and known future requirements and the dimensions of items of equipment or devices of a particular manufacturer. Verify that all materials, equipment and devices proposed for use on this Project are within the constraints of the allocated space.

C. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.

D. Coordinate location of access panels and doors for electrical items that are behind finished surfaces or otherwise concealed. Access doors and panels are specified in Division 08 Section "Access Doors and Frames."

E. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Firestopping" and in this Section.

F. Roof-Mounted Equipment: Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 07 Section "Roof Accessories."

1.13 WARRANTY

A. Contractor shall provide a minimum one (1) year warranty on installation and workmanship.

1.14 MAINTENANCE

A. Support Availability: The Contractor shall commit to make available local support for the product and system during the Warranty or Extended Warranty periods.

PART 2 PRODUCTS

2.01 IDENTIFICATION (LABELING) SYSTEM

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Brady
   2. Brother
   3. Dymo
   4. Hellerman-Tyton

2.02 FIRESTOP SYSTEMS

A. General:

1. Provide through-penetration firestop systems that are compatible with one another, with the substrates forming openings, and with the items penetrating through-penetration firestop systems, under conditions of service and application, as demonstrated by through-penetration firestop system manufacturer based on testing and field experience.
2. Provide components for each through-penetration firestop system that are needed to install fill materials. Use only components specified by the firestopping manufacturer and approved by the qualified testing agency for the designated fire-resistance-rated systems.

B. Manufacturers: Subject to compliance with requirements and with through-penetration firestop systems listed in Volume 2 of the UL Fire Resistance Directory, provide products by Specified Technologies, Inc. (STI) or Engineer approved equal.

C. Materials:
1. Firestop Sealants: Single component latex formulations that upon cure do not re-emulsify during exposure to moisture, the following products are acceptable:
a. STI SpecSeal Series SSS Sealant.
b. STI SpecSeal Series LCI Sealant.
2. Firestop Putty: Intumescent, non-hardening, water resistant putties containing no solvents, inorganic fibers or silicone compounds, the following products are acceptable:
a. STI SpecSeal Series SSP Putty.
3. Firestop Pillows: Re-enterable, non-curing, mineral fiber core encapsulated on six sides with intumescent coating contained in a flame retardant poly bag, the following products are acceptable:
a. STI SpecSeal Series SSB Pillows.
4. Fire-Rated Cable Grommet: Molded, two-piece grommet with an integral fire and smoke sealing foam membrane for sealing individual cable penetrations through framed wall assemblies. Grommet snaps together around cable and locks tightly into the wall. The following products are acceptable:
a. STI EZ-Firestop Grommets.
5. Fire-Rated Cable Pathways: Device modules comprised of steel pathway with self-adjusting intumescent foam pads allowing 0 to 100 percent cable fill, the following products are acceptable:
a. STI EZ-PATH Fire Rated Pathway.

2.03 SLEEVES FOR RACEWAYS AND CABLES

A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.

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.

2.04 GROUT

A. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, nonmetallic aggregate grout, noncorrosive, non-staining, mixed with water to consistency suitable for application and a 30-minute working time.

PART 3 EXECUTION

3.01 CABLING SYSTEM INSTALLATION

A. Allowable Cable Bend Radius and Pull Tension:

1. In general, ESS system cable cannot tolerate sharp bends or excessive pull tension during installation.
2. Refer to cable manufacturer's bend radius recommendations for the maximum allowable limits.
3. After installation, exposed cable and other surfaces must be cleaned free of lubricant residue. Use only lubricants specifically designed for cable installation.

B. Pull Strings:
1. Horizontal cable requirements
a. Provide pull strings in all new conduits, including all conduits with cable installed as part of this contract.
b. Pull string shall have a rated average breaking strength of 200 lbs.
c. Data and video cables can be pulled in tandem with pull strings.
d. During pulling sessions, pull strings must move freely to prevent cable jacket/cable damage.

C. Conduit Fill: Reference manufacturer's Design Installation Guidelines manual.

D. Coordinate the features of materials and equipment so they form an integrated system. Match components and interconnections for optimum future performance and backward compatibility.

E. Expansion Capability: Unless otherwise indicated, provide spare conductor pairs in cables, positions in patch panels, cross connects, and terminal strips, and space in cable pathways and backboard layouts to accommodate 20% future increase in campus distribution and active workstations.

F. In the event of a breach of the representations and warranties contained herein, the Contractor, at their own expense, shall take all measures necessary to make the cabling system work and comply with the applicable manufacturer written technical recommendations and standards.

G. Owner’s technical representative will make periodic inspection of the project in progress. One inspection will be performed at the conclusion of cable pulling, prior to closing of the false ceiling to inspect the method of cable routing and support and the firestopping of penetrations. A second inspection will be performed at completion of cable termination to validate compliance with manufacturer’s minimum bend radius, and that cable ends are dressed neatly and orderly, etc.

3.02 EXAMINATION

A. Field Measurements
1. Verify dimensions in areas of installation by field measurements before fabrication and indicate measurements on shop drawings.
2. Coordinate fabrication schedule with construction progress to avoid delaying the work.

B. Established Dimensions
1. Where field measurements cannot be made without delaying the work, establish dimensions and proceed with fabricating units without field measurements.
2. Coordinate supports, adjacent construction, and fixture locations to ensure actual dimensions correspond to established dimensions.

3.03 PREPARATION

A. Contractor’s RCDD shall review, approve and stamp all Shop Drawings, Submittal Documents, Coordination Drawings and As Built Drawings.

B. Pre-Installation Inspection:
1. Contractor shall visually inspect all cables, cable reels, and shipping cartons to detect possible cable damage incurred during shipping and transport.

2. Visibly damaged goods are not acceptable and shall be replaced by the Contractor at no additional cost to the Owner.

3.04 LABELING

A. Cable labels: Self-adhesive vinyl or vinyl-cloth wraparound tape markers, machine printed with alphanumeric cable designations.

B. Flat-surface labels: Self-adhesive vinyl or vinyl-cloth labels, machine printed with alphanumeric cable designations.

C. Provide transparent plastic label holders, and 4-pair marked colored labels.

D. Install colored labels according to the type of field as per ANSI/TIA 606-A color code designations.

E. Use ANSI/TIA 606-A: “designation strip color-code guidelines for voice, data, cross- connect, riser, and backbone fields”

3.05 CODES, RULES, PERMITS, FEES, INSPECTIONS, REGULATION, ETC.

A. Contractor shall give all necessary notices, obtain and pay for all permits, government sales taxes, fees, inspections and other costs, including all utility connections, meters, meter settings, extensions, etc. in connection with his work.

B. Contractor shall file all necessary plans, utility easement requests and drawings, survey information on line locations, load calculations, etc. prepare all documents and obtain all necessary approvals of all utility and governmental departments having jurisdiction; obtain all certificates of inspection for his work and deliver same to the Engineer before request for acceptance and final payment for the work.

C. Ignorance of Codes, Rules, Regulations, Laws, etc. shall not render the Contractor irresponsible for compliance. The Contractor shall be versed in all Codes, Rules and Regulations pertinent to the work prior to submission of a proposal.

D. Contractor shall include in the work, without extra cost, any labor, materials, services, apparatus and drawings in order to comply with all applicable laws, ordinances, rules and regulations, whether or not indicated or specified.

E. Where minimum code requirements are exceeded in the Design, the Design shall govern.

F. Ensure that the work is accomplished in accordance with the OSHA Standards and any other applicable government requirements.

G. All work relating to the handicapped shall be in accord with regulations currently enforced by the Authority Having Jurisdiction.

H. Where conflict arises between any code and the plans and/or specifications, the code shall apply except in the instance where the plans and specifications exceed the requirements of the code. Any changes required as a result of these conflicts shall be brought to the attention of the Engineer at least ten working days prior to bid date, otherwise the Contractor shall make the required changes at his own expense. The provisions of the codes constitute minimum standards for wiring methods, materials, equipment and construction and compliance therewith will be required for all electrical work, except where the drawings and specifications require better materials, equipment, and construction than these minimum standards, in which case the drawings and specifications shall be the minimum standards.

3.06 CUTTING AND PATCHING

A. Unless otherwise indicated or specified, each Contractor shall provide cutting and patching necessary to install the work specified in this Division. Patching shall match adjacent surfaces to the satisfaction of the Engineer and shall be in accord with the Architect's standards for such work, as applicable.

B. Each Contractor shall be responsible for all openings, sleeves, trenches, etc. that he may require in floors, roofs, ceilings, walls, etc. and shall coordinate all such work with the General Contractor and all other trades. Contractor shall coordinate with the General Contractor any openings which he is to provide before submitting a bid proposal in order to avoid conflict and disagreement during construction. Improperly located openings shall be reworked at the expense of the responsible Contractor.

C. Each Contractor shall plan his work ahead and shall place sleeves, frames or forms through all walls, floors and ceilings during the initial construction, where it is necessary for conduit, conductors, wireways, etc. to go through; however, when this is not done, this Contractor shall do all cutting and patching as well as reinforcement required for the installation of his work, or he shall pay other trades for doing this work when so directed by the Engineer. Any damage caused to the buildings by the workmen of the responsible Contractor must be corrected or rectified by him at his own expense.

D. Cut holes in casework, equipment panels, etc. (if any), as required to pass pipes in and out.

E. Notify other trades in due time where openings of chases in new concrete or masonry are required. Set all concrete inserts and sleeves for work. Failing to do this, cut openings for work and patch same as required at own expense.

F. Openings in slabs and walls shall be cut with core drill. Hammer devices will not be permitted. Edges of trenches and large openings shall be scribe cut with a masonry saw.

G. No structural members shall be cut without the approval of the Structural Engineer and all such cutting shall be done in a manner directed by him.

H. Each Contractor shall be responsible for properly shoring, bracing, supporting, etc. any existing and/or new construction to guard against cracking, settling, collapsing, displacing or weakening while openings are being made. Any damage occurring to the existing and/or new structures, due to failure to exercise proper precautions or due to action of the elements, shall be promptly and properly made good to the satisfaction of the Engineer.

I. All work improperly done or not done at all as required by the Communications trades in this section will be performed by the General Contractor at the direction of the Contractor whose work is affected. The cost of this work shall be paid for by the Contractor responsible.

3.07 SLEEVES AND PLATES

A. Provide and locate all sleeves and inserts required for work before the floors and walls are built, or be responsible for the cost of cutting and patching required where sleeves and inserts were not installed, or where incorrectly located. Each Contractor shall do all drilling required for the installation of his hangers. Drilling of anchor holes may be prohibited in post-tensioned concrete construction, in which case the Contractor shall request approved methods from the Architect and shall carefully coordinate setting of inserts, etc., with the Structural Engineer and/or Architect.

B. Galvanized steel sleeves shall be provided for all communications conduit passing thru concrete floor slabs and concrete, masonry, tile and gypsum wall construction.

C. Cast iron sleeves shall be installed through all walls where pipe enters the building below grade. Sleeves shall be flush with each face of the wall and shall be sufficiently larger than the entering pipe to permit thorough caulking with lead and oakum between pipe and sleeve for waterproofing.

D. In all cases, sleeves shall be at least two pipe sizes larger than nominal pipe diameter.

E. Where conduit motion due to expansion and contraction will occur, make sleeves of sufficient diameter to permit free movement of pipe. Check floor and wall construction finishes to determine proper length of sleeves for various locations; make actual lengths to suit the following:
   1. Terminate sleeves flush with walls, partitions and ceiling.
   2. In areas where pipes are concealed, as in chases, terminate sleeves flush with floor.
   3. In all areas where pipes are exposed, extend sleeves ½ inch above finished floor, except in rooms having floor drains, where sleeves shall be extended 3/4 inches above floor.

F. Sleeves shall be constructed of 24-gauge galvanized sheet steel with lock seam joints for all sleeves set in concrete floor slabs terminating flush with the floor. All other sleeves shall be constructed of galvanized steel pipe unless otherwise indicated on the drawings.

G. Fasten sleeves securely in floors, walls, so that they will not become displaced when concrete is poured or when other construction occurs around them. Take precautions to prevent concrete, plaster or other materials being forced into the space between pipe and sleeve during construction. Fire and smoke stop all sleeves in a manner approved by the local authority having jurisdiction or per prevailing codes.

H. Sleeves passing through exterior wall (none are permitted thru roof) or where there is a possibility of water leakage and damage shall be caulked water tight for horizontal sleeves and flashed and counter-flashed with lead (4 lb.) or copper and soldered to the piping, lapped over sleeve and properly weather sealed. All roof penetrations shall be made inside mechanical equipment curbs.

I. All rectangular or special shaped openings in plaster, stucco or similar materials including gypsum board shall be framed by means of plaster frames, casing beads, wood or metal angle members as required. The intent of this requirements is to provide smooth even termination of wall, floor and ceiling finishes as well as to provide a fastening means for lighting fixtures, panels, etc. Lintels shall be provided where indicated over all openings in bearing walls, etc.

3.08 WEATHERPROOFING

A. Where any work pierces waterproofing, including waterproof concrete, the method of installation shall be as approved by the Architect and/or Engineer before work is done. Furnish all necessary sleeves, caulking and flashing required to make openings absolutely watertight.

B. Wherever work penetrates roofing, it shall be done in a manner that will not diminish or void the roofing guarantee or warranty in any way. Coordinate all such work with the roofing installer.

3.09 FIRESTOPPING

A. Refer to Division 07 Section “Firestopping” for additional requirements.

B. Preparation:
   1. Examination of Conditions: Examine areas and conditions under which work is to be performed and identify conditions detrimental to proper or timely completion.
   2. Surfaces to which firestop materials will be applied shall be free of dirt, grease, oil, scale, rust, release agents, water repellents, and any other substances that may inhibit optimum adhesion.
   3. Provide masking and temporary covering to prevent soiling of adjacent surfaces by firestopping materials.
   4. Do not proceed until unsatisfactory conditions have been corrected.

C. Through-Penetration Firestop System Installation:
   1. Install through-penetration firestop systems in accordance with the conditions of testing and classification as specified in the published design.

2. Comply with manufacturer's instructions for installation of through-penetration firestop systems products.
3. Seal all openings or voids made by penetrations to ensure an air and water resistant seal.
4. Protect materials from damage on surfaces subjected to traffic.

D. Do not penetrate rated fire walls, ceilings or floors with conduit, cable, wireway or other raceway system unless all penetrations are protected in a code compliant manner which maintains the fire-rating of the assembly. Firestop all openings made in walls, chases, ceilings and floors. Patch all openings around conduit, wireway, etc., with appropriate type material to provide needed fire rating at fire walls, ceilings and floors. Fire proofing materials and method of application shall be approved by the local authority having jurisdiction.

E. Apply firestopping to penetrations of fire-rated floor and wall assemblies for communications installations to restore original fire-resistance rating of assembly.

F. Apply putty pads to boxes located in fire-rated wall assemblies in which a horizontal distance of greater than 24" between boxes is not maintained.

G. Install and seal penetrations (conduit, sleeves, slots, chases) into or through fire-rated barriers created by or made for or on the behalf of the Contractor to prevent the passage of smoke, fire, toxic gas, or water through the penetrations.

H. Coordinate firestopping procedures and materials with General Contractor.

I. Solutions and shop drawings/submittals for firestop materials and systems shall be presented to the General Contractor for written approval of materials/systems prior to purchase and installation.

J. Following the pathway of others through compliant and non-compliant penetrations does not remove the requirement to maintain code-compliant firestopping.

K. Supply Owner with training manuals with instructions on methods of adding or removing cabling to/from firestopped sleeves and chases.

L. Provide manufacturer recommended material for rated protection for any given barrier.

M. Laminate and permanently affix adjacent to chases the following information:
1. Manufacturer of firestop system
2. Date of installation/repair.
3. Part and model numbers of system and all components
4. Name and phone numbers of local distributor and manufacturer's corporate headquarters

N. The material chosen shall be distinctively colored to be clearly distinguishable from other materials, adhere to itself, and maintain the characteristics for which it is designed to allow for the removal and/or addition of communication cables without the necessity of drilling holes in the material.

3.10 TESTING

A. Upon completion of the communications infrastructure systems, including all pathways and grounding, the Contractor shall test the system.
1. Cables and termination modules shall be affixed, mounted or installed to the designed/specified permanent location prior to testing.
2. Any removal and reinstallation of any component in a circuit, including faceplates, shall require retesting of that circuit and any other disturbed or affected circuits.
3. Cable/jack shall be affixed, mounted or installed to the designed/specified permanent location prior to testing.
    a. Any removal and reinstallation of any component in the circuit shall require retesting of that circuit.
4. Approved instruments, apparatus, services, and qualified personnel shall be utilized.

5. If tests fail, Contractor shall correct as required to produce a legitimate passing test.
6. Manipulation of tester parameters on a failing test in order to achieve a passing test is unacceptable.
7. If the Contractor is found to have manipulated or falsified any failing test result to show a “PASS” for any reason (without written notice and prior approval of the Owner), the Contractor shall be required to employ a Third-Party Testing Agent selected by the Owner to retest the complete cable plant and shall be required to pay all costs associated with this retesting.

B. These specifications will be strictly enforced.
1. The Contractor must verify that the requirements of the specifications are fully met through testing with an approved tester (rated for testing parameters listed elsewhere), and documentation as specified below.
2. This includes confirmation of requirements by demonstration, testing and inspection. Demonstration shall be provided at final walk-through in soft copy and printed test data.

C. Notification of the likelihood of a cable exceeding standardized lengths must be made prior to installation of the cable.
1. Without contractor’s prior written notice and written approval by the Owner, testing that shows some or all pairs of cable not meeting specifications, shall be replaced at Contractor’s expense (including respective connectors).
2. With the Owner’s written approval, the over-length cable(s) shall be excluded from requirements to pass standardized tests and shall be explicitly identified.

D. Testing is still required for non-compliant cabling.
1. The tests shall be for wire-mapping, opens, cable-pair shorts, and shorts-to- ground.
2. The test results must be within acceptable tolerances and shall be submitted with the Owner’s acceptance document.

E. Contractor will complete all work and documentation according to manufacturer guidelines to ensure manufacturer’s warranty remains in effect.
1. Contractor shall obtain certificates from manufacturer attesting to warranty being in effect and include certificates with other deliverables due at the completion of the project.

F. Owner reserves the right to be present during any or all testing.

3.11 SCAFFOLDING, RIGGING AND HOISTING

A. Furnish all scaffolding, rigging, hoisting, and services necessary for erection and delivery into the premises of any equipment and apparatus furnished. Remove same from premises when no longer required in strict accordance with OSHA Guidelines.

3.12 OPTION TO RELOCATE DEVICES

A. The location of voice and data outlets and other similar devices along with their associated connections may be relocated at the Owner's option, at no additional cost to the Owner, to a point within 10 feet of their present location provided the Contractor is notified prior to rough-in or installation.

3.13 CLEANING

A. Work areas will be kept in a broom clean condition throughout the duration of the installation process.

B. Remove all unnecessary tools and equipment, unused materials, packing materials, and debris from each area where Work has been completed unless designated for storage.

C. The Contractor will damp clean all surfaces prior to final acceptance by Owner.

D. After completion of all work and before final acceptance of the work, thoroughly clean all equipment and materials and remove all foreign matter such as grease, dirt, plaster, labels, stickers, etc., from the exterior of equipment, fixtures and all other associated or adjacent fabrication.

3.14 ACCEPTANCE

A. Once all work has been completed, test documentation has been submitted, and Owner is satisfied that all work is in accordance with contract documents, the Owner shall notify Contractor in writing of formal acceptance of the system.

B. Contractor must warrant in writing that 100% of the installation meets the requirements specified herein (Standards Compliance & Test Requirements).

C. Acceptance shall be subject to completion of all work, successful post-installation testing which yields 100% PASS rating, and receipt of full documentation soft and hard copies as describe herein.

3.15 INDEMNIFICATION

A. The Contractor shall hold harmless and indemnify the Engineer, employees, officers, agents and consultants from all claims, loss, damage, actions, causes of actions, expense and/or liability resulting from, brought for, or on account of any personal injury or property damage received or sustained by any person, persons, (including third parties), or any property growing out of, occurring, or attributable to any work performed under or related to this contract, resulting in whole or in part from the negligence of the Contractor, any subcontractor, any employee, agent or representative.

3.16 HAZARDOUS MATERIALS

A. Any worker, occupant, visitor, inspector, etc., who encounters any material of whose content they are not certain shall promptly report the existence and location of that material to the Contractor and/or Owner. The Contractor shall, as a part of his work, insure that his workers are aware of this potential and what they are to do in the event of suspicion. He shall also keep uninformed persons from the premises during construction. Furthermore, the Contractor shall insure that no one comes near to or in contact with any such material or fumes therefrom until its content can be ascertained to be non-hazardous.

B. CMTA, Inc., Consulting Engineers, have no expertise in the determination of the presence of hazardous materials. Therefore, no attempt has been made by them to identify the existence or location of any such material. Furthermore, CMTA nor any affiliate thereof will neither offer nor make any recommendations relative to the removal, handling or disposal of such material.

C. If the work interfaces, connects or relates in any way with or to existing components which contain or bear any hazardous material, asbestos being one, then, it shall be the Contractor's sole responsibility to contact the Owner and so advise him immediately.

D. The Contractor by execution of the contract for any work and/or by the accomplishment of any work thereby agrees to bring no claim relative to hazardous materials for negligence, breach of contract, indemnity, or any other such item against CMTA, its principals, employees, agents or consultants. Also, the Contractor further agrees to defend, indemnify and hold CMTA, its principals, employees, agents and consultants, harmless from any such related claims which may be brought by any subcontractors, suppliers or any other third parties.

END OF SECTION

SECTION 28 0503
ELECTRONIC SAFETY AND SECURITY SHOP DRAWINGS AND SUBMITTALS

PART 1 GENERAL

1.01 SHOP DRAWINGS

A. Each Contractor shall submit to the Architect and/or Engineer, within thirty days after the date of the Contract, sets of shop drawings and/or manufacturer's descriptive literature (coordinate exact quantity with architectural specifications) on all equipment required for the fulfillment of his contract. Each shop drawing and/or manufacturer's descriptive literature shall have proper notation indicated on it and shall be clearly referenced per the specifications and/or schedules, etc., so that the Architect and/or Engineer may readily determine the particular item the Contractor proposes to furnish. All data and information scheduled, noted or specified by hand shall be noted in color red on the submittals. The Contractor shall make any corrections or changes required and shall resubmit for final review as requested. Review of such drawings, descriptive literature and/or schedules shall not relieve the Contractor from responsibility for deviation from drawings or specifications unless they have, in writing, directed the reviewer's attention to such deviations at the time of submission of drawings, literature and manuals; nor shall it relieve them from responsibility for errors or omissions of any nature in shop drawings, literature and manuals. The term "as specified" will not be accepted.

B. If the Contractor fails to comply with the requirements set forth above, the Architect and/or Engineer shall have the option of selecting any or all items listed in the specifications or on the drawings, and the Contractor will be required to provide all materials in accordance with this list.

C. Review of shop drawings by the Engineer applies only to conformance with the design concept of the project and general compliance with the information given in the contract documents. In all cases, the installing Contractor alone shall be responsible for furnishing the proper quantity of equipment and/or materials required, for seeing that all equipment fits the available space in a satisfactory manner and that piping, electrical and all other connections are suitably located.

D. The Engineer's review of shop drawings, schedules, product data or other required submittal data shall not relieve the Contractor from responsibility for the adaptability of the equipment or materials to the project, compliance with applicable codes, rules, regulations, information that pertains to fabrication and installation, dimensions and quantities, electrical characteristics, and coordination of the work with all other trades involved in this project.

E. No cutting, fitting, rough-in, connections, etc., shall be accomplished until reviewed equipment shop drawings are in the hands of the Contractors concerned. It shall be each Contractor's responsibility to obtain reviewed shop drawings and to make all connections, etc. in the neatest and most workmanlike manner possible. Each Contractor shall coordinate with all the other Contractors having any connections, roughing-in, etc., to the equipment, to make certain proper fit, space coordination, voltage and phase relationships are accomplished.

F. In accord with the provisions specified hereinbefore, shop drawings, descriptive literature and schedules shall be submitted on each of the following indicated items as well as any equipment or systems deemed necessary by the Engineer:
   1. Raceways:
      a. Conduit (each type).
      b. Bridle ring assembly.
      c. J-hook assembly.
      d. Junction, pull, and device boxes
   2. Systems: Each system submittal is to be complete with legible cutsheets for all devices, equipment, special wiring, etc. Also, provide scaled building layout drawings that indicate device placement, wiring, etc. Refer to the specific system's specification for additional submittal requirements where required.

a. Access Control System
b. Intrusion Detection System
c. Fire Alarm System

3. Miscellaneous
   a. Control panel assemblies.
   b. Non-standard junction/pullboxes

G. Specification Compliance Certification: Where this Section and other Sections of this Division require Specification Compliance Certification to be submitted, comply with the following:
   1. Prepare a line-by-line Specification Compliance Certification by marking up a copy of the Contract Document specification section in the left margin. Accompany the markup with a written report explaining all items that are not marked with “Compliance”. Submit line-by-line markup, written report of deviations and alternates and a cover letter certified by Manufacturer or Installer that prepared the Specification Compliance Certification. Use the following key for preparing the line-by-line markup.
      a. “C” for Compliance: By noting the term "compliance" or "C" in the margin, it shall be understood that the manufacturer is in full compliance with the item specified and will provide exactly the same with no deviations.
      b. “D” for Deviation: By noting the term "deviation" or "D" in the margin, it shall be understood that the manufacturer prefers to provide a different component in lieu of that specified.
      c. “A” for Alternate: By noting the term "alternate" or "A" in the margin, it shall be understood that the manufacturer proposes to provide the same operating function but prefers to do it in a different manner.
      d. “N/A” for Not Applicable: By noting the term “not applicable” or “N/A” in the margin, it shall be understood that the specified item is not applicable to the project.

1.02 SPECIAL WRENCHES, TOOLS AND KEYS

A. Each Contractor shall provide, along with the equipment provided, any special wrenches or tools necessary to dismantle or service equipment or appliances installed by him. Wrenches shall include necessary keys, handles and operators for valves, switches, etc. and keys to alarm pull boxes, panels, etc. At least two of any such special wrench, keys, etc. shall be turned over to the Architect prior to completion of the project. Obtain a receipt that this has been accomplished and forward a copy to the Engineer.

1.03 FIRE ALARM SHOP DRAWINGS

A. The Contractor and equipment supplier shall submit to the Architect and/or Engineer, fire alarm system shop drawings complete with catalog cuts, descriptive literature and complete system wiring diagrams for their review prior to submittal to the Authority Having Jurisdiction for their review.

1.04 MAINTENANCE AND OPERATION MANUALS

A. Upon substantial completion of the project, the Electrical Contractor shall deliver to the Engineers (in addition to the required Shop Drawings) three complete copies of operation and maintenance instructions and parts lists for all equipment provided. These documents shall at least include:
   1. Detailed operating instructions.
   2. Detailed maintenance instructions including preventive maintenance schedules.
   3. Addresses and phone numbers indicating where parts may be purchased.
   4. Reference architectural specifications for additional requirements.

B. Refer to individual Contract Document specification sections for additional requirements.

PART 2 PRODUCTS (NOT APPLICABLE)

PART 3 EXECUTION (NOT APPLICABLE)

END OF SECTION

SECTION 28 0510
SCOPE OF THE ELECTRONIC SAFETY AND SECURITY WORK

PART 1 GENERAL

1.01 SUMMARY

A. Each Communications Contractor's attention is directed to Division 28 Section “Common Electronic Safety and Security Requirements” and all other Contract Documents as they apply to his work.

1.02 SCOPE

A. The Electronic Safety and Security Work for this Project includes all labor, materials, equipment, devices, and related items required to completely install, test, place in service and deliver to the Owner complete safety and security systems in accordance with the accompanying plans and all provisions of these specifications. This work shall primarily include, but is not limited to the following:
   1. All j-hooks, fittings, etc. – Coordinate with Division 26.
   2. All wiring devices and device plates.
   3. All system hardware, equipment and installation.
   4. All programming, scheduling and testing.

B. Grounding, per NEC and the specified requirements.

C. All necessary fees and cost for permits, inspections, etc.

D. Coordination with Division 21 for interface with fire suppression systems.

E. Coordination with Division 23 for interface with HVAC systems and building instrumentation and control system.

F. Coordination with Division 26 for power, rough-in, conduit and cable pathways.

G. Coordination with Division 27 for low voltage structured cabling systems.

H. Access control system as indicated.

I. Intrusion detection system as indicated.

J. Emergency responder radio antenna system as indicated.

K. Fire alarm system as indicated.

PART 2 PRODUCTS (NOT APPLICABLE)

PART 3 EXECUTION (NOT APPLICABLE)

END OF SECTION

SECTION 28 0539
EMERGENCY RESPONDER RADIO ANTENNA SYSTEM

PART 1 GENERAL

1.01 SUMMARY

A. Design, furnish, install, and test a complete and operating in-building Emergency Responder Radio Antenna System (ERRAS) for the new elementary school to provide complete coverage for the public safety agencies as required by the local fire department and the authority having jurisdiction (AHJ). The system will support only the emergency responder radio system and no others. Provisions for supporting other cell phone carriers, Wi-Fi signals, and the Owner's private security and/or maintenance radio systems shall not be included.

B. This Section includes the minimum indoor signal levels, signal level verification testing, system design, plan submittal requirements, and system acceptance for an Emergency Responder Radio Antenna System (ERRAS) installed in accordance with IFC 510.

C. This Section includes the requirements for an ERRAS for the purposes of amplifying emergency responder radio signals to achieve minimum signal strength in 95 percent of all areas on each floor of the building. Provide all equipment, materials, labor, supervision and services necessary for or incidental to the installation of a complete ERRAS.

D. It shall be the responsibility of the Emergency Responder Radio Antenna System Contractor to obtain all required permits, approvals and certifications from the AHJ. All fees associated with the licensing shall be paid by the Contractor.

E. Final acceptance and approval are required from the local AHJ in writing prior to contract closeout.

F. Section Includes:
   1. Bi-directional amplifiers (BDA's).
   2. Distributed antenna system.
   3. Coaxial cables.
   4. Splitters and direction couplers.
   5. Battery Back-Up System or UPS.
   6. All other equipment and components necessary for a complete and functioning Emergency Responder Radio Antenna System.

G. Related Sections include the following:
   1. Division 26 Section "Raceways and Boxes for Electrical Systems" for raceways, fittings, boxes, enclosures, and cabinets for electrical wiring.
   2. Division 28 Section "Digital Addressable Voice Evacuation Fire Alarm System" for interface of Emergency Responder Radio Antenna System with the fire alarm system.

1.02 DEFINITIONS

A. AHJ: Authority Having Jurisdiction.

B. Attenuation: The reduction in signal power, expressed in decibels (dB), as a result of coupling, heat loss, or transmission distance in a cable or in air.

C. BDA: Bi-Directional Amplifier. Device used to amplify band-selective or multi-band RF signals in the uplink, to the base station for enhanced signals and improved coverage.

D. CBC: Coupled Bonding Conductor. A bonding conductor placed on the outside of any technology cable used to suppress transient noise.

E. DAQ: Delivered Audio Quality Definitions. This is a universal standard often cited in systems designs and specifications.
   1. DAQ 1: Unusable, speech present but not intelligible.

2. DAQ 2: Understandable with considerable effort. Frequent repetition due to noise and/or distortion.
3. DAQ 3: Speech understandable with slight effort. Occasional repetition required due to noise and/or distortion.
4. DAQ 3.5: Speech understandable with repetition only rarely required. Some noise and/or distortion.
5. DAQ 4: Speech easily understood. Occasional noise and/or distortion.
6. DAQ 4.5: Speech easily understood. Infrequent noise and/or distortion.
7. DAQ 5: Speech easily understood.

F. DAS: Distributed Antenna System. A network of service antennas connected at intervals along shielded coaxial transmission lines and all connected to head-end electronics amplifying the signals to be distributed. Often refers to a system that includes both the passive distribution system and the active amplifying electronics.

G. Directional Coupler. A component which directs a small portion of downstream RF energy to a port which can be connected to an antenna or another branch of distribution cabling, and also serves as a combiner of upstream energy between the tap port and through the connection port.

H. Donor Antenna: The antenna, usually mounted on the outside of a structure where a DAS is installed, which picks up signals over-the-air from a donor service.

I. Donor Source: The repeater, transceiver, cell site, or other radio site that produces signals which a DAS will relay and distribute.

J. ERRAS: Emergency Responder Radio Antenna System. A two-way radio communication system installed to assure the effective operation and coverage of radio communications systems for fire, emergency medical services and/or law enforcement agencies within a building or structure. A system used by firefighters, police, and other emergency services personnel.

K. EMT: Electrical Metallic Tubing.

L. FCC: Federal Communications Commission. Federal agency responsible for implementing and enforcing America's communications laws and regulations.

M. OET 65 Standards: FCC's Bulletin 65 provides Guidelines for Human Exposure to Radio Frequency Electromagnetic Fields.

N. Public Safety/First Responder: Agencies which are charged with the responsibility of responding to emergency situations. These include, but are not limited to, law enforcement department, fire departments, and emergency medical companies.

O. Reflected Power: Power which is reflected back along a transmission line as a result of discontinuities in line impedance caused at connectors or close proximity of metallic objects.

P. RF: Radio Frequency. Energy from electromagnetic waves, or alternating currents that produce electromagnetic waves, in the spectrum of radio frequencies 30 kHz to 300 GHz.

Q. Splitter: A passive component that has a single input port and two or more output ports, effectively splitting the signal equally amongst the output ports. It also serves to combine upstream signals from the "output" ports into composite signals at the "input" port.

1.03 REGULATIONS

A. Codes, regulations and standards referenced in this Section include:
1. NFPA 1: The National Fire Code (including Annex O from 2009)
2. NFPA 70: The National Electrical Code
3. NFPA 72: The National Fire Alarm Code
4. NFPA 101: The Life Safety Code

5. NFPA 1221: Standard for the Installation, Maintenance and Use of Emergency Services Communication Systems
6. UL 2524: First Edition In-Building Two-Way Emergency Radio Communication Enhancement Systems
7. IFC 510: International Fire Code, Emergency Responder Radio Coverage
8. FCC 47 CFR: Private Land Mobile Radio
9. FCC 47 90.219-2007: Services-Use of Signal Boosters
10. FCC Rules Part 22, Part 90 and Part 101
11. FCC OET 65 Standards: Guidelines for Human Exposure to Radio Frequency Electromagnetic Fields
12. ADA: Americans with Disabilities Act

1.04 ACTION SUBMITTALS

A. Submit product data and shop drawings in accordance with Division 01 and Division 28 Section “Electronic Safety and Security Shop Drawings and Submittals” for products specified under PART 2 - PRODUCTS.

B. Specification Compliance Certification: Submit a Specification Compliance Certification in accordance with Division 28 Section “Electronic Safety and Security Shop Drawings and Submittals”.

C. Product Data: For each type of proposed system component specified, including dimensioned drawings showing minimum clearances and installed features.
   1. Provide copies of manufacturer specification sheets of all system components including:
      a. Amplifiers
      b. Antennas
      c. Coaxial cable, couplers, splitters, combiners, or other passive components
      d. Backup battery and charging system with run time specifications
   2. Submit product certificates signed by the manufacturer of radio system components certifying that their products comply with specified requirements.
   3. Contractor and manufacturer shall supply sufficient information to indicate the proposed system is based on the latest hardware, software technology and products and complies with specified requirements and FCC regulations.
   4. An indication of any deviations from Contract Documents requirements, including variations and limitations. Show any revisions to equipment layout required by use of selected equipment.
   5. A product data index and complete equipment list including each product submitted for approval with the manufacturer’s name, part number and any included options or selections.

D. Shop Drawings:
   1. Submit shop drawings locating all components of the system indicating circuit routing, cable type, and gauge. Include information that will allow the Contractor to coordinate interdisciplinary work and when necessary guide the manufacturer or fabricator in producing the product.
   2. Include elevation detail names for each elevation view. Sheet title shall include site name, address, sheet number, floor plan number and north arrow. Include site plan view of the subject buildings and surrounding property to clearly indicate the location and orientation of roof mounted outdoor antennas associated with the proposed system.
   3. Include a minimum of one (1) building elevation depicting the location of any outdoor antenna associated with the proposed system. Include height of antenna centerline above building, orientation, and location of all external grounding connections.

4. Include a detail plan view of all IT rooms housing head-end and/or other consolidated equipment, showing the location of the rack(s) and/or enclosure(s) of the ERRAS equipment.
5. Include a separate plan view of each interior floor where indoor antenna systems are proposed. Include antenna numbers, coaxial cable routes, and the locations of any other system components including splitters, couplers, filters, amplifiers, etc. All component shall be named or labeled for reference in power budget calculations tables. Overlay approximated coverage radii indicating -95 dBm downlink (base to mobile) signal strength around each proposed indoor coverage antenna. Include results of any previous coverage testing per grid, if available.
6. Include a minimum of one (1) detail elevation view(s) of all rack(s) and/or enclosure(s) housing the ERRAS equipment. Identify each piece of equipment by brand, model number and equipment type.
7. Specify antenna grounding and surge protection in accordance with NEC Article 810.
8. Specify the back-up power source (Life Safety), and include calculations to ensure the back-up power requirements as specified in this standard are met.

E. Wiring Diagrams:
1. Submit wiring diagrams from manufacturer differentiating clearly between factory and field-installed wiring. Include diagrams for each component of the system with all terminals and interconnections identified. Make all diagrams specific to this Project.

F. Ambient Signal Level Measurements: For all proposed systems utilizing broadband amplification schemes, including bi-directional amplifiers, ambient signal levels measurements for nearby carriers (800 MHz consideration) in the adjacent SMR and cellular bands must be provided. This will ensure the amplifier will not be overdriven and create harmful interface.
1. A maximum amplitude plot (“Max Hold”) of signal strength (dBm) vs. frequency (MHz), between 863 MHz and 880 MHz. Perform measurement for at least ten (10) minutes during the hours of 7 AM – 7 PM, Monday through Friday.
2. Resolution Bandwidth shall be 10 KHz.
3. Place markers on any carrier measured over -55 dBm to readily identify signal strength and frequency. No more than three (3) markers are required.
4. Place one (1) marker on the active City/County 800 MHz control channel(s).
5. All plans shall be submitted electronically in a radio propagation format.

G. General Submittal Requirements:
1. Submittals shall be approved by AHJ prior to submitting them to Architect and Engineer.

1.05 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.
1. Copies of FCC Licenses for both the Designer and Project Manager.
2. Letter from manufacturer stating that the Contractor is an Authorized Factory Distributor for the area where Project is located.
3. The system described in the submittals shall be certified by an FCC Licensed Designer and installation shall be supervised by an FCC Licensed Project Manager.

B. Field quality-control reports.

C. Testing reports.
1. Submit all field test records of the ERRAS. These shall include, but not be limited to:
a. Preconstruction Tests: Tests performed with the AHJ prior to construction of the new facility to verify that the municipality has signal coverage in that area.
b. Mid-Construction Tests: Tests performed with the AJH during construction, once walls have been constructed and the exterior roof and glazing is installed.

c. Final Testing: Tests performed in conforming with IFC Section 51 0.5.3 and Section 51 0.6. This testing is to be signed off by the AHJ. Engineers shall also be present for the final testing process.

2. All testing records shall be submitted with operations and maintenance information and close out documents.

D. Sample Warranty: For special warranty.

1.06 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For radio systems and components to include in emergency, operation, and maintenance manuals.
1. Include data for each type of product, including all features and operating sequences, both automatic and manual.
2. Provide names, addresses, and telephone numbers of service organizations that carry stock of repair parts of the system to be furnished.
3. Include record of field tests of the radio system.
4. Provide a parts list with manufacturer and model number for commonly replaced parts.
5. Include complete instructions for the inspection, testing, and maintenance of the system. Include copies of all calculation sheets used to configure the system.

1.07 QUALITY ASSURANCE

A. Installer Qualifications: Engage an experienced factory-authorized installer to perform work of this Section. The Contractor shall meet the following requirements:
1. As a business entity, shall be an authorized distributor and designated representative of the ERRAS manufacturer, with full warranty privileges, and shall have been actively engaged in the business of selling, installing, and servicing ERRAS for a period of at least five (5) years.
2. Employ factory trained technicians capable of supporting the maintenance of the system. No contract employees are allowed unless they have been to the factory service school within the last 18 months. A certificate of this training shall be provided with the Contractor's submittal.
3. Employ full time local technicians and installers. The manufacturer shall maintain a full-time factory employed service staff for product support and service.
4. Maintain an office within 150-miles of the job site, staffed with trained technicians who are qualified and licensed to supervise the installation, to be responsible that the system is installed as submitted, to conduct system start up and perform a 100 percent operational audit of all installed devices, to instruct the Owner's representatives in the proper operation of the system, and to provide service throughout the warranty period.
5. Fully experienced in the design and installation of the type of system herein specified and shall furnish with the contract proposal an itemized list of the installations of the type specified herein. The list shall include the name of the project, date of completion, the amount of the contract, the name and telephone number of a qualified person to contact for reference. This list must contain at least two (2) projects within a 150-mile radius of the school district to allow school administration officials to visit the job site for review of the system installation and service. Each reference project listed must utilize equipment by the same manufacturer as the proposed system.
6. Not have any grievances or complaints of record regarding workmanship, code compliance, or service response. A Contractor that has any prior finding(s) of a code or license violation or has any litigation in process concerning the installation of a system is unacceptable.

B. Source Limitations for Radio System and Components: Obtain radio system components from a single source who assumes responsibility for compatibility of system components.

C. Radio Components, Devices, and Accessories: All equipment shall be UL listed and labeled and in accordance with applicable NEMA and ANSI Standards. Where copper cabling is routed to an area, either in another building, or with a separate electrical service, the Technology Contractor shall provide primary protective equipment.

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. All racks and enclosures shall be either welded or assembled with paint piercing ground washers, grounding strip and bonding jumper.

1.08 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace radio system equipment and components that fail in materials or workmanship within specified warranty period.
   1. Warranty Extent: All equipment and components not covered in the Maintenance Service Agreement.
   2. Any equipment, cabling or wiring shown to be defective shall be replaced, repaired, or adjusted free of charge.
   3. All labor and materials shall be provided at no expense to the Owner.
   4. Warranty Period: One (1) year from date of Substantial Completion.

B. Immediately prior to the end of the warranty period, the system shall be inspected and certified for the following year at no additional cost to the Owner.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, available integrators offering products that may be incorporated in the work include, but are not limited to:
   1. ADRF
   2. Axell Wireless.
   3. Farenhyt by Honeywell.
   4. Gamewell-FCI by Honeywell.
   5. Notifier by Honeywell.
   6. SOLiD Technologies, Alliance Corporation.
   7. Tessco.
   8. Times Microwave.

2.02 GENERAL PERFORMANCE REQUIREMENTS

A. Compatibility: The equipment, including but not limited to repeaters, transmitters, receivers, signal boosters, cabling, fiber distributed antenna system, etc., shall not interfere with the existing communication systems utilized by the Public Safety and First Responder agencies.

B. Power Supplies: At least two (2) independent and reliable power supplies shall be provided, one primary and one secondary. The primary power source shall be supplied from a dedicated 20 ampere branch circuit and comply with 4.4.1.4 of NFPA 72. The secondary power source shall be a dedicated battery, capable of operating with in-building radio system for at least 24 hours of 100 percent system operation. The battery system shall automatically charge in the presence of external power input. The battery system shall be contained in one NEMA 4 or 4X type enclosure. Monitoring the integrity of power supplies shall be in accordance with 4.4.7.3 or NFPA 72.

C. Survivability:
   1. Physical Protection: All wiring and fiber optics shall be installed in conduit. Refer to Division 26 Section “Raceways and Boxes for Electrical Systems” for type, sizing and installation standards.

2. Fire Performance: All main risers or trunks of the antenna system shall be installed with resistance to attack from a fire using one of the following methods:
   a. A 2-hour fire rated cable or cable system.
   b. Routing the cable through a 2-hour fire rated enclosure(s) or shaft(s).
   c. System configured in a looped design, routing through 1-hour fire rated enclosure(s) or shaft(s). The circuit shall be capable of transmitting and receiving a signal during a single open or non-simultaneous single ground fault on a circuit conductor.
   d. Performance alternative approved by the authority having jurisdiction.
3. Cabinet: The signal booster and all associated RF filters shall be housed in a single, NEMA 4 certified, painted steel weather tight box. The cabinet shall be large enough to dissipate internal heat without venting the inside of the cabinet to the outside atmosphere.
4. Operating Temperatures: -22 degrees F to +120 degrees F minimum temperature range, including microprocessors. Equipment installed on the roof of structures shall be rated for the expected extreme temperatures associated with rooftop installations.
5. Rooftop installations shall require a pitch pocket for proper weathertight roof penetrations.
6. Passive Equipment: Passband shall be 700-900 MHz, IP rating of 2 GHz.
7. Cable: Passband shall be 700-900 MHz. Cable shall be rated for fire plenum and riser rating.

2.03 SYSTEM COMPONENTS

A. Signal Strength:
   1. Downlink or Inbound Signal: A minimum signal strength of -95 dBm and a DAQ of 3.5 shall be receivable throughout 95 percent of the building. In critical areas, the signal coverage should be receivable over 99 percent of the critical areas such as, command center(s), fire pump rooms, stairs, elevator lobbies, and sectional valve locations or others as defined by the AHJ.
   2. Uplink or Outbound Signal: Minimum signal strength of -95 dBm received at the local Fire Department Radio System from the coverage area.
   3. Isolation: A donor antenna must maintain isolation from the distributed antenna system. The donor antenna signal level shall be a minimum of 15 dB above the distributed antenna system under all operating conditions.

B. Permissible Systems:
   1. Buildings and structures shall be equipped with an FCC Certificated Class B Bi-Directional Amplifier(s) as needed.
   2. The distributed antenna system may utilize a radiating cable, fixed antennas or a combination of both.
   3. Bi-directional amplifiers shall be FCC Certified and registered prior to installation.

C. Supported Frequencies: The radio system shall support VHF, UHF, and frequencies in the 700 and 900 MHz as required for local public safety and first responder bands as utilized by the local municipality.

D. Reject Filters: Notch filter sections shall be incorporated to minimize adjacent channel cellular and SMR degradation of the signal booster performance. The minimum downlink band adjacent band rejection shall be 35 dB or greater at 865 MHz and 870 MHz.

E. Band Migration Capability: The signal booster shall include re-tunable or replaceable filters to accommodate rapid and economic passband changes in the event of mandatory FCC changes within the NPSPAC band. The use of non-adjustable and non-replaceable RF input and output filters is prohibited.

F. Output Level Control: An automatic output leveling circuit shall be included for both passbands with a minimum dynamic range of 60 dB, less any gain reduction setting, to maintain FCC out of band and spurious emission compliance.

G. Degraded Performance in Emergencies: The system shall be designed to allow degraded performance in adverse conditions, such as abnormally high temperatures resulting from nearby fires, extreme voltage fluctuations or other abnormal conditions that may occur during an emergency. Circuits that intentionally disable the signal booster in such situations (i.e. over/under voltage, over/under current, over/under temperature, etc.) will not be implemented as the standard mode for public safety applications.

H. Mode of Operation: The system shall be normally powered on and shall continuously provide passing of frequencies within the Public Safety and First Responder bands.

I. All in-building radio systems shall be compatible with both analog and digital communications simultaneously at the time of installation.

2.04 SYSTEM MONITORING

A. The ERRAS shall include a connection to the fire alarm system. The ERRAS shall include automatic supervisory and trouble signals for malfunctions of the signal booster(s) and power supply(ies) that are annunciated by the fire alarm system and comply with the following:
   1. The integrity of the circuit monitoring signal booster(s) and power supply(ies) shall comply with NFPA 72. Coordinate and provide this integration, as part of this system, with the fire alarm system contractor that is authorized to service the facility's fire alarm system.
   2. System and signal booster(s) supervisory signal shall include the following:
      a. Antenna malfunction
      b. Signal booster failure
   3. Power supply supervisory signals shall include the following for each signal booster:
      a. Loss of normal ac power
      b. Failure of battery charger
      c. Low battery capacity, alarming at 70 percent of battery capacity.
   4. Any resulting trouble alarm shall be automatically transmitted to an approved central station or proprietary supervising station as defined in NFPA 72 and shall sound an audible signal at a constantly attended location.

B. A sign shall be located at the fire alarm panel with the name and telephone number of the local Fire Department indicating that they shall be notified of any failures that extend past the 2-hour time limit.

C. A dedicated supervised monitoring panel shall be provided at a location designated by the AHJ inside the facility to annunciate the status of all signal booster locations. The monitoring panel shall provide visual and labeled indication of the following for each signal booster:
   1. Normal AC power
   2. Signal booster trouble
   3. Antenna failure
   4. Loss of normal AC power
   5. Failure of battery charger
   6. Low battery capacity

2.05 PERMIT REQUIRED

A. A permit must be obtained prior to the construction or modification of an ERRAS as required by IFC 510 and the AHJ and must also be approved by the Emergency Radio Communication Division. A copy of the permit shall be posted visibly on the main active component, or at the point of primary system operation.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine areas and conditions for compliance with requirements for ventilation, temperature, humidity, and other conditions affecting performance of the Work.

1. Verify that manufacturer's written instructions for environmental conditions have been permanently established in spaces where equipment and wiring are installed, before installation begins.

B. Examine roughing-in for electrical connections to verify actual locations of connections before installation.

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

3.02 INSTALLATION

A. Distribution System Signal Wires and Cables:
1. Wires and cables shall enter each equipment enclosure, console, cabinet or rack in such a manner that all doors or access panels can be opened and closed without removal or disruption of the cables.
2. Wires or cables routed between consoles, cabinets, racks, and other equipment shall be installed in an approved conduit or cable tray that is secured to building structure.
3. Cable pathways, conduit, and cable support systems shall be complete with bushings, deburred, cleaned, and secure prior to installation of cable.
4. Before energizing the system, completely test all cables after installation and replace any that are found to be defective. Test for short circuits, ground faults, continuity, and insulation.
5. Install cables without damaging conductors, shield, or jacket.
6. Do not bend cables, while handling or installing, to radii smaller than as recommended by manufacturer.
7. Pull cables without exceeding cable manufacturer’s recommended pulling tensions. Any pulling compounds utilized must be approved by the cable manufacturer.
8. In all exposed ceiling areas such as mechanical rooms, cable shall be fully enclosed in conduit.
9. Cable must not be fastened to electrical conduits, mechanical ductwork or piping, sprinkler piping, or routed to obstruct access to hatches, doors, utility access panels, or service work areas. Do not route cables through fire doors, ventilation shafts, grates, or parallel for more than four-feet with line voltage electrical conductors. System cables shall not be run loose on ceiling grid or ceiling tiles.
10. Each cable run shall be free of splices. No terminations, splices, or equipment will be installed in or above ceilings.
11. Do not route any communication cable within two feet of any light fixture, HVAC unit, service access area, electrical panel, or any device containing a motor or transformer.

B. System Installation:
1. Coaxial antenna cabling shall not be installed in the same conduit, raceway, or cable trays used for other systems.
2. All equipment shall be connected according to the OEM’s specifications to ensure correct installation and system performance.
3. Coordinate all roof penetrations with Owner and/or roofing contractor.

C. Non-Interference
1. No radio signal amplifications system capable of operating on frequencies or causing interference on frequencies assigned to the jurisdiction by the FCC shall be installed without prior coordination and approval from the AHJ. The Owner shall suspend and correct other equipment installations that de-grade the performance of the ERRA.

3.03 DELIVERY, STORAGE, AND HANDLING

A. Delivery: Deliver materials to site in manufacturer’s original, unopened containers and packaging, with labels clearly identifying product name and manufacturer.

B. Storage: Store materials in clean, dry area indoors in accordance with manufacturer's instructions.

C. Handling: Protect materials from damage during handling and installation.

3.04 LICENSING

A. All fees associated with the licensing shall be paid by the Owner.

B. All testing must be done on frequencies authorized by the FCC.

3.05 GROUNDING

A. Ground cable shields and equipment per Manufacturer's requirements.

B. Antenna mast shall be grounded per NFPA 70 NEC requirements, Division 27 Section "Grounding and Bonding of Communications Systems", and antenna manufacturer's requirements.

C. Provide grounding blocks and surge protection for outside coaxial cabling.

D. Bond the antenna mast to the lightning protection system (if applicable).

3.06 FIELD QUALITY CONTROL

A. The local AHJ will review plans and specifications. Upon acceptance, plans will be stamped to indicate approval. Stamped plans are required to be present at the acceptance test. Any field changes that occur during construction shall be incorporated into new As-Built plans, including any manufacturer's data sheets for any equipment changes not submitted in the original submittal. As-Built plans, if required due to system changes, shall be submitted to the local AHJ for approval.

B. Tests shall be made using frequencies close to the frequencies used by the Fire Department and appropriate emergency services. If testing is done on the actual frequencies, then this testing must be coordinated with the local Fire Department unit. All testing must be done on frequencies authorized by the FCC. A valid FCC license will be required if testing is done on frequencies different from the police, fire or emergency medical frequencies.

C. Field tests shall be witnessed by the AHJ.

D. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

E. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
   1. Visual Inspection: Conduct visual inspection prior to testing.
      a. Inspection shall be based on completed As-Built Drawings and system documentation.
   2. Testing Procedures:
      a. Testing of the system shall conform to the testing requirements as described in the International Fire Code (IFC) Section 51 0.5.3.
      b. All testing must be done on frequencies authorized by the FCC and in use by local agencies as directed by the AHJ.
      c. Each floor of the building shall be divided into a grid of approximately 20 equal grid areas of a minimum of 20 feet and a maximum of 80 feet per grid to a maximum of 128,000 sf per level. For floors with more than 128,000 sf per floor, it will require that it be divided into grid sectors of no more than 20 grids per sector and tested individually per sector.
      d. Minimum Signal Strength: For testing system signal strength and quality, the testing shall be based on the delivered audio quality (DAQ) system. A DAQ level below 3.5 shall be considered a failed test for a given grid cell.

e. Measurements shall be made with the antenna held in a vertical position at 3 to 4 feet above the floor to simulate a typical portable radio worn on the belt or turnout coat pocket.
f. All measurements shall be made in an averaged mode with sampling minimums as specified below:
    1) Average signal levels shall be recorded while walking an “X” pattern with the center of the pattern located approximately in the center of each grid area.
    2) The linear distance of each side of the “X” shall be 10 percent of the length of the grid’s side, and a minimum length of 10 feet. At least one sample per each five feet traveled shall be recorded, and no less than five samples per measurement recorded.
    3) A test location approximately in the center of each grid area will be selected for the test, then the radio will be enabled to verify two-way communications to and from the outside of the building through the public safety agency’s radio communications system. Once the test location has been selected, prospecting for a better spot within the grid area will not be permitted.
    4) A maximum of two nonadjacent areas will be allowed to fail the test. A failure occurs when the measured signal level falls below the minimums specified above.
g. Thoroughly test all components of the systems and devices proposed herein to assure equipment specifications are met. This contractor will start up, test, and debug systems to ensure that all aspects of the system are working, documented, and reporting properly.
h. Active components shall be tested to establish initial system gains of equal value to those of design criteria. During subsequent inspections, gain values shall be measured to ensure values equal to those at time of final acceptance.

3. Final Acceptance Testing:
    a. All acceptance testing shall be done in the presence of a local AHJ representative and the Owner.
    b. Small scale drawings (11-inch x 17-inch) of the structure shall be provided by the Contractor to the Owner. The plans shall show each floor divided into the grids as described above, and the results of the pre-testing. Each grid shall be labeled to indicate the DAQ result from the final acceptance testing.
    c. The Contractor shall provide the latest approved plans for the system, including any manufacturer’s data sheets for any equipment changes not submitted in the original submittal to the Owner.
    d. Include testing results of the repeater (output wattage, gain level, etc.) and connection to the fire alarm.

F. Reacceptance Testing: Perform reacceptance testing to verify the proper operation of added or replaced devices and appliances.

G. Radio system will be considered defective if it does not pass tests and inspections.

H. Prepare test and inspection reports.

I. Maintenance Test and Inspection: Perform tests and inspections listed for weekly, monthly, quarterly, and semiannual periods. Use forms developed for initial tests and inspections.

J. Annual Test and Inspection: One year after date of Substantial Completion, test radio system. Use forms developed for initial tests and inspections.

3.07 ANNUAL TESTING

A. Annual tests shall be the Owner’s responsibility. All live components of the system, such as signal boosters, power supplies, and backup batteries shall be tested at a minimum of once every 12 months. Owner shall maintain documentation at the request of the AHJ.

1. The re-testing will be done at no expense to the AHJ or the appropriate emergency services departments as required in the original testing procedures.

B. All tests shall be conducted, documented, and signed by a person in possession of a current FCC General Radio Telephone Operator License, or a technician certification issued by the Association of Public-Safety Communications Officials International (APCO) or equivalent as determined by the local Fire Marshal.

C. Fire Department Radio personnel, after providing reasonable notice to the Owner or their representative, shall have the right to enter onto the property to conduct field testing to be certain that the required level of radio coverage is present.

3.08 SERVICE MAINTENANCE CONTRACT

A. Provide a maintenance contract with a Radio Service Provider with name of authorized company, who will provide a 24-hour by 7-day emergency response within two (2) hours after notification. The system shall be maintained in accordance with FCC requirements. The contract shall be for five (5) years.

B. Maintain a list of contact personnel with phone numbers at the radio repeater system cabinet. The contact personnel shall have knowledge of the building and the repeater system and be available to respond to the building in the case of an emergency.

C. Radio Service Provider maintenance contract shall include but not be limited to the following:
   1. Annual Test:
      a. All active components of the distributed antenna system, including but not limited to amplifier, power supplies, and back-up batteries, shall be tested a minimum of once every 12 months.
      b. Amplifiers shall be tested to ensure that the gain is the same as it was upon initial installation and acceptance. The original gain shall be noted and any change in gain shall be documented.
      c. Back-up batteries and power supplies shall be tested under load for a period of 1 hour to verify that they will operate during an actual power outage.
      d. Active components shall be checked to determine that they are operating within the manufacturer's specifications for their intended purpose.
      e. Documentation of the test shall be maintained on site and a copy forwarded to the local Fire Department Radio Supervisor upon completion of the test.

3.09 TRAINING

A. On-site training sessions shall be conducted by the ERRAS Contractor. It shall be the responsibility of the Contractor to coordinate time and location of training sessions with the Owner. Provide documented general instruction as follows:
   1. Provide instructions to the maintenance personnel to include the location, inspection, normal maintenance, testing and operation of all system components. Provide a minimum of four (4) hours, two (2) 2-hour sessions separated by a minimum of two (2) weeks.
   2. Provide instruction to designated personnel on the functions and operation of the system provided including capabilities, limitations, and the meaning of status messages. State the proper procedure for testing, routine maintenance, and request for service. Provide detailed instruction on the operation of the system. Provide a minimum of four (4) hours, two (2) 2-hour sessions separated by a minimum of two (2) weeks.

END OF SECTION

SECTION 28 1300
ACCESS CONTROL SOFTWARE AND DATABASE MANGEMENT

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. New access control software and database management shall integrate into Owner's existing Vanderbilt Security Management access control system used throughout the district. Provide all necessary servers, controllers, licenses and appurtenances for a complete functioning system.

B. Section Includes:
   1. Security access operating system and application software.
   2. Security access controllers connected to high-speed electronic-data transmission network.

C. Related Requirements:
   1. Division 27 Section "Intercommunications and Program Systems" for automated emergency messages and/or tones to be broadcast during an emergency lockdown sequence.
   2. Division 28 Section "Access Control System Hardware Devices" for access control system hardware, such as card readers, credential cards, and networked hardwired electronic locks.

1.03 SCOPE

A. This document includes a general description, functional requirements, operational characteristics, and criteria for the Access Control and Security Management System (ACSMS). The ACSMS shall be a product of a single manufacturer.

B. Furnish and install a complete microprocessor-based ACSMS as specified herein. The system shall include, but not be limited to, all control equipment, power supplies, power circuits, signal initiating and signaling devices, conduit, wire, network cabling, fittings, and all other accessories required to provide a complete and operable system.

C. The installing contractor shall design and provide a complete system, meeting the requirements of these specifications. Provide all security system devices required for a complete system perimeter coverage acceptable to all governing authorities, Architect, Engineer, and Owner.

D. Conduct a pre-construction meeting with Owner's personnel, installing technician, project superintendent, and Engineer prior to the start of any construction.

E. Connect this Project location to the district monitoring station as designated by the Owner.

F. Additional responsibilities of the ACSMS Contractor are as follows:
   1. Input all access control doors, door position switches, door release buttons, and all other devices into ACSMS mapping feature.
   2. Mapping feature shall be programmed for complete monitoring of all devices as well as complete functionality of doors. Features shall include but not be limited to:
      a. Lock
      b. Unlock
      c. Lockdown
      d. Position
      e. Alarm for propped door

3. Provide integration for Video Management System for this Project. All door and camera integrations shall be reviewed with Owner prior to programming. Provide all required video client licenses integrated with the camera recording system per campus.

1.04 DEFINITIONS

A. Credential: Data assigned to an entity and used to identify that entity.

B. DTS: Digital Termination Service. A microwave-based, line-of-sight communication provided directly to the end user.

C. Identifier: A credential card; keypad personal identification number; or code, biometric characteristic, or other unique identification entered as data into the entry-control database for the purpose of identifying an individual. Where this term is presented with an initial capital letter, this definition applies.

D. Location: A Location on the network having a workstation-to-controller communications link, with additional controllers at the Location connected to the workstation-to-controller link with a TIA 485-A communications loop. Where this term is presented with an initial capital letter, this definition applies.

E. Workstation: Personal computer. Applies to the central station, workstations, and file servers.

F. RAS: Remote access services.

G. RF: Radio frequency.

H. ROM: Read-only memory. ROM data are maintained through losses of power.

I. TCP/IP: Transport control protocol/Internet protocol.

J. TWAIN: Technology without an Interesting Name. A programming interface that lets a graphics application, such as an image editing program or desktop publishing program, activate a scanner, frame grabber, or other image-capturing device.

K. WMP: Windows media player.

L. Wiegand: Patented magnetic principle that uses specially treated wires embedded in the credential card.

M. WYSIWYG: What You See Is What You Get. Text and graphics appear on the screen the same as they will in print.

1.05 ACTION SUBMITTALS

A. Submit product data and shop drawings in accordance with Division 01 and Division 28 Section “Electronic Safety and Security Shop Drawings and Submittals” for products specified under PART 2 - PRODUCTS.

B. Specification Compliance Certification: Submit a Specification Compliance Certification in accordance with Division 28 Section “Electronic Safety and Security Shop Drawings and Submittals”.

C. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories.

D. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
   1. Indicate system components, wiring diagrams, and load calculations.
   2. System labeling schedules, including electronic copy of labeling schedules.
   3. Wiring Diagrams: For power, signal, and control wiring, show typical wiring schematics.
   4. Cable Administration Drawings: As specified in "Identification" Article.
   5. Battery and charger calculations for controllers.

1.06 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.07 CLOSEOUT SUBMITTALS

A. Contract Close-Out Submittals: Provide one (1) electronic format manual including operating instructions, maintenance recommendations and parts list including wiring and connection diagrams modified to reflect as-built conditions.

B. Manuals: Final copies of the manuals shall be delivered within 14 days after completing the installation test. Each manual's contents shall be identified on the cover. The manual shall include names, addresses, and telephone numbers of the contractor responsible for the installation and maintenance of the system and the factory representatives for each item of equipment for each system. The manuals shall have a table of contents and labeled sections. The final copies delivered after completion of the installation test shall include all modifications made during installation, checkout, and acceptance testing. The manuals shall consist of the following:
   1. Functional Design Manual: The functional design manual shall identify the operational requirements for the system and explain the theory of operation, design philosophy, and specific functions. A description of hardware and software functions, interfaces, and requirements shall be included.
   2. Hardware Manual: The manual shall describe all equipment furnished including:
      a. General description and specifications.
      b. Installation and check out procedures.
      c. Equipment layout and electrical schematics to the component level.
      d. System layout drawings and schematics.
      e. Alignment and calibration procedures.
      f. Manufacturers repair parts list indicating sources of supply.
   3. Software Manual: The software manual shall describe the functions of all software and shall include all other information necessary to enable proper loading, testing, and operation. The manual shall include:
      a. Definition of terms and functions.
      b. System use and application software.
      c. Initialization, start up, and shut down.
      d. Reports generation.
      e. Details on forms customization and field parameters.

C. As-Built Drawings: During system installation, the Contractor shall maintain a separate hard copy set of drawings, elementary diagrams, and wiring diagrams of the ACS to be used for record drawings. This set shall be accurately kept up to date by the Contractor with all changes and additions to the ACS. Copies of the final as-built drawings shall be provided to the end user in DXF format.

1.08 QUALITY ASSURANCE

A. Manufacturers Qualifications: Engage qualified manufacturers with a minimum of five (5) years of documented experience in providing access control and security systems equipment and software similar to that indicated for this Project and that have a proven record of successful in-service performance.
   1. Software and access control systems components to have been previously and thoroughly tested together with proven installations similar in size and functionality to the design requirements indicated for this Project.

B. Supplier Qualifications: Supplier/Dealers, verifiably authorized and in good standing with the primary product manufacturers, with a minimum of three (3) years of experience supplying integrated access control systems similar in material, design, and scope to that indicated for this Project and whose work has resulted in construction with a proven record of successful in-service performance.

1. Schlage access control products are required to be supplied only through designated “Authorized Channel Partners.”

C. System Integrator Qualifications: Systems Integrators, verifiably factory trained and certified by the primary product manufacturers, with a minimum of three (3) years documented experience installing complete integrated access control systems similar in material, design, and scope to that indicated for this Project and whose work has resulted in construction with a proven record of successful in-service performance. Qualifications include, but are not necessarily limited, to the following:
   1. References: Provide a list of references for similar projects including contact name, phone number, name and type of project.
   2. Professional Staffing: Firms to have a dedicated access control systems integration department with full time, experienced professionals on staff experienced in providing on site consulting services for both electrified door hardware and integrated access control systems installations.
   3. Factory Training: Installation and service technicians are to be competent factory trained and certified personnel capable of maintaining the system.
   4. Service Center: Firms to have a service center capable of providing training, in-stock parts, and emergency maintenance and repairs at the Project site with 24-hour/7-days a week maximum response time.

D. Installer Qualifications:
   1. Certified technicians, verifiably authorized with the primary product manufacturers for installation of IP-Enabled, Wireless, and Power-over-Ethernet Access Control products in accordance with documented instructions and NFPA 80.
   2. The installer shall be the authorized representative of the Access Control Manufacturer to sell, install, and service the proposed manufacturer’s product for at least three (3) years.
   3. The installer must have Vanderbilt Security Management System training certification from the manufacturer. No person is allowed to work on the system without proper manufacturer’s certification.
   4. The installer shall provide 24-hour, 365-day per year emergency service with factory trained service technicians.
   5. The installer shall have personnel on their staff that has been actively engaged in the business of designing, selling, installing, and servicing security alarm systems for at least ten (10) years.

E. Source Limitations: Obtain the access control door hardware, system firmware and application software specified in this Section from a single source, qualified supplier/integrator 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 integrated access control door hardware from the same manufacturer as mechanical door hardware, unless otherwise indicated.
   3. Networked, hardwired electronic locks are required to be supplied and installed only through designated Allegion partners and certified integrators.

1.09 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials in original packaging. Store and handle in accordance with the manufacturer’s requirements.
   1. Store in temperature- and humidity-controlled environment in original manufacturer's sealed containers. Maintain ambient temperature between 50 and 85 deg F, and not more than 80 percent relative humidity, noncondensing.

1.10 WARRANTY

A. Warranty Period: The entire system shall be warranted against defects in materials and workmanship for a period of one (1) year from date of Substantial Completion including labor.

B. ACSMS Software and Field Hardware Warranty:
   1. ACSMS Software shall be warranted for a period of 90 Days from the date of shipment from the manufacturer to be free of defects and will function in substantial accordance to the published specification.
   2. ACSMS Field Hardware shall be warranted for a period of three (3) years from the date of Substantial Completion, will be free from defects and will function in general accordance with the product specifications.

C. ACSMS Third Party Device warranties are transferred from the manufacturer to the contractor, which may then transfer third party warranties to the owner. Specific third-party warranty details, terms and conditions, remedies and procedures, are either expressly stated on, or packaged with, or accompany such products. The warranty period may vary from product to product. These products include but are not limited to devices that are directly interconnected to the ACSMS field hardware or computers and are purchased directly from the ACSMS manufacturer. Examples may include but not be limited to; Credential Printers, Reader Heads, Computers etc..

PART 2 PRODUCTS

2.01 ACCESS CONTROL SOFTWARE

A. Manufacturer: Open Options.

2.02 GENERAL REQUIREMENTS

A. The Access Control and Security Management System (ACSMS) shall be a highly scalable, robust access control and security management system developed using the latest in development technology. The ACSMS shall provide a singular interface capable of controlling multiple, geographically independent sites and provide alarm monitoring, video management integration, ID badging, personnel and cardholder management, and situational control of all connected devices from a single application.

B. The ACSMS must fully support the Authentic Mercury Security Corporation controllers and sub-controllers.

C. The ACSMS must support credential readers that communicate via RS-485.

D. The ACSMS must support the Open Supervised Device Protocol (OSDP).

E. A sufficient number of controllers and sub-controllers will be provided to monitor all credential reader, monitor point, and relay point locations shown on plan.

2.03 FEATURES

A. Multi-User/Network Capabilities: The ACSMS shall support multiple operator workstations via local area network/wide area network (LAN/WAN). The communications between the workstations and the server computer shall utilize the TCP/IP standard over industry standard IEEE 802.3 (Ethernet). The communications between the server and workstations shall be supervised, and shall provide the ability to generate alarm messages when the server is unable to communicate with a workstation.

B. Operating Environment: The ACSMS shall be a 3-tier client/server, ODBC compliant application based on Microsoft tools and standards. The ACSMS application shall operate in the following environments: Windows 10 Enterprise/Professional. Windows Server 2016 and 2019.

C. Multi-level Password Protection: The ACSMS application shall provide multi-level password protection, with user-defined operator name/password combinations. Name/password log-on shall restrict operators to selected areas of the program. The application shall allow the assignment of operator levels to define the system components that each operator has access to view, operate, change, or delete.

D. NT Authentication: The ACSMS application will support the implementation of NT authentication, thereby utilizing the credentials supplied by the network administrator to authenticate during the login process of the system.

E. Strong Password Enforcement: The ACSMS application shall have an option to enforce strong passwords and by setting minimum character lengths and complexity requirements.

F. Graphical User Interface: The ACSMS shall be fully compliant with Microsoft Graphical User Interface (GUI) standards, with the look and feel of the software being that of a standard Windows application, including hardware tree-based system configuration.

G. Concurrent Licensing: The ACSMS shall support concurrent client workstation licensing. The ACSMS application shall be installed on any number of client workstations, and shall provide the ability for any of the client workstations to connect to the application server as long as the maximum number of concurrent connections purchased has not been exceeded.

H. Access Control Software Suite: The ACSMS shall be a scalable application such that there is no requirement for separate tiers or editions of software. The same code set used for smaller, more localized installations, shall be the same code set used for enterprise system deployments.

I. System Partitioning/Filtering: The ACSMS shall provide the option to restrict access to personnel and hardware data based on login and profile.

J. Encryption: The ACSMS shall provide multiple levels of data encryption.
   1. Must support 128-bit or 256-bit AES data encryption between the host and intelligent controllers. The encryption shall ensure data integrity that is compliant with the requirements of FIPS-197 and SCIF environments. Master keys shall be downloaded to the intelligent controller, which shall then be authenticated through the Access Control and Security Management System based on a successful match.
   2. Transparent database encryption, including log files and backups.
   3. SQL secure connections via SSL.

K. Industry Standard Panel Communication: The ACSMS shall communicate with the access control intelligent controllers via LAN/WAN connections utilizing industry standard communication protocols.

L. Supervised Alarm Points: The ACSMS shall provide both supervised and non-supervised alarm point monitoring with the ability to specify custom values of resistance. On recognition of an alarm, the ACSMS shall be capable of switching and displaying the video from the camera connected to the video management system that is associated with the alarm point.

M. Multiple Account Support: The ACSMS shall allow support for multiple accounts allowing separate access to the personnel database, badge layout, operator access, and reporting. Physical hardware may be filtered by profile level into “sites”. “Sites” may be assigned to one or more operator profiles. The system shall allow control of common areas between operator profiles. Access levels and time schedules shall be global to allow for easy administration and filtering. The global access levels and time schedules shall be capable of being used by one or more operator profiles.

N. Camera Support: The ACSMS shall support, via integrated VMS platforms, pan, tilt, zoom, and touring features.

O. Display Live Video: The ACSMS shall support an option to view live video from a camera connected to an integrated VMS. The cameras from the integrated VMS shall be able to be associated with any hardware device programmed in the ACSMS and opened automatically on any system event or operator-initiated command sequence.

P. Global/Anti-Passback: The ACSMS shall support multiple modes of anti-passback, by which cardholders must follow a specified sequence of card reads in the configured areas.

Q. Alarm Events: The ACSMS shall include a feature where alarm events with defined priorities shall be able to pop-up automatically in an Alarm event window for operator attention.
   1. The pop-up shall display the following information:
      a. Description of the event.
      b. Time and date.
      c. Point description.
      d. If a card event, the card number.
      e. Type of event.
      f. Cardholder name.
   2. An event counter shall also display the number of times the event was reported to the Alarm event monitor prior to Acknowledgement or Clearing the event. Event instructions shall be made available by double clicking on the event.
   3. The Alarm shall display an icon to indicate that a camera is associated to the device.
   4. The Alarm event window shall allow the operator to initiate a physical response to the event as well as a written response. Responses shall include but not be limited to:
      a. Acknowledge.
      b. Clear.
      c. Open a pre-programmed floor plan.
      d. Activate or de-activate.
      e. Pulse.
      f. Add comment.
      g. Retrieve archived video and bring up live video.
      h. Disarm or arm.

R. Global Device Control: The ACSMS shall allow manual control of one or more selected inputs, outputs, and doors. Global device control shall include pulse, timed pulse, and energize/de-energize or return to normal options for output points and arm/disarm or return to normal options for input points. For global control of doors, the ACSMS shall include Disabled, Unlocked, Locked, Facility Code Only, Card Only, PIN Only, Card and PIN, Override Mode, and Cancel Override Mode.

S. Global Edit: The ACSMS shall support, by way of a multi-select function, a method to globally edit input points, outpoint points, doors, readers, personnel and cards.

T. Levels of System Operation:
   1. The ACSMS shall include a feature to define the levels of system operation for each individual operator using passwords and profiles. System operation for individual operators shall include, but not be limited to:
      a. Restricted time periods for login.
      b. Inactivity notifications.
      c. Lockout for failed logon attempts.
   2. Operator actions range from:
      a. No view or control rights.
      b. Basic monitoring including the ability to block the viewing of card and/or personal identification numbers.
      c. Full control of the system including programming.

U. Distributed Processing: All the control components of the ACSMS shall utilize “Distributed-Processing” design. The distributed processing shall include the ability to download operating parameters to any field panel, thus allowing the field panel to provide full operating functions independent of the ACSMS application server.

2.04 FUNCTIONAL CAPABILITIES

A. All transactions and audits shall be logged by date and time to the database.

B. The end-user shall have the ability to make any system configuration changes such as, but not limited to door open time, door contact shunt time, point and door names, when and where a cardholder is authorized, and the ability to add or modify personnel records at any time and without assistance from the manufacturer or system installer.

C. Global Anti-pass Back: Allows cardholders to enter/exit any such defined card reader area on any intelligent control panel provided they follow the required in/out flow.

D. Duress PIN Feature: Configurable in operation by which the cardholder either adds a specified digit to their unique PIN or appends a specified digit to their unique PIN.

E. All updates and changes to the programming in the intelligent controllers shall take place real-time and will not require manual downloads to propagate system changes.

F. Available Application Program Interface (API): Built on current development technologies that allows the integration of third-party programs or systems.

G. Intuitive Graphical User Interface (GUI): An operator will not be required to close or switch views to another part of the application in order to edit or view any aspect of the system. The GUI must be fully customizable allowing for an infinite number of operator views to be created and assigned. The GUI must support drag and drop functions within the multi-document interface.
   1. The GUI shall be developed in such a manner that any place that a personnel record or hardware device is shown that an operator can right click on it and open the properties or execute control functions.

H. Global I/O Functions: Any point programmed in the system can be configured to control any other point on the system regardless of which intelligent controllers they reside on.

I. All necessary system drivers shall run as Windows services and as such do not require the Operating System to be logged in on the application server.

J. Support for thick client, web client and mobile client applications that provide system management functions.

K. Situation Level Manager: Provides five different states that can be initiated by clicking on a single, color coded button. The Situation Levels shall by configurable on the following objects: Doors, Time Schedules, Input Points, Output/Relay Points, and Credentials.

L. Direct Commands: Allow the creation of a single button to control a single or multiple devices simultaneously by clicking one button, based on operator privileges.
   1. Direct Commands shall be one of many ways to incorporate facility lockdowns and return to normal or all clear states.
   2. Direct Commands shall have the ability to password protect to require additional authentication prior to execution.

M. Remove From Service: Remove an input point from service, where by any change of state on that point is ignored, regardless of the point arm/disarm state. Removing a point from service goes beyond disarming the point, as it can be rearmed via a programmed or manual event, thereby reporting alarm conditions once again. A point that has been removed from service must be returned to service in order to see change of state events on it.

N. Override Modes on Doors: Current mode of the door can be overridden to another state. (i.e. Card Only, Card & PIN, Locked, Disabled). When the mode of door has been overridden, it will remain in that state, regardless of any scheduled commands or manual control initiated based on time or operator execution. When the override mode is canceled, the door will revert to the state that it is supposed to be in. For example, if a time schedule has activated to unlock the door, then it will revert to that state without any additional programming or intervention from the operator.

O. Removal from service and override modes must be selectable with the following options:
   1. Indefinite: The state will remain until it has been cancelled.
   2. For a specified number of minutes.
   3. Until a specific time of the current day.

2.05 PERSONNEL AND CARHOLDER MANAGEMENT

A. Provide a personnel browser method of managing personnel data in a hierarchical tree. The personnel browser shall be sortable by any field of data stored in the personnel record. Browser shall have ability to:
   1. Create unlimited custom personnel groups that personnel records can be assigned to where by personnel records can be assigned to one or more personnel groups.
   2. Assign default access levels to custom personnel groups that cardholders will inherit or disinherit as they are added or removed to or from custom personnel groups.
   3. Assign one or more credentials to a single personnel record.
   4. Support a maximum of 128 access levels per credential per intelligent controller.

B. Vacation Start Function: Allows the temporary disabling of cards for a specified number of days.

C. Temporary Upgrade of Access Levels: Operator can temporarily assign an access level with start and stop dates.

D. Situation Level: Any or all credentials activate or deactivate based on a system-controlled Situation Level.

2.06 INTEGRATED GRAPHICS MAPS

A. Provide an integrated graphical map module allowing for the importation of floor plans and other .JPG or .BMP files for use in plotting hardware and other connected devices programmed in the system onto the graphic layouts. This shall not require any additional licensing fees.

B. Assign a graphic map as a homepage of any point in the system, thereby linking that device to that map and allowing the system to automatically load the graphic upon an alarm condition from any pint that is plotted on it.

C. Hyperlink the graphic maps to one another thereby creating a “drill down” effect.

D. Create buttons on the graphic maps which can then be linked to Direct Commands.

2.07 CONTROLLERS

A. Controllers: Intelligent peripheral control unit, complying with UL 294, that stores time, date, valid codes, access levels, and similar data downloaded from the central server for controlling its operation.

B. Battery Backup: Sealed, lead acid; sized to provide run time during a power outage of 90 minutes, complying with UL 924.
   1. Provide wall-mounted enclosures in quantities as required for Project.

C. Alarm Annunciation Controller:
   1. The controller shall automatically restore communication within 10 seconds after an interruption with the field device network.

a. Inputs: Monitor dry contacts for changes of state that reflect alarm conditions. Provides at least eight alarm inputs, which are suitable for wiring as normally open or normally closed contacts for alarm conditions.
b. Alarm-Line Supervision:
   1) Supervise the alarm lines by monitoring each circuit for changes or disturbances in the signal by monitoring for abnormal open, grounded, or shorted conditions using dc change measurements. System shall initiate an alarm in response to an abnormal current, which is a dc change of 5 percent or more for longer than 500 ms.
   2) Transmit alarm-line-supervision alarm to the central station during the next interrogation cycle after the abnormal current condition.
c. Outputs: Managed by central-station software.

2.08 TRANSFORMERS

A. NFPA 70, Class II control transformers, NRTL listed. Transformers for security access-control system shall not be shared with any other system.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine pathway elements intended for cables. Check raceways, cable trays, and other elements for compliance with space allocations, installation tolerances, hazards to cable installation, and other conditions affecting installation.

B. Examine roughing-in for LAN and control cable conduit systems to workstations, controllers, card readers, and other cable-connected devices to verify actual locations of conduit and back boxes before device installation.

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

3.02 PREPARATION

A. Comply with recommendations in SIA CP-01.

B. Comply with TIA 606-B, "Administration Standard for Commercial Telecommunications Infrastructure."

C. Product Schedules: Obtain detailed product schedules from manufacturer of access-control system or develop product schedules to suit Project. Fill in all data available from Project plans and specifications and publish as Product Schedules for review and approval.
   1. Record setup data for control station and workstations.
   2. For each Location, record setup of controller features and access requirements.
   3. Propose start and stop times for time zones and holidays, and match up access levels for doors.
   4. Set up groups, facility codes, linking, and list inputs and outputs for each controller.
   5. Assign action message names and compose messages.
   6. Set up alarms. Establish interlocks between alarms and video surveillance features.
   7. Lockdown: Establish lockdown sequences and programming.
   8. Prepare and install alarm graphic maps.
   9. Develop user-defined fields.
   10. Develop screen layout formats.
   11. Propose setups for guard tours and key control.
   12. Discuss badge layout options; design badges.
   13. Complete system diagnostics and operation verification.
   14. Prepare a specific plan for system testing, startup, and demonstration.
   15. Develop acceptance test concept and, on approval, develop specifics of the test.

16. Develop cable and asset-management system details; input data from construction documents. Include system schematics and Visio Technical Drawings in electronic format.

D. In meetings with Architect and Owner, present Product Schedules and review, adjust, and prepare final setup documents. Use approved, final Product Schedules to set up system software.

3.03 IDENTIFICATION

A. Develop cable administration drawings for system identification, testing, and management. Use unique, alphanumeric designation for each cable, and label cable and jacks, connectors, and terminals to which it connects with the same designation. Use logical and systematic designations for facility's architectural arrangement.

B. Label each terminal strip and screw terminal in each cabinet, rack, or panel.
1. All wiring conductors connected to terminal strips shall be individually numbered, and each cable or wiring group being extended from a panel or cabinet to a building-mounted device shall be identified with the name and number of the particular device as shown.
2. Each wire connected to building-mounted devices is not required to be numbered at the device if the color of the wire is consistent with the associated wire connected and numbered within the panel or cabinet.
3. Provide violet-colored jacket on all access control cabling. Coordinate with Division 27 Section “Communications Copper Horizontal Cabling”.

C. At Project completion, cable and asset management documents shall reflect as-built conditions. Provide an electronic PDF overall plan of the school with access control door hardware locations marked in red.

3.04 SYSTEM SOFTWARE AND HARDWARE

A. Develop, install, and test software and hardware, and perform database tests for the complete and proper operation of systems involved. Assign software license to Owner.

3.05 LOCKDOWN SEQUENCES

A. Coordinate with Owner in programming and testing all lockdown sequences in the ACSMS. All sequences must be programmed and operational prior to Substantial Completion of Project.

B. Building Lockdown:
1. The Reception area shall be equipped with a local momentary pushbutton to initiate a building wide lock down sequence.
2. When initiated, all exterior doors shall be locked.
3. Release: The lockdown sequence shall only be released with a valid credential card scan from the lockdown release card reader in the Reception area.
4. Refer to Drawings for door locations and for additional sequence information.

3.06 STARTUP SERVICE

A. Engage a factory-authorized service representative to supervise and assist with startup service.
1. Complete installation and startup checks according to approved procedures and with manufacturer's written instructions.
2. Enroll and prepare badges and access cards for Owner's operators, management, and security personnel.

3.07 PROTECTION

A. Maintain strict security during the installation of equipment and software. Rooms housing the control station, and workstations that have been powered up shall be locked and secured with an activated burglar alarm and access-control system reporting to a central station complying with UL 1610, "Central-Station Burglar-Alarm Units," during periods when a qualified operator in the employ of Contractor is not present.

3.08 DEMONSTRATION

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

B. Provide a minimum of eight (8) hours of video recorded training for the Owner.

C. Train Owner's maintenance personnel to adjust, operate, and maintain security access system. See Division 01 Section "Demonstration and Training."

D. Train Owner’s administration personnel at the school how to initiate remote door lock/unlock sequences and how to initiate and reset lockdown sequences.

E. Develop separate training modules for the following:
   1. Computer system administration personnel to manage and repair the LAN and databases and to update and maintain software.
   2. Operators who prepare and input credentials to man the workstations and to enroll personnel.
   3. Security and hardware maintenance personnel.

END OF SECTION

SECTION 28 1500
ACCESS CONTROL HARDWARE DEVICES

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Wire, program, and integrate electric door hardware furnished by Door Hardware subcontractor, including:
   1. Electric exit devices
   2. Electric cylinder locks
   3. Electric strikes at exterior gates

B. Furnish, install, and integrate Access Control System hardware including:
   1. Door wiring harnesses, electric power transfers, door cords, etc as needed for connection of door hardware to system.
   2. Door controller hardware.
   3. Credential readers.
   4. Door release button(s).
   5. "Lockdown" button(s).

C. Install and/or integrate devices furnished by Door Hardware subcontractor, including:
   1. Door hardware power supplies

D. Related Requirements:
   1. Division 08 Section “Door Hardware” for coordination with access control hardware and door hardware.
   2. Division 28 Section “Access Control Software and Database Management” for integration with access control software.

1.03 DEFINITIONS

A. Abbreviations
   1. API: Application Programming Interface
   2. IEC: International Electrotechnical Commission
   3. IEEE: Institute of Electrical and Electronics Engineers
   4. IKxx (where xx is a 2-character designation): Impact protection rating as defined by IEC 62262
   5. IP: Internet Protocol, an OSI Layer 3 communication protocol for interconnecting computer networks
   6. IPxx (where xx is a 2-character designation): Ingress protection as defined by IEC 60529.
   7. OSDP – Open Supervised Device Protocol, a standard for encrypted serial communication between credential reader and access control hardware system developed by SIA and published as IEC60839-11-5
   8. PoE – Power over Ethernet
   9. RF: Radio frequency.
   10. RFID: Radio frequency Identification, an identifier technology using near- or intermediate-field RF communication to communicate an Identifier between a Credential and the access control management system.
   11. TCP: Transmission Control Protocol, an OSI Layer 4 transport protocol.
   12. UDP: Uniform Datagram Protocol, an OSI Layer 4 transport protocol.
   13. Wi-Fi: Wireless Ethernet as defined by the IEEE 802.11 standards.

B. Credential: An object or device (such as an RFID card) which contains or embodies an Identifier and is assigned to an entity and used to identify that entity to the system.

C. Identifier: A unique number, biometric characteristic, cryptographic key, or other unique identification entered as data into the entry-control database for the purpose of identifying an individual. Where this term is presented with an initial capital letter, this definition applies.

D. Wiegand (Effect): Patented magnetic principle that uses specially treated wires embedded in the credential card.

E. Wiegand (Standard): Wiring and protocol specification for communication between credential reader and access control hardware system.

1.04 ACTION SUBMITTALS

A. Submit product data and shop drawings in accordance with Division 01 and Division 28 Section “Electronic Safety and Security Shop Drawings and Submittals” for products specified under PART 2 - PRODUCTS.

B. Specification Compliance Certification: Submit a Specification Compliance Certification in accordance with Division 28 Section “Electronic Safety and Security Shop Drawings and Submittals”.

C. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. Reference each product to a location on Drawings. Test and evaluation data presented in Product Data shall comply with SIA BIO-01.

D. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1.05 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.06 CLOSEOUT SUBMITTALS

A. Contract Close-Out Submittals: Provide one (1) electronic format manual including operating instructions, maintenance recommendations and parts list including wiring and connection diagrams modified to reflect as-built conditions.

B. Manuals: Final copies of the manuals shall be delivered within 14 days after completing the installation test. Each manual’s contents shall be identified on the cover. The manual shall include names, addresses, and telephone numbers of the contractor responsible for the installation and maintenance of the system and the factory representatives for each item of equipment for each system. The manuals shall have a table of contents and labeled sections. The final copies delivered after completion of the installation test shall include all modifications made during installation, checkout, and acceptance testing. The manuals shall consist of the following:

1. Functional Design Manual: The functional design manual shall identify the operational requirements for the system and explain the theory of operation, design philosophy, and specific functions. A description of hardware and software functions, interfaces, and requirements shall be included.
2. Hardware Manual: The manual shall describe all equipment furnished including:
    a. General description and specifications.
    b. Installation and check out procedures.
    c. Equipment layout and electrical schematics to the component level.
    d. System layout drawings and schematics.
    e. Alignment and calibration procedures.
    f. Manufacturers repair parts list indicating sources of supply.

3. Software Manual: The software manual shall describe the functions of all software and shall include all other information necessary to enable proper loading, testing, and operation. The manual shall include:
   a. Definition of terms and functions.
   b. System use and application software.
   c. Initialization, start up, and shut down.
   d. Reports generation.
   e. Details on forms customization and field parameters.

C. As-Built Drawings: During system installation, the Contractor shall maintain a separate hard copy set of drawings, elementary diagrams, and wiring diagrams of the ACS to be used for record drawings. This set shall be accurately kept up to date by the Contractor with all changes and additions to the ACS. Copies of the final as-built drawings shall be provided to the end user in DXF format.

1.07 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. Fuses of all kinds, power and electronic, equal to 10 percent of amount installed for each size used, but no fewer than three units.

1.08 QUALITY ASSURANCE

A. Manufacturers Qualifications: Engage qualified manufacturers with a minimum of five (5) years of documented experience in providing access control and security systems equipment and software similar to that indicated for this Project and that have a proven record of successful in-service performance.
   1. Software and access control systems components to have been previously and thoroughly tested together with proven installations similar in size and functionality to the design requirements indicated for this Project.

B. Supplier Qualifications: Supplier/Dealers, verifiably authorized and in good standing with the primary product manufacturers, with a minimum of three (3) years of experience supplying integrated access control systems similar in material, design, and scope to that indicated for this Project and whose work has resulted in construction with a proven record of successful in-service performance.

C. System Integrator Qualifications: Systems Integrators, verifiably factory trained and certified by the primary product manufacturers, with a minimum of three (3) years documented experience installing complete integrated access control systems similar in material, design, and scope to that indicated for this Project and whose work has resulted in construction with a proven record of successful in-service performance. Qualifications include, but are not necessarily limited, to the following:
   1. References: Provide a list of references for similar projects including contact name, phone number, name and type of project.
   2. Professional Staffing: Firms to have a dedicated access control systems integration department with full time, experienced professionals on staff experienced in providing on site consulting services for both electrified door hardware and integrated access control systems installations.
   3. Factory Training: Installation and service technicians are to be competent factory trained and certified personnel capable of maintaining the system.
   4. Service Center: Firms to have a service center capable of providing training, in-stock parts, and emergency maintenance and repairs at the Project site with 24-hour/7-days a week maximum response time.

D. Installer Qualifications:

1. Certified technicians, verifiably authorized with the primary product manufacturers for installation of IP-Enabled, Wireless, and Power-over-Ethernet Access Control products in accordance with documented instructions and NFPA 80.
2. The installer shall be the authorized representative of the Access Control Manufacturer to sell, install, and service the proposed manufacturer's product for at least three (3) years.
3. The installer shall provide 24-hour, 365-day per year emergency service with factory trained service technicians.
4. The installer shall have personnel on their staff that has been actively engaged in the business of designing, selling, installing, and servicing security alarm systems for at least ten (10) years.

E. Source Limitations: Obtain the access control door hardware, system firmware and application software specified in this Section from a single source, qualified supplier/integrator 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 integrated access control door hardware from the same manufacturer as mechanical door hardware, unless otherwise indicated.

1.09 DELIVERY, STORAGE, AND HANDLING

A. Store in temperature- and humidity-controlled environment in original manufacturer's sealed containers. Maintain ambient temperature between 50 and 85 deg F, and not more than 80 percent relative humidity, noncondensing.

B. Open each container; verify contents against packing list; and file copy of packing list, complete with container identification, for inclusion in operation and maintenance data.

C. Mark packing list with the same designations assigned to materials and equipment for recording in the system labeling schedules that are generated by software specified in "Cable and Asset Management Software" Article.

D. Save original manufacturer's containers and packing materials and deliver as directed under provisions covering extra materials.

1.10 PROJECT CONDITIONS

A. Environmental Conditions: System shall be capable of withstanding the following environmental conditions without mechanical or electrical damage or degradation of operating capability:
1. Control Station: Rated for continuous operation in ambient conditions of 60 to 85 deg F and a relative humidity of 20 to 80 percent, noncondensing.
2. Indoor, Controlled Environment: NEMA 250, Type 1 enclosure. System components, except the central-station control unit, installed in air-conditioned indoor environments shall be rated for continuous operation in ambient conditions of 36 to 122 deg F dry bulb and 20 to 90 percent relative humidity, noncondensing.
3. Outdoor Environment: NEMA 250, NEMA 250, Type 3R enclosures. System components installed in locations exposed to weather shall be rated for continuous operation in ambient conditions of minus 30 to plus 122 deg F dry bulb and 20 to 90 percent relative humidity, condensing. Rate for continuous operation where exposed to rain as specified in NEMA 250, winds up to 85 mph.

1.11 WARRANTY

A. Warranty Period: The entire system shall be warranted against defects in materials and workmanship for a period of one (1) year from date of Substantial Completion including labor.

B. ACMS Software and Field Hardware Warranty:
1. ACMS Field Hardware shall be warranted for a period of three (3) years from the date of Substantial Completion, will be free from defects and will function in general accordance with the product specifications.

2. ACSMS Third Party Device warranties are transferred from the manufacturer to the contractor, which may then transfer third party warranties to Owner. Specific third-party warranty details, terms and conditions, remedies and procedures, are either expressly stated on, or packaged with, or accompany such products. The warranty period may vary from product to product. These products include but are not limited to devices that are directly interconnected to the ACSMS field hardware or computers and are purchased directly from the ACSMS manufacturer. Examples may include but not be limited to; Credential Printers, Reader Heads, Computers etc.

PART 2 PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. 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.

B. Comply with NFPA 70 , "National Electrical Code."

C. Comply with SIA DC-03 and SIA DC-07.

2.02 DOOR HARDWARE, CRASHBARS, ETC.

A. Manufacturers: Door hardware are to be as manufactured by:
   1. Allegion.

B. Refer to Division 8 Door Hardware Specifications for further information.

2.03 DOOR HARDWARE POWER SUPPLIES:

A. Provide power supply in wall-mounted NEMA-1 cabinet.

B. Accessories: Provide terminal block with eight fusible outputs and battery backup kit.

C. Power supplies to be located in technology closet serving each building area, with low-voltage cabling run from closet to door. No power supplies shall be installed above ceiling.

D. Power Supply Products: Subject to requirements, provide:
   1. Schlage PS-902, PS-904, or PS-906.

E. Battery Backup Products: Subject to requirements, provide:
   1. Schlage 900-BBK battery backup kit.

F. Fused Terminal Block: Subject to requirements, provide:
   1. Schlage #900-8F fused output terminal block.

   NO SUBSTITUTIONS except by written Owner approval.

2.04 DOOR CONTROLLER HARDWARE

A. Door controller hardware connects door hardware and credential readers to Owner’s access control system.

B. Controller Products: Subject to requirements, provide:
   1. Open Options SSP-D2 (Mercury LP1502).
      NO SUBSTITUTIONS except by written Owner approval.

C. Power Supply: Schlage PS902.

D. Provide double pole, double throw door position contacts at each exterior door or set of exterior double doors to monitor door position.
   1. George Risk Industries (GRI) #195-12 or equal.

E. Provide necessary licensing for each card reader-controlled door. Coordinate licensing with Owner.

2.05 RFID CREDENTIAL READERS

A. Reader(s) shall be compatible with the following 125kHz RFID Credential technologies:

1. Schlage Legacy Prox

B. Reader(s) shall be compatible with the following 13.56MHz RFID Credential technologies:
   1. Schlage MIFARE Classic
   2. Schlage MIFARE Plus
   3. Schlage MIFARE DESFire EV1 / EV2 / EV3

C. System Interface:
   1. Compatible with local processor / door controller.
   2. Wiegand

D. Response Time: Credential Reader shall respond to passage requests by generating a signal that is sent to the controller. Response time shall be 800 ms or less, from the time the card reader finishes reading the credential card until a response signal is generated.

E. Enclosure: Suitable for surface, mullion, pedestal, or weatherproof mounting.

F. Reader Power: Reader(s) shall draw power from their associated controller.

G. Display: Digital visual indicator shall provide visible and audible status indications. Indicate power on or off, whether user passage requests have been accepted or rejected, and whether the door is locked or unlocked.

H. Proximity Readers:
   1. Active-detection proximity card readers shall provide power to compatible credential cards through magnetic induction, and shall receive and decode a unique identification code number transmitted from the credential card.
   2. The card reader shall read proximity cards in a range from direct contact to at least 5 inches from the reader.

I. Communication Protocol: Compatible with local processor.

J. The reader shall have "flash" download capability to accommodate card format changes. The card reader shall have capability of transmitting data to security control panel and shall comply with ISO/IEC 7816.

K. Manufacturers: Provide products by the following:

L. Products: Subject to requirements, provide the following:
   1. Schlage MT11 – Mullion-mounted card reader
   2. Schlage MT15 – Single gang wall-mounted card reader
      NO SUBSTITUTIONS except by written Owner approval.

2.06 CREDENTIALS: FOBS

A. Provide thin keyfob-type credential with 125kHz prox technology.

B. Products: Subject to requirements, provide:
   1. Schlage #7610T
      NO SUBSTITUTIONS except by Written Owner approval.

C. Provide five hundred (500) fobs for new campus.

2.07 PUSH-BUTTON SWITCHES

A. Manufacturers: Provide products by the following:
   1. Safety Technology International (STI) SS2 series.

B. Push-Button Switches: Momentary-contact push buttons with stainless steel backplate with colored polycarbonate cover.

C. Electrical Ratings:
   1. Minimum continuous current rating of 10A at 120-V ac.
   2. Contacts that will make 720 VA at 60A and that will break at 720 VA at 10A.

3. Provide turn-to-reset option where required on Drawings.

D. Enclosures: Flush mounting. Push buttons shall be suitable for flush mounting in the switch enclosures.

E. Power: Push-button switches shall be powered from their associated controller, using dc control.

2.08 CABLES

A. General Cable Requirements: Comply with requirements in Division 27 Section "Communications Copper Horizontal Cabling" and as recommended by system manufacturer for integration requirement.

B. Plenum-Rated TIA 485-A Cables:
1. Paired, two pairs, No. 22 AWG, stranded (7x30) tinned copper conductors.
2. Fluorinated ethylene propylene insulation.
3. Unshielded.
4. Fluorinated ethylene propylene jacket.
5. NFPA 70 Type: Type CMP
6. Flame Resistance: NFPA 262, Flame Test.

C. Paired, Plenum-Type, Reader and Wiegand Keypad Cables:
1. Three pairs, No. 22 AWG, stranded (7x30) tinned copper conductors, plastic insulation, individual aluminum-foil/polypropylene-tape shielded pairs each with No. 22 AWG, stranded tinned copper drain wire, 100 percent shield coverage, and fluorinated-ethylene-propylene jacket.
2. NFPA 70, Type CMP.
3. Flame Resistance: NFPA 262 flame test.

D. LAN Cabling:
1. Comply with requirements in Section 27 1513 "Communications Copper Horizontal Cabling."

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine pathway elements intended for cables. Check raceways, cable trays, and other elements for compliance with space allocations, installation tolerances, hazards to cable installation, and other conditions affecting installation.

B. Examine roughing-in for LAN and control cable conduit systems to PCs, controllers, card readers, and other cable-connected devices to verify actual locations of conduit and back boxes before device installation.

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

3.02 PATHWAYS

A. Cable Support:
1. All cable not installed inside conduit or a designated cable tray system shall be installed in a dedicated cable support system such as j-hooks for the entire run of each cable including, but not limited to, service loops.
2. The approved cable support system shall be attached directly to the building steel at a serviceable height. In the event that the building steel is not 5-foot above the finished ceiling, provide a dedicated threaded rod extending within 5-foot of the finished ceiling and mount the support hanger to the threaded rod.

3. All cable installed shall be attached to independent cable support system with plenum rated Velcro and a plenum rated Velcro tie shall be installed between each cable support to keep cables neatly bundled throughout the entire run. Tie wraps will only be allowed to be used inside the control panels as required to manage the cables within each type of panel.
4. Absolutely no cable not installed in conduit will be allowed to be attached directly to the building's steel or supported in any other method than that stated above.
5. Coordinate with all other trades on the Project to ensure that the pathway of this system does not interfere with the installation of the other trades and to prevent the installed product of other trades from putting strain on the installed cabling.

B. Conduit/Raceway:
1. All wiring shall be installed in an approved conduit/raceway system (except where permitted by NEC and the local authority having jurisdiction). Maximum conduit "fill" shall not exceed 40 percent per NEC.
2. Conduit and raceway system shall be installed as specified under Division 26 Section "Raceways and Boxes for Electrical Systems".
3. Minimum conduit size shall be 3/4-inch EMT. Provide engineered shop drawings for approval prior to installation.
4. All conduit ends shall have a protective bushing to prevent wire damage. Bushings must be installed prior to installing cable or wire. Cutting the bushing to install around installed cables or wires will not be accepted.

3.03 WIRING AND CABLING INSTALLATION

A. Comply with NECA 1, "Good Workmanship in Electrical Construction."

B. Comply with Division 27 Section "Communications Optical Fiber Backbone Cabling" and with Division 27 Section "Communications Copper Horizontal Cabling".

C. All wiring shall be in accordance with the National Electrical Code and Local Codes. All wiring sizes shall conform to recommendations of the equipment manufacturer and as indicated on the engineered shop drawings.

D. All wire shall be UL Listed CL2 for limited energy (300V) applications and shall be installed in conduit. Limited energy MPP wire may be run open in return air ceiling plenums provided such wire is UL Listed for such applications and is of the low smoke producing fluorocarbon type and complies with NEC Article 760 if so approved by the local authority having jurisdiction.

E. No AC wiring or any other wiring shall be run in the same conduit as security alarm wiring.

F. Install LAN cables using techniques, practices, and methods that are consistent with Category 6 rating of components and fiber-optic rating of components, and that ensure Category 6 and fiber-optic performance of completed and linked signal paths, end to end.

G. Systems utilizing open cabling techniques with low smoke plenum cable shall provide conduit in all inaccessible locations, inside concealed walls, all mechanical/electrical rooms, or other areas where cabling might be exposed or subject to damage.

H. Junction boxes and enclosures containing security-system components or cabling, and which are easily accessible to employees or to the public, shall be provided with tamper resistant fasteners and/or tamper detection switches. In addition, hinged enclosure doors shall be equipped with locking hardware. Boxes above ceiling level in occupied areas of the building shall not be considered accessible. Junction boxes and small device enclosures below ceiling level and easily accessible to employees or the public shall be covered with a suitable cover plate and secured with tamperproof screws.

I. Install end-of-line resistors at the field device location and not at the controller or panel location.

3.04 CABLE APPLICATION

A. Comply with TIA 569-D, "Commercial Building Standard for Telecommunications Pathways and Spaces."

B. Cable application requirements are minimum requirements and shall be exceeded if recommended or required by manufacturer of system hardware.

C. TIA 485-A Cabling: Install at a maximum distance of 4000 feet between terminations.

D. Card Readers and Keypads:
   1. Install number of conductor pairs recommended by manufacturer for the functions specified.
   2. Unless manufacturer recommends larger conductors, install No. 22 AWG wire if maximum distance from controller to the reader is 250 ft., and install No. 20 AWG wire if maximum distance is 500 ft.
   3. For greater distances, install "extender" or "repeater" modules recommended by manufacturer of the controller.
   4. Install minimum No. 18 AWG shielded cable to readers and keypads that draw 50 mA or more.

E. Install minimum No. 16 AWG cable from controller to electrically powered locks. Do not exceed 250 ft. between terminations.

3.05 GROUNDING

A. Comply with Division 26 Section "Grounding and Bonding."

B. Comply with IEEE 1100, "Recommended Practice for Power and Grounding Electronic Equipment."

C. Ground cable shields, drain conductors, and equipment to eliminate shock hazard and to minimize ground loops, common-mode returns, noise pickup, cross talk, and other impairments.

D. Bond shields and drain conductors to ground at only one point in each circuit.

E. Signal Ground:
   1. Terminal: Locate in each equipment room and wiring closet; isolate from power system and equipment grounding.
   2. Bus: Mount on wall of main equipment room with standoff insulators.
   3. Backbone Cable: Extend from signal ground bus to signal ground terminal in each equipment room and wiring closet.

3.06 PUSH BUTTON INSTALLATION AND IDENTIFICATION

A. Provide pushbutton at back wall of Reception area to initiate lockdown sequence. Refer to Drawings for pushbutton location. Provide clear polycarbonate cover with local alarm horn over pushbutton to avoid accidental activation. Button shall be color-coded and labeled as follows:
   1. “LOCKDOWN” – Red

3.07 IDENTIFICATION

A. Label each terminal strip and screw terminal in each cabinet, rack, or panel.
   1. All wiring conductors connected to terminal strips shall be individually numbered, and each cable or wiring group being extended from a panel or cabinet to a building-mounted device shall be identified with the name and number of the particular device as shown.
   2. Each wire connected to building-mounted devices is not required to be numbered at the device if the color of the wire is consistent with the associated wire connected and numbered within the panel or cabinet.

B. Provide self-adhesive, color-coded, identification marker on ceiling grid directly below any device requiring an IP-connection or service above the ceiling. Ceiling marker to be Seton L12723 or equivalent. Security related devices should utilize a black identification marker on the ceiling grid.

C. At Project completion, cable and asset management documents shall reflect as-built conditions. Provide an electronic PDF overall plan of the school with access control door hardware locations marked in red.

3.08 SYSTEM SOFTWARE AND HARDWARE

A. New system shall integrate with Owner's existing cloud-based Vanderbilt Security Management Access Technology access control solution.

B. Develop, install, and test software and hardware, and perform database tests for the complete and proper operation of systems involved. Assign software license to Owner.

C. Provide two (2) electronic copies of the final programming and program software to the Owner's Security Supervisor after final approval.

3.09 FIELD QUALITY CONTROL

A. 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.

B. Tests and Inspections:
   1. LAN Cable Procedures: Inspect for physical damage and test each conductor signal path for continuity and shorts. Use tester approved for type and kind of installed cable. Test for faulty connectors, splices, and terminations. Test according to TIA 568-C.1, "Commercial Building Telecommunications Cabling Standards - Part 1: General Requirements." Link performance for balanced twisted-pair cables must comply with minimum criteria in TIA 568-C.1.
   2. Test each circuit and component of each system. Tests shall include, but are not limited to, measurements of power-supply output under maximum load, signal loop resistance, and leakage to ground where applicable. System components with battery backup shall be operated on battery power for a period of not less than 10 percent of the calculated battery operating time. Provide special equipment and software if testing requires special or dedicated equipment.
   3. Operational Test: After installation of cables and connectors, demonstrate product capability and compliance with requirements. Test each signal path for end-to-end performance from each end of all pairs installed. Remove temporary connections when tests have been satisfactorily completed.

C. Devices and circuits will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports. Submit a written test report from an authorized representative of the equipment manufacturer that the system has been 100 percent tested and approved. Final test shall be witnessed by Owner, Engineer, Contractor and performed by the equipment supplier. Final test report must be received and acknowledged by the Owner prior to Substantial Completion.

3.10 DELIVERY, STORAGE, AND HANDLING

A. Delivery: Deliver materials to site in manufacturer's original, unopened containers and packaging, with labels clearly identifying product name and manufacturer.

B. Storage: Store materials in clean, dry area indoors in accordance with manufacturer's instructions.

C. Handling: Protect materials from damage during handling and installation.

3.11 STARTUP SERVICE

A. Engage a factory-authorized service representative to supervise and assist with startup service.
   1. Complete installation and startup checks according to approved procedures and with manufacturer's written instructions.
   2. Enroll and prepare badges and access cards for Owner's operators, management, and security personnel.
   3. Provide on-site visit by Manufacturer’s in-house personnel to train Owner’s operations personnel.
   4. DEMONSTRATION

B. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain the ACSMS equipment.

C. Provide a minimum of eight (8) hours of video recorded training for the Owner.

D. Coordinate training and demonstration with Division 28 Section “Access Control Software and Database Management.”

END OF SECTION

SECTION 28 2200
VIDEO SURVEILLANCE SYSTEM

PART 1 GENERAL

1.01 SUMMARY

A. Section includes a video surveillance system consisting of video management systems, IP security cameras, network digital video recorders, data transmission wiring, and accessory equipment.

B. Provide licenses, equipment, storage space, and any other items required to expand the Owner's existing VMS to add all devices shown on the Drawings. The installation shall comply with applicable codes and standards in effect at the Project site and as indicated in the Specifications and Drawings.

C. Coordinate with other system vendors, where appropriate, to facilitate equipment installation, scheduling, protection of equipment and access to the Project site in order to provide the Owner a substantially complete project in a timely manner.

1.02 DEFINITIONS

A. AGC: Automatic gain control.

B. BNC: Bayonet Neill-Concelman - type of connector.

C. B/W: Black and white.

D. CCD: Charge-coupled device.

E. FTP: File transfer protocol.

F. IP: Internet protocol.

G. LAN: Local area network.

H. MPEG: Moving picture experts group.

I. NTSC: National Television System Committee.

J. PC: Personal computer.

K. PTZ: Pan-tilt-zoom.

L. RAID: Redundant array of independent disks.

M. TCP: Transmission control protocol - connects hosts on the Internet.

N. UPS: Uninterruptible power supply.

O. VMS: Video Management System

P. WAN: Wide area network.

1.03 QUALITY ASSURANCE

A. Installer Qualifications: The proposing/installing contractor shall meet/provide the following requirements:

1. Dealer/integrator of the VMS Manufacturer authorized to sell, install, program, train, and service the proposed manufacturer's system.
2. Licensed by the State of Texas as a security services contractor to design, sell, install, and service security systems.
3. Ability to provide 24-hour, 365 day per year emergency service with factory trained service technicians.
4. Personnel on staff that have been actively engaged in the business of designing, selling, installing, and servicing video surveillance systems for at least ten (10) years.

5. Certified by the manufacturing company in all aspects of design, installation, and testing of the products described herein. Each contractor shall furnish with their submittal a letter from the manufacturer indicating they are a dealer in good standing.
6. Certified by the manufacturer of the products, adhere to the engineering, installation and testing procedures and utilize the authorized manufacturer components and distribution channels.
7. Experienced in all aspects of this work and shall be required to demonstrate direct experience on recent systems of similar type and size. The contractor shall own and maintain tools and equipment necessary for successful installation and testing of video surveillance distribution systems and have personnel who are adequately trained in the use of such tools and equipment.
8. Resume of qualifications shall be submitted with the Contractor's proposal indicating the following:
    a. A list of five (5) recently completed projects using the product proposed of similar type and size with contact names and telephone numbers for each.
    b. A list of test equipment proposed for use in verifying the installed integrity of metallic cable systems on this Project.
    c. A technical resume of experience for the Contractor's project manager and on-site installation supervisor who shall be assigned to this Project.
    d. A list of technical product training attended by the Contractor's personnel that shall install the video surveillance system shall be submitted.
    e. Any subcontractor who shall assist the video surveillance contractor in performance or this work shall have the same training and certification as the video surveillance contractor.
9. Submit to Engineer, prior to the start of any work, the factory training certificates for all personnel that will be working on the Video Management System. No person is allowed to work on the system without proper manufacturer's certification.

B. The entity providing pricing to furnish and install the system specified within this Specification Section and the physical installing entity of this system shall be one in the same. Absolutely no subcontracting on any portion of this system, by the system's proposing entity, will be allowed.

C. Contractor must be a current integrator of solution in the Houston area, have a permanent office located within 150 miles of the Project, and be able to include information on current support staff to be able to service the client.

D. The Owner's representative reserves the right to reject any and all portions of the work performed, either on technical or aesthetic grounds.

1.04 REGULATORY REQUIREMENTS

A. Standards: All work shall be performed in accordance with the latest revisions of the following standards and codes:
1. Local Building Code
2. Local Electrical Code
3. NEC National Electrical Code

B. Other References:
1. TIA/EIA-568-A – Commercial Building Telecommunications Wiring Standard
2. TIA/EIA-569 – Commercial Building Standard for Telecommunications Pathways and Spaces
3. TIA/EIA-606 – The Administration Standard for the Telecommunications Infrastructure of Commercial Buildings
4. TIA/EIA-607 – Commercial Building Grounding and Bonding Requirements for Telecommunications

5. TIA/EIA TSB 67 – Transmission Performance Specification for Field Testing of Unshielded Twisted-Pair Cabling Systems
6. ISO/IEC 11801 – Generic Cabling Standard
7. EN 50173 – Generic Cabling Standards for Customer Premises

C. Governing Codes and Conflicts: If the requirements of these Specifications or Drawings exceed those of the governing codes, regulations, and manufacturer's installation requirements, then the requirements of these Specifications and Drawings shall govern. However, nothing in the Drawings or Specifications shall be construed to permit work not conforming to all governing codes, regulations, and manufacturer's installation requirements.

1.05 ACTION SUBMITTALS

A. Submit product data and shop drawings in accordance with Division 01 and Division 28 Section "Electronic Safety and Security Shop Drawings and Submittals" for products specified under PART 2 - PRODUCTS.

B. Specification Compliance Certification: Submit a Specification Compliance Certification in accordance with Division 28 Section "Electronic Safety and Security Shop Drawings and Submittals".

C. Product Data: For each type of product indicated. Include dimensions and data on features, performance, electrical characteristics, ratings, and finishes. Complete manufacturer's product literature for all cable, termination components, cable supports, cable labels, field devices, and other products to be used in the installation. In addition, whenever substitutions for recommended products are made, samples (when requested by the Owner/Engineer) and the manufacturer's supporting documentation demonstrating compatibility with other related products shall be included. The submittal shall have some type of distinguishing marker or pointer to indicated specific product that is to be provided.

D. Shop Drawings: For video surveillance. Include plans, elevations, sections, details, and attachments to other work.
1. Location of all control equipment and remote power sources
2. Location of all field devices and outlets
3. Location of wall penetration sleeves including size of each sleeve and quantity of cables passing through each sleeve
4. Functional Block Diagram: Show single-line interconnections between components for signal transmission and control. Show cable types and sizes.
5. Wiring Diagrams: For power, signal, and control wiring.

E. Design Data: Include an equipment list consisting of every piece of equipment by model number, manufacturer, serial number, location, and date of original installation. Add pretesting record of each piece of equipment, listing name of person testing, date of test, set points of adjustments, name and description of the view of preset positions, description of alarms, and description of unit output responses to an alarm.

1.06 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

B. Product Warranty: Sample of special warranty.

C. Testing: Proposed system test result forms and a list of instrumentation to be used for systems testing.

D. Certifications: The contractor shall submit all of the following certifications and the certifications must contain dates which are valid from the date of proposal and not expire any sooner than 12 months after Substantial Completion of the Project.

1. Manufacturer's Authorized Dealer/Installer Certification: This certification must be held by the proposing/installing contractor and state that the proposing/installing contractor is an authorized dealer/installer of the system specified within the Project Specifications. The certification must have been obtained by the office that is within a 75-mile radius of the Project's location.
2. Installer Certification: This certification must be held by at least 25 percent of the on-site staff and be made available at the site if requested by the Owner, Architect, and/or Project's Technology Consultant.
3. Licenses: This includes all licenses required by the State of Texas, the federal government, local authorities having jurisdiction, and any organization that governs the specific system.

1.07 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For cameras, power supplies, infrared illuminators, monitors, videotape recorders, digital video recorders, video switches, and control-station components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," and in Division 28 Section "Electronic Safety and Security Shop Drawings and Submittals," include the following:
   1. The manual shall also include manufacturer's data sheets and installation manuals/instructions for all equipment installed and a list of recommended spare parts.
   2. Replacement components recommended to be stored at the site for ready access.
   3. Generic or typical owner's instruction and operation manual shall not be acceptable to fulfill this requirement.
   4. Operating and maintenance instructions for all devices within the system. These instructions shall reflect any changes made during the course of construction and shall be provided to the Owner for their use in a three-ring binder labeled with the Project name and description.
   5. Provide a copy of the sign in and training sign off sheets.

B. Inspection and Test Reports: During the course of the Project, the Contractor shall maintain an adequate inspection system to ensure that the materials supplied and the work performed, conform to contract requirements. The Contractor shall provide written documentation that indicates that materials acceptance testing was conducted as specified. The Contractor shall also provide documentation which indicates that all cable termination testing was completed and that all irregularities were corrected prior to job completion.
   1. Provide complete test reports for all cabling and devices that comprise system as outlined in this document.
   2. Include the name, address and telephone of the authorized factory representative with a 24-hour emergency service number.

C. As-Built Drawings: An up-to-date record set of approved shop drawing prints that have been revised to show each and every change made to the structured cabling system from the original approved shop drawings. Drawings shall consist of a scaled plan of each building showing the placement of each individual item or the technical cabling system equipment as well as raceway size and routing, junction boxes, and conductor size, quantity, and color in each raceway.
   1. Include cable pathways, device locations with correct labeling, control equipment locations, remote power supply locations, cross connect locations, and MDF/IDF locations. The as-built drawings shall be prepared using AutoCAD 2017 or later. Provide the Owner with electronic versions of the as-builts on CD media and one (1) hard copy set per binder.

2. 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 self-documented by the system.
3. One (1) 30” x 42” laminated floor plan sheet of each floor/area illustrating technology drops and cable designation. Contractor shall provide one complete floor plan sheet for each system panel and remote power supply location.

D. Warranty: A copy of the manufacturer’s warranty on the installed system.

E. Any keys to cabinets and/or equipment and special maintenance tools required to repair, maintain, or service the system.

1.08 PROJECT CONDITIONS

A. Environmental Conditions: Capable of withstanding the following environmental conditions without mechanical or electrical damage or degradation of operating capability:
1. Interior, Controlled Environment: System components, except central-station control unit, installed in temperature-controlled interior environments shall be rated for continuous operation in ambient temperatures of 36 to 122 deg F dry bulb and 20 to 90 percent relative humidity, noncondensing. Use NEMA 250, Type 1 enclosures.
2. Interior, Uncontrolled Environment: System components installed in non- temperature-controlled interior environments shall be rated for continuous operation in ambient temperatures of 0 to 122 deg F dry bulb and 20 to 90 percent relative humidity, noncondensing. Use NEMA 250, Type 3R enclosures.
3. Exterior Environment: System components installed in locations exposed to weather shall be rated for continuous operation in ambient temperatures of minus 30 to plus 122 deg F dry bulb and 20 to 90 percent relative humidity, condensing. Rate for continuous operation when exposed to rain as specified in NEMA 250, winds up to 85 mph. Use NEMA 250, Type 3R enclosures.
4. Security Environment: Camera housing for use in high-risk areas where surveillance equipment may be subject to physical violence.

1.09 QUALITY ASSURANCE

A. Manufacturer Qualifications: Minimum 5-year experience manufacturing similar products.

B. System Integrator shall provide the following as part of the System Solution:
1. Complete product and technical data specification sheets that include all material and equipment and shall be available freely online.
2. List of all equipment with part numbers, manufacturer, firmware, and assigned IP addresses.
3. List of all equipment with part numbers, manufacturer, firmware, and assigned IP addresses.
4. Placement Diagram showing the proposed location of all system hardware devices.
5. System Calculation of all network bandwidth and storage requirements for System Servers to ensure proper planning of computing and networking infrastructure.

C. Installer Qualifications: Minimum 2-year experience installing similar products. Installers shall be trained and authorized by the Manufacturer to install, integrate, test, and commission the system.

1.10 PRE-INSTALLATION MEETINGS

A. Convene minimum two weeks prior to starting work in this section.
1. End user provides specific details, A/E by specification shall ensure coordination by Contractors to establish and schedule meetings for pre-installation.

1.11 DELIVERY, STORAGE, AND HANDLING

A. Deliver and store products in manufacturer's unopened packaging bearing the brand name and manufacturer's identification until ready for installation.

B. Handling: Handle materials to avoid damage.

1.12 SEQUENCING

A. Ensure that products of this section are supplied to affected trades in time to prevent interruption of construction progress.

1.13 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of cameras, equipment related to camera operation, and control-station equipment that fail in materials or workmanship within specified warranty period.
   1. Warranty Period: Three (3) years from date of Substantial Completion.

B. All such warranties shall include all parts (All VMS and IP security devices).

C. Labor and all other costs as necessary to maintain the equipment in operating condition as intended by the product manufacturer after a period of one (1) year shall be negotiated with the Owner upon Project completion.

PART 2 PRODUCTS

2.01 GENERAL

A. Provide all incidental and/or miscellaneous hardware not explicitly specified below as required for a complete and operational system.

B. Materials shall be listed or shall be approved equivalent products of other manufacturers meeting the intent and quality level of the Specifications. All approved equivalent products shall be published by addendum ten (10) days prior to proposal for Architect/Engineer review.

C. All equipment and materials used shall be standard components, regularly manufactured, and regularly utilized in the manufacturer’s system.

D. All systems and components shall have been thoroughly tested and proven in actual use.

E. All systems and components shall be provided with the availability of a toll-free 24-hour technical support phone number from the manufacturer. The phone number shall allow for immediate technical assistance for either the dealer/installer or the end user at no charge.

F. All systems and components shall be provided with an explicit manufacturer warranty.

2.02 MANUFACTURERS

A. Acceptable Manufacturer: Hanwha Techwin, which is located at: 500 Frank W. Burr Blvd.; Teaneck, NJ 07666; 877-213-1222; www.HanwhaSecurity.com.

2.03 IP SECURITY CAMERAS

A. Camera Model Selection Guidelines:
   1. Brand Selection - All cameras provided to Tomball ISD shall be Hanwha Techwin Wisenet cameras. If a dealer chooses to install another brand of camera at any Tomball ISD facility, the camera(s) shall be replaced, at no cost to the Tomball ISD, by the installing dealer with the following approved Hanwha Techwin Wisenet cameras models.
      a. Substitution Request – Dealer may request to submit alternate Hanwha cameras models to Tomball ISD for review and acceptance (or not) by Security Management. If so, specific model acceptance must be approved by Tomball Security Management prior submitting any quotes.
   2. Indoor Camera Guidance (presumes wide angle lens FoV & 40PPF)
      a. Single Sensor Cameras:

1) QNV-8080R – 5MP for viewing areas up to 35-feet away, larger rooms.
2) XNV-6011W – 2MP for viewing smaller areas; viewing area up to 15-feet
3) XND-C6083RV – 2MP viewing entrance/exit doors; viewing area up to 20-feet
4) XND-C8083RV – 6MP viewing lobbies, waiting areas, larger rooms; viewing area up to 40-feet
5) XND-C9083RV – 4K large lobbies, long hallways, large rooms, warehouses, or situations requiring highest resolution details; viewing area up to 55-feet
6) PND-A9081RV – 4K AI camera for high level awareness of object (person/vehicle) detection and alerting

b. 360-degree Fisheye Cameras:
1) XNF-9010RV – 12MP 360-degree view for larger rooms (30’ x 30’) or areas requiring greater resolution detail such as cash handling, people identification, etc.

c. Multi-Sensor Cameras:
1) PNM-9000VD – Dual 2x 5MP camera for hallways (2 views); viewing area up to 40-feet each camera direction.
2) PNM-8082VT – Triple 3x 2MP camera for T-hallways (3 views); viewing area up to 20-feet each camera direction.
3) PNM-9084QZ – Quad 4x 2MP camera for 4 hallways (4 views); viewing area up to 20-feet each camera direction.
4) PNM-9085RQZ – Quad 4x 5MP camera for 4 hallways (4 views) / rooms; viewing area up to 40-feet each camera direction.

3. Outdoor Camera Guidance (presumes wide angle lens FoV & 40PPF):
a. Single Sensor Camera
1) XNV-C6083R – 2MP camera viewing entrance/exit doors; viewing area up to 20-feet.
2) XNV-68083R – 6MP camera area view; viewing area up to 40-feet.
3) XNV-C9083R – 4K camera larger area views; viewing areas up to 55-feet
4) PNV-A9081R – 4K camera AI high level alerts / notifications

b. Panoramic Cameras – 180-degree view
1) PNM-9022V – 4x2MP panoramic 180-degree view camera; viewing distances up to 30-foot radius.
2) PNM-9031RV – 4x5MP panoramic 192-degree view camera; viewing distances up to 50-foot radius.
3) PNM-9085RQZ – Quad 4x 5MP parking lot camera, 360-degree viewing.

c. 360-degree Fisheye Cameras
1) XNF-9010RV – 12MP 360-degree view

d. Multi-Sensor Cameras:
1) PNM-9000VD – Dual 2x 5MP camera for hallways (2 views); viewing area up to 40-feet each camera direction.
2) PNM-8082VT – Triple 3x 2MP camera for T-hallways (3 views); viewing area up to 20-feet each camera direction.
3) PNM-9084QZ – Quad 4x 2MP camera for 4 hallways (4 views); viewing area up to 20-feet each camera direction.
4) PNM-9085RQZ – Quad 4x 5MP camera for 4 hallways (4 views) / rooms; viewing area up to 40-feet each camera direction.

4. Elevator Camera:
a. XNV-6012 – Small form factor surface mount in elevator; include optional Power over Ethernet (PoE) as needed:
1) Hanwha Model TEU-F01 for powering (POE) camera over Unshielded Twisted Pair (UTP / CAT wire) elevator cab traveler wire

2) Hanwha Model TEC-C01 for powering (POE) camera over Coax elevator cab traveler wire (use with legacy (existing) Coax camera upgrades).

B. Minimum Camera Performance Requirements:
1. Video Compression and Transmission: Cameras shall have the following properties relating to video signals they produce.
a. Compression: H.265, H.264 and MJPEG. Each derived from a dedicated encoder and capable of being streamed independently and simultaneously.
1) H.265 and H.264: Maximum of 30 fps at all resolutions.
2) MJPEG: Maximum of 30 fps
b. Video Stream Profiles: Able to configure 6-10 independent profiles with differing encoding, quality, frame rate, resolution, and bit rate settings.
c. Video Streams: 10 independent stream types using unicast protocol.
1) Multicast and unicast video streaming.
d. DDNS Configurable: At no additional cost by manufacturer.
e. Smart Codec: Dynamic GOV, and Dynamic FPS to efficiently manage bitrate of video stream.
2. Camera Physical and Performance Properties:
a. Impact Protection: IK08~IK10 vandal resistance for indoor cameras
b. IP66 rating minimum for Outdoor Cameras
c. Resolution and FPS
1) 2MP camera imager sensors shall transmit full 1080P resolution (1920x1080) at a 30FPS using all Codecs (H.265/H.264/MJPEG) with no FPS reduction with the implementation of WDR and / or analytics in the camera.
2) 5MP camera imager sensors shall transmit full 2560x1920 resolution at a 30FPS using all Codecs (H.265/H.264/MJPEG) with no FPS reduction with the implementation of WDR and / or analytics in the camera.
3) 6MP camera imager sensors shall transmit full 3328x1872 resolution at a 30FPS using all Codecs (H.265/H.264/MJPEG) with no FPS reduction with the implementation of WDR and / or analytics in the camera.
4) 4K camera imager sensors shall transmit full 3840x2160 resolution at a 30FPS using all Codecs (H.265/H.264/MJPEG) with no FPS reduction with the implementation of WDR and / or analytics in the camera.
d. Configurable privacy masking regions utilizing a 4 point polygon
e. Camera Models with IR Illumination True day and night operation with removable IR cut filter.
f. Digital Noise Reduction: 2D and 3D technology.
g. Cameras for viewing in darkness shall include Integral IR illumination, providing effective visibility of 65.62 ft (20 m) at 0 Lux when activated in black and White mode.
3. Intelligence and Analytics: A suite of integral intelligent operations and analytic functions to include:
a. Motion Detection: Eight definable detection areas with 8 point polygonal zones, minimum and maximum object size.
b. Logical Events Detection from Camera Video Input:
1) Tampering (scene change).
2) Defocus detection.
3) Motion detection with metadata.
4) Virtual Area Based Event:
(a) Enter or exit.
5) Virtual Line Based Event:
(a) Directional detection.
(b) Crossing.

4. Interoperability: ONVIF Profile S, G, and T compliant and SUNAPI API.
5. Camera Characteristics:
   a. Built-in web server, accessed via standard browsers including MS Internet Explorer, Firefox, Chrome and Safari.
   b. Dual edge recording slot like Micro SD/SDHC/SDXC memory card with configurable pre-alarm and post-alarm recording intervals.
   c. Bi-directional audio.
   d. Alarms and notifications supported.
   e. PoE capable.
6. Multi-Sensor Camera Additional Requirements:
   a. In addition, all multi-sensor cameras (including Duo (2) Imager Sensors and Quad (4) Imager Sensors) shall also include the following Model: PNM-7002VD/PNM-9000VD, PNM-9084QZ, PNM-9084RQZ, PNM-9085RQZ, PNM-9002VQ, PNM-9022V and PNM-9030V, PNM-9031RV, PNM-9322VQP as manufactured by Hanwha Techwin America.
   b. Each Video Channel shall utilize a dedicated SOC to that Video Channel to process and deliver full frame rate video at 30 FPS using all Compression Codecs (H.265, H.264 and MJPEG), with no degradation or reduction to any individual Video Channel or Collectives Channels when enabling WDR or advanced video analytics.
   c. Each Video Channel shall support individual enablement of intelligent analytics, WDR, and codec selection independent of the remaining video channels.
   d. Each Channel supports SD card.
   e. One single power supply for all multi-channels

C. UPS and Electrical Surge Protection:
   1. All Network Camera to NVR Connections Shall incorporate an appropriate in line network Surge Protection Device when the Network Camera is located on the exterior of a building and connecting network switch / Network Recorder on interior of building.
   2. All Critical Operation Network Cameras shall be on a POE Switch attached to a Pure Sine Wave Power Conditioning UPS or UPS circuit that is sized for the specified required operational time. It is recommended that all UPS systems are sized to provide back-up power for a minimum of 20 minutes or owner stated guidance, with 20% growth capacity, to maintain Video System Operation during brief outages or generator activation and power cut over.

2.04 VIDE MANAGEMENT SYSTEMS (VMS)

A. Video Management System (VMS):
   1. Software: Wisenet Wave v4.2 as manufactured by Hanwha Techwin America.
   2. System Requirements:
      a. Open video platform designed for use in any video application.
      b. Specified Software: To include, free of charge, any API or SDKs necessary to integrate third party devices and systems.
      c. Specified Video Management Solution's Architecture: To include Desktop, Media Server, Mobile, and Cloud applications.
   3. Software Components Characteristics: Four applications working seamlessly together.
      a. Cloud Application: Enables simple remote connectivity, viewing, and management of an unlimited number of systems and users.
      b. Media Server Application: Responsible for discovering, connecting to, and managing system users, devices, and associated data.
      c. Desktop Application: Capable of acting as a stand-alone media player or as a client application for connecting to and managing systems.
      d. Mobile Application: For iOS and Android devices that allows users to connect to, view, search, and control IP cameras over Wi-Fi or Data networks.

4. Built-In Developer and Integration Tools: Accessible from System Server's Web Admin Interface (compatible with all major browsers).
    a. Server API: SUNAPI implementation giving developers the ability to access every system feature available.
    b. API Change Log: List of breaking changes in API from version to version.
    c. Video Source Integration SDK: Integrate virtually any live or recorded video source (IP Cameras, NVRs, DVRs, etc.) into the VMS with methods for discovering, displaying, analyzing and recording video, as well as integrating device I/O ports and related motion detection information.
5. System Architecture:
    a. Server Hive Architecture:
        1) System servers are equal synchronizing system databases in real-time.
        2) Users can connect to any system server to see and manage entire system.
        3) Servers support automatic camera failover ensuring limited loss of video recording in event of hardware or network failure.
    b. One-Click System Wide Updates:
        1) System Administrators' Capabilities:
            (a) Upgrade entire system via single button in Desktop Application.
            (b) Upgrade on demand to latest release or specific builds with specific functionality or bug fixes.
    c. Use secure technologies for inter-application communication and security.
        1) Email Server: Client (Mobile, Desktop, Web) Communications - HTTPS Email - TLS / SSL - TLS; default option.
        2) Salted/Hashed Passwords: Local credentials protected using a salted MD5 hash, cloud credentials should use a complex multi-level hash.
    d. The VMS will not require any licenses to increase the number of supported devices, users, or servers.

B. VMS Server Application:
1. Runs on the following operating system:
    a. Microsoft:
        1) Windows 10 Professional, Windows 10 IOT Enterprise.
        2) Windows Server 2019.
2. Minimum Compatible Computing Hardware:
    a. Any hardware able to run a compatible operating system.
    b. Capable of recording 128 dual-streaming IP cameras (256 streams) on a single core of an Intel Core i5 processor.
3. Performance:
    a. Automatically discover, stream, and record any ONVIF Profile S IP camera located on same subnet as server application.
    b. Manually discover, stream, and record RTSP, HTTP, or UDP (multicast, unicast) streams.
    c. Automatic camera failover without any additional licenses.
    d. Unlimited number of users and custom user roles.
    e. User Login Credential Management: LDAP / Active Directory / Open LDAP integration.
    f. Record and Stream
        1) Video: H.264, H.265, and MJPEG.
        2) Audio: AAC, PCM (mu-Law, A-law), g726, and MP3.
    g. Transcode Streams on Demand: For delivery to 3rd party system devices.
        1) Codecs: H.265, H.264, MJPEG or WebM.
    h. Pass-through high-res or low-res HLS streams from connected devices.

i. Support Addressing: IPv4 or IPv6.
j. Operator ability to change size of reserved disk space for storage drives.
k. Concurrent recording of all connected cameras / streams to two servers in real-time.
l. Server-side, CPU-based motion analysis for all connected IP cameras with no perceptible increase, less than 3 percent, in CPU usage.

C. VMS Desktop Application:
1. Runs on the following operating systems:
a. Microsoft:
1) Windows 10
2) Windows 10 IOT Enterprise Solutions.
3) Windows Server 2019
b. Apple / Mac:
1) OSX 10.12: Sierra.
2) OSX 10.13: High Sierra.
3) OSX 10.14: Mojave.
2. Minimum Compatible Computing Hardware:
a. Any hardware able to run a compatible operating system with a CPU that supports OpenGL 2.1 and Intel HD Graphics 3000 (or higher).
b. Will not require any dedicated graphics drive to work at full capacity; 64 streams on a 64 bit OS, 24 streams on a 32 bit OS, and use the CPU for all video decoding and rendering.
3. Performance and Basis Structure:
a. Navigation Panel: Main menu button, an interactive cloud-login icon, tabbed layouts, minimize and maximize icons, a contextual help icon, and a close application icon.
b. Resource Panel (Left): Contains all system resources (Servers, Devices, Users, Layouts, Offline files, etc.) with collapsible structure and a keyword search mechanism to allow operators to quickly search for a display live streams / cameras, offline video and image files, or any combination thereof.
c. Notifications Panel (Right): Shows all system or rules-engine generated notifications which can be clicked on to display relevant resource in the viewing grid.
d. Timeline Panel (Bottom): Allows for navigation and search of recorded video files.
e. Viewing Grid (Main Viewing Area): A flexible adaptive grid interface which allows operators to create and share customized layouts of system resources.
4. Operation: Allow operators to do the following:
a. Scroll to and zoom in on any zone of viewing grid.
b. Drag and drop to reassign cameras from one server to another server.
c. Via a flexible timeline, view dates of any and all archived video in the System for a specific camera, or groups of cameras.
d. Manually Create Bookmarks: With start time, end time, name, description, and tags, for later search. Bookmarks must also be able to be created using the Rules engine.
e. Execute a Smart Motion Search: By selecting a subset of a live camera stream with results shown in red on the flexible timeline. Smart Motion search should be able to search a year (12 months, 365 days) of archived video in less than one second.
f. Search video archives by date and time with a responsive, adaptive timeline.
g. View, search and export all system events, system bookmarks, system logs and audit trail of operator actions and replay related video.
h. Create and share lockable layouts.
i. Modify and save a shared layout to affect an instantaneous change to that layout on the VMS Desktop application of any user connected to the system viewing that layout (when the system administrator saves the layout the layout will update in real time for any user viewing that layout).

j. Support two-way audio between operators and supported devices.
k. Support audio alerts as an action that can be played on users' computers or connected system devices.
l. Force open an alarm layout triggered by any system or 3rd party event with one or many associated cameras or resources.
m. Force users to set the camera's initial password upon enrollment for best cyber security practices.

2.05 VMS SOFTWARE LICENSES

A. All new systems shall provide, at minimum, one WAVE VMS license per camera. Additionally, if additional cameras are being added to existing system, dealer shall include one new WAVE license per camera. Following are the acceptable WAVE VMS camera license references.

B. Model: WAVE-PRO-01,-04,-08,-16,-24,-48 as manufactured by Hanwha Techwin America
1. Description: WAVE camera license, Enables one IP stream recording per “-0x” license(s) purchased.
a. Purchase sufficient quantity of WAVE licenses as needed to record the number of camera streams being added to a WAVE System
b. Note: Cameras that used only for Live Patient Room Monitoring and will NOT be recorded, then WAVE licenses for these specific cameras are not necessary. However, proper sizing of the Recording Server is still required to support the cameras.

C. Model: WAVE-VW-02 as manufactured by Hanwha Techwin America
1. Description: WAVE, Video Wall License, Enables displaying video on up to two (2) additional monitors with remote control of video displayed on those monitors.

D. Model: WAVE-ENC-04 as manufactured by Hanwha Techwin America
1. Description: WAVE, 4 Channel Encoder License

E. Model: WAVE-IO-01 as manufactured by Hanwha Techwin America
1. Description: WAVE, I/O module license, Enables one (1) I/O module.

2.06 CLIENT WAVE WORKSTATION

A. Model: WWT-P-7401 WAVE Client Workstation supporting up to Four (4) attached monitors.
1. The Workstation shall have a dedicated operating system drive to facilitate accelerated boot and application load times.
a. OS Drive – 1x 256GBSSD internally mounted with Operating System - Microsoft Windows 10 Pro
2. Video Storage - support to add additional 3.5” drive with capacity options for 1TB, 2TB, 4TB, 8TB, 10TB, 12TB, or 14TB per drive at Speed of 7200 rpm
3. Processor: Qty 1 Intel® 9th Generation Core™ Processor, Intel® Core™ i7-9700, 3.0Ghz to 4.7Ghz (8 Cores, 8 Threads, 12MB) and 16 GB DDR4 RAM memory
4. Graphics Cards - NVIDIA® Quadro® P620 with 4x HDMI adapters
5. Network Controller 1. Ports: 1 x 1GbE RJ45
6. Additional Ports - Video output: Varies with GPU, (1) HDMI 2.0b, (1) DisplayPort 1.4 on motherboard, up to (4) DisplayPort 1.4 , USB: Front: (2) USB 3.1, (2) USB 2.0, Rear: (2) USB 3, (2) USB 2.0
7. Electrical - Power: 100–240 V AC, auto-ranging, Power Supplies: 200W 80 Plus Bronze
8. Mechanical - Dimensions (w x d x h): 3.7" (97mm) x 11.5" (292mm) x 11.4" (290mm)
9. Weight: 11.42 pounds (5.14 kg)
10. Environmental - Operating temperature: 50°F - 95° F (10°C - 35°C)

B. UPS and Electrical Surge Protection:

1. All Client Workstations shall be connected to a properly sized Pure Sine Wave Power Conditioning UPS or circuit to prevent voltage fluctuations (increase or decrease) that can affect operation and cause damage to the equipment.
2. All Client Workstations shall be installed on an electrical circuit that incudes protection against transient voltage surges.
3. It is recommended that all UPS systems are sized to provide back-up power for a minimum of 20 minutes or owner stated guidance, with 20% growth capacity, to maintain Video System Operation during brief outages or generator activation and power cut over.

2.07 ACCESSORIES

A. Accessory Products: Provide the following accessories to properly install and mount all cameras as required by the specific camera installation locations, as applicable to the system selected and as scheduled on the Drawings.
   1. Pendant caps
   2. Corner mount brackets
   3. Wall mount brackets
   4. Recess mount kits
   5. Pole mount brackets
   6. Back box mounts
   7. 2x2 ceiling mounts
   8. Sun shields
   9. Work boxes
   10. Smoked dome covers
   11. PTZ/Dome housings
   12. PTZ/Dome mounts
   13. HD CCTV accessories
   14. Network camera PoE injectors and accessories
   15. UTP video devices
   16. Monitor stands
   17. Surge protection
   18. UPS battery back-up
   19. UPS circuits

2.08 CABLE AND INSTALLATION

A. All required network cabling to each camera location on this Project shall be provided by the Owner’s structured cabling system installer, unless otherwise noted. All camera IP data cabling shall be yellow in color.

B. Provide all penetrations and all conduits as necessary for installation of security camera installation.

C. All exterior penetrations require necessary weatherproofing to avoid moisture penetration.

D. All outdoor cable runs underground shall be rated for underground use.

E. Provide all power circuits required for the servers and camera power supplies.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine pathway elements intended for cables. Check raceways and other elements for compliance with space allocations, installation tolerance, hazards to camera installation, and other conditions affecting installation.

B. Examine roughing-in for LAN, WAN, and IP network before device installation.

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

3.02 PREPARATION

A. System Integrator: Confirm the solution proposal planning and design with the installing contractor (if different company from integrator), to be in compliance with Ochsner standards as described in this document, with any exception approved in writing by Ochsner Security Administration.

B. The network design and configuration to be verified for compatibility and performance with the input/output devices.

C. Network Configuration: Tested and qualified by Systems Integrator prior to remote device installation.

D. Equipment to be tested and configured in accordance with instructions provided by the System Integrator prior to installation.

E. All firmware found in products to be the latest and most up-to-date provided by the manufacturer, or of a version as specified by the provider of the Video Management Application (VMA).

F. All equipment requiring users to log on using a password shall be configured with user/site-specific password/passwords. No system/product default passwords shall be allowed.

G. Confirm hardware will be stored in an environment where temperature and humidity are in the range specified by the Manufacturer.

3.03 INSTALLATION

A. Install products per manufacturer's recommendations and approved submittals.
   1. Comply with manufacturer's installation and configuration documentation available to the System Integrator to ensure all steps have been taken to provide a reliable, easy-to-operate system.
      a. System Integrator shall be a Hanwha Techwin (Silver or higher) STEP Partner in good standing with manufacturer.
      b. System Integrator shall provide Technicians that have completed, at minimum, Hanwha WAVE Online Technician Training program.
      c. STEP Partner shall be able to offer extended warranty were applicable.
   2. Program and configure all products per the requirements of Tomball ISD Standards and specific site requirements which shall include, at minimum, the following: (additional requirements may applicable, refer to Tomball ISD Security Administration for details).
      a. All cameras and Network Recorders shall be programmed with Tomball ISD provided IP addresses and password requirements, along with naming guidance as instructed by Tomball ISD Security Administration.
      b. All Network Camera Recorders shall use the Tomball ISD NTP (Network Time Protocol) designated server.
      c. All IP Cameras shall have the primary Video Stream programmed to send 15 FPS at 2MP, 5MP, 6MP, 4K (depending on camera model), using the H.265 Codec to stream to the Network Recorder for recording.
      d. All IP Cameras shall have the secondary Video Stream programmed to send 7FPS using H.265 codec to the Network Recorder for client display and non-motion detection recording if motion based alarm recording is implemented.
      e. All IP Cameras shall have a third Video Stream programmed to send 7 FPS at VGA (640x480) using H.264 to the Network Video Recorder for remote access via mobile device as needed.
      f. All indoor cameras shall have video motion detection zones configured and active and walk tested for sensitivity functionality for use during facility closed hours (if applicable to the facility).

g. All outdoor cameras, if using motion detection, shall have objects such as trees or bushes that can move from the wind, to have motion detection masked off. Outdoor motion detection shall be used carefully for viewing areas considered stable (not plants) such as sidewalks, roads, buildings, doors, and the cameras shall have adequate artificial lighting provided or utilize camera IR light.
h. All VMS Client Workstations shall be configured to automatically connect to the designated Network Recorders upon launch of the VMS Client application.
i. Training – User Training may be required and is to be included as needed. Contact Tomball ISD Security Administration for guidance.

B. System Integrator personnel must comply with all applicable state and local licensing requirements.

C. Prior to acceptance of installed system, the System Integrator will test the system in conditions simulating the final installed environment, which shall be witnessed by the Owner or Owner's Representative, and shall adjust the complete system as required until proper operation is achieved.
1. System Integrator shall email a copy of the final approved Wisenet Device Manager Site Configuration File and Wisenet Device Manager Report as part of the job completion process.

3.04 WIRING

A. Comply with requirements in Division 27 Section "Pathways for Communications Systems."

B. Wiring Method:
1. Install cables in raceways, except in accessible indoor ceiling spaces. Conceal raceways and wiring except in unfinished spaces.
2. In suspended ceiling areas where duct, cable trays, or conduit are not available, Contractor shall bundle, in bundles of 15 cables or less, with cable ties snug, but not deforming the cable geometry. Cable bundles shall be supported with J-hooks attached to the building structure and framework at a maximum of 5-foot intervals. Plenum rated cables ties shall be used in all appropriate areas. The Contractor shall adhere to the manufacturer's requirements for bending radius and pulling tension of all cables.
3. Cables shall not be attached to accessible ceiling grid supports or laid directly on the ceiling grid.
4. Cables shall not be attached to or supported by fire sprinkler heads or delivery systems or any environmental sensor located in the ceiling air space.

C. Cable Support:
1. All cable not installed inside conduit or a designated cable tray system shall be installed in a dedicated cable support system for the entire run of each cable including, but not limited to, service loops.
2. The approved cable support system shall be attached directly to the building steel at a serviceable height. In the event that the building steel is greater than 5-feet above the finished ceiling, provide a dedicated threaded rod extending 5-feet above the finished ceiling and mount the support hook to the threaded rod.
3. Cable support shall be installed at a maximum of 5-foot on center.
4. All cable installed shall be attached to the support system with plenum rated Velcro and a plenum rated Velcro tie shall be installed between each cable support to keep wires neatly bundled throughout the entire run. Tie wraps will only be allowed to be used inside the control panels as required to manage the wires within each type of panel.
5. Absolutely no cable, not installed in conduit, will be allowed to be attached directly to the building steel or supported in any other manner than as stated above.

6. It is the responsibility of the installing contractor to coordinate with all other trades on the Project to ensure that the pathway of this system does not interfere with the installation of the other trades and to prevent the installed product of other trades from putting strain on the installed wiring.
7. Do not route cable through webbing or structural steel.

D. Conduit/Raceway:
1. Conduit and raceway system shall be installed as specified under Division 26 Section “Raceways and Boxes for Electrical Systems.”
2. Minimum conduit size shall be ¾-inch EMT. Maximum conduit “fill” shall not exceed 40 percent per NEC.
3. Systems utilizing open wiring techniques with low smoke plenum cable shall provide conduit in all inaccessible locations, inside concealed walls, all mechanical/electrical rooms, or other areas where wiring might be exposed or subject to damage.
4. All conduit ends shall have a protective bushing to prevent cable damage. Bushings must be installed prior to installing cable. Cutting bushing to install around installed cables will not be accepted.

E. Fire Wall Penetrations: The Contractor shall avoid penetration of fire rated walls and floors wherever possible. Contractor shall also seal all floor, ceiling and wall penetrations in fire or smoke barriers and in the wiring closet.

F. Wall Penetrations: Where penetrations are necessary, they shall be sleeved with metallic conduit and resealed with an Underwriter Laboratories (UL) approved sealant. Provide three-sided pre-finished metal hood and seal to wall where conduit penetrates exterior wall.

G. Do not install wall mounted cameras into metal fascia. Ensure they are mounted into brick, and sealed top and sides (not bottom).

3.05 CABLING INSTALLATION

A. Cabling between wiring closet and camera locations shall be made as individual home runs. No intermediate splices may be installed or utilized between the wiring closet and the camera location.

B. All cable must be handled with care during installation so as not to change performance specifications.

C. Placement: All cabling and associated hardware shall be placed so as to make efficient use of available space. All cabling and associated hardware shall be placed so as not to impair the Owner’s efficient use of their full capacity.

D. Cabling within Enclosures: Bundle, lace, and train cables to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.

E. For communication wiring, comply with the following:
1. Division 27 Section "Communications Optical Fiber Backbone Cabling."
2. Division 27 Section "Communications Copper Horizontal Cabling."

F. Pulling Cable: Do not exceed manufacturer's recommended pulling tensions. 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.

G. Do not run any power cabling for any security equipment on rack tray system due to EMI considerations. Provide individual cabling support for all low voltage power cabling.

3.06 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals according to Division 27 Section "Common Communications Requirements."

B. Labels: The Contractor shall label all outlets using permanent machine engraved labels approved by the Owner. Label patch panels in the MDF or IDF to match those on corresponding camera locations. The font shall be at least one-eighth inch (1/8”) in height, block. All labels shall correspond to as-builts and to final test reports.

C. Contractor shall ensure complete typed labeling of all cameras with numbers that correspond to locations on video server. Labeling system shall correspond to the Owner’s labeling system. Verify with Owner. Provide tags (black letters on white labels, plastic coated) on all cables and outlets.

D. All cables shall be labeled at both ends with a machine label and all terminations shall be stenciled with a typed label for quick circuit identification. Labeling shall conform to TIA/EIA standard 606 and include interconnect cable identification numbers.

E. A floor plan, clearly labeled with all numbered camera locations, shall be included in the as-built plans.

3.07 FIELD QUALITY CONTROL

A. 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.

B. Tests and Inspections:
   1. Inspection: Verify that units and controls are properly installed, connected, and labeled, and that interconnecting wires and terminals are identified.
   2. 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 video-surveillance equipment for acceptance and operational testing as follows:
      a. Prepare equipment list described in "Informational Submittals" Article.
      b. Verify operation of auto-iris lenses.
      c. Set back-focus of fixed focal length lenses. At focus set to infinity, simulate nighttime lighting conditions by using a dark glass filter of a density that produces a clear image. Adjust until image is in focus with and without the filter.
      d. Set back-focus of zoom lenses. At focus set to infinity, simulate nighttime lighting conditions by using a dark glass filter of a density that produces a clear image. Additionally, set zoom to full wide angle and aim camera at an object 50 to 75 feet away. Adjust until image is in focus from full wide angle to full telephoto, with the filter in place.
      e. Set and name all preset positions; consult Owner's personnel.
      f. Set sensitivity of motion detection.
      g. Connect and verify responses to alarms.
      h. Verify operation of control-station equipment.
   3. 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.
   4. 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.

C. Video surveillance system will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

3.08 SYSTEM STARTUP

A. Work shall be complete and ready to operate prior to final acceptance.

B. Program initial user groups and users.

C. Video Surveillance System shall be preprogrammed to include a floor plan graphic of each area where cameras are located and the exact camera locations and name of cameras. Field verification of camera names is required to complete this task.

D. Video Surveillance System shall be programmed to include Owner’s logical camera groupings.

3.09 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose. Tasks shall include, but are not limited to, the following:
   1. Check cable connections.
   2. Check proper operation of cameras and lenses. Verify operation of auto-iris lenses and adjust back-focus as needed.
   3. Adjust all preset positions; consult Owner's personnel.
   4. Recommend changes to cameras, lenses, and associated equipment to improve Owner's use of video surveillance system.
   5. Provide a written report of adjustments and recommendations.

3.10 CLEANING

A. Clean installed items using methods and materials recommended in writing by manufacturer.

B. Clean video-surveillance-system components, including camera-housing windows, lenses, and monitor screens.

3.11 DEMONSTRATION AND TRAINING

A. Train Owner's maintenance personnel to adjust, operate, and maintain video-surveillance equipment.
   1. Train Owner's maintenance personnel on procedures and schedules for troubleshooting, servicing, and maintaining equipment.
   2. Demonstrate methods of determining optimum alignment and adjustment of components and settings for system controls.
   3. Review data in maintenance manuals. Refer to Division 1 Section "Contract Closeout."
   4. Schedule training with Owner, through Architect, with at least seven days advance notice.
   5. Conduct a minimum of six hours training as specified in instructions to Owner's employees in Division 1 Section "Contract Closeout."
   6. Provide a copy of the sign-in and training sign-off sheets in the Operations and Maintenance Manual.

END OF SECTION

SECTION 28 3100
INTRUSION DETECTION SYSTEM

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Section Includes:
   1. Integrated Digital Alarm Communicator System (DACS), including but not limited to the following:
      a. Control panel.
      b. Enclosures.
      c. Keypads.
      d. Door Switches.
      e. Motion Detectors.
      f. Accessories required to provide a complete DACS.
      g. Wiring.
   2. Intrusion detection with communication links to perform monitoring, alarm, and control functions.
   3. Integration of other electronic and electrical systems and equipment.
   4. The Contractor shall be responsible for identifying requirements for permits from the local police department for the installation of the alarm system specified herein and shall assist the Owner in obtaining the relevant alarm permits.

B. Related Sections:
   1. Division 23 Section “Instrumentation and Control for HVAC”.
   2. Division 28 Section “Access Control Software and Database Management”.

1.03 DEFINITIONS

A. BAS: Building automation system.

B. CCTV: Closed-circuit television.

C. PIR: Passive infrared.

D. RFI: Radio-frequency interference.

E. UPS: Uninterruptible power supply.

F. Control Unit: System component that monitors inputs and controls outputs through various circuits.

G. Master Control Unit: System component that accepts inputs from other control units and may also perform control-unit functions. The unit has limited capacity for the number of protected zones and is installed at an unattended location or at a location where it is not the attendant's primary function to monitor the security system.

H. Monitoring Station: Facility that receives signals and has personnel in attendance at all times to respond to signals. A central station is a monitoring station that is listed.

I. Protected Zone: A protected premises or an area within a protected premises that is provided with means to prevent an unwanted event.

J. Standard Intruder: A person who weighs 100 lb or less and whose height is 60 inches or less; dressed in a long-sleeved shirt, slacks, and shoes.

K. Standard-Intruder Movement: Any movement, such as walking, running, crawling, rolling, or jumping, of a "standard intruder" in a protected zone.

L. Systems Integration: The bringing together of components of several systems containing interacting components to achieve indicated functional operation of combined systems.

M. Zone. A defined area within a protected premises. It is a space or area for which an intrusion must be detected and uniquely identified. The sensor or group of sensors must then be assigned to perform the detection, and any interface equipment between sensors and communication must link to master control unit.

1.04 REFERENCES

A. National Fire Protection Association (NFPA)
   1. National Electric Code, Article 760 (NFPA 70).
   2. National Fire Alarm Code (NFPA 72).

B. Administrative Council for Terminal Attachments (ACTA):
   1. ANSI/TIA-968-A-2002 Technical Requirements for Connection of Terminal Equipment to the Telephone Network.

C. American National Standards Institute (ANSI):
   1. ANSI C63.4 Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz.

D. Federal Communications Commission (FCC):
   1. Title 47 C.F.R. Part 15; Class B – Radiated and Conducted Emissions.
   2. Title 47 C.F.R. Part 68; rules governing the connection of Terminal Equipment (TE) to the Public Switched Telephone Network (PSTN).

E. The National Institute of Standards and Technology of the United States of America (NIST):
   1. Federal Information Processing Standards Publications 197 (FIPS 197) –Advanced Encryption Standard (AES).

F. International Organization For Standardization (ISO):
   1. 9001 - Quality System.

G. Underwriters Laboratories, Inc. (UL):
   1. UL 50 - Enclosures for Electrical Equipment.
   2. UL 294 – Access Control System Units.
   3. UL 365 - Police Station Connected Burglar Alarm Units and Systems.
   4. UL 609 - Local Burglar Alarm Units and Systems.
   5. UL 1076 – Proprietary Burglar Alarm Units and Systems
   6. UL 1610 - Central Station Burglar-Alarm Units.
   7. UL 60950-1 - Information Technology Equipment - Safety.
   8. UL 636 – Hold up alarms

1.05 ACTION SUBMITTALS

A. Submit product data and shop drawings in accordance with Division 01 and Division 28 Section “Electronic Safety and Security Shop Drawings and Submittals” for products specified under PART 2 - PRODUCTS.

B. Specification Compliance Certification: Submit a Specification Compliance Certification in accordance with Division 28 Section “Electronic Safety and Security Shop Drawings and Submittals”.

C. Product Data: Components for sensing, detecting, systems integration, and control, including dimensions and data on features, performance, electrical characteristics, ratings, and finishes.

D. Shop Drawings: Shop drawings shall provide details of proposed system and the work to be provided. Include point-to-point drawings of systems and wiring diagrams of individual devices.
   1. Detailed wiring diagrams and system description.
   2. System device locations on architectural floor plans.
   3. Full Schematic of system, including wiring information for all devices.
   4. Functional Block Diagram: Show single-line interconnections between components including interconnections between components specified in this Section and those furnished under other Sections. Indicate methods used to achieve systems integration. Indicate control, signal, and data communication paths and identify programmable logic controllers and control interface devices and media to be used. Describe characteristics of network and other data communication lines.
      a. Indicate methods used to achieve systems integration.
      b. Indicate control, signal, and data communication paths and identify PLCs, networks, control interface devices, and media to be used.
      c. Describe characteristics of network and other data communication lines.
      d. Describe methods used to protect against power outages and transient voltages including types and ratings of isolation and surge suppression devices used in data, communication, signal, control, and ac and dc power circuits.
   5. Raceway Riser Diagrams: Detail raceway runs required for intrusion detection and for systems integration. Include designation of devices connected by raceway, raceway type and size, and type and size of wire and cable fill for each raceway run.
   6. UPS: Sizing calculations.
   7. Site and Floor Plans: Indicate final outlet and device locations, routing of raceways, and cables inside and outside the building. Include room layout for master control-unit console, terminal cabinet, racks, and UPS.
   8. Master Control-Unit Console Layout: Show required artwork and device identification.
   9. Retain first subparagraph below for addressable systems.
   10. Device Address List: Coordinate with final system programming.
   11. System Wiring Diagrams: Include system diagrams unique to Project. Show connections for all devices, components, and auxiliary equipment. Include diagrams for equipment and for system with all terminals and interconnections identified.
   12. Details of surge-protection devices and their installation.
   13. Sensor detection patterns and adjustment ranges.

E. Design Data: Include method of operation and supervision of each component and each type of circuit. Show sequence of operations for manually and automatically initiated system or equipment inputs. Description must cover this specific Project; manufacturer's standard descriptions for generic systems are unacceptable.

1.06 INFORMATION SUBMITTALS

A. Qualification Data: For Installer and intrusion detection systems integrator.

B. Field quality-control reports.

C. Product Warranty: Sample of special warranty.

D. Field Test Reports: Test plan and report defining all tests required to ensure that system meets technical, operational, and performance specifications within 60 days of date of Contract award.

E. Evaluation Reports: Examination reports documenting inspections of substrates, areas, and conditions.

1.07 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For intrusion detection system to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

1. Data for each type of product, including features and operating sequences, both automatic and manual.
2. Master control-unit hardware and software data.

B. As-Built Documents: Upon completion of installation, the Contractor shall prepare "as-built" drawings of the system. These "As-builts" shall be 30 inches by 42 inches format reproducible drawings of each floor plan indicating exact device locations, panel terminations, cable routes and wire numbers as tagged and color-coded on the cable tag.
   1. Include final point-to-point wiring diagrams of each type of device.
   2. As-built drawings shall be submitted to the Owner for approval prior to the system acceptance walk-through.

C. Parts list.

1.08 QUALITY ASSURANCE

A. Manufacturer Qualification:
   1. The system shall be the standard product of one manufacturer, and the manufacturer shall have been in business manufacturing similar products for at least 5 years.
   2. Manufacturer's Quality System: Registered to ISO 9001:2000 Quality Standard.

B. Installer Qualification:
   1. An employer of workers, at least one of whom is a Certified Alarm Technician, Level 1.
   2. Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.
   3. Layout Responsibility: Preparation of Shop Drawings by a Technician.
   4. Installation Supervision: Installation shall be under the direct supervision of Level 2 Commercial Installer, who shall be present at all times when Work of this Section is performed at Project site.
   5. Minimum of five years’ experience installing access control, surveillance and security systems and devices.
   6. After-sales support: The Contractor shall be a factory-authorized and trained dealer of the system and shall be factory-trained and certified to maintain/repair the system after system acceptance.

C. Intrusion Detection Systems Integrator Qualifications: An experienced intrusion detection equipment supplier and Installer who has completed systems integration work for installations similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful in-service performance.
   1. At least one of whom is a Certified Systems Integrator.

D. Testing Agency Qualifications: Certified by BICSI.
   1. Testing Agency's Field Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

E. System Requirements:
   1. All equipment, systems, and materials furnished and installed under this section shall be installed in accordance with the applicable standards of:
      a. National Codes: NEC, NFPA, UBC, BOCA, SBCCI, IBC, as applicable.
      b. Approvals and listings: UL, ULC, FM, ANSI SIA CP-01, CSFM, as applicable.
      c. Local Authorities Having Jurisdiction (AHJ).

1.09 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials in manufacturer's original, unopened, undamaged containers; and unharmed original identification labels.

B. Store products in manufacturer's unopened packaging until ready for installation.

C. Protect store materials from environmental and temperature conditions following manufacturer's instructions.

D. Handle and operate products and systems according to manufacturer's instructions.

1.10 PROJECT CONDITIONS

A. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's absolute limits.

1.11 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer and Installer agree to repair or replace components of intrusion detection devices and equipment that fail in materials or workmanship within specified warranty period.
   1. Warranty Period: Five (5) years from date of Substantial Completion.

B. Service/Maintenance:
   1. System maintenance and repair of system or workmanship defects during the warranty period shall be provided by the Contractor free of charge (parts and labor).
   2. Periodic testing of the system shall be carried out on a monthly or quarterly basis to ensure the integrity of the control panel, the sensing devices, and the telephone lines.
   3. The installer shall correct any system defect within six hours of receipt of call from the Owner.

PART 2 - PRODUCTS

2.01 SYSTEM DESCRIPTION

A. A functionally complete, integrated Digital Alarm Communicator System (DACS) per manufacturer's guidelines, codes and specification requirements. The DACS shall include the following:
   1. Control Panel with built-in Ethernet jack for event communication and remote services.
   2. Control Panel with an optional, supervised telephone line interface module.
   3. Recording and retention of event information in a dedicated event log.
   4. Incorporate an integral real-time clock, calendar, and a test timer.
   5. Incorporate battery charging capabilities with supervision of battery voltage and battery leads.
   6. Time / event-based scheduling system.
   7. Capable of supervision of peripheral devices and communications interfaces.
   8. Accommodate configuration and operation of separate, independent areas.
   9. Accommodate hard-wired or wireless point expansion via eight-point interface modules and RF receivers.
   10. Accommodate addressable expansion utilizing a 2-wire bus.
   11. Incorporate removable terminal strips for wiring connection to facilitate simple service and replacement
   12. Electrically supervised detection loops and power supplies with battery(s) maintenance. This supervision shall be programmable for the purposes of reporting this information to the DACR.
   13. Capable of sending (manually or automatically) test and status reports to remote DACRs.
   14. Accommodate test, diagnostics, and configuration programming functions locally or remotely via a portable programmer or a computer running the Remote Programming Software (RPS).
   15. Annunciate alarm, trouble, service reminders, and other relevant system status messages in custom English, Latin American Spanish, Portuguese and/or French Canadian text at the ACC.

2.02 MANUFACTURERS

A. Acceptable Manufacturer: Bosch Security Systems, Inc.; 130 Perinton Parkway; Fairport, NY 14450. ASD. Toll Free Tel: 800-289-0096. Tel: 585-223-4060. Email: request info (presales.support@us.bosch.com). Web: www.boschsecurity.us.

B. Substitutions: Not permitted.

2.03 SYSTEM COMPONENT REQUIREMENTS

A. 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.

B. Control Units, Devices, and Communications with Monitoring Station: Listed and labeled by a qualified testing agency for compliance with SIA CP-01.

C. Compatibility: Detection devices and their communication features, connecting wiring, and master control unit shall be selected and configured with accessories for full compatibility with the following equipment:
   1. Door hardware specified in Division 08 Section "Door Hardware."
   2. Elevators specified in Division 14 Section "Hydraulic Elevators."
   3. Lighting controls specified in Division 26 Section "Networked Lighting Control."
   4. Access control system specified in Division 28 Section "Access Control System."
   5. Fire alarm system specified in Division 28 Section "Digital, Addressable, Voice Evacuation Fire-Alarm System."

D. Surge Protection: Protect components from voltage surges originating external to equipment housing and entering through power, communication, signal, control, or sensing leads. Include surge protection for external wiring of each conductor entry connection to components.
   1. Minimum Protection for Power Lines 120 V and More: Auxiliary panel suppressors complying with requirements in Division 26 Section "Surge Protection for Low-Voltage Electrical Power Circuits."
   2. Minimum Protection for Communication, Signal, Control, and Low-Voltage Power Lines: Listed and labeled by a qualified testing agency for compliance with NFPA 731.

E. Intrusion Detection Units: Listed and labeled by a qualified testing agency for compliance with UL 639.

F. Interference Protection: Components shall be unaffected by radiated RFI and electrical induction of 15 V/m over a frequency range of 10 to 10,000 MHz and conducted interference signals up to 0.25-V rms injected into power supply lines at 10 to 10,000 MHz.

G. Self-Testing Devices: Automatically test themselves periodically, but not less than once per hour, to verify normal device functioning and alarm initiation capability. Devices transmit test failure to master control unit.

H. Addressable Devices: Transmitter and receivers shall communicate unique device identification and status reports to master control unit.

I. Remote-Controlled Devices: Individually and remotely adjustable for sensitivity and individually monitored at master control unit for calibration, sensitivity, and alarm condition.

2.04 CONTROL PANEL

A. The DACS control panel shall be Bosch Security Systems, Inc. model B9512G comprising a fully integrated intrusion system. The control panel shall support the following:
   1. The DACS control panel shall be Bosch Security Systems, Inc. model B9512G comprising a fully integrated intrusion system. The control panel shall support the following:
   2. Optional Telephone Line Module, programmable for signaling and supervision.
   3. Integrated Conettix IP based communication provides high-speed, secure alarm transport and control.

4. Thirty-two (32) programmable areas with perimeter and interior partitioning.
5. Eight (8) on-board, hardwired points with expansion capability for a total of 599 using a combination of wired or wireless points.
6. Compatibility with Color Graphic Touch Screen, 2-line alpha numeric capacitive touch, ATM style LCD or 2-line LCD style Alarm Keypads.
7. Local or remote programming, test, and diagnostic capability via a computer running the Remote Programming Software (RPS).
8. Integrated USB port for local programming and diagnostics using a computer running Remote Programming Software (RPS) and a male USB2.0 to male USB 2.0 cable with no additional hardware modules required.
9. Support the use of an Apple iOS device and/or Android device for control. Functions to include arming, disarming and control of outputs and access door, viewing of connected IP cameras. This application shall connect directly to the DACS using internet, wifi or cellular communications and shall not require a third-party server of network operations center (NOC).
10. Allow integration with up to 16 Bosch IP video cameras using the built-in Ethernet connection, allowing the cameras to act as inputs and outputs.
11. Support integration with the Bosch Video Management System (BVMS) using the built-in Ethernet adapter.
12. Support up to thirty-two (32) custom functions allowing the installer to combine up to 6 functions into one command. These custom functions shall be operated by keypad command, point activation, keyfob button, or programmable schedule.
13. Support up to 32 keypad shortcuts which allow the installer to define which commands are available at each keypad.
14. Offer multiple language support that can be assigned per keypad. Languages supported must include English, Latin American Spanish, Portuguese and/or Canadian French.
15. Support flash firmware upgrades of systems firmware for the control panel and peripherals, allowing for future updates.
16. Integrated real time clock, calendar, test timer and programmable scheduling capability for relay control and automatic execution of system functions based on a time / event.
17. Provide 1.4 amps of power for standby operation and 2.0 amps of alarm power, both rated at 12 VDC.
18. Three (3) configurable form ‘C’ wet or dry-contact relay outputs with expansion capability for up to an additional 472 dry-contact relay outputs.
19. Integrated battery charger with reverse hook up protection, battery supervision and battery deep discharge protection.
20. Supervision of peripheral devices and communications interface(s).

B. Point Functionality and Expansion:
   1. Each point in the system shall be programmable to provide the following type of response in the system:
      a. Always on (24-hour response).
      b. On when the system is Master Armed.
      c. Only on when the system is Perimeter Armed.
      d. Displays / Does Not Display at the ACC when the point is activated.
      e. Provides / Does Not Provide entry warning tone.
      f. Sounds / Does Not Sound audible alarm indication.
      g. The Point is bypassable / not bypassable.
      h. Alarm Verification with programmable verification time.
      i. Relay activation by Point.
      j. Provides / Does Not Provide "watch point" capability.
      k. Provides Swinger Bypass.

l. Defers Bypass Report.
m. Can return to the system after being force armed and then restoring.
n. Can return to the system after being bypassed and then restoring.
o. Keyswitch arming (maintained or momentary)
p. Activate by Custom Function
q. Activate following an output

2. The system shall support a programmable Monitor delay functionality for supervision of points during disarmed periods. These points may be programmed to ignore status from 1 to 60 minutes and will activate only if the point is off-normal for this time period.
3. The system shall support a programmable delay response functionality for supervision of points during armed or disarmed periods. These points may be programmed to ignore status from 1 to 60 minutes and will activate only if the point is off-normal for this time period.
4. The system shall support virtual points and outputs for customized programming of events
5. The DACS shall be capable of supporting "group zoning." Group zoning refers to the combining of points into a separately identifiable and separately annunciated (programmable text) areas.
6. The DACS shall be capable of allowing variable point response times via programming. Point response times shall be programmable over a range of 300 milliseconds to 4.5 seconds.
7. The DACS shall have the capability to expand up to 599 separately identifiable points, of which 8 are on-board and 472 are off-board wired, addressable or wireless points.
   a. The eight (8) on-board points shall be able to accommodate powered class B functionality using a powered loop interface module.
   b. Point Expansion Modules (Wired and Wireless) shall be able to be located remote to the main panel to a maximum distance of 1000 feet.
   c. Addressable modules shall be able to be located remote to the panel to a maximum of 500 feet.
8. The BACS shall have the capability to expand up to 99 separately identifiable points, of which eight (8) are on-board and 91 are off-board addressable points connected to multiplexed backbone trunks via wired modules and/or wireless receivers.
   a. The eight (8) on-board points shall be able to accommodate powered class B functionality using a powered loop interface module.
   b. Point Expansion Modules (Wired and Wireless) shall be able to be located remote to the main panel to a maximum distance of 1000 feet.
   c. Addressable modules shall be able to be located remote to the panel to a maximum of 500 feet.

C. Areas/Accounts:
1. Support 32 independent areas. Each of the 32 areas shall have custom text associated with the armed state, disarmed state and point-off-normal state.
2. Capability of assigning 1 to 4 account identifiers to the areas depending on the distribution of areas per account.
3. All of the areas must be capable of Master (All) and/or Perimeter (Part) arming (excluding predefined Interior protection).
4. Capability of logically grouping 1 or more points into an area, or conversely, dividing 2 or more points into two or more areas.
5. Any area shall be configurable to allow arming by specific users when a programmable number of devices are faulted or bypassed.
6. Areas shall be independently controlled by their corresponding ACC.
7. Area(s) shall accommodate assignment of independent account numbers to define annunciation, control, and reporting functions.

8. Capability of linking multiple areas to a shared area which may be automatically controlled (hallway or lobby).
9. Accommodate conditional area arming dependant on the state of other areas (master or associate). Any area can be configured for perimeter and interior arming, not requiring a separate area for this function.

D. Output Relay Expansion: The DACS shall provide the capability for output relay expansion using relay expansion modules. Independent control of relay functions by area shall be possible through programming assignments.
   1. The DACS shall be capable of activating 472 additional relay outputs for auxiliary functions based on its classifications (area vs. panel wide). Output Expansion Modules shall be able to be located remote to the main panel to a maximum distance of 1000 feet. Eight (8) relays (Form C) are to be provided per octo-relay module.
   2. The DACS shall be capable of controlling relays and automatically executing system functions based on a time / event scheduling program. The program can be hour, day of week or day of month based.
   3. Relays and other outputs may be programmed to follow up to 14 different area conditions or up to 12 panel conditions. Relays may also be programmed to follow individual points or groups of points.
   4. The DACS shall support 5 different types of alarm output selections: Steady, Pulsed, Temporal Code 3 and Temporal Code 4.

E. Scheduling: The DACS shall support scheduling capabilities with the following characteristics:
   1. Arm / Disarm specific area(s) based on open/close windows.
   2. Bypass / Unbypass point(s).
   3. Activate / Deactivate relay(s).
   4. Send test reports.
   5. Up to 4 programmable holiday schedules of 366 days each (includes leap year). Based on the holiday settings, different time windows for open/close and other system functions can be executed.
   6. Automatic adjustment of system clock for daylight savings time.

F. Alarm Keypads:
   1. The DACS shall accommodate connection with up to 32 ACCs, each capable of displaying custom English, Latin American Spanish, Portuguese or Canadian French text on a liquid crystal display.
   2. The Alarm Keypads shall accommodate viewing and configuration of system parameters including:
      a. Network Parameters:
         1) DHCP Enable/Disable for the selected network module.
         2) UPnP Enable/Disable for the selected network module.
         3) IP Address for the selected network module
         4) Subnet Mask for the selected network module.
         5) Default Gateway for the selected network module.
         6) Port Number for the selected network module - The module's port number shall range from 0 to 65,535.
         7) DNS Server Address for the selected module's DNS server IP address
         8) DNS Host Name for the selected module. The DNS host name shall contain up to 63 characters.
         9) AES Encryption Key Size – Enable/Disable encryption by selecting the AES encryption key size for the selected network module.
         10) AES Encryption Key String - The user shall be able to display, add and modify the AES encryption string based upon the key size previously configured for the selected network module.

b. Point Parameters:
   1) Point Selection between one and the maximum number of points in the control panel.
   2) Point Registration to allow system response from a specific physical point on any one of the expansion modules; On-board or Point expansion modules (wired or wireless)
   3) Wireless points shall be able to be enrolled in the system via an auto enrollment feature.
c. Event Routing Parameters to allow programming of up to 4 report routing groups as well as configuration of primary and secondary paths.

G. User Passcodes and Authority: Passcodes shall be programmable with authority levels to allow users to operate any or all areas.
1. Up to 2000 different passcodes shall be accommodated
2. Each passcode shall be 3 to 6 digits (variable) and be assigned a 32-character user name
3. User access to System features and functions shall be configurable based on 14 individually programmable levels of authority assigned to the user passcode. Additionally, the system shall have the capability to assign to the user passcode, a different authority level in each of the areas. A service passcode can be assigned to the servicing agent allowing the agent limited access to system functions. User-programmable / activated functions include:
   a. Arming the system: All areas, specific area(s) only, perimeter instant, perimeter delayed, perimeter partial, watch mode, and arming the system with a duress passcode.
   b. Disarming the system: All areas, specific area(s) only and disarming with a duress passcode.
   c. Viewing system status: Faulted points, event memory, bypassed points, area status and point status.
   d. Implementation functions: Bypass a point, unbypass a point, reset sensors, silence bell, activating relays, initiating the remote programming function locally to allow programming the system from a remote location.
   e. Testing the system: Local Walk test, Service Walk test, send report to remote DACR to check the telephone link, and programming the time and date for the next test report transmission.
   f. Change system parameters: ACC display brightness, system time and date, and add/delete/change passcodes.
   g. Extend the closing time of the system.
   h. Transmitting special alerts and activating audible and visible signals.
   i. Executing multiple commands / ACC keystrokes from a single Menu / Command List item. This function shall be able to have a 32 character (alphanumeric) title to identify it on the ACC display.
   j. Editing of time / event based scheduling program from the ACC.
   k. The DACS shall also provide a "service menu" to implement functions such as viewing and printing the system log, displaying the system firmware revision number, and defaulting (toggling) text displays between custom and default text displays for troubleshooting.
4. The DACS shall allow users to change their own user passcode from the Alarm Keypad (ACC). Managers shall be capable of changing the user passcodes and authority assignments by area of other users from the ACC.
5. The DACS shall incorporate a programmable "Passcode Follows Scope" feature to allow users to arm or disarm only the area they are entering with one simple command or control all areas from one ACC.

H. Communication: The DACS shall be capable of reporting system events and supervisory reports including alarm, trouble, missing modules, restorals, system status, AC failure, battery status to primary and secondary off-site DACR's. The following features shall be supported.
   1. Capable of communicating via dial-up analog telephone lines, over a LAN/WAN/Internet using a wired network interface module, or over a cellular network using a CDMA Cellular interface module.
   2. The Bosch Modem4 communications format shall be utilized for optimum system performance. The Modem4 format provides the maximum data information to the receiver for alarms, troubles, restorals, bypasses, relay activation, opening/closings, and card access. The detailed information includes the point numbers with text, peripheral device numbers, user numbers with text, and area information. As an alternative format, Contact ID may be used although it will include less detailed information like point or user text.
   3. Capable of sending text (SMS) messages to compatible devices without requiring that these messages are sent to a monitoring center
   4. Capability of communicating with up to 8 different DACRs using up to 4 different phone numbers, up to 24-digits in length and/or 4 URL/IP addresses over a network.
   5. Report to a Commercial Central Station that is using a Bosch D6600 Receiver/Gateway or a Bosch D6100i Receiver using Modem4 as a preferred format or Contact ID as an alternate format.
   6. Provide the transmission information sent from the DACS that includes alarms, troubles, restorals, bypasses, relay activation, opening/closings, and card access. When using the ModemIIIa² format the detailed information includes the point numbers with text, peripheral device numbers, user numbers with text, and area information.
   7. The DACS reports shall be classified, by event, into ten subcategories or "report groups." Each group represents similar types of events. Individual events within each group shall be selectively enabled or disabled for transmission. The ten report groups shall be as follows:
      a. Burglar Reports.
      b. User Reports.
      c. Test Reports.
      d. Diagnostic Reports.
      e. Relay Reports.
      f. Auto Function Reports.
      g. RPS Reports.
      h. Point Reports.
      i. User Change Reports.
      j. Access Reports.
   8. Capability to verify the integrity of the remote communications path and switch to alternate paths when a communications failure occurs.
   9. Capable of unattended mode of operation whereby programming and configuration updates are automatically transferred using the Remote Programming Software (RPS). These updates can initiate from either the control panel or the remote computer using RPS.

I. Network Communication: The DACS shall be capable of network communications over a LAN, WAN, Intranet, or the Internet. The system shall include supervision of the network communication utilizing configurable periodic heartbeats to the Digital Alarm Communications Receiver (DACR). The DACR shall provide notification of the loss of communications from a networked system after a programmable timeframe since the last communication. The notification options shall be programmable and include local annunciation or indication to automation software.
   1. The network interface module shall be capable of supporting Dynamic Host Communication Protocol (DHCP) to obtain an IP Address.

2. The system shall support a method of authentication between the control panel and the receiver to ensure that the control panel has not been compromised or replaced.
3. The network interface modules shall be capable of supporting encryption using a minimum of 256-bit AES Encryption (Rijndael) certified by NIST (National Institute of Standards and Technology) utilizing the Cipher Block Chaining (CBC) method.
4. The network interface module shall support a 10/100BaseT connection to an Ethernet network.
5. The control panel shall be capable of network communication with a programmable poll time to send periodic heartbeats to the receiver, programmable ACK Wait time, and programmable retry time. In the situation where a communication path is unsuccessful, the control panel shall be capable of attempting backup communication through an available communication method to the same receiver or a backup receiver.
    a. The control panel shall have the ability to automatically adjust the heartbeat rate of a backup path that is using cellular to the heartbeat rate of the primary path in case of a primary path failure. Upon restoral of the primary path, the heartbeat rate of the backup path shall automatically restore to the original rate. This allows a system utilizing cellular communications to keep the wireless charges low.
    b. The network communication between the control panel and the receiver shall use Modem4 or Contact ID.
    c. The control panel shall be capable of two-way communication using a wired network interface module with a 10/100BaseT on a LAN/WAN/Internet configuration or with a cellular module on the Internet.
    d. The control panel shall be capable of configuring the destination of the receiver using a URL or static IP Address.
    e. The control panel shall be capable of using DNS to lookup the IP Address of the receiver when programmed with a URL.
    f. The control panel shall support UPnP for automated Port Forward configuration in the router where the control panel is installed.
    g. The control panel shall support AutoIP to enable the RPS software to connect to the control panel locally using an IP Direct connection.
    h. The control panel shall support configuration of the IP parameters from the keypad eliminating the need for a PC to configure the IP device.
    i. The control panel shall support network diagnostics from a keypad to allow local testing of network connectivity. The diagnostics should include, Ethernet cable connected, gateway configuration ok, DNS lookup operational, and external network connectivity (such as the Internet) operational.
    j. The system shall be capable of meeting DCID 6/9 and UL 2050 standards.

J. Event Log: The DACS shall maintain a log of events indicating time, day, month, year type of event, account number, area number, user ID, point text, user text and primary/secondary event route. The system shall allow the following characteristics:
1. The DACS shall be capable of storing up to 10,000 events
2. The DACS shall support viewing of logs locally at the ACC and remotely via an upload to a remote central station computer running the RPS software.
3. The DACS shall provide notification via a report to the DACR when the event log reaches a programmable “percent full capacity". This allows retrieval of stored events via RPS to prevent any loss of event history.
4. Group, signal type and area can route events to specific receivers.
5. Each DACR shall be designated as a primary, backup, or duplicate destination for each report group. Assigning an event to multiple routing groups provides for duplicate destinations for the event. The transmission of grouped events allows the reporting of different types of information to different remote DACRs.

K. Testing, Diagnostic, and Programming Facilities: The DACS shall be capable of sending (manually or automatically) test and status reports to remote DACRs.
   1. The DACS shall be capable of sending automatic tests daily, weekly or once every 28 days. Automatic test times shall be programmable to provide an offset of up to 24 hours from the current time.
   2. Automatic test reports shall be programmable to be deferred by one test interval if any other report is transmitted in the current interval.
   3. Automatic test reports and remote system access for diagnostics shall be supported via a remote central station computer with Remote Programming Software (RPS).
   4. The DACS shall be programmable locally or remotely. Programming shall be accomplished via a Keypad or a computer with a remote programmer and diagnostic software package (RPS).
   5. The DACS shall allow an on-site user to initiate remote programming while on-line with the servicing location. The remote programming device must provide a compare feature and allow for downloading either the stored program or the (un)modified program copied from the panel.
   6. The DACS shall allow the local programming option to be disabled and must provide a method to program a panel while no one is on premises, when the panel shares a line with an answering machine.
   7. The DACS shall accommodate IP Diagnostic to verify settings and operation of the network interface modules; Host name, MAC address, IPV4 address assignment. The IP Connection test shall include; Link test to verify physical cable integrity, Ping test to verify gateway response, ping test to verify address on the internet.
   8. Wireless point diagnostics shall include signal strength and device states of registered wireless points in the system.
   9. The number of system testing and programming sessions shall be restricted via the use of program locking features and passwords. Passcode protection in excess of sixteen million combinations is required.
   10. New modules support enhanced diagnostics through RPS

L. Miscellaneous Features: Programmable alarm output timer, 4 programmable entry delay times, exit delay programmable by area, individually programmable point of protection text, point bypassing, key switch arming capability with LED outputs.

M. False Alarm Reduction: The DACS shall comply with all ANSI SIA CP-01 2010 requirements for false alarm reduction

N. Ambush Detection: The DACS shall include an early ambush feature that requires that the user disarm, and then inspect the facility within a specified time period, before entering their passcode or a different authorized passcode again. If the user does not enter a passcode a second time, a duress event is generated. If the user does enter a passcode within the specified time period, the system disarms.

O. Two Man Rule: The DACS shall include a programmable feature that requires 2 separate passcodes to be entered to disarm the system. After 1 passcode is entered, the system will prompt for a second passcode to be entered on the same ACC. Without the second passcode, the system shall not disarm.

P. Dual Authentication: The DACS shall support Dual Authentication by area. Areas programmed for Dual Authentication require activate of a card and a passcode to allow access to system functions, arm/disarm, or access control doors.

Q. Area Re-Arm: The System shall support programmable area re-arm time of 1 minute to 24 hours.

R. User-Programmable Features: The DACS shall provide a menu driven interface to provide a user-friendly command structure for programming / customizing the system to the operational criteria of the application. The DACS shall be capable of being operated via:
   1. The Command Structure.
   2. Menu / Command List.

2.05 SYSTEM INTERFACE REQUIREMENTS

A. Grounding: The Contractor shall properly earth ground the DACS to prevent electrostatic charges and other transient electrical surges from damaging the DACS panel.

B. Primary Power: The Contractor shall provide a dedicated 120 VAC power circuit to the DACS system. The 120 VAC is stepped down to power the DACS panel using a class two, plug-in transformer. This power circuit shall be properly rated to continuously power all points and functions indefinitely in full alarm condition.

C. Primary Power Supervision: When the primary power source fails, the system can be configured to report an "AC Fail" message to a commercial central station.
   1. The message can also be programmed to "tag-along" with another message transmitted to the central station.
   2. The system will always display a loss of primary power on the ACC and may be configured to provide additional audible warning.
   3. The transmission delay of this message is programmable from 5 seconds to 86 minutes with an optional 6 to 12-hour transmission delay

D. Secondary Power (Standby Battery): The Contractor shall provide adequate battery power as defined by the relevant application criteria, (UL 864 and UL 985 for alarm installations). Appropriate battery chargers shall be provided consistent with the battery back-up capacity. The most current accepted version of NFPA 72 and any applicable local codes or AHJ requirements must be met accordingly.

E. Secondary Power Supervision: When the secondary power source experiences a 85 percent depletion of its standby capacity, the system can be configured to report a "Low Battery" message to a commercial central station. The system will always display a low battery condition on the ACC and may be configured to provide additional audible warning.

F. Telephone Interface: The control panel in the DACS shall be equipped with an optional phone line monitor and shall interface with the phone lines via RJ-31X jacks for supervision of the telephone line connection.
   1. The telephone line interface shall conform with FCC rules (Title 47 C.F.R. part 68).
   2. When a telephone line is determined to be out of service by the DACS panel, the event will be annunciated locally on the ACC and transmitted to the central station over the alternate communications interface. The transmission delay of this message is programmable from ten to two-hundred forty seconds.

G. Ethernet Interface: The DACS shall include a integrated Ethernet interface module as the primary, or back-up means of communicating to a DACR.
   1. Built-in IP-based alarm transport, programming, and control
   2. The module shall accommodate 128 and 256-bit AES encryption using CBC (Cipher Block Chaining) mode.
   3. 10BASE T or 100BASE T network connection
   4. Full-duplex and half-duplex support

H. Cellular Interface: The DACS may use a cellular radio module as the primary, or backup, means of communicating to a DACR. Up to 4 IP Addresses shall be available for routing system events. The supervision time shall be programmable with a range of 5 to 65,535 seconds. The module shall accommodate 128 and 256-bit AES encryption using CBC (Cipher Block Chaining) mode.

I. Auxiliary Function Control Interfaces: The DACS shall accommodate auxiliary functions such as activating bells, strobes, or lights and shall be accomplished using the optional application specific relay modules. These auxiliary interfaces shall be electrically isolated to avoid inter-system interferences or damage to the system.

J. Wiring: The contractor shall provide cables consistent with the manufacturer's recommendations. The following general guidelines shall be followed for wiring installation:
   1. Wiring shall be appropriately color-coded with permanent wire markers. Copper conductors shall be used.
   2. All signal cables provided under this contract shall be Class II, plenum-rated cable where required. Where subject to mechanical damage, wiring shall be enclosed in metal conduits or surface metallic raceway.
   3. Data wires shall not be enclosed in conduit or raceways containing AC power wires.
   4. Where EMI may interfere with the proper operation of the DACS circuits, twisted/shielded cable shall be used.

K. Environmental Conditions: The DACS shall be designed to meet the following environmental conditions:
   1. The system shall be designed for a storage temperature of -10° C to 70°C (14° F to 158°F).
   2. The system shall be designed for an operating temperature of 0° C to 50°C (32° F to 120°F).
   3. The system shall be designed for normal operation in an 85% relative humidity environment.
   4. The system shall meet or exceed the requirements of FCC rules Title 47 C.F.R. Part 15, Class B devices, and Part 68, IEC EMC directive

2.06 ENCLOSURES

A. Interior Sensors: Enclosures that protect against dust, falling dirt, and dripping noncorrosive liquids.

B. Interior Electronics: NEMA 250, Type 12.

C. Exterior Electronics: NEMA 250, Type 4X, fiberglass.

D. Screw Covers: Where enclosures are readily accessible, secure with security fasteners of type appropriate for enclosure.

2.07 ALARM KEYPADS

A. Bosch B920 keypad.

B. Description:
   1. Built-in proximity reader.
   2. Four inputs and one output.
   3. Built-in sounder that produces several distinct audible warning tones. Each audible tone sounds different so users can recognize an event by hearing its unique tone.

2.08 DOOR SWITCHES

A. Description: Balanced-magnetic switch, complying with UL 634, installed on frame with integral overcurrent device to limit current to 80 percent of switch capacity. Bias magnet and minimum of two encapsulated reed switches shall resist compromise from introduction of foreign magnetic fields. Switches shall be double-pole, double-throw.

B. Flush-Mounted Switches: Unobtrusive and flush with surface of door frame.

C. Overhead Door Switch: Balanced-magnetic type, listed for outdoor locations, and having door-mounted magnet and floor-mounted switch unit.

2.09 MOTION SENSORS

A. Manufacturer: Bosch ISC-PDL1-W18G-H Professional Series TriTech Motion Detector.

B. Description: Passive infrared and microwave Doppler radar detection.

C. Device Performance:
   1. Sensitivity: Adjustable pattern coverage to detect a change in temperature of 2 deg F or less, and standard-intruder movement within sensor's detection patterns at any speed between 0.3 to 7.5 fps across two adjacent segments of detector's field of view.
   2. Test Indicator: LED test indicator that is not visible during normal operation. When visible, indicator shall light when sensor detects an intruder. Locate test enabling switch under sensor housing cover.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine areas to receive devices and notify adverse conditions affecting installation or subsequent operation.

B. Do not begin installation until unacceptable conditions are corrected.

C. If preparation is the responsibility of another installer, notify architect of unsatisfactory preparation before proceeding.

D. Ensure selected location is secure and offers protection from accidental damage.

E. Location shall provide reasonable temperature and humidity conditions, free from sources of electrical and electromagnetic interference.

F. Ensure power source is protected against accidental shutoff.

G. Install all equipment and materials in accordance with the "current" recommendations of the manufacturer. The work shall also be in accordance with:
   1. Installation criteria defined in these specifications and in the construction documents.
   2. Factory Representative can be the Bosch Security Systems Inc Security Dealer.
   3. Approved submittals.
   4. Applicable requirements of referenced standards.

H. The contractor shall provide the following services as part of the contract:
   1. Supervision of sub-contractors.
   2. Coordination of other contractors for system-related work (electrical contractor, finish hardware contractor, architect, and general contractor).
   3. Attending site construction/coordination meetings.
   4. Keeping updated construction drawings at the construction site.
   5. Meeting construction deadlines per the construction schedule.

I. Programming of the system shall include the following tasks:
   1. Programming system configuration parameters (hardware and software, zone/circuit numbers, communication parameters).
   2. Programming operational parameters such as opening/closing reports and windows, system response text (custom English) displays of events, activation of relays that drive auxiliary devices, and identifying types of zones/loops.
   3. Programming passcodes according to the authorities and functions defined by the owner.
   4. Other system programming tasks required by the owner. These additional programming requirements shall be coordinated between the owner and the contractor.
   5. Software of hardware should be the most current version upon installation, as well firmware shall be current version available upon commissioning of system.
   6. Operational Testing: The contractor shall perform thorough operational testing and verify that all system components are fully operational.

7. Hard-copy System Printout: The contractor shall submit a hard-copy system printout of all components tested and certify 100 percent operation indicating all devices/panels/units have passed the test criteria set forth by the manufacturer.
8. Acceptance Test Plan Form: An acceptance test plan form shall be prepared/provided by the contractor prior to the acceptance walk-through.
9. This form shall include separate sections for each device/panel/unit as well as a column indicating the manufacturer's performance allowance/margin, a column indicating the result of the testing performed by the contractor (pass/fail), and an empty column for recording findings during the walk-through.
10. During programming of the system, coordinate with Owner the actual final room numbers for labeling purposes. Do NOT use construction room numbers.

J. The contractor shall certify completion in writing and schedule the commissioning walk-through. The contractor shall provide all the tools and personnel needed to conduct an efficient commissioning process.

3.02 SYSTEM INTEGRATION

A. Integrate intrusion detection system with the following systems and equipment:
1. Electronic door hardware.
2. Access control.
3. Fire-alarm system.
4. Video surveillance.
5. Building automation system.

B. Building Automation System (BAS) Interface: Provide dry contact interface with BAS to allow BAS to know when building intrusion detection system is armed.

3.03 SYSTEM INSTALLATION

A. Comply with UL 681 and NFPA 731.

B. Install wall-mounted equipment, with tops of cabinets not more than 72 inches above the finished floor.

C. Alarm Areas/Zones:
1. Provide a separate zone for the 4th floor administration offices area from the remainder of the building.

D. Field devices installation:
1. Alarm Keypads: Install keypads as indicated on Drawings.
2. Door Switches: Neatly install braided lead into door frame. Braided lead should not be installed to protrude from frame or cause an obstruction in the door operation. It is the Contractor’s responsibility to coordinate with the door installer before drilling and gain approval from the Owner on location and aesthetics of the installation.
3. Motion Sensors: Ceiling mount where indicated on Drawings or wall mount at 8-feet a.f.f.

E. Software of hardware should be the most current version upon installation, as well firmware shall be current version available upon commissioning of system.

3.04 WIRING INSTALLATION

A. Wiring Method: Install wiring in metal raceways according to Division 27 Section "Pathways for Communications Systems," except in accessible indoor ceiling spaces and in interior hollow gypsum board partitions where cable may be used. Conceal raceways and wiring except in unfinished spaces and as indicated. Minimum conduit size shall be 1/2 inch. Control and data transmission wiring shall not share conduit with other building wiring systems.

B. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points. Use lacing bars and distribution spools. Separate power-limited and non-power-limited conductors as recommended in writing by manufacturer. Install conductors parallel with or at right angles to sides and back of enclosure. Connect conductors that are terminated, spliced, or interrupted in any enclosure associated with intrusion system to terminal blocks. Mark each terminal according to system's wiring diagrams. Make all connections with approved crimp-on terminal spade lugs, pressure-type terminal blocks, or plug connectors.

C. Wires and Cables:
   1. Conductors: Size as recommended in writing by system manufacturer unless otherwise indicated.
   2. 120-V Power Wiring: Install according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables" unless otherwise indicated.

D. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

E. Install power supplies and other auxiliary components for detection devices at control units unless otherwise indicated or required by manufacturer. Do not install such items near devices they serve.

F. Identify components with engraved, laminated-plastic or metal nameplate for master control unit and each terminal cabinet, mounted with corrosion-resistant screws.

3.05 FIELD QUALITY CONTROL

A. Pretesting: After installation, align, adjust, and balance system and perform complete pretesting to determine compliance of system with requirements in the Contract Documents. Correct deficiencies observed in pretesting. Replace malfunctioning or damaged items with new ones and retest until satisfactory performance and conditions are achieved. Prepare forms for systematic recording of acceptance test results.
   1. Report of Pretesting: After pretesting is complete, provide a letter certifying that installation is complete and fully operable; include names and titles of witnesses to preliminary tests.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

C. Tests and Inspections: Comply with provisions in NFPA 731, Ch. 9, "Testing and Inspections."
   1. Inspection: Verify that units and controls are properly labeled and interconnecting wires and terminals are identified.
   2. Test Methods: Intrusion detection systems and other systems and equipment that are associated with detection and accessory equipment shall be tested according to Table "Test Methods" and Table "Test Methods of Initiating Devices."

D. Installation contractor shall submit a written test report that the system has been 100 percent tested and approved. Final test shall be witnessed by the owner, engineer, electrical contractor, chief security officer, and performed by the installation contractor. Final test report shall be received and acknowledged by the owner prior to request for final payment.

E. Documentation: Comply with provisions in NFPA 731, Ch. 4, "Documentation."

F. Provide instruction to the owner's satisfaction with regard to proper use and operation of the system.

G. Determine and report all problems to the manufacturer's customer service department.

3.06 ADJUSTING

A. System maintenance and repair of system or workmanship defects during the warranty period shall be provided by the Contractor free of charge (parts and labor).

B. Periodic testing of the system shall be carried out on a monthly or quarterly basis to ensure the integrity of the control panel, the sensing devices, and the telephone lines.

C. The installer shall correct any system defect within six hours of receipt of call from the Owner.

3.07 PROTECTION

A. Protect installed products until completion of project.

B. Touch-up, repair or replace damaged products before substantial completion.

END OF SECTION

SECTION 28 4600
FIRE DETECTION AND ALARM

PART 1 GENERAL

1.01 SUMMARY

A. Design and Provide a complete new fire alarm system for the new Tomball ISD High School facility.

B. Fire alarm system shall incorporate Emergency Voice Alarm and Communication System (EVACS) style notification.

C. Section Includes:
   1. Fire Alarm System Delegated Design
   2. Fire Alarm System Installation, including all components, wiring, and conduit.
   3. Transmitters for communication with supervising station.
   4. Maintenance of fire alarm system under contract for specified warranty period.

1.02 DEFINITIONS

A. AHJ: Authority (or Authorities) Having Jurisdiction.

B. EVACS: Emergency Voice Alarm Communication System as defined in NFPA 72, also known as "Voice Evacuation"

C. FAA: Fire Alarm System Annunciator

D. FACP: Fire Alarm Control Panel

E. FPP: Licensed Fire Alarm Planning Professional.

F. HVAC: Heating, Ventilating, and Air-Conditioning

G. NICET: National Institute for Certification in Engineering Technologies

H. UON: Unless Otherwise Noted

1.03 REFERENCE STANDARDS

Standards referenced below shall be current edition including all revisions, UON.

A. 36 CFR 1191 - Americans with Disabilities Act (ADA) Accessibility Guidelines for Buildings and Facilities; Architectural Barriers Act (ABA) Accessibility Guidelines current edition.

B. ADA Standards - 2010 ADA Standards for Accessible Design 2010.

C. IEEE C62.41.2 - IEEE Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and less) AC Power Circuits 2002 (Corrigendum 2012).

D. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum) 2020.

E. NFPA 70 - National Electrical Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

F. NFPA 72 - National Fire Alarm and Signaling Code Most Recent Edition Cited by Referring Code or Reference Standard.

G. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems 2024.

H. NFPA 101 - Life Safety Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

I. UL 268 - Standard for Smoke Detectors for Fire Alarm Systems Current Edition, Including All Revisions.

J. UL 268A - Standard for Smoke Detectors for Duct Application Current Edition, Including All Revisions.

K. UL 521 - Standard for Heat Detectors for Fire Protective Signaling Systems Current Edition, Including All Revisions.

L. UL 864 - Control Units and Accessories for Fire Alarm Systems Current Edition, Including All Revisions.

M. UL 1480 - Standard for Speakers for Fire Alarm and Signaling Systems, Including Accessories Current Edition, Including All Revisions.

N. UL 1971 - Standard for Signaling Devices for the Hearing Impaired Current Edition, Including All Revisions.

1.04 ACTION SUBMITTALS

A. Delegated Design Submittal: Contractor shall perform all planning, calculations, etc. necessary for a complete fire alarm design, and prepare and submit to Authority Having Jurisdiction all documentation required for plan review and permitting, including but not limited to floor plans, riser diagrams, and description of operation.

B. Qualifications and Product Data:
   1. Copy (if any) of list of data required by authority having jurisdiction.
   2. NFPA 72 "Record of Completion", filled out to the extent known at the time.
   3. Manufacturer's detailed data sheet for each component, including wiring diagrams, installation instructions, and circuit length limitations.
   4. Evidence of designer qualifications.
   5. Evidence of installer qualifications.
   6. Evidence of instructor qualifications; training lesson plan outline.
   7. Evidence of maintenance contractor qualifications, if different from installer.

C. Shop Drawings and Design Calculations:
   1. Shop drawing submittal shall be approved by AHJ prior to submission to Architect & Engineer.
   2. Clear and concise description of operation, with input/output matrix similar to that shown in NFPA 72 Appendix A-7-5-2.2(9), and complete listing of software required.
   3. System zone boundaries and interfaces to fire safety systems.
   4. Location of all components, circuits, and raceways; mark components with identifiers used in control unit programming.
   5. Circuit layouts; number, size, and type of raceways and conductors; conduit fill calculations; spare capacity calculations; notification appliance circuit voltage drop calculations.
   6. List of all devices on each signaling line circuit, with spare capacity indicated.
   7. Description of power supplies; if secondary power is by battery include calculations demonstrating adequate battery power.

1.05 CLOSEOUT SUBMITTALS

A. Inspection and Test Reports:
   1. Submit inspection and test plan prior to closeout demonstration.
   2. Submit documentation of satisfactory inspections and tests.
   3. Submit NFPA 72 "Inspection and Test Form," filled out.

B. Operating and Maintenance Data: See Section 01 7800 for additional requirements; revise and resubmit until acceptable; have one set available during closeout demonstration:
   1. Complete set of specified design documents, as approved by authority having jurisdiction.
   2. Additional printed set of project record documents and closeout documents, bound or filed in same manuals.
   3. Contact information for firm that will be providing contract maintenance and trouble call-back service.

4. List of recommended spare parts, tools, and instruments for testing.
5. Replacement parts list with current prices, and source of supply.
6. Detailed troubleshooting guide and large scale input/output matrix.
7. Preventive maintenance, inspection, and testing schedule complying with NFPA 72; provide printed copy and computer format acceptable to Owner.
8. Detailed but easy to read explanation of procedures to be taken by non-technical administrative personnel in the event of system trouble, when routine testing is being conducted, for fire drills, and when entering into contracts for remodeling.

C. Project Record Documents: Have one set available during closeout demonstration:
1. Complete set of floor plans showing actual installed locations of components, conduit, and zones.
2. "As installed" wiring and schematic diagrams, with final terminal identifications.
3. "As programmed" operating sequences, including control events by device, updated input/output chart, and voice messages by event.

D. Closeout Documents:
1. Certification by manufacturer that the system has been installed in compliance with manufacturer's installation requirements, is complete, and is in satisfactory operating condition.
2. NFPA 72 "Record of Completion", filled out completely and signed by installer and authorized representative of authority having jurisdiction.
3. Maintenance contract.

1.06 MAINTENANCE MATERIAL SUBMITTALS

A. Maintenance Materials, Tools, and Software: Furnish the following for Owner's use in maintenance of project.
1. Furnish spare parts of same manufacturer and model as those installed; deliver in original packaging, labeled in same manner as in operating and maintenance data and place in spare parts cabinet.
2. In addition to the items in quantities indicated in PART 2, furnish the following:
a. All tools, software, and documentation necessary to modify the fire alarm system using Owner's personnel; minimum modification capability to include addition and deletion of devices, circuits, and zones, and changes to system description, operation, and evacuation and instructional messages.
b. One copy, on USB Flash Media, of all software not resident in read-only-memory.
c. Spare Lamps for Remote Indicating Lamp units: One unit, or 5% of the quantity of remote indicating lamp units installed, whichever is greater.
d. Spare Lamps for Strobe Units: One unit, or 5% of the quantity of strobes and horn strobes installed, whichever is greater.
e. Extra Fuses: Two for each size of installed fuse; Provide in a box or cabinet with compartments marked with fuse types and sizes.

1.07 QUALITY ASSURANCE

A. Designer (Fire Alarm Planning Professional) Qualifications: NICET Level III or IV (3 or 4) certified fire alarm technician or registered fire protection engineer, employed by installing Contractor.

B. Installer Qualifications: Firm with minimum 3 years documented experience installing fire alarm systems of the specified type and providing contract maintenance service as a regular part of their business.
1. Authorized representative of control unit manufacturer; submit manufacturer's certification that installer is authorized; include name and title of manufacturer's representative making certification.
2. Installer Personnel: At least 2 years of experience installing fire alarm systems.

3. Supervisor: NICET level III or IV (3 or 4) certified fire alarm technician; furnish name and address.

C. Maintenance Contractor Qualifications: Same entity as installer.

D. Instructor Qualifications: Experienced in technical instruction, understanding fire alarm theory, and able to provide the required training; trained by fire alarm control unit manufacturer.

1.08 PROJECT CONDITIONS

A. Use of Devices during Construction: Protect devices during construction unless devices are placed in service to protect the facility during construction.

B. Coordinate the work of this section with the work of other sections, including sprinkler systems, elevators, HVAC systems, and security/door locking systems.

1.09 WARRANTY

A. Provide control panel manufacturer's warranty that system components other than wire and conduit are free from defects and will remain so for 1 year after date of Substantial Completion.

B. Provide installer's warranty that the installation is free from defects and will remain so for 1 year after date of Substantial Completion.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Fire Alarm Control Units and Accessories:
1. Carrier Fire & Security Solutions/Edwards; EST4 Series (Basis of Design).
2. Honeywell Security & Fire Solutions/Notifier; _____.

B. Initiating Devices and Notification Appliances:
1. Same manufacturer as control units.

C. No Substitutions except by written written approval from Owner and Engineer

2.02 FIRE ALARM SYSTEM

A. Fire Alarm System: Provide a new automatic fire detection and alarm system:
1. Provide all components necessary for a fully operational system in accordance with AHJ-approved design, applicable prescriptive codes, and design notes on contract drawings.
2. Protected Premises: Entire building shown on drawings.
3. Comply with the following; where requirements conflict, order of precedence of requirements is as listed:
   a. ADA Standards.
   b. The requirements of the local authority having jurisdiction , which is Harris County Fire Marshall's Office.
   c. Applicable local codes.
   d. Contract Documents (drawings and specifications).
   e. NFPA 101.
   f. NFPA 72; where the word "should" is used consider that provision mandatory; where conflicts between requirements require deviation from NFPA 72, identify deviations clearly on design documents.
4. Evacuation Alarm: Single smoke zone; general evacuation of entire premises.
5. Voice Notification: Provide emergency voice/alarm communications with multichannel capability; digital.
6. Program notification zones and voice messages as directed by AHJ.
7. Fire Alarm Control Unit: New, located at main telecommunication equipment room (MDF).

B. Supervising Stations and Fire Department Connections:
1. Public Fire Department Notification: By on-premises supervising station.

2. On-Premises Supervising Station: Existing proprietary station operated by Owner, located at _____.
3. Remote Supervising Station: UL-listed central station under contract to facility.
4. Means of Transmission to Remote Supervising Station: Digital alarm communicator transmitter (DACT), VoIP with Cellular Backup.

C. Circuits:
1. Initiating Device Circuits (IDC): Class B.
2. Signaling Line Circuits (SLC): Class B.
3. Notification Appliance Circuits (NAC): Class B.
4. Pathway Survivability: Level 0.

D. Spare Capacity:
1. Notification Appliance Circuits: Minimum 25 percent spare capacity.
2. Speaker Amplifiers: Minimum 25 percent spare capacity.
3. Fire Alarm Control Units: Capable of handling all circuits utilized to capacity without requiring additional components other than plug-in control modules.

E. Power Sources:
1. Primary: Dedicated branch circuits of the facility normal power distribution system.
2. Secondary: Storage batteries.
3. Capacity: Sufficient to operate entire system for period specified by NFPA 72.

2.03 FIRE SAFETY SYSTEMS INTERFACES

A. Supervision: Provide supervisory signals in accordance with NFPA 72 for the following:
1. Sprinkler water control valves.
2. Dry-pipe sprinkler system pressure.
3. Dry-pipe sprinkler valve room low temperature.
4. Elevator shut-down control circuits.

B. Alarm: Provide alarm initiation in accordance with NFPA 72 for the following:
1. Sprinkler water flow.
2. Kitchen hood suppression activation; also disconnect fuel source from cooking equipment.
3. Elevator lobby, elevator hoistway, and elevator machine room smoke detectors.

C. Elevators:
1. Elevator lobby, hoistway, and machine room smoke detectors: Elevator recall for fire fighters' service.
2. Elevator Machine Room Heat Detector: Shut down elevator power prior to hoistway sprinkler activation.
3. Sprinkler pressure or waterflow: Shut down elevator power prior to hoistway sprinkler activation.

D. HVAC:
1. Duct Smoke Detectors: Close dampers indicated; shut down air handlers.
2. Smoke and Fire/Smoke Damper Actuators: Close dampers, shut down air handlers.

E. Doors:
1. Smoke Barrier Door Magnetic Holders: Release upon activation of smoke detectors in smoke zone on either side of door, upon alarm from manual pull station on same floor, and upon sprinkler activation on same floor. Refer to Section 08 7100.
2. Overhead Coiling Fire Doors: Release upon activation of smoke detectors in smoke zone on either side of door, upon alarm from manual pull station on same floor, and upon sprinkler activation on same floor. Refer to Section 08 3323.

2.04 COMPONENTS

A. General:

1. Provide flush mounted units where installed in finish areas; in unfinished areas, surface mounted unit are acceptable.
2. Provide legible, permanent labels for each control device, using identification used in operation and maintenance data.

B. Fire Alarm Control Units: Digital, addressable type; listed, classified, and labeled as suitable for the purpose intended.

C. Master Fire Alarm Control Panel (FACP):
1. Field-programmable, microprocessor-based, modular, power-limited design.
2. Software, programs, system database, event history, etc. shall be held in non-volatile system memory to retain information through failure of primary and secondary power supplies.
3. FACP shall include a real-time clock for time annotation of events.
4. FACP shall provide a minimum 500-event history log.
5. Complying with UL 864.
6. Display: Graphical LCD type.
7. Digital Alarm Communicator Transmitter (DACT):
   a. DACT shall be acceptable to the remote central station and comply with UL 632.
   b. Communicator shall monitor communication line status, conduct automatic self-tests and initiate a System Trouble signal if service is lost.
   c. Communicator shall provide local annunciation and display capabilities for local testing and troubleshooting.
   d. Secondary Power: Communicator shall be provided with integral rechargeable battery and automatic charger.
8. Network Communications:
   a. Provide network communications and accessories as needed for fire alarm system IP communication to central station according to fire alarm manufacturer's written requirements.
   b. Provide inegration gateway using BACnet for connection to building automation system.
9. 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.
   a. Alarm current draw of entire fire-alarm system shall not exceed 80 percent of the power-supply module rating.
10. Secondary Power: 24-V dc supply system with batteries, automatic battery charger, and automatic transfer switch.
   a. Batteries: Sealed lead calcium.
   b. Sufficient capacity to provide power for entire system upon loss of normal AC power for a period of 24 hours with 15 minutes of alarm signaling at end of this 24-hour period, as required by NFPA 72, Local Systems.

D. Remote Annunciator(s): at main reception, central plant, and each concession stand building.
1. Display and user interface located remotely from main control panel.
2. Signals annunciated and functions available at annunciator shall match those of FACP for alarm, including alarm / supervisory / trouble indications, acknowledging, silencing, resetting, and testing.
3. Each annunciator shall be provided with a remote microphone for EVACS ana

E. Addressable Modules:
1. Provide addressable modules suitable for connection to fire alarm control unit signaling line circuits.

2. Unless otherwise indicated, use addressable modules only in clean, dry, indoor, nonhazardous locations.
3. Monitor Modules: Unless devices are explicitly permitted to be connected together as zone, provide separate addressable monitor module for each conventional dry-contact input device in order to be individually identifiable by addressable fire alarm control unit.
4. Releasing Control Modules: Provide as indicated or as required for control of listed solenoids in releasing applications.
5. Relay Modules: Provide as indicated or as required to perform necessary functions via dry-contact interface. Where load exceeds module contact rating, provide accessory power isolation relays suitable for load as required.
6. Signaling Line Circuit (SLC) Isolating Modules: Provide as indicated or as required to automatically isolate short circuits on connected sections of SLC loops and allow other sections to continue to function normally. Provide automatic reset upon correction of short circuit.

F. Initiating Devices:
1. Addressable Systems:
   a. Addressable Devices: Individually identifiable by addressable fire alarm control unit.
   b. Provide suitable addressable interface modules as indicated or as required for connection to conventional (non-addressable) devices and other components that provide a dry closure output.
2. Manual Pull Stations: Only at attended locations as indicated on drawings.
   a. Spares: Provide 1 extra.
   b. Pull Station Local Alarm Cover: At each pull station, provide a factory-fabricated clear plastic cover with top hinge and integral, battery-powered local alarm. Lifting cover actuates alarm to discourage false-alarm operation of pull station. Safety Technology International #Stopper II series or equal.
3. Smoke Detectors & Detector Bases: In each storage room, covering paths of egress, and all other locations required per prescriptive code. Refer to prescriptive codes referenced for detailed requirements.
   a. Detectors shall be twist-lock mounted to a fixed base wiring module, allowing replacement of detector without disturbing permanent wiring.
   b. Comply with UL 268.
   c. Spares: Provide 1 spare or 5% of quantity installed, whichever is greater.
4. Duct Smoke Detectors: At air handling equipment > 2000 CFM as required by code.
   a. Detectors shall be twist-lock mounted to a fixed base wiring module and sampling enclosure, allowing replacement of detector without disturbing permanent wiring.
   b. Weatherproof Duct Housing Enclosure: NEMA 250, type 4X; NRTL listed for use with the supplied detector for smoke detection in HVAC ducts.
   c. Sampling Tubes: Design as recommended by manufacturer for specific duct size, air velocity, and installation conditions where applied.
   d. Relay Fan Shutdown: Programmable relay rated to interrupt fan motor control unit.
   e. Comply with UL 268A.
   f. Spares: Provide 1 extra.
5. Heat Detectors & Detector Bases: In kitchens, break rooms, and other locations where fire detection is required but smoke detection is subject to a high probability of false alarms. See prescriptive codes referenced for detailed requirements.
   a. Detectors shall be combination-type, programmable to actuate by either fixed temperature or rate-of-rise unless otherwise indicated.
   b. Detectors shall be twist-lock mounted to a fixed base wiring module, allowing replacement of detector without disturbing permanent wiring.
   c. Comply with UL 521.
   d. Spares: Provide 1 spare or 5% of quantity installed, whichever is greater.

G. Notification Appliances:
   1. Bells: At each fire protection sprinkler system entry. See prescriptive codes referenced for detailed requirements..
   2. Speaker/Strobes: In accordance with applicable prescriptive codes..
      a. Combination device meeting same specifications and requirements as individual devices described below.
      b. Spares: Provide 1 extra.
   3. Speakers: In accordance with applicable prescriptive codes..
      a. Voice notification appliances complying with UL 1480.
      b. Locate speakers for voice notification to meet the intelligibility requirements of the "Notification Appliances" and "Emergency Communications Systems" chapters in NFPA 72.
         1) High-range Units: 2 to 15 W
         2) Low-range Units: 1 to 2 W.
         3) Matching Transformers: Tap range matched to acoustical environment of speaker location.
      c. Spares: Provide 1 extra.
   4. Strobes: In accordance with applicable prescriptive codes..
      a. Xenon strobe lights complying with UL 1971.
      b. Rated light output: 15, 30, 75, or 110 cd, selectable in the field.
      c. Where wireguards or other protective covers are used, light output ratings required shall be calculated with guards in place.
      d. Flashing pattern shall be synchronized as prescribed in ADA Standards.
      e. Spares: Provide 1 extra.
   5. Provide ceiling-mounted notification appliances except where ceilings are not present or noted on drawings to be free of devices. Refer to architectural plans for ceiling types, heights, and keep-out zones.
   6. Provide wireguards in gyms and other areas where devices may be subject to physical damage.

H. Door Holders
   1. Provide wall- or floor-mounted electromagnetic type hold-opens complete with matching doorplates as indicated on technology and/or architectural drawings and specifications.
   2. Units shall require no more than 3 W to develop 25-lbf holding force.
   3. Material and finish: match door hardware.

I. Remote Power Supply Units for Peripherals
   1. Where required by the fire alarm system manufacturer, remote power supplies shall be provided that will provide sufficient current to drive audio/visual or other required devices.
   2. These units shall be located in electrical closets, mechanical rooms or similar spaces. They shall not be installed in finished areas, storage rooms, etc., without the permission of the Engineer. All locations shall be indicated on the shop drawing submissions.
   3. Remote power supplies shall be provided with local intelligence compatible with the digital multiplex network, so they have a unique address, providing the ability to monitor the supply for loss of power, shorts, grounds an d other supervisory functions.
   4. Provide dedicated 120-volt power circuit(s) from nearby panelboards as required, whether indicated on the plans or not.

J. Circuit Conductors: Copper or optical fiber; color code and label.
   1. Interconnection cabling between buildings shall be optical fiber. No exceptions.

K. Surge Protection: In accordance with IEEE C62.41.2 category B combination waveform and NFPA 70; except for optical fiber conductors.

1. Initiating Device Circuits, Notification Appliance Circuits, and Communications Circuits: Provide surge protection at each point where circuit exits or enters a building; rated to protect applicable equipment; for 24 V(dc) maximum dc clamping voltage of 36 V(dc), line-to-ground, and 72 V(dc), line-to-line.

L. Locks and Keys: Deliver keys to Owner.

M. Instruction Charts: Printed instruction chart for operators, showing steps to be taken when a signal is received (normal, alarm, supervisory, and trouble); easily readable from normal operator's station.
1. Frame: Stainless steel or aluminum with polycarbonate or glass cover.
2. Provide one for each control unit and/or annunciator where operations are to be performed.
3. Obtain approval of Owner prior to mounting; mount in location acceptable to Owner.
4. Provide extra copy with operation and maintenance data submittal.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine areas and conditions for compliance with requirements for ventilation, temperature, humidity, and other conditions affecting performance of the Work.
1. Verify that manufacturer's written instructions for environmental conditions have been permanently established in spaces where equipment and wiring are installed, before installation begins.

B. Examine roughing-in for electrical connections to verify actual locations of connections before installation.

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

3.02 DELIVERY, STORAGE, AND HANDLING

A. Delivery: Deliver materials to site in manufacturer’s original, unopened containers and packaging, with labels clearly identifying product name and manufacturer.

B. Storage: Store materials in clean, dry area indoors in accordance with manufacturer’s instructions.

C. Handling: Protect materials from damage during handling and installation.

3.03 INSTALLATION

A. Install in accordance with applicable codes, NFPA 72, NFPA 70, AHJ requirements, and Contract Documents.

B. Pathways:
1. Pathways above recessed ceilings and in non-accessible locations may be routed exposed.
a. Exposed pathways located less than 96 inches above the floor shall be installed in EMT.
2. Pathways shall be installed in EMT.
3. Conceal all wiring, conduit, boxes, and supports where installed in finished areas.

C. Install wall-mounted equipment, with tops of cabinets not more than 78 inches above the finished floor.

D. Install manual fire-alarm box(es) in the normal path of egress within 60 inches of the exit doorway, between 42 inches and 48 inches above floor level.
1. Provide "Stopper II" (or equal) covers on all manual stations except the manual station installed directly adjacent to the fire alarm control panel.

E. Install a cover on each smoke detector that is not placed in service during construction. Cover shall remain in place except during system testing. Remove cover prior to system turnover.

F. Install framed instructions in a location visible from fire-alarm control unit.

G. Grounding:
   1. 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.
   2. Ground shielded cables at the control panel location only. Insulate shield at device location.

3.04 PARTIAL SEQUENCES OF OPERATION

A. Fire-alarm signal initiation shall be by one or more of the following devices and systems:
   1. Manual pull stations.
   2. Smoke detectors.
      a. Provide UL-Listed alarm verification feature. Activate an approved "alarm verification" sequence at FACP and detector as prescribed by UL 864.
   3. Heat detectors.
   4. Automatic sprinkler system water flow.
   5. Fire-extinguishing system operation.
   6. Kitchen Hood fire suppression system.

B. Initiation of fire alarm signal shall automatically perform the following actions:
   1. Annunciate alarm condition and specific initiating device addressable point at FACP and FAA(s).
   2. Sound a distinctive voice-message evacuation signal throughout the zone(s) in alarm in accordance with NFPA 72 public mode alarm prescriptive requirements.
   3. Activate flashing visual strobe alarm assemblies in accordance with NFPA 72 public mode alarm prescriptive requirements.
   4. Unlock electric door locks in designated egress paths.
   5. Release fire and smoke door hold-open devices.
   6. Switch HVAC controls to fire alarm mode & shut down HVAC equipment rated 2000 cfm or greater that circulate air in the zone(s) in alarm in accordance with NFPA 90A.
   7. Recall elevators to primary or alternate recall floors.
   8. Transmit alarm message to remote supervising station in accordance with NFPA 72.

C. Supervisory signal initiation shall be by one or more of the following devices and actions:
   1. Valve supervisory switch(es).
   2. Duct smoke detectors.
   3. User disabling of zones or individual devices.
   4. Loss of communication with any panel on the network.

D. 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. Loss of communication with any addressable sensor, input module, relay, control module, remote annunciator, printer interface, or Ethernet module.
   4. Loss of primary power at FACP.
   5. Break in standby battery circuitry
   6. Failure of battery charging.
   7. Abnormal position of any switch at FACP or annunciator.
   8. Voice signal amplifier failure.

E. Initiation of supervisory or trouble signal shall automatically perform the following actions:

1. Annunciate supervisory or trouble condition and specific addressable point(s) at FACP and FAA(s).
2. Sound a distinctive audio alert at panel and annunciator locations.
3. After a time delay of 200 seconds, transmit a supervisory or trouble signal to remote supervising station in accordance with NFPA 72.

3.05 INSPECTION AND TESTING FOR COMPLETION

A. Field tests shall be witnessed by Authority Having Jurisdiction. Notify AHJ and comply with their requirements for scheduling inspections and tests and for observation by their personnel.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Prepare for testing by ensuring that all work is complete and correct; perform preliminary tests as required.

D. Provide all tools, software, and supplies required to accomplish inspection and testing.

E. Perform inspection and testing in accordance with NFPA 72 and requirements of local authorities; document each inspection and test.
   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 the "Completion Documents, Preparation" table in the "Documentation" section of the "Fundamentals" chapter in NFPA 72.
      b. Comply with the "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 the "Test Methods" table in the "Testing" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
   3. Factory-authorized service representative shall prepare the "Fire Alarm System Record of Completion" in the "Documentation" section of the "Fundamentals" chapter in NFPA 72 and the "Inspection and Testing Form" in the "Records" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72.

F. Correct defective work, adjust for proper operation, and retest until entire system complies with Contract Documents.

G. Prepare test and inspection reports.

H. Maintenance Test and Inspection: Perform tests and inspections listed for weekly, monthly, quarterly, and semiannual periods. Use forms developed for initial tests and inspections.

I. 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.

3.06 OWNER PERSONNEL INSTRUCTION

A. Provide the following instruction to designated Owner personnel:
   1. Hands-On Instruction: On-site, using operational system.
   2. Classroom Instruction: Contractor furnished classroom, on-site or at other local facility.

B. Administrative: One-hour session(s) covering issues necessary for non-technical administrative staff; classroom:
   1. Initial Training: 1 session post-occupancy.

C. Basic Operation: One-hour sessions for attendant personnel, security officers, and engineering staff; combination of classroom and hands-on:
   1. Initial Training: 1 session post-occupancy.

D. Furnish the services of instructors and teaching aids; have copies of operation and maintenance data available during instruction.

3.07 MAINTENANCE

A. See Section 01 7000 - Execution and Closeout Requirements, for additional requirements relating to maintenance service.

B. Provide to Owner, at no extra cost, a written maintenance contract for entire manufacturer's warranty period, to include the work described below.

C. Perform routine inspection, testing, and preventive maintenance required by NFPA 72, including:
   1. Maintenance of fire safety interface and supervisory devices connected to fire alarm system.
   2. Repairs required, unless due to improper use, accidents, or negligence beyond the control of the maintenance contractor.
   3. Record keeping required by NFPA 72 and authorities having jurisdiction.

D. Provide trouble call-back service upon notification by Owner:
   1. Provide on-site response within 2 hours of notification.
   2. Include allowance for call-back service during normal working hours at no extra cost to Owner.
   3. Owner will pay for call-back service outside of normal working hours on an hourly basis, based on actual time spent at site and not including travel time; include hourly rate and definition of normal working hours in maintenance contract.

E. Provide a complete description of preventive maintenance, systematic examination, adjustment, cleaning, inspection, and testing, with a detailed schedule.

F. Maintain a log at each fire alarm control unit, listing the date and time of each inspection and call-back visit, the condition of the system, nature of the trouble, correction performed, and parts replaced. Submit duplicate of each log entry to Owner's representative upon completion of site visit.

G. Comply with Owner's requirements for access to facility and security.

3.08 SOFTWARE SERVICE AGREEMENT

A. Comply with UL 864.

B. Technical Support: Beginning at Substantial Completion, service agreement shall include software support for two years.

C. Upgrade Service: At Substantial Completion, update software to latest version. Install and program software upgrades that become available within two 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.

D. Installer shall provide a backup copy of the installed program database on USB drive upon completion of the project. They shall also provide the current version for the panel provided.

END OF SECTION

SECTION 31 1000
SITE CLEARING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. All applicable provisions of the Bidding and Contract Requirements, and Division 1 - General Requirements shall govern the work under this section.

1.02 WORK INCLUDED

A. This Section includes the following:
   1. Clearing and grubbing.
   2. Stripping and stockpiling topsoil.
   3. Temporary erosion and sedimentation control measures.

B. Related Sections include the following:
   1. Division 32 Section "Chain Link Fences and Gates" for temporary construction fencing.

1.03 MATERIAL OWNERSHIP

A. Except for stripped topsoil or other materials indicated to remain Owner's property, cleared materials shall become Contractor's property and shall be removed from Project site.

1.04 PROJECT CONDITIONS

A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during site-clearing operations.
   1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.
   2. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.
   3. Do not proceed with work on adjoining property until directed by Engineer.

B. Utility Locator Service: Notify utility locator service for area where Project is located before site clearing.

C. Do not commence site clearing operations until temporary erosion and sedimentation control measures are in place.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.01 TEMPORARY EROSION AND SEDIMENTATION CONTROL

A. Provide temporary erosion and sedimentation control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways, according to sediment and erosion control Drawings.

B. Inspect, repair, and maintain erosion and sedimentation control measures during construction until permanent vegetation has been established.

C. Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal.

3.02 TREE PROTECTION

A. Reference 015639 “Tree and Plant Protection”.

3.03 UTILITIES

A. Locate, identify, disconnect, and seal or cap off utilities indicated to be removed.
   1. Arrange with utility companies to shut off indicated utilities.

B. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:
   1. Notify Engineer and Owner not less than two days in advance of proposed utility interruptions.
   2. Do not proceed with utility interruptions without Owner's written permission.

C. Excavate for and remove underground utilities indicated to be removed.

3.04 CLEARING AND GRUBBING

A. Remove obstructions, trees, shrubs, grass, and other vegetation to permit installation of new construction.
   1. Do not remove trees, shrubs, and other vegetation indicated to remain or to be relocated.
   2. Cut minor roots and branches of trees indicated to remain in a clean and careful manner where such roots and branches obstruct installation of new construction.
   3. Grind stumps and remove roots, obstructions, and debris extending to a depth of 18 inches (450 mm) below exposed subgrade.
   4. Use only hand methods for grubbing within tree protection zone.

B. Fill depressions caused by clearing and grubbing operations with satisfactory soil material unless further excavation or earthwork is indicated.
   1. Place fill material in horizontal layers not exceeding a loose depth of 8 inches (200 mm) and compact each layer to a density equal to adjacent original ground.

3.05 TOPSOIL STRIPPING

A. Remove sod and grass before stripping topsoil.

B. Strip topsoil to whatever depths are encountered in a manner to prevent intermingling with underlying subsoil or other waste materials.
   1. Remove subsoil and nonsoil materials from topsoil, including trash, debris, weeds, roots, and other waste materials.

C. Stockpile topsoil materials away from edge of excavations without intermixing with subsoil. Grade and shape stockpiles to drain surface water. Cover to prevent windblown dust.
   1. Limit height of topsoil stockpiles to 72 inches (1800 mm).
   2. Do not stockpile topsoil within tree protection zones.
   3. Dispose of excess topsoil as specified for waste material disposal.
   4. Select subparagraph above or below.
   5. Stockpile surplus topsoil to allow for respreading deeper topsoil.

3.06 SITE IMPROVEMENTS

A. Remove existing above- and below-grade improvements as indicated and as necessary to facilitate new construction.

B. Remove slabs, paving, curbs, gutters, and aggregate base as indicated.
   1. Unless existing full-depth joints coincide with line of demolition, neatly saw-cut length of existing pavement to remain before removing existing pavement. Saw-cut faces vertically.
   2. Paint cut ends of steel reinforcement in concrete to remain to prevent corrosion.

3.07 DISPOSAL

A. Disposal: Remove surplus soil material, unsuitable topsoil, obstructions, demolished materials, and waste materials including trash and debris, and legally dispose of them off Owner's property.

1. Separate recyclable materials produced during site clearing from other nonrecyclable materials. Store or stockpile without intermixing with other materials and transport them to recycling facilities.

END OF SECTION

SECTION 31 2000
EARTH MOVING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. All applicable provisions of the Bidding and Contract Requirements, and Division 1 - General Requirements shall govern the work under this section.

1.02 WORK INCLUDED

A. This Section includes the following:
   1. Subgrade course for pavements.
   2. Base material for asphalt paving.

B. All earthwork to be performed and materials used shall be in accordance with the Geotechnical Engineering Report. In the event of a discrepancy between the above-referenced standards, the plans, and/or any portion of this specification section, the order of precedence will be the above-referenced report, the City Design Standards, and then these specifications. The Contractor shall contact the engineer in the event of a discrepancy.

1.03 DEFINITIONS

A. Backfill: Soil material or controlled low-strength material used to fill an excavation.
   1. Initial Backfill: Backfill placed beside and over pipe in a trench, including haunches to support sides of pipe.
   2. Final Backfill: Backfill placed over initial backfill to fill a trench.

B. Base Material: Course placed between the subgrade asphaltic concrete paving.

C. Borrow Soil: Satisfactory soil imported from off-site for use as fill or backfill.

D. Excavation: Removal of material encountered above subgrade elevations and to lines and dimensions indicated.
   1. Authorized Additional Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions as directed by Engineer. Authorized additional excavation and replacement material will be paid for according to Contract provisions for changes in the Work.

E. Fill: Soil materials used to raise existing grades.

F. Subgrade: Surface or elevation remaining after completing excavation, or top surface of a fill or backfill immediately below base material.

1.04 SUBMITTALS

A. Material Test Reports: From a qualified testing agency indicating and interpreting test results for compliance of the following with requirements indicated:
   1. Classification according to ASTM D 2487 of each borrow soil material proposed for fill and backfill.
   2. Laboratory compaction curve according to ASTM D 698 for each borrow soil material proposed for fill and backfill.

1.05 PROJECT CONDITIONS

A. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted in writing by Owner and then only after arranging to provide temporary utility services according to requirements indicated.

1. Notify Owner not less than two days in advance of proposed utility interruptions.
2. Do not proceed with utility interruptions without Owner's written permission.
3. Contact utility-locator service for area where Project is located before excavating.

B. Demolish and completely remove from site existing underground utilities indicated to be removed. Coordinate with utility companies to shut off services if lines are active.

PART 2 - PRODUCTS

2.01 SOIL MATERIALS

A. General: Provide borrow soil materials when sufficient satisfactory soil materials are not available from excavations.

B. Satisfactory Soils: On-site soils are suitable for use as fill within the pavement areas, provided they are free from organics and debris. Select fill must be used for grade adjustments in the helipad area.

C. Unsatisfactory Soils: Materials, which do not comply with the requirements for acceptable material or which, cannot be compacted to the specified or indicated density.

D. Subgrade: Stabilize the subgrade to materials as specified by Texas Department of Transportation. The subgrade material should be compacted to at least 98 percent of the modified Proctor maximum dry density (AASHTO T-180).

E. Base Material: The limerock base course should have a minimum Limerock Bearing Ratio (LBR) of 100 and should be compacted to 98 percent of the modified Proctor maximum dry density (AASHTO T-180).

F. Select Fill: USCS Classification CL and/or SC, with a Plasticity Index between 10 and 20.

PART 3 - EXECUTION

3.01 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earthwork operations.

B. Provide protective insulating materials to protect subgrades and foundation soils against freezing temperatures or frost.

3.02 DEWATERING

A. Prevent surface water and ground water from entering excavations, from ponding on prepared subgrades, and from flooding Project site and surrounding area.

B. Protect subgrades from softening, undermining, washout, and damage by rain or water accumulation.

1. Reroute surface water runoff away from excavated areas. Do not allow water to accumulate in excavations. Do not use excavated trenches as temporary drainage ditches.

3.03 EXCAVATION, GENERAL

A. Unclassified Excavation: Excavate to subgrade elevations regardless of the character of surface and subsurface conditions encountered. Unclassified excavated materials may include rock, soil materials, and obstructions. No changes in the Contract Sum or the Contract Time will be authorized for rock excavation or removal of obstructions.

1. If excavated materials intended for fill and backfill include unsatisfactory soil materials and rock, replace with satisfactory soil materials.

3.04 EXCAVATION FOR WALKS AND PAVEMENTS

A. Excavate surfaces under walks and pavements to indicated lines, cross sections, elevations, and subgrades.

3.05 EXCAVATION FOR UTILITY TRENCHES

A. Excavate trenches to indicated gradients, lines, depths, and elevations.

B. Excavate trenches to uniform widths to provide the following clearance on each side of pipe or conduit. Excavate trench walls vertically from trench bottom to 12 inches (300 mm) higher than top of pipe or conduit, unless otherwise indicated.

C. Trench Bottoms: Excavate trenches 4 inches (100 mm) deeper than bottom of pipe elevation to allow for bedding course. Hand excavate for bell of pipe.

1. Excavate trenches 6 inches (150 mm) deeper than elevation required in rock or other unyielding bearing material to allow for bedding course.

3.06 SUBGRADE INSPECTION

A. Notify Testing Agency when excavations have reached required subgrade.

B. If Testing Agency determines that unsatisfactory soil is present, continue excavation and replace with compacted backfill or fill material as directed.

1. Proof-roll subgrade below pavements with heavy pneumatic-tired equipment to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades. Completely proof-roll subgrade in one direction, repeating proof-rolling in direction perpendicular to first direction. Limit vehicle speed to 3 mph (5 km/h).
2. Proof-roll with a loaded 10-wheel, tandem-axle dump truck weighing not less than 20 tons.
3. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by Engineer, and replace with compacted backfill or fill as directed.

C. Authorized additional excavation and replacement material will be paid for according to Contract provisions for changes in the Work.

D. Reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities, as directed by Engineer, without additional compensation.

3.07 STORAGE OF SOIL MATERIALS

A. Stockpile borrow soil materials and excavated satisfactory soil materials without intermixing. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.

1. Stockpile soil materials away from edge of excavations. Do not store within drip line of remaining trees.

3.08 BACKFILL

A. Place all backfill in strict accordance with Geotechnical Report for this project.

B. Place and compact backfill in excavations promptly, but not before completing the following:

1. Construction below finish grade including, where applicable, subdrainage, dampproofing, waterproofing, and perimeter insulation.
2. Surveying locations of underground utilities for Record Documents.

3. Testing and inspecting underground utilities.
4. Removing concrete formwork.
5. Removing trash and debris.
6. Removing temporary shoring and bracing, and sheeting.
7. Installing permanent or temporary horizontal bracing on horizontally supported walls.

C. Place backfill on subgrades free of mud, frost, snow, or ice.

3.09 SOIL FILL

A. Plow, scarify, bench, or break up sloped surfaces steeper than 1 vertical to 4 horizontal so fill material will bond with existing material.

B. Place and compact fill material in layers to required elevations as follows:
1. Under grass and planted areas, use satisfactory soil material.
2. Under walks and pavements, use satisfactory soil material.

C. Place soil fill on subgrades free of mud, frost, snow, or ice.

3.10 SOIL MOISTURE CONTROL

A. Uniformly moisten or aerate subgrade and each subsequent fill or backfill soil layer before compaction to within 2 percent of optimum moisture content.
1. Do not place backfill or fill soil material on surfaces that are muddy, frozen, or contain frost or ice.
2. Remove and replace, or scarify and air dry otherwise satisfactory soil material that exceeds optimum moisture content by 2 percent and is too wet to compact to specified dry unit weight.

3.11 COMPACTION OF SOIL BACKFILLS AND FILLS

A. All compaction in strict accordance with Geotechnical recommendations.

B. Place backfill and fill soil materials in layers not more than 8 inches (200 mm) in loose depth for material compacted by heavy compaction equipment.

C. Place backfill and fill soil materials evenly on all sides of structures to required elevations, and uniformly along the full length of each structure.

D. Compact soil materials to not less than the following percentages of maximum dry unit weight according to ASTM D 698:
1. Under pavements, scarify and recompact existing subgrade and each layer of backfill or fill soil material at 95 percent. Refer to Geotechnical Report for thickness.
2. Under walkways, scarify and recompact top 6 inches (150 mm) below subgrade and compact each layer of backfill or fill soil material at 95 percent.
3. Under lawn or unpaved areas, scarify and recompact top 6 inches (150 mm) below subgrade and compact each layer of backfill or fill soil material at 95 percent.
4. For utility trenches, compact each layer of initial and final backfill soil material at 95 percent.

3.12 GRADING

A. General: Uniformly grade areas to a smooth surface, free of irregular surface changes. Comply with compaction requirements and grade to cross sections, lines, and elevations indicated.
1. Provide a smooth transition between adjacent existing grades and new grades.

2. Cut out soft spots, fill low spots, and trim high spots to comply with required surface tolerances.

3.13 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified independent geotechnical engineering testing agency to perform field quality-control testing.

B. Testing agency will test compaction of soils in place according to ASTM D 1556, ASTM D 2167, ASTM D 2922, and ASTM D 2937, as applicable. Tests will be performed at the following locations and frequencies:

1. Paved Areas: At subgrade and at each compacted fill and backfill layer, at least 1 test for every 2000 sq. ft. (186 sq. m) or less of paved area, as indicated in Geotechnical Report, but in no case fewer than 3 tests.
2. Trench Backfill: At each compacted initial and final backfill layer, at least 1 test for each 150 feet (46 m) or less of trench length, but no fewer than 2 tests.

C. When testing agency reports that subgrades, fills, or backfills have not achieved degree of compaction specified, scarify and moisten or aerate, or remove and replace soil to depth required; re-compact and retest until specified compaction is obtained.

3.14 PROTECTION

A. Protecting Graded Areas: Protect newly graded areas from traffic, freezing, and erosion. Keep free of trash and debris.

B. Repair and reestablish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or where they lose compaction due to subsequent construction operations or weather conditions.

1. Scarify or remove and replace soil material to depth as directed by Engineer; reshape and recompact.

C. Where settling occurs before Project correction period elapses, remove finished surfacing, backfill with additional soil material, compact, and reconstruct surfacing.

1. Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of restoration to greatest extent possible.

3.15 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Disposal: Remove surplus satisfactory soil and waste material, including unsatisfactory soil, trash, and debris, and legally dispose of it off Owner's property.

END OF SECTION

SECTION 31 2310
BUILDING EXCAVATION AND FILL

PART 1 – GENERAL

1.01 DESCRIPTION

A. Work included: Excavate, backfill, compact, and grade for the building to the elevations shown on the Drawings, as specified herein, and as needed to meet the requirements of the construction shown in the Contract Documents.

B. Related work:
   1. Documents affecting work of this Section include, but are not necessarily limited to, General Conditions, Supplementary Conditions, and Sections in Division 1 of these Specifications.
   2. Section 00 3132 – Geotechnical Data.
   3. Section 01 4000 – Quality Requirements.

1.02 QUALITY ASSURANCE

A. Use adequate numbers of skilled workers who are thoroughly trained and experienced in the necessary crafts and who are completely familiar with the specified requirements and the methods needed for proper performance of the work of this Section.

B. Use equipment adequate in size, capacity, and numbers to accomplish the work of this Section in a timely manner.

C. In addition to complying with requirements of governmental agencies have jurisdiction, comply with the directions of the Geotechnical Engineer.

1.03 PRODUCT HANDLING

A. Comply with pertinent provisions of Supplementary Conditions.

PART 2 – PRODUCTS

2.01 SOIL MATERIALS

A. Provide fill as indicated on the Drawing Sheets prepared by the various design professionals on the project.

PART 3 – EXECUTION

3.01 SURFACE CONDITIONS

A. Examine the area and conditions under which work of this Section will be performed. Correct conditions detrimental to timely and proper completion of the Work. Do not proceed until unsatisfactory conditions are corrected.

3.02 FINISH ELEVATIONS AND LINES

A. Finish grades shall be as shown on the site plan and shall form straight lines of slope between elevation markings.

3.03 PROCEDURES

A. Utilities:
   1. Unless shown to be removed, protect active utility lines shown on the Drawings or other wise made known to the Contractor prior to excavating. If damaged, repair or replace at no additional cost to the Owner.
   2. If active utility lines are encountered, and are not shown on the Drawings or otherwise made known to the Contractor, promptly take necessary steps to assure that service is not interrupted.
   3. If service is interrupted as a result of work under this Section, immediately restore service by repairing the damaged utility at no additional cost to the Owner.
   4. If existing utilities are found to interfere with the permanent facilities being constructed under this Section, immediately notify the Architect and secure his instructions.

5. Do not proceed with permanent relocation of utilities until written instructions are received from the Architect.

B. Protection of persons and property:
   1. Barricade open holes and depressions occurring as part of the Work, and post warning lights on property adjacent to or with public access.
   2. Operate warning lights during hours from dusk to dawn each day and as otherwise required.
   3. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, washout, and other hazards created by operations under this Section.

C. De-watering:
   1. Remove all water, including rain water, encountered during trench and sub-structure work to an approved location by pumps, drains, and other approved methods.
   2. Keep excavations and site construction area free from water.
   3. Use means necessary to prevent dust becoming a nuisance to the public, to neighbors, and to other work being performed on or near the site.

D. Maintain access to adjacent areas at all times.

3.04 EXCAVATING

A. Perform excavating of every type of material encountered within the limits of the Work to the lines, grades, and elevations indicated and specified herein.

B. Surplus material:
   1. Dispose of unsatisfactory excavated material, and surplus satisfactory excavated material, away from the Project site.

C. Unauthorized excavation:
   1. Unauthorized excavation consists of removal of materials beyond indicated sub-grade elevations or dimensions without specific instruction from the Architect or the Geotechnical Engineer.
   2. Under footings, foundations, or retaining walls:
      a. Fill unauthorized excavations by extending the indicated bottom elevation of the footing or base to the excavation bottom, without altering the required top elevation.
      b. When acceptable to the Geotechnical Engineer, lean concrete fill may be used to bring the bottom elevation to proper position.
   3. Elsewhere, backfill and compact unauthorized excavations as specified for authorized excavations, unless otherwise directed by the Geotechnical Engineer.

D. Stability of excavations:
   1. Slope sides in accordance with OSHA requirements. For proposal purposes, proposers shall assume 1.5H:1V maximum slope. Steeper slopes are permitted only when allowed by OSHA or the Geotechnical Engineer. Calculations and drawings sealed by an Engineer licensed in the State of Texas, shall be submitted to the Architect and Engineer for design of any alternative excavation protection systems.
   2. Shore and brace where sloping is not possible because of space restrictions or stability of the materials being excavated.
   3. Maintain sides and slopes of excavations in a safe condition until completion of backfilling.

E. Shoring and bracing:
   1. Provide materials for shoring and bracing as may be necessary for safety of personnel, protection of work, and compliance with requirements of governmental agencies having jurisdiction.
   2. Maintain shoring and bracing in excavations regardless of the time period excavations will be open.
   3. Carry shoring and bracing down as excavation progresses.

F. Excavating for structures:

1. Conform to elevations and dimensions shown within a tolerance of 0.10 ft., and extending a sufficient distance from footings and foundations to permit placing and removing concrete formwork, installation of services, other construction required, and for inspection.
2. In excavating for footings and foundations, take care not to disturb bottom of excavation:
   a. Excavate by hand tools to final grade just before concrete is placed.
   b. Trim bottoms to required lines and grades to leave solid base to receive concrete.
   c. Where continuous or spot footings are shown to be bearing on the soil, compact the bottom of the footing as noted in Paragraph 3.06 of this Section. Trenches and foundation holes shall be dry and free of water when concrete is placed.
3. Excavate for footings and foundations only after general site excavating, filling, and grading are complete.

3.05 FILLING AND BACKFILLING

A. General:
   1. For each classification listed below, place acceptable soil material in layers to required sub-grade elevations. Provide fill and backfill as indicated on the Drawing Sheets prepared by the various design professionals on the project.

B. Backfill excavations as promptly as progress of the Work permits, but not until completion of the following.
   1. Acceptance of construction below finish grade including, where applicable, dampproofing and waterproofing.
   2. Inspecting, testing, approving, and recording locations of underground utilities.
   3. Removing concrete formwork.
   4. Removing shoring and bracing, and backfilling of voids with satisfactory materials.
   5. Removing trash and debris.
   6. Placement of horizontal bracing on horizontally supported walls.

C. Placing and compacting:
   1. Place backfill and fill materials in layers not more than 8" in loose depth.
   2. Before compacting, moisten or aerate each layer as necessary to provide the optimum moisture content.
   3. Compact each layer to required percentage of maximum density for area.
   4. Do not place backfill or fill material on surfaces that are muddy, frozen, or containing frost or ice.
   5. Place backfill and fill materials evenly adjacent to structures, to required elevations.
   6. Take care to prevent wedging action of backfill against structures by carrying the material uniformly around the structure to approximately the same elevation in each lift.
   7. Where the construction includes basement or other underground walls having structural floors over them, do not backfill such walls until the structural floors are in place and have attained sufficient strength to support the walls.

3.06 COMPACTING

A. Compact the soil within the building lines as indicated in the Structural drawings and the geotechnical report. If there are any discrepancies, the Contractor shall compact to the most stringent case of these.

B. Control soil compaction during construction outside building lines to provide the minimum percentage of density specified for each area as determined according to ASTM D698 Standard Proctor Density.

3.07 FIELD QUALITY CONTROL

A. An Special Inspection and Testing Agency (SITA) will perform field quality control tests and inspections, as specified in Section 01 4533.

3.08 MAINTENANCE

A. Protect newly graded areas.

B. Where completed compacted areas are disturbed by subsequent construction operations or adverse weather, scarify the surface, reshape, and compact to the required density prior to further construction.

PART 4 – TRENCHING REQUIREMENTS

4.01 GENERAL

A. These requirements shall be used for all trench excavations deeper than five (5) feet. The excavating and trenching operation manual of OSHA, Subpart B (latest edition) shall be the minimum governing requirement of this item and is hereby made a part of this specification.
   1. Banks more than 5 feet high shall be shored, laid back to a stable slope, or some other equivalent means of protection shall be provided where employees may be exposed to moving ground or cave-ins. Refer to Table P-1 as a guide sloping of banks. Trenches less than 5 feet in depth shall also be effectively protected when examination of the ground indicates hazardous ground movement may be expected.
   2. Sides of trenches in unstable or soft material, 5 feet or more in depth, shall be shored, sheeted, braced, sloped, or otherwise supported by means of sufficient strength to protect the employees working within them. See Table P-1, P-2 (following paragraph (l) of this section.)
   3. Sides of trenches in hard or compact soil, including embankments, shall be shored or otherwise supported when the trench is more than 5 feet in depth and 8 feet or more in length. In lieu of shoring, the sides of the trench above the 5-foot level may be sloped to preclude collapse, but shall not be steeper than a 1-foot rise to each 1/2-foot horizontal. When the outside diameter of a pipe is greater than 6 feet, a bench of 4-foot minimum shall be provided at the toe of the sloped portion.
   4. Materials used for sheeting and sheet piling, bracing, shoring, and underpinning, shall be in good serviceable condition, and timbers used shall be sound and free from large or loose knots, and shall be designed and installed so as to be effective to the bottom of the excavation.
   5. Additional precautions by way of shoring and bracing shall be taken to prevent slides or cave-ins when excavations or trenches are made in locations adjacent to backfilled excavations, or where excavations are subjected to vibrations from railroad or highway traffic, the operation of machinery, or any other source.
   6. Employees entering bell-bottom pier holes shall be protected by the installation of a removable-type casing of sufficient strength to resist shifting of the surrounding earth. Such temporary protection shall be provided for the full depth of that part of each pier hole which is above the bell. A lifeline, suitable for instant rescue and securely fastened to a shoulder harness, shall be worn by each employee entering the shafts. This lifeline shall be individually manned and separate from any line used to remove materials excavated from the bell footing.
   7. Minimum requirements for trench timbering shall be in accordance with Table P-2.
   8. Braces and diagonal shores in a wood shoring system shall not be subjected to compressive stress in excess of values given by the following formula:
      a. S=3-20L/D
      b. Maximum ratio L/D=50
      c. Where: L= Length, unsupported, in inches.
      d. D= Least side of the timber in inches.
      e. S= Allowable stress in pounds per square inch of cross-section.
   9. When employees are required to be in trenches 4 feet deep or more, an adequate means of exit, such as a ladder or steps shall be provided and located so as to require no more than 25 feet of lateral travel.
   10. Bracing or shoring of trenches shall be carried along with the excavation.
   11. Cross braces or trench jacks shall be placed in true horizontal position, be spaced vertically, and be secured to prevent sliding, falling, or kickouts.

12. Portable trench boxes or sliding trench shields may be used for the protection of personnel in lieu of a shoring system or sloping. Where such trench boxes or shields are used, they shall be designed, constructed, and maintained in a manner which will provide protection equal to or greater than the sheeting or shoring required for the trench.
13. Backfilling and removal of trench supports shall progress together from the bottom of the trench.
14. Jacks or braces shall be released slowly and, in unstable soil, ropes shall be used to pull out the jacks or braces from above after employees have cleared the trench.

B. Definitions applicable to this subpart:
1. "Accepted engineering requirements (or practices)" - Those requirements or practices which are compatible with standards required by a registered architect, a registered professional engineer, or other duly licensed or recognized authority.
2. "Angle of repose" - The greatest angle above the horizontal plane at which a material will lie without sliding.
3. "Bank" - A mass of soil rising above a digging level.
4. "Belled excavation" - A part of a shaft or footing excavation, usually near the bottom and bell-shaped; i.e., an enlargement of the cross section above.
5. "Braces (trench)" - The horizontal members of the shoring system whose ends bear against the uprights or stringers.
6. "Excavation" - Any manmade cavity or depression in the earth's surface, including its sides, walls, or faces, formed by earth removal and producing unsupported earth conditions by reasons of the excavation. If installed forms or similar structures reduce the depth-to-width relationship, an excavation may become a trench.
7. "Faces" - See paragraph (k) of this section.
8. "Hard compact soil" - All earth materials not classified as running or unstable.
9. "Kickouts" - Accidental release or failure of a shore or brace.
10. "Sheet pile" - A pile, or sheeting, that may form one of a continuous interlocking line, or a row of timber, concrete, or steel piles, driven in close contact to provide a tight wall to resist the lateral pressure of water, adjacent earth, or other materials.
11. "Sides", "Walls", or "Faces" - The vertical or inclined earth surfaces formed as a result of excavation work.
12. "Slope" - The angle with the horizontal at which a particular earth material will stand indefinitely without movement.
13. "Stringers" (wales) - The horizontal members of a shoring system whose sides bear against the uprights or earth.
14. "Trench" - A narrow excavation made below the surface of the ground. In general, the depth is greater than the width, but the width of a trench is not greater than 15 feet.
15. "Trench jack" - Screw or hydraulic type jacks used as cross bracing in a trench shoring system.
16. "Trench shield" - A shoring system composed of steel plates and bracing, welded or bolted together, which support the walls of a trench from the ground level to the trench bottom and which can be moved along as work progresses.
17. "Unstable soil" - Earth material, other than running, that because of its nature or the influence of related conditions, cannot be depended upon to remain in place without extra support, such as would be furnished by a system of shoring.
18. "Uprights" - The vertical members of a shoring system.
19. "Wales" - See paragraph (m) of this section.
20. "Walls" - See paragraph (k) of this section.

END OF SECTION

SECTION 31 3116
TERMITE CONTROL

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Chemical soil treatment.

1.02 REFERENCE STANDARDS

A. Title 7, United States Code, 136 through 136y - Federal Insecticide, Fungicide and Rodenticide Act 2019.

1.03 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements, for submittal procedures.

B. Product Data: Indicate toxicants to be used, composition by percentage, dilution schedule, intended application rate.

C. Test Reports: Indicate regulatory agency approval reports when required.

D. Manufacturer's Certificate: Certify that toxicants meet or exceed specified requirements.

E. Certificate of compliance from authority having jurisdiction indicating approval of toxicants.

F. Manufacturer's Application Instructions: Indicate caution requirements and materials list of proposed items to be provided under this section.

G. Record and document moisture content of soil before application, date and rate of application, areas of application, and diary of toxicity meter readings and corresponding soil coverage.

H. Installer Qualifications: Company specializing in performing work of the type specified and with minimum 5 years years of documented experience.

I. Maintenance Data: Indicate re-treatment schedule .

J. Warranty: Submit warranty and ensure that forms have been completed in Owner's name.

1.04 QUALITY ASSURANCE

A. Installer Qualifications: Company specializing in performing this type of work and:
   1. Having minimum of 5 years documented experience.
   2. Approved by manufacturer of treatment materials.
   3. Licensed in Texas.

1.05 WARRANTY

A. See Section 01 7800 - Closeout Submittals, for additional warranty requirements.

B. Provide five year installer's warranty against damage to building caused by termites.
   1. Include coverage for repairs to building and to contents damaged due to building damage. Repair damage and, if required, re-treat.
   2. Inspect annually and report in writing to Owner. Provide inspection service for 5 years from Date of Substantial Completion.
   3. Make inspections, retreatment, and repairs at no additional cost to the Owner.

PART 2 PRODUCTS

2.01 CHEMICAL SOIL TREATMENT

A. Toxicant Chemical: EPA Title 7, United States Code, 136 through 136y approved; synthetically color dyed to permit visual identification of treated soil.

B. Diluent: Recommended by toxicant manufacturer.

C. Manufacturers:
   1. Bayer Environmental Science Corp: www.backedbybayer.com/pest-management.
   2. FMC Professional Solutions: www.fmcprosolutions.com.
   3. Syngenta Professional Products: www.syngentaprofessionalproducts.com.

4. Substitutions: See Section 01 6000 - Product Requirements.

D. Mixes: Mix toxicant to manufacturer's instructions.

E. If combinations of toxicants are approved by governmental agencies having jurisdiction, provide toxicants having such approval and in the maximum strength so approved, at no additional cost to the Owner.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that soil surfaces are unfrozen, sufficiently dry to absorb toxicant, and ready to receive treatment.

B. Verify final grading is complete.

3.02 APPLICATION - CHEMICAL TREATMENT

A. Comply with requirements of U.S. EPA and applicable state and local codes.

B. Spray apply toxicant in accordance with manufacturer's instructions.

C. Apply toxicant at following locations:
1. Under Slabs-on-Grade.
2. In Crawl Spaces.
3. At Interior Side of Foundation Surface.
4. Utility Entrances
5. Immediately below expansion joints, control joints, and all areas where slab will be penetrated by construction features.
6. Where exterior facings or veneers extend below grade level along the exterior side of all foundation walls.
7. Where unit masonry foundation construction is used.

D. Under slabs, apply toxicant immediately prior to installation of vapor barrier or void forms.

E. At foundation walls, apply toxicant immediately prior to finish grading work outside foundations.

F. Apply extra treatment to structure penetration surfaces such as pipe or ducts, and soil penetrations such as grounding rods or posts.

G. Re-treat disturbed treated soil with same toxicant as original treatment.

H. If inspection or testing identifies the presence of termites, re-treat soil and re-test.

3.03 PROTECTION

A. Do not permit soil grading over treated work.

END OF SECTION

SECTION 31 3213
SOIL MIXING STABILIZATION

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. All applicable provisions of the Bidding and Contract Requirements, and Division 1 - General Requirements shall govern the work under this section.

B. This Section includes soil mixing stabilization and specialties outside the building, including the following:
   1. Excavation, treatment, and backfilling of subgrade for lime stabilization.

C. All soil mixing stabilization to be performed and materials used shall be in accordance with the Geotechnical Engineering Report. In the event of a discrepancy between the above-referenced report and any portion of this specification section, the above-referenced report will govern. The Contractor shall contact the Engineer in the event of a discrepancy.

1.02 REFERENCE STANDARDS

A. American Society for Testing Materials (ASTM) latest edition
   1. C150 Portland Cement
   2. C618 Fly Ash and Raw or Calcined Natural Pozzolan for use as a Mineral Admixture in Portland Cement Concrete
   3. C 977 Quicklime and Hydrated Lime for Soil Stabilization
   4. D 1633 Compressive Strength of Molded Soil-Cement Cylinders

B. American Association of State Highway and Transportation Officials (AASHTO) latest edition
   1. M 216 Lime for Soil Stabilization

C. National Lime Association (NLA)
   1. Bulletin 326 Lime Stabilization Construction Manual

D. Texas Department of Transportation Standards
   1. TXDOT Item 260 Lime Treatment (Road Mixed)
   2. TXDOT Item 265 Fly Ash or Lime – Fly Ash Treatment (Road Mixed)

1.03 ENVIRONMENTAL REQUIREMENTS

A. Do not install mixed materials in wind in excess of 10 mph or when temperature is below 40 degrees Fahrenheit.

1.04 QUALITY ASSURANCE

A. Perform work in accordance with state and local standards in conjunction with requirements specified herein.

1.05 SUBMITTALS

A. Submit 30-pound sample of each material to be used at the site in airtight containers to the independent testing laboratory or submit gradation and certification of material that is to be used to the independent testing laboratory for review.

B. Submit name of each materials supplier and specific type and source of each material. Change in source requires approval of Owner.

C. Submit mix design and materials mix ratio that will achieve specified requirements of state and local agencies for soil stabilization.

PART 2 – PRODUCTS

2.01 MATERIALS

A. Hydrated Lime: TXDOT Item 260

2.02 EQUIPMENT

A. Perform operations using suitable, well maintained equipment capable of excavating subsoil, mixing and placing materials, wetting, consolidating, and compacting of material.

PART 3 – EXECUTION

3.01 PREPARATION

A. Obtain approval from the independent testing laboratory of mix design before proceeding with placement.
B. Start stabilization only when weather and soil conditions are favorable for successful application of proposed material.
C. Proofroll subgrade to identify areas in need of stabilization in accordance with Section 312000.

3.02 EXCAVATION

A. Excavate subsoil to depth sufficient to accommodate soil stabilization.
B. Remove lumped subsoil, boulders, and rock that interfere with achieving uniform subsoil conditions.
C. Notify Construction Manager of unexpected subsurface conditions. Discontinue affected work in area until notified to resume work.
D. Correct areas over-excavated in accordance with Section 31 20 00.
E. Remove excess excavated material from site.

3.03 SOIL TREATMENT AND BACKFILLING

A. Lime Stabilized Subgrade: Where indicated on Construction Drawings or as required after continual failure, treat prepared subgrade with hydrated lime in accordance with state highway department specifications (TXDOT Item 260).
   1. A minimum of 48 hours of tempering time shall be provided before final mixing.
   2. Subgrade soils shall be treated with lime at a rate of 6 to 8 percent lime, by dry weight.
B. Subsoil shall be in accordance with Section 31 20 00.
C. Maintain optimum moisture of mixed materials to attain required stabilization and compaction.
D. Finish subgrade surface in accordance with Section 31 20 00.
E. Remove surplus mix materials from site at no additional cost to the Owner.

3.04 CURING

A. Immediately following compaction of mix, seal top surface with curing seal.
B. Do not permit traffic for 72 hours after sealing top surface.

3.05 FIELD QUALITY CONTROL

A. Compression test and analysis of hardened fill material will be performed in accordance with Section 02300.
B. If tests indicate work does not meet specified requirements, remove work, replace and retest, at no cost to owner.

END OF SECTION

SECTION 31 5000
EXCAVATION SUPPORT AND PROTECTION

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Section includes temporary excavation support and protection systems.

B. Related Requirements:

1. Section 013233 "Photographic Documentation" for recording preexisting conditions and excavation support and protection system progress.
2. Section 312000 "Earth Moving" for excavating and backfilling and for controlling surface-water runoff and ponding.
3. Section 312319 "Dewatering" for dewatering excavations.

1.03 PREINSTALLATION MEETINGS

A. Pre-installation Conference: Conduct conference at Project site.

1. Review geotechnical report.
2. Review existing utilities and subsurface conditions.
3. Review coordination for interruption, shutoff, capping, and continuation of utility services.
4. Review proposed excavations.
5. Review proposed equipment.
6. Review monitoring of excavation support and protection system.
7. Review coordination with waterproofing.
8. Review abandonment or removal of excavation support and protection system.

1.04 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, performance properties, and dimensions of individual components and profiles, and calculations for excavation support and protection system.

B. Shop Drawings: For excavation support and protection system, prepared by or under the supervision of a qualified professional engineer.

1. Include plans, elevations, sections, and details.
2. Show arrangement, locations, and details of soldier piles, piling, lagging, tiebacks, bracing, and other components of excavation support and protection system according to engineering design.
3. Indicate type and location of waterproofing.
4. Include a written plan for excavation support and protection, including sequence of construction of support and protection coordinated with progress of excavation.

1.05 INFORMATIONAL SUBMITTALS

A. Contractor Calculations: For excavation support and protection system. Include analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

B. Existing Conditions: Using photographs, show existing conditions of adjacent construction and site improvements that might be misconstrued as damage caused by inadequate performance of excavation support and protection systems. Submit before Work begins.

C. Record Drawings: Identify locations and depths of capped utilities, abandoned-in-place support and protection systems, and other subsurface structural, electrical, or mechanical conditions.

1.06 FIELD CONDITIONS

A. Interruption of Existing Utilities: Do not interrupt any utility serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility according to requirements indicated:
   1. Notify Owner no fewer than two days in advance of proposed interruption of utility.
   2. Do not proceed with interruption of utility without Owner's written permission.

B. Project-Site Information: A geotechnical report has been prepared for this Project and is available for information only. The opinions expressed in this report are those of a geotechnical engineer and represent interpretations of subsoil conditions, tests, and results of analyses conducted by a geotechnical engineer. Owner is not responsible for interpretations or conclusions drawn from the data.

C. Survey Work: Engage a qualified land surveyor or professional engineer to survey adjacent existing buildings, structures, and site improvements; establish exact elevations at fixed points to act as benchmarks. Clearly identify benchmarks and record existing elevations.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. Provide, monitor, and maintain excavation support and protection system capable of supporting excavation sidewalls and of resisting earth and hydrostatic pressures and superimposed and construction loads.
   1. Contractor Design: Design excavation support and protection system, including comprehensive engineering analysis by a qualified professional engineer.
   2. Prevent surface water from entering excavations by grading, dikes, or other means.
   3. Install excavation support and protection systems without damaging existing buildings, structures, and site improvements adjacent to excavation.
   4. Continuously monitor vibrations, settlements, and movements to ensure stability of excavations and constructed slopes and to ensure that damage to permanent structures is prevented.

2.02 MATERIALS

A. General: Provide materials that are either new or in serviceable condition.

B. Structural Steel: ASTM A 36/A 36M, ASTM A 690/A 690M, or ASTM A 992/A 992M.

C. Steel Sheet Piling: ASTM A 328/A 328M, ASTM A 572/A 572M, or ASTM A 690/A 690M; with continuous interlocks.
   1. Corners: [Site-fabricated mechanical interlock] [Roll-formed corner shape with continuous interlock].

D. Wood Lagging: Lumber, mixed hardwood, nominal rough thickness of size and strength required for application.

E. Shotcrete: Comply with Section 033713 "Shotcrete" for shotcrete materials and mixes, reinforcement, and shotcrete application.

F. Cast-in-Place Concrete: ACI 301, of compressive strength required for application.

G. Reinforcing Bars: ASTM A 615/A 615M, Grade 60, deformed.

H. Tiebacks: Steel bars, ASTM A 722/A 722M.

I. Tiebacks: Steel strand, ASTM A 416/A 416M.

PART 2 - EXECUTION

3.01 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards that could develop during excavation support and protection system operations.
   1. Shore, support, and protect utilities encountered.

B. Install excavation support and protection systems to ensure minimum interference with roads, streets, walks, and other adjacent occupied and used facilities.
   1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.

C. Locate excavation support and protection systems clear of permanent construction so that construction and finishing of other work is not impeded.

3.02 SOLDIER PILES AND LAGGING

A. Install steel soldier piles before starting excavation. Extend soldier piles below excavation grade level to depths adequate to prevent lateral movement. Space soldier piles at regular intervals not to exceed allowable flexural strength of wood lagging. Accurately align exposed faces of flanges to vary not more than 2 inches from a horizontal line and not more than 1:120 out of vertical alignment.

B. Install wood lagging within flanges of soldier piles as excavation proceeds. Trim excavation as required to install lagging. Fill voids behind lagging with soil, and compact.

C. Install wales horizontally at locations indicated on Drawings and secure to soldier piles.

3.03 SHEET PILING

A. Before starting excavation, install one-piece sheet piling lengths and tightly interlock vertical edges to form a continuous barrier.

B. Accurately place the piling, using templates and guide frames unless otherwise recommended in writing by the sheet piling manufacturer. Limit vertical offset of adjacent sheet piling to 60 inches. Accurately align exposed faces of sheet piling to vary not more than 2 inches from a horizontal line and not more than 1:120 out of vertical alignment.

C. Cut tops of sheet piling to uniform elevation at top of excavation.

3.04 TIEBACKS

A. Drill, install, grout, and tension tiebacks.

B. Test load-carrying capacity of each tieback and replace and retest deficient tiebacks.
   1. Have test loading observed by a qualified professional engineer responsible for design of excavation support and protection system.

C. Maintain tiebacks in place until permanent construction is able to withstand lateral earth and hydrostatic pressures.

3.05 BRACING

A. Bracing: Locate bracing to clear columns, floor framing construction, and other permanent work. If necessary to move brace, install new bracing before removing original brace.
   1. Do not place bracing where it will be cast into or included in permanent concrete work unless otherwise approved by Architect.
   2. Install internal bracing if required to prevent spreading or distortion of braced frames.

3. Maintain bracing until structural elements are supported by other bracing or until permanent construction is able to withstand lateral earth and hydrostatic pressures.

3.06 FIELD QUALITY CONTROL

A. Survey-Work Benchmarks: Resurvey benchmarks as required during installation of excavation support and protection systems, excavation progress, and for as long as excavation remains open. Maintain an accurate log of surveyed elevations and positions for comparison with original elevations and positions. Promptly notify Architect if changes in elevations or positions occur or if cracks, sags, or other damage is evident in adjacent construction.

B. Promptly correct detected bulges, breakage, or other evidence of movement to ensure that excavation support and protection system remains stable.

C. Promptly repair damages to adjacent facilities caused by installation or faulty performance of excavation support and protection systems.

3.07 REMOVAL AND REPAIRS

A. Remove excavation support and protection systems when construction has progressed sufficiently to support excavation and earth and hydrostatic pressures. Remove in stages to avoid disturbing underlying soils and rock or damaging structures, pavements, facilities, and utilities.

1. Remove excavation support and protection systems to a minimum depth of 48 inches below overlying construction and abandon remainder.
2. Fill voids immediately with approved backfill compacted to density specified in Section 312000 "Earth Moving."
3. Repair or replace, as approved by Architect, adjacent work damaged or displaced by removing excavation support and protection systems.

B. Leave excavation support and protection systems permanently in place.

END OF SECTION

SECTION 31 6329
DRILLED CONCRETE PIERS AND SHAFTS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Machine drilled shaft and belled base.

B. Concrete and reinforcement.

C. Shaft liner, if required.

1.02 RELATED REQUIREMENTS

A. Section 01 1400 - Work Restrictions

B. Section 01 4000 - Contractor's Quality Assurance

C. Section 01 4533 - Code-Required Quality Control

D. Section 03 2000 - Concrete Reinforcing: Requirements for concrete reinforcement.

E. Section 03 3000 - Cast-in-Place Concrete: Requirements for concrete.

1.03 PRICE AND PAYMENT PROCEDURES

A. Proposers shall assume all drilled piers shall be installed as shown on the construction documents as part of the construction, with adjustments made by unit price. The same unit price shall be used for adding linear feet as is used for deducting linear feet. If more than one unit price is submitted for each type, (e.g. if a different price is submitted for adding than for deducting), the average of the absolute values shall be used for adding and deducting. Proposers shall provide a unit price for each type of pier, $/LF, with the Proposal. If a unit price is not provided with the Proposal and made part of the Agreement with the Owner, the Contractor shall not begin installation of drilled piers until a unit price is proposed and the Owner agrees to the unit price. If a unit price is not agreed to by the Owner before drilled piers begin, the Architect will establish a unit price that the Architect believes to be fair and reasonable, based solely on the Architect's opinion, to make any cost adjustments if the actual piers vary from the designed piers. The Proposal and Unit Prices shall include costs of mobilizing equipment. For example, if equipment needs to be remobilized to drill piers at the end of the project, the Owner shall not be responsible for the costs of remobilization.

B. Designed Piers:
   1. Design Pier Quantity: Determined by the quantity of piers indicated in the Contract Documents. Refer to Typical Details and Plans. The Plans may not show all piers required by the typical details at, for example, site structures such as fences.
   2. Design Pier Length: By the linear foot measured from bottom of pier to top of pier elevation as indicated.
   3. Pier Casings: By the linear foot. Per Structural Drawings.

C. Actual Piers:
   1. Actual Pier Quantity: Determined by quantity of piers identified in the Project Record Documents.
   2. Actual Pier Length: Determined by length of piers identified in Project Record Documents.
   3. Pier Casings: By the linear foot. The actual cased length shall be defined from the top of the pier to the bottom of the casing. Any pier penetration below the bottom of the casing shall be considered uncased pier length.

D. Adjustments to the Contract Sum/Price will be made if the Actual Pier Quantity or Length differs from Design Pier Quantity or Length, based on unit prices established in the Agreement and as follows:
   1. Unit price per unit length. To calculate cost adjustment, multiply unit price by difference between the sum of the total Design Pier Lengths for all piers of each type on the project and Actual Pier Lengths for all piers of each type on the project.

2. The Contractor shall not be compensated for penetrations deeper than indicated to be required by the Owner's Testing Laboratory

E. Determination of Unit Measurements: Identified by site measurements and verified by Owner's testing laboratory. The Contractor shall notify the Laboratory when the last pier has been drilled and request a report from the Laboratory to assist with the calculation of cost adjustment. The Laboratory shall determine the difference between the sum of the total Design Pier Lengths for all piers of each type on the project and Actual Pier Lengths for all piers of each type on the project

1.04 REFERENCE STANDARDS

A. ACI 336.1 - Specification for the Construction of Drilled Piers 2001.

B. ASTM A36/A36M - Standard Specification for Carbon Structural Steel 2019.

C. ASTM A283/A283M - Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates 2018.

D. ASTM A929/A929M - Standard Specification for Steel Sheet, Metallic-Coated by the Hot-Dip Process for Corrugated Steel Pipe 2018.

1.05 ADMINISTRATIVE REQUIREMENTS

A. Preinstallation Meeting: Conduct a preinstallation meeting at least one week prior to the start of the work of this section; require attendance by all affected installers.

1.06 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements, for submittal procedures.

B. Shop Drawings:
1. Pier Diameter
2. Anticipated length
3. Pier reinforcement
4. Top of pier elevations

C. Project Record Documents: Record actual locations of piers, pier diameter, and pier length. Accurately record the following:
1. Sizes, lengths, and locations of piers.
2. Sequence of placement.
3. Final base and top elevations.
4. Deviation from indicated locations.
5. Placement and configuration of reinforcement deviations.

1.07 QUALITY ASSURANCE

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

PART 2 PRODUCTS

2.01 MATERIALS

A. Casing: Temporary casings of steel conforming to ASTM A 36 of sufficient strength to withstand handling and drilling stresses, concrete pressures, and surrounding earth and water pressures.

B. Concrete Materials and Mix: Specified in Section 03 3000.

C. Reinforcement: Specified in Section 03 2000; spiral wound. Spiral bars shall be smooth rod spiral, not deformed rebar. Vertical pier reinforcement shall not be spliced. Vertical bars shall be shipped to the project in stock lengths and field cut after measuring each pier.

D. Equipment: Appropriate for dewatering excavated shaft.

E. Reinforcement Supports:
1. Manufacturers

a. Subject to compliance with requirements indicated herein, provide products of one of the listed manufacturers.
b. Pier Sleds and Bolsters:
1) Pieresearch, 501 East Main Street, Arlington, TX, 800-342-2409, www.pieresearch.com.
2) Foundation Technologies, Inc., Tucker, GA, www.foundationtechnologies.com.
3) Blackthorn, Inc., 6113 Brookville Sale Road, Clayton, OH, www.blackthorn-inc.com.
4) EZ-Lok Products by Dayton Superior, 1002 Avenue T, Grand Prairie, TX, 800-745-3703, www.daytonsuperior.com.
5) Substitutions under provisions of Section 01 6000 - Product Requirements.

2. Pier Sled or Wheel Spacers
a. Pier sleds shall be fabricated concrete support with minimum compressive strength of 8,500 psi and integral wire ties.
b. Wire ties: plain finish.
1) Manufactured sizes:
(a) Nominal 8 x 3 x 1-1/4 inch
(b) Nominal 8 x 4 x 1-1/4 inch
(c) Use 3-inch sled for uncased and 4-inch sled for cased piers.
c. Wheel spacers shall be EZ-LOK - PLW-300/4-HD, 3/4-inch thick.
d. Provide minimum three sleds or wheels around the cage at 10'-0" maximum on center spaced uniformly to properly align cage in shaft.

3. Pier Bolster
a. Fabricated concrete support with minimum compressive strength of 8,500 psi and integral wire ties.
1) Wire ties: plain finish.
2) Manufactured size: nominal 4-inch diameter by 3-inch high with two 9-gage wires for attachment to bottom of reinforcing cage.
b. Minimum number of bolsters, spaced to support steel free of earth, per structural drawings (every other vertical bar reinforcement bar minimum).

PART 3 EXECUTION

3.01 PREPARATION

A. Use placement method which will not cause damage to nearby structures.

B. Notify adjacent and affected land owners and building occupants before proceeding with the work.

C. Protect structures near the work from damage.

D. Prepare to place piers from excavated working elevation.

E. Grade perimeter of pier and shaft area to prevent surface water from draining into soil borings. Provide temporary means and methods, as required, to maintain surface diversion until no longer needed, or as directed by the Architect.

F. Test Pier Holes: (The paragraphs below shall not apply to light pole bases.)
1. The Contractor shall drill all Test Pier Holes (belling and/or dewatering if required) as indicated on the Structural Drawings in the presence of the Special Inspection and Testing Agency (SITA). If none are shown on the Structural Drawings, the Contractor shall drill one Test Pier Hole (to the diameter and depth required for a most common pier size provided in the Structural Drawings, (belling if required) for every 50,000 square feet of floor plan within the building area with the location(s) to be determined by the SITA.

2. Within one (1) business day after receiving the Test Pier Hole Report from the SITA, the Contractor shall forward the report to the Geotechnical Engineer for their review of general conformance with the borings provided in the Geotechnical Report and to the Structural Engineer with a Request for Information (RFI), requesting verification that the conditions encountered are generally consistent with those required for proposal purposes (total lineal feet of cased and uncased piers). If conditions are significantly different from what was anticipated, the Structural Engineer may recommend modification of the pier design(s).
3. Information included in test pier hole submission shall include the following:
    a. Elevation of top of grade
    b. Depth to bearing strata (as noted in Structural Drawings)
    c. Depth water encountered (if applicable)
    d. Any strata within the boring that may cause concern for sloughing during construction of piers.

3.02 INSTALLATION

A. Refer to Section 01 1400 for work restrictions regarding the schedule of drilled pier installation.

B. Construct piers in accordance with ACI 336.1.

C. Drill vertical pier shafts to diameters and depths indicated.

D. Place steel casings during drilling operations. Set firmly in place. If casing is to be temporary, install shaft liner with sufficient strength to withstand concrete pressures.
    1. Withdrawal of temporary casings is at option of Contractor.

E. Clean shaft and bottom of loose material. Provide temporary means and methods, as required, to remove all water from soil borings as needed, or until directed by the Geotechnical Engineer.

F. Allow inspection of shaft prior to placement of reinforcement and concrete.

G. Place reinforcing steel in accordance with Section 03 2000.

H. Fabrication and Placing of Reinforcing
    1. All steel reinforcing cages shall be completely fabricated in a rigid fashion in order to permit expeditious placement into the shaft excavation by service equipment with a minimum time delay.
    2. The reinforcing steel cage for the shafts, consisting of longitudinal bars and hoops or ties, shall be completely assembled and placed into the shaft as a unit. Each longitudinal bar shall be tied to each hoop or tie.
    3. Place pier bottom bolsters in accordance with manufacturer's recommendations.
    4. Place pier side sleds in accordance with manufacturer's recommendations.

I. Place concrete in single pour, in accordance with Section 03 3000 with equipment designed for vertical placement of concrete.

J. Placing of Concrete
    1. Concrete may be placed through a tremie if desired by the Contractor if concrete will not strike the side of the shaft.
    2. Concrete shall be placed as soon as practical after the pier excavation has been completed and in no case shall the time lapse between completion of the excavations and concrete placement therein exceed four (4) hours (no pier excavation shall be left open overnight).
    3. Placement of concrete in any individual shaft shall be continuous from the beginning of concrete placement to the completion of any individual shaft installation. Concrete shall be vibrated.

K. Coordinate casing withdrawal with concrete placement so that concrete pressure head exceeds anticipated outside soil and water pressure above bottom of casing at all times during withdrawal. Vibration and rotation will not be permitted during extraction of the casing and special care shall be exercised to insure that separation or squeezing of the freshly placed concrete does not occur. At all times during extraction of the casing, the concrete head within the casing shall be sufficient to prevent encroachment of ground water or caving material into the freshly placed concrete.

L. Extend reinforcement or provide dowels for connection of caps and grade beams.

M. Set tops of piers to elevations indicated.

3.03 TOLERANCES

A. Install piers with maximum variation from location, plumbness, bottom area, diameter, and anchorage locations as specified in ACI 336.1.

B. Maximum Variation From Vertical: 1 in 48.

C. Maximum Variation From Design Top Elevation: Plus 3 inches, minus 1 inch.

D. Maximum Out-of-Position: 2 inches.

3.04 FIELD QUALITY CONTROL

A. A Special Inspection and Testing Agency (SITA) will perform field quality control tests and inspections, as specified in Sections 01 4516 and 01 4533.

3.05 UNACCEPTABLE PIERS

A. Unacceptable Piers: Piers that fail, are placed out of position, are below elevations, or are damaged.

B. Provide additional piers or replace piers failing to conform to specified requirements.

END OF SECTION

SECTION 32 1313
CONCRETE PAVING

PART 1 – GENERAL

1.01 RELATED DOCUMENTS

A. All applicable provisions of the Bidding and Contract Requirements, and Division 1 – General Requirements shall govern the work under this section.

1.02 WORK INCLUDED

A. This Section includes exterior cement concrete pavement for driveways, parking lots, curbs and gutters, and walkways.

B. All concrete paving to be performed and materials to be used shall be in accordance with the Geotechnical Engineering Report and the applicable requirements in the American Concrete Institute's Manual of Concrete Practice. In the event of a discrepancy between the above-referenced report and any portion of this specification section, the above-referenced report will govern. The Contractor shall contact the Engineer in the event of a discrepancy.

1.03 SUBMITTALS

A. Mix Design: Submit one (1) copy of the Mix design prepared by the batch plant servicing the Project.

1.04 QUALITY ASSURANCE

A. Manufacturer Qualifications: Manufacturer of ready-mixed concrete products who complies with ASTM C 94/C 94M requirements for production facilities and equipment.

1.05 PROJECT CONDITIONS

A. Traffic Control: Maintain access for vehicular and pedestrian traffic as required for other construction activities.

PART 2 – PRODUCTS

2.01 FORMS

A. Form Materials: construction grade wood or metal, or other approved panel-type materials to provide full-depth, continuous, straight, smooth exposed surfaces.

B. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent treatments of concrete surfaces.

2.02 STEEL REINFORCEMENT

A. Reinforcing Bars: ASTM A 615/A 615M, Grade 60.

B. Joint Dowel Bars: Plain steel bars, ASTM A 615/A 615M, Grade 60. Cut bars true to length with ends square and free of burrs.

C. Tie Bars: ASTM A 615/A 615M, Grade 60.

D. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars, welded wire reinforcement, and dowels in place. Manufacture bar supports according to CRSI's "Manual of Standard Practice" from steel wire, plastic, or precast concrete of greater compressive strength than concrete.

2.03 CONCRETE MATERIALS

A. Cementitious Material: Portland Cement: ASTM C 150, Type II

B. Normal-Weight Aggregates: ASTM C 33, Class 4S coarse aggregate, uniformly graded. Provide aggregates from a single source.

1. Maximum Coarse-Aggregate Size 1 1/2-inch (38 mm) nominal.
2. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.

C. Water: ASTM C 94/C 94M.

D. Air-Entraining Admixture: ASTM C 260.

E. Chemical Admixtures: Provide admixtures certified by manufacturer to be compatible with other admixtures and to contain no more than 0.1 percent water-soluble chloride ions by mass of cementitious material.

1. Water-Reducing Admixture: ASTM C 494/C 494M, Type A.
2. Retarding Admixture: ASTM C 494/C 494M, Type B.
3. Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type D.
4. High-Range, Water-Reducing Admixture: ASTM C 494/C 494M, Type F.
5. High-Range, Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type G.
6. Plasticizing and Retarding Admixture: ASTM C 1017/C 1017M, Type II.

2.04 CURING MATERIALS

A. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. (305 g/sq. m) dry.
B. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.
C. Water: Potable.
D. White-Pigmented Curing Compound: ASTM C 1315

2.05 RELATED MATERIALS

A. Expansion- and Isolation-Joint-Filler Strips: ASTM D 1751, asphalt-saturated cellulosic fiber

2.06 PAVEMENT MARKINGS

A. Pavement-Marking Paint: Latex, waterborne emulsion, lead and chromate free, ready mixed, complying with FS TT-P-1952, with drying time of less than 45 minutes.

2.07 WHEEL STOPS

A. Wheel Stops: Precast, air-entrained concrete, 2500-psi minimum compressive strength, 4-1/2 inches high by 10 inches wide by 72 inches long. Provide chamfered corners and holes for anchoring to substrate.
   1. Dowels: Galvanized steel, 3/4-inch (19-mm) diameter, 18-inch (254-mm) minimum length.

2.08 CONCRETE MIXTURES

A. Prepare design mixtures, proportioned according to ACI 301, for each type and strength of normal-weight concrete determined by either laboratory trial mixes or field experience.
B. Proportion mixtures to provide normal-weight concrete with the following properties:
   2. Compressive Strength (28 Days): 4,000 psi
   3. Maximum Water-Cementitious Materials Ratio at Point of Placement: 0.50
   4. Slump Limit: 4 inches
C. Add air-entraining admixture at manufacturer's prescribed rate to result in normal-weight concrete at point of placement having an air content as follows:
   1. Air Content: do not exceed 2 percent
D. Chemical Admixtures: Use admixtures according to manufacturer's written instructions.
   1. Use water-reducing admixture in concrete, as required, for placement and workability.
   2. Use water-reducing and retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.

PART 3 – EXECUTION

3.01 EXAMINATION

A. Examine exposed subgrades and subbase surfaces for compliance with requirements for dimensional, grading, and elevation tolerances.
B. Proof-roll prepared subbase surface below concrete pavements with heavy pneumatic-tired equipment to identify soft pockets and areas of excess yielding.
   1. Completely proof-roll subbase in one direction and repeat in perpendicular direction. Limit vehicle speed to 3 mph.
   2. Proof-roll with a 20-ton pneumatic roller or similar equipment, such as a fully loaded dump truck.
   3. Subbase with soft spots and areas of pumping or rutting exceeding depth of 1/2 inch require correction according to requirements in Division 31 Section "Earth Moving."
      Proceed with concrete pavement operations only after nonconforming conditions have been corrected and subgrade is ready to receive pavement.

3.02 PREPARATION

A. Remove loose material from compacted subbase surface immediately before placing concrete.

3.03 EDGE FORMS AND SCREED CONSTRUCTION

A. Set, brace, and secure edge forms, bulkheads, and intermediate screed guides for pavement to required lines, grades, and elevations. Install forms to allow continuous progress of work and so forms can remain in place at least 24 hours after concrete placement.
B. Clean forms after each use and coat with form-release agent to ensure separation from concrete without damage.

3.04 STEEL REINFORCEMENT

A. General: Comply with CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.
B. Clean reinforcement of loose rust and mill scale, earth, ice, or other bond-reducing materials.
C. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position during concrete placement. Maintain minimum cover to reinforcement.

3.05 JOINTS

A. General: Form construction, isolation, and contraction joints and tool edgings true to line with faces perpendicular to surface plane of concrete. Construct transverse joints at right angles to centerline, unless otherwise indicated.
    1. When joining existing pavement, place transverse joints to align with previously placed joints, unless otherwise indicated.
B. Construction Joints: Set construction joints at side and end terminations of pavement and at locations where pavement operations are stopped for more than one-half hour unless pavement terminates at isolation joints.
    1. Continue steel reinforcement across construction joints, unless otherwise indicated. Do not continue reinforcement through sides of pavement strips, unless otherwise indicated.
    2. Provide tie bars at sides of pavement strips where indicated.
    3. Butt Joints: Use epoxy bonding adhesive at joint locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
    4. Doweled Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or asphalt-coat one-half of dowel length to prevent concrete bonding to one side of joint.
C. Isolation Joints: Form isolation joints of preformed joint-filler strips abutting concrete curbs, catch basins, manholes, inlets, structures, walks, other fixed objects, and where indicated.
    1. Extend joint fillers full width and depth of joint.
    2. Terminate joint filler not less than 1/2 inch (13 mm) or more than 1 inch (25 mm) below finished surface if joint sealant is indicated.
    3. Place top of joint filler flush with finished concrete surface if joint sealant is not indicated.
    4. Furnish joint fillers in one-piece lengths. Where more than one length is required, lace or clip joint-filler sections together.
    5. Protect top edge of joint filler during concrete placement with metal, plastic, or other temporary preformed cap. Remove protective cap after concrete has been placed on both sides of joint.
D. Contraction Joints: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of the concrete thickness, as follows to match jointing of existing adjacent concrete pavement:
    1. Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch- (3-mm-) wide joints into concrete when cutting action will not tear, abrade, or otherwise damage surface and before developing random contraction cracks.
    2. Doweled Contraction Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or asphalt coat one-half of dowel length to prevent concrete bonding to one side of joint.

E. Edging: Tool edges of pavement, gutters, curbs, and joints in concrete after initial floating with an edging tool to a 3/8-inch (10-mm) radius. Repeat tooling of edges after applying surface finishes. Eliminate tool marks on concrete surfaces.
F. Joint sealants: Joints shall be sealed with approved exterior pavement joint sealants and shall be installed in accordance with manufacturer's recommendations.

3.06 PAVEMENT MARKING

A. Do not apply pavement-marking paint until layout, colors, and placement have been verified with Engineer.
B. Allow concrete pavement to cure for 28 days and be dry before starting pavement marking.
C. Sweep and clean surface to eliminate loose material and dust.
D. Apply paint with mechanical equipment to produce pavement markings of dimensions indicated with uniform, straight edges. Apply at manufacturer's recommended rates to provide a minimum wet film thickness of 15 mils (0.4 mm).

3.07 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified independent testing and inspecting agency to perform field tests and inspections and prepare test reports.
B. Testing Services: Testing of composite samples of fresh concrete obtained according to ASTM C 172 shall be performed according to the following requirements:
    1. Testing Frequency: Obtain at least 1 composite sample for each 100-cu. yd. (76 cu. m) or fraction thereof of each concrete mix placed each day.
    2. When frequency of testing will provide fewer than five compressive-strength tests for each concrete mixture, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.
    3. Slump: ASTM C 143/C 143M; one test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mix. Perform additional tests when concrete consistency appears to change.
    4. Air Content: ASTM C 231, pressure method; one test for each composite sample, but not less than one test for each day's pour of each concrete mix.
    5. Concrete Temperature: ASTM C 1064; one test hourly when air temperature is 40 deg F (4.4 deg C) and below and when 80 deg F (27 deg C) and above, and one test for each composite sample.
    6. Compression Test Specimens: ASTM C 31/C 31M; cast and laboratory cure one set of three standard cylinder specimens for each composite sample.
    7. Compressive-Strength Tests: ASTM C 39/C 39M; test 1 specimen at 7 days and 2 specimens at 28 days.
        a. A compressive-strength test shall be the average compressive strength from 2 specimens obtained from same composite sample and tested at 28 days.
C. Strength of each concrete mix will be satisfactory if average of any 3 consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than 500 psi (3.4 MPa).
D. Test results shall be reported in writing to Engineer, concrete manufacturer, and Contractor within 48 hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mixture proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests.
E. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Engineer but will not be used as sole basis for approval or rejection of concrete.
F. Additional Tests: Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Engineer.
G. Remove and replace concrete pavement where test results indicate that it does not comply with specified requirements.

H. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

END OF SECTION

SECTION 32 1314
CONCRETE SIDEWALK

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. All applicable provisions of the Bidding and Contract Requirements, and Division 1 – General Requirements shall govern the work under this Section.

1.02 WORK INCLUDED

A. The work specified in this Section consists of the construction of concrete sidewalk in accordance with these Specifications and in conformity with the lines, grades, dimensions, and notes shown on the plans.

1.03 RELATED WORK

A. Section 024119 – Selective Demolition

B. Division 31 – Earthwork

PART 2 - PRODUCTS

2.01 CONCRETE

A. Concrete shall be Class A Concrete unless otherwise shown on the plans.

2.02 FORMS

A. Forms for this work shall be made of either wood or metal and shall have a depth equal to the plan dimensions for the depth of concrete being deposited against them. They shall be straight, free from warp or bends, and of sufficient strength when staked, to resist the lateral pressure of the concrete without displacement from lines and grade. Forms shall be cleaned each time they are used and shall be oiled prior to placing the concrete.

2.03 SUBGRADE AND GRADING

A. Excavation shall be made to the required depth, and the foundation material upon which the sidewalk is to be set shall be compacted to a firm, even surface, true to grade and cross-section, and shall be moist at the time that the concrete is placed.

2.04 JOINTS

A. Expansion joints between the sidewalk and the curb, and at all other locations indicated on the plans, shall be 1/4-inch wide, formed with a preformed joint filler. Preformed joint filler shall meet the requirements of AASHTO M153 or AASHTO M213.

B. Contraction joints may be of the open type or may be sawed. Open type contraction joints shall be formed by staking a metal bulkhead in place and depositing the concrete on both sides. After the concrete has set sufficiently to preserve the width and shape of the joint, the bulkhead shall be removed. After the sidewalk has been finished over the joint, the slot shall be edged with a tool having a 1/2-inch radius.

If the CONTRACTOR elects to saw the contraction joints, a slot approximately 1/8-inch-wide and not less than 1-1/2 inches deep shall be cut with a concrete saw after the concrete has set, and within the following periods of time:

Contraction joints shall be constructed at not more than twenty (20) foot intervals and shall be in place within twelve (12) hours after finishing.

PART 3 - EXECUTION

3.01 PLACING

B. The concrete shall be placed in the forms to the required depth and shall be vibrated and spaded until mortar entirely covers its surface.

3.02 FINISHING

A. Screeding: The concrete shall be struck-off by means of a wood or metal screed, used perpendicular to the forms, and floated in order to obtain the required grade and remove surplus water and laitance.

B. Surface requirements: The concrete shall be given a broom finish. The surface variations shall not be more than 1/4 inch under a ten-foot straightedge, nor more than 1/8 inch on a five-foot transverse section. The exposed edge of the slab shall be carefully finished with an edging tool having a radius of 1-1/2 inch.

3.03 CURING

A. The concrete shall be continuously cured for a period of at least 72 hours. Curing shall be commenced after finishing has been completed and as soon as the concrete has hardened sufficiently, to permit application of the curing material without marring the surface.

B. Wet burlap, white-pigmented curing compound, waterproof paper or polyethylene sheets may be used for the curing.

END OF SECTION

SECTION 32 1373
CONCRETE PAVING JOINT SEALANTS

PART 1 - GENERAL

RELATED DOCUMENTS

A. All applicable provisions of the Bidding and Contract Requirements, and Division 1 – General Requirements shall govern the work under this section.

1.02 WORK INCLUDED

A. This Section includes the following:
   1. Expansion and contraction joints within cement concrete pavement.
   2. Joints between cement concrete and asphalt pavement.

1.03 SUBMITTALS

A. Product Data: For each joint-sealant product indicated. In the event of a discrepancy between this specification section and the City Design Criteria, the City's Design Criteria shall govern. The Contractor shall notify the Engineer in the event of a discrepancy.

1.04 QUALITY ASSURANCE

A. Installer Qualifications: An employer of workers trained and approved by manufacturer.
B. Source Limitations: Obtain each type of joint sealant through one source from a single manufacturer.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to Project site in original unopened containers or bundles with labels indicating manufacturer, product name and designation, color, expiration date, pot life, curing time, and mixing instructions for multicomponent materials.
B. Store and handle materials to comply with manufacturer's written instructions to prevent their deterioration or damage due to moisture, high or low temperatures, contaminants, or other causes.

1.06 PROJECT CONDITIONS

A. Do not proceed with installation of joint sealants under the following conditions:
   1. When ambient and substrate temperature conditions are outside limits permitted by joint-sealant manufacturer or are below 40 deg F (4.4 deg C).
   2. When joint substrates are wet or covered with frost.
   3. Where joint widths are less than those allowed by joint-sealant manufacturer for applications indicated.
   4. Where contaminants capable of interfering with adhesion have not yet been removed from joint substrates.

PART 2 – PRODUCTS

2.01 MATERIALS, GENERAL

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

2.02 COLD-APPLIED JOINT SEALANTS

A. Type NS Silicone Sealant for Concrete: Single-component, low-modulus, neutral-curing, nonsag silicone sealant complying with ASTM D 5893 for Type NS.
   1. Available Products:
      a. Crafco Inc.; RoadSaver Silicone.
      b. Dow Corning Corporation; 888.

B. Type SL Silicone Sealant for Concrete and Asphalt: Single-component, low-modulus, neutral-curing, self-leveling silicone sealant complying with ASTM D 5893 for Type SL.
   1. Available Products:
      a. Crafco Inc.; RoadSaver Silicone SL.
      b. Dow Corning Corporation; 890-SL.

2.03 HOT-APPLIED JOINT SEALANTS

A. Elastomeric Sealant for Concrete: Single-component formulation complying with ASTM D 3406.
   1. Available Products:
      a. Crafco Inc.; Superseal 444/777.
      b. Meadows, W. R., Inc.; Poly-Jet 3406.

B. Sealant for Concrete and Asphalt: Single-component formulation complying with ASTM D 3405.
   1. Available Products:
      a. Koch Materials Company; Product No. 9005.
      b. Koch Materials Company; Product No. 9030.
      c. Meadows, W. R., Inc.; Sealtight Hi-Spec.
      d. Approved equals.

2.04 JOINT-SEALANT BACKER MATERIALS

A. General: Provide joint-sealant backer materials that are nonstaining; are compatible with joint substrates, sealants, primers, and other joint fillers; and are approved for applications indicated by joint-sealant manufacturer based on field experience and laboratory testing.

B. Round Backer Rods for Cold- and Hot-Applied Sealants: ASTM D 5249, Type 1, of diameter and density required to control sealant depth and prevent bottom-side adhesion of sealant.

C. Backer Strips for Cold- and Hot-Applied Sealants: ASTM D 5249; Type 2; of thickness and width required to control sealant depth, prevent bottom-side adhesion of sealant, and fill remainder of joint opening under sealant.

D. Round Backer Rods for Cold-Applied Sealants: ASTM D 5249, Type 3, of diameter and density required to control sealant depth and prevent bottom-side adhesion of sealant.

2.05 PRIMERS

A. Primers: Product recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from preconstruction joint-sealant-substrate tests and field tests.

PART 3 – EXECUTION

3.01 EXAMINATION

A. Examine joints indicated to receive joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting joint-sealant performance.
   1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with joint-sealant manufacturer's written instructions.
   1. Joint Priming: Prime joint substrates where indicated or where recommended in writing by joint-sealant manufacturer, based on preconstruction joint-sealant-substrate tests or prior experience. Apply primer to comply with joint-sealant manufacturer's written instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or migration onto adjoining surfaces.

3.03 INSTALLATION OF JOINT SEALANTS

A. General: Comply with joint-sealant manufacturer's written installation instructions for products and applications indicated unless more stringent requirements apply.

B. Sealant Installation Standard: Comply with recommendations in ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.

C. Install backer materials of type indicated to support sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.
   1. Do not leave gaps between ends of backer materials.
   2. Do not stretch, twist, puncture, or tear backer materials.
   3. Remove absorbent backer materials that have become wet before sealant application and replace them with dry materials.

D. Install sealants using proven techniques that comply with the following and at the same time backings are installed:
   1. Place sealants so they directly contact and fully wet joint substrates.
   2. Completely fill recesses provided for each joint configuration.
   3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.

E. Tooling of Nonsag Sealants: Immediately after sealant application and before skinning or curing begins, tool sealants according to requirements specified below to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint.
   1. Remove excess sealants from surfaces adjacent to joint.
   2. Use tooling agents that are approved in writing by joint-sealant manufacturer and that do not discolor sealants or adjacent surfaces.

F. Provide joint configuration to comply with joint-sealant manufacturer's written instructions, unless otherwise indicated.

G. Provide recessed joint configuration for silicone sealants of recess depth and at locations indicated.

3.04 CLEANING

A. Clean off excess sealants or sealant smears adjacent to joints as the Work progresses by methods and with cleaning materials approved by manufacturers of joint sealants and of products in which joints occur.

3.05 PROTECTION

A. Protect joint sealants during and after curing period from contact with contaminating substances and from damage resulting from construction operations or other causes so sealants are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated joint sealants immediately

and replace with joint sealant so installations with repaired areas are indistinguishable from the original work.

END OF SECTION

SECTION 32 1723
PAVEMENT MARKINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. All applicable provisions of the bidding and Contract Requirements, and Division 1 – General Requirements shall govern the work under this Section.

1.2 WORK INCLUDED

A. The work covered by this Section shall include the furnishing of all labor, equipment and materials necessary to construct and install all pavement marking, and striping in accordance with the plans and these specifications.

1.3 RELATED WORK

A. Section 321216 – Asphalt Paving
B. Section 321313 – Concrete Paving

1.4 QUALITY ASSURANCE

A. Perform all work in accordance with the requirements of local agencies.

PART 2 - PRODUCTS

2.1 PAVEMENT MARKINGS

A. Chlorinated rubber-alkyd type, as per Fed Spec. No. TT-P-115, Type III, or conforming to the applicable Sections of the Texas Department of Transportation Standard Specifications.
   1. Paint shall be factory mixed, quick drying and non-bleeding type.
   2. Color shall be as per D.O.T. requirements.
   3. Striping, arrows, lane markers and stop bars shall be provided with paint containing reflective additive.

B. Thermoplastic paint shall conform to the applicable Sections of the Texas Department of Transportation Standard Specifications.

C. Traffic paint shall conform to the applicable Sections of the Texas Department of Transportation Standard Specifications.

PART 3 - EXECUTION

3.1 TRAFFIC AND LANE MARKINGS

A. Sweep dust and loose material from the sealed surface.

B. Apply paint striping as indicated on the drawings, with suitable mechanical equipment to produce uniform straight edges.
   1. Apply in not less than (2) two coats as per manufacturer's recommended rates of applications.

C. Protect pavement markings until completely dry in accordance with manufacturer’s recommendations.

END OF SECTION

SECTION 32 1828
TENNIS COURTS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Design, engineering and construction of post-tensioned concrete tennis courts.

B. Tennis court related fencing and gates.

C. Wind screens.

D. Nets, posts and hardware.

E. Surfacing and court markings.

F. Court lighting.

G. The “Work” of this Section is defined to include, but not necessarily to be limited to:

1. Requirements indicated are to establish a minimum standard. Provide tennis court work to meet these standards, but in no case less than those required by the Tennis Court Design Engineer.
2. The scope of this work shall be the construction of the Tennis Courts as on the site plans as a complete and whole construction package including, but not be limited to, the engineered design of the Tennis Courts concrete slab and foundation, and fencing. Further, the scope of work shall include, but not be limited to the furnishing and installation or construction of the Tennis Courts including the concrete footings, concrete slab, reinforcing, pad preparation as recommended by the geotechnical report, all soil stabilization below and five feet outside the perimeter of the slab, fencing, nets, posts, and windscreens. In addition to the court, provide lighting Poles, fixtures, all necessary wiring, electrical panels, transformers, timers, and electrical service to the Tennis Courts from the nearest power service.
3. Tennis Courts shall comply with the latest U.I.L. rules and regulation and be constructed to comply with United States Tennis Association (USTA) Specifications.
4. Entire system including but not limited to, courts, fencing, equipment and lighting along with any other accessory items, shall be designed as a performance specification. A Professional Engineer licensed in the State of Texas shall seal the court designs submitted.
5. A full copy of the geotechnical report has been included in the project manual.

1.02 RELATED REQUIREMENTS

A. Documents affecting work of this Section include, but are not necessarily limited to, General Conditions, Supplementary Conditions, and Sections in Division 01 of these Specifications.

B. Section 00 3132 - Geotechnical Data.

C. Section 03 3000 - Cast-In-Place Concrete.

D. Section 03 3800 - Post-Tensioned Concrete.

E. Section 26 5668 - Tennis Court Lighting

1.03 ADMINISTRATIVE REQUIREMENTS

A. Preinstallation Meeting: Conduct a preinstallation meeting two weeks prior to the start of the work of this section; require attendance by all affected installers.

B. Coordination: Coordinate the installation of court lighting with size, location and installation of service utilities.

C. Sequencing: Ensure that utility connections are achieved in an orderly and expeditious manner.

1.04 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements, for submittal procedures.

B. Product data: Within 15 calendar days after the Contractor has received the Owner's Notice to Proceed, submit the following:
   1. Materials list of items proposed to be provided under this Section, and related Sections;
   2. Manufacturer's specifications and other data needed to prove compliance with the specified requirements; including color samples.
   3. Shop drawings requirements for submission to the local AHJ for permitting.

C. Manufacturer's recommended installation procedures which, when approved by the Architect, will become the basis for accepting or rejecting actual installation procedures used on the Work.

D. Shop Drawings:
   1. Submit sealed design documents and calculations for for submission to the local AHJ for permitting requirements and A/E review.
      a. Foundation Design
      b. Dimensioned court layouts
      c. Equipment locations.
      d. Fencing calculations and layouts
      e. Striping width and color.
      f. Proposed colored graphic or logo.
   2. Shop drawing sheets that include engineering information designed by the Contractor’s Delegated Design Engineer shall be signed and sealed in accordance with the Texas Engineering Practice Act. Sheets that do not provide information designed by the Contractor’s Engineer do not require being signed and sealed. Calculation packages require a signed and sealed cover sheet only. Any submittals requiring to be signed and sealed that are received without the signature and seal will be rejected without review.
   3. Submit a copy of the latest U.I.L. rules and regulations verifying compliance.

E. Samples: Accompanying the submittal described above, submit Samples of each sealant, each backing material, each primer, and each bond breaker proposed to be used.

1.05 QUALITY ASSURANCE

A. Designer Qualifications: Perform design under direct supervision of a Professional Engineer experienced in design of this type of work and licensed in Texas.

B. Tennis Court Contractor shall have completed at least ten (10) similar size tennis court projects in the last three years.

C. Surfacing applicator shall have a minimum of one hundred (100) tennis court applications of proven experience.

D. Use adequate numbers of skilled workmen who are thoroughly trained and experienced in the necessary crafts and who are completely familiar with the specified requirements and the methods needed for proper performance of the work of this Section.

E. Submission of Substitute Materials:
   1. If other than the product specified, submit at least five working days prior to the bid date a complete type written list of all such proposed substitutions together with sufficient data, drawings, samples, literature, and other detailed information as will demonstrate to the satisfaction of the Owner that the proposed substitute material is equal in quality and utility to that originally specified. Under no circumstances will a surfacing system comprised of several products produced or manufactured from different sources be considered.

1.06 DELIVERY, STORAGE, AND HANDLING

A. See Section 01 6000 - Product Requirements, for transportation, handling, storage and protection procedures.

B. Do not use material which has exceeded the shelf life recommended by its manufacturer.

1.07 FIELD CONDITIONS

A. Ambient Conditions: Do not install materials when environmental conditions are outside of the acceptable ranges recommended by the manufacturer.

B. Weather Limitations: No part of the construction involving the surfacing system may be conducted during rain or when rain is imminent. The air and surface temperature must be at least 50 deg. F. and rising. Do not apply when surface temperature is above 140 deg. F.

C. Existing Conditions: See subsurface investigation report; see Section 00 3132.

1.08 WARRANTY

A. See Section 01 7800 - Closeout Submittals, for additional warranty requirements.

B. Provide three year manufacturer warranty for windscreens.

C. System Warranty:
   1. Provide a written guarantee warranting the entire system, including all materials, devices, and workmanship to be free of defects for a period of five (5) years from the date of completion, unless otherwise indicated. Any defects in materials, devices, and workmanship which become apparent within the guarantee period shall be repaired or replaced by the contractor at his own expense, and at no additional cost to the Owner.

PART 2 PRODUCTS AND EXECUTION

2.01 GENERAL

A. The materials and installation of foundations, synthetic surfaces, fences, equipment for tennis courts and tennis court lighting indicated are a part of these specifications are minimum standards but shall be in no case less than those required by the Design Engineer.

2.02 TENNIS COURT POST-TENSIONED SLAB

A. See Section 03 3800 - Post-Tensioned Concrete.

2.03 TENNIS COURT LIGHTING

A. See Division 26 - Tennis Court Lighting

2.04 TENNIS COURT COLOR SURFACING

A. Manufacturers:
   1. California Products Corp.; Plexipave System: www.plexipave.com.
   2. Substitutions: See Section 01 6000 - Product Requirements.

B. Materials:
   1. Patching Mix (California Court Patch Binder) - for use in patching cracks, holes, depressions and other surface imperfections.
   2. Crack Filler (Plexipave Crack Filler) - for use in filling fine cracks.
   3. Concrete Preparer - specially formulated acid heat for use in neutralizing the concrete in preparation for the Plexipave System.
   4. Adhesion Primer - (California TiCoat) - two component water based epoxy primer for uncoated concrete surfaces.
   5. Acrylic Filler Course (California Acrylic Resurfacer) - for use as a filler for new or existing concrete surfaces. The 100% acrylic filler shall be blended with approved silica sand at the job site.
   6. Acrylic Color Playing Surface (Plexichrome/Plexipave Color Base) - for use as the finish color and texture. Plexichrome and Plexipave Color Base are blended at the job site to achieve the correct surface texture. Factory Fortified Plexipave may be used as an alternative material.
   7. Line Paint (California Line Paint) - for use as the line marking on the court/play surface.
   8. Water: - for use in dilution/mixing shall be clean and potable.

2.05 TENNIS COURT CHAIN LINK FENCING

A. Height
   1. Height of fence shall be 10' - 0".

B. Fabric
   1. Nine gauge (9 Ga.) black resin clad fabric shall have a polyvinyl chloride coating, minimum wall thickness of .015 inches over a galvanized substrate. The base metal shall have a minimum breaking strength of five hundred fifty pounds (550 lbs.) and a zinc coat weight of .1503 pounds per square foot of uncoated wire surface. Top and bottom salvage of the fabric shall be knuckled with one and three-quarters inch (1 ¾") mesh.

C. Pipe and Accessories
   1. Method of Manufacturing: Pipe used for fence framework shall be cold rolled and electric-resistance-welded from steel conforming to ASTM A-569 and hot dip galvanized to ASTM A-525 G-90 zinc weight both inside and outside the pipe. The outside then receives a conversion coating and fusion bonded black polyester powder coating. the application of the coating will consist of three (3.0) mils of cured thermosetting polyester powder coatings applied over zinc phosphate pretreatment of galvanized steel.
   2. Posts: All line, and gateposts shall be two and seven-eighths inch outside diameter (2 7/8" O.D.) with a wall thickness of eleven gauge (11 Ga.) and a minimum yield strength of fifty-five thousand pounds per square inch (55,000 psi). Corner posts shall be 4" pipe, outside diameter, 9.1 lbs. per ft.
   3. Rails: Shall be one and five-eighths inch outside diameter (1 5/8" O.D.) pipe with a wall thickness of thirteen gauge (13 Ga.) and a minimum yield strength of fifty five thousand pounds per square inch (55,000 psi) and provided with seven inch (7") long expansion sleeve couplings. Provide top, middle and bottom rails.
   4. Accessories:
      a. Fabric Ties: Eleven gauge (11 Ga.) galvanized steel tie wire to fasten fabric to framework. Tension wire shall be attached to fabric bottom with heavy galvanized hog rings.
      b. Tension Wire: Two (2) strands of twelve and half gauge (12.5 Ga.) steel wire twisted together.
      c. Tension Bands: Beveled edge type with nuts and bolts.
      d. Line Post Tops: Heavy galvanized cast from eye top fitting.
      e. Terminal Post Tops: Heavy galvanized iron tops of bullet type construction.
      f. Coating: All accessories to receive black polyester powder coating.
   5. Gates: Construct gate frames with one and five-eighths inches outside diameter (1 5/8" O.D.) rail material with welded corners. Provide fabric filler same as used in fence and use heavy duty galvanized hardware with lockable latches.

D. Workmanship: The complete fence shall be plumb, both in line and transverse to the fence, straight and rigid with fabric tightly stretched and held firmly in place. Details of construction not specified, shall be performed in keeping with standard good fencing practices.

E. Posts: Space all posts not more than eight feet (8') apart and set in concrete, as shown on the drawings.

F. Rails: Set rails as nearly parallel to the finish grade as possible and at the specified height of the fence.

G. Fabric Ties: Provide a minimum of six (6) ties for each ten-foot (10') of rail and one tie to each foot of post height. Ties to tension wire shall be made with heavy galvanized hog rings at six (6) per ten foot (10') of tension wire.

H. Tension Bands: Provide one (1) fastener for each one foot (1') of fabric height.

I. Gates:
   1. Size: Clear opening 3 feet wide by 7 feet high.
   2. Provide with transom extending above gate opening to top of fence height indicated.

2.06 TENNIS COURT EQUIPMENT

A. Manufacturers / Suppliers:
   1. E.J. Renner and Associates, Inc., Denver, CO.
   2. Substitutions: See Section 01 6000 - Product Requirements.

B. Tennis Net Posts
   1. Model: Vogue 2.5.
   2. Internal brass worm-gear take-up, baked-on black polyester powder coating, continuous lacing rod, and galvanized sleeves. Two and half inches (2 ½") square with three-sixteenths inch (3/16") wall thickness.
   3. Set in concrete foundations three feet (3') deep by two feet (2') diameter. Net posts to be laid out according to the United States Tennis Court and Track Builders Association specifications.

C. Nets
   1. Model: Edwards 30LS Double Top Net.
   2. 3.5 mm double stitched, braided polyethylene (three hundred ten pound – 310 lb. test) body, top six rows of net body are double mesh with extra heavy spun polyester headband.
   3. Hung flush with the net posts and thirty-six inches (36") high in the center.

D. Center Straps
   1. Model: TWCS.
   2. Two and one-eighth inches (2 1/8") wide, white nylon webbing with adjusting buckle and bottom snap hook.
   3. Loop strap around net, hook into anchor, and tighten so that the net is thirty-six inches (36") high in the center.

E. Center Strap Anchor
   1. Model: GAS-30.
   2. Anchor is tubular pipe nine inches (9") long by one and seven-eighths inches (1 7/8") diameter with a three-sixteenth inch (3/16") anchoring pin.
   3. Set in concrete eight inches by eight inches (8" x 8").

F. Windscreen Curtain
   1. Nine foot (9') high Dacron windscreen fabricated of seven ounce (7 oz.) open mesh polyester with brass grommets every twelve inches (12") along the top, bottom, and sides.
   2. The nine foot (9') high curtains shall be accurately measured, fabricated, and attached with nine gauge (9 Ga.) galvanized hog rings and #8 polyrope for the center seam.

PART 3 EXECUTION

3.01 SOIL PREPARATION UNDER THE TENNIS COURTS SLAB

A. The Contractor's Tennis Court Engineer shall review the geotechnical report(s) and submit proposed soil preparation under the tennis court to the Architect. The soil preparation shall achieve a reduction in the estimated potential vertical movement so that the estimated potential vertical movement is no more than one (1) inch according to the Geotechnical Engineer. The soil preparation shall be in accordance with the recommendations of the Geotechnical Report(s) provided with this Project Manual. If the Geotechnical Engineering report does not provide recommendations for reducing the potential vertical movement to no more than one (1) inch, Proposers shall not assume what will be acceptable but instead shall request information from the Architect at least five (5) days before submitting a proposal. If the Geotechnical Engineering report does not provide recommendations for achieving no more than a one (1) inch estimated potential vertical movement and a request for information is not submitted to the Architect at least five (5) days before Proposals are submitted, and the Proposal is accepted by the Owner, the Contractor shall be responsible for all costs to prepare the soil as recommended by the Geotechnical Engineer to achive an estimated potential vertical movement of no more than one (1) inch.

3.02 INSTALLATION - TENNIS COURT POST-TENSIONED SLAB

A. See Section 03 3800 - Post-Tensioned Concrete.

3.03 INSTALLATION - TENNIS COURT LIGHTING

A. See Section 26 5668 - Tennis Court Lighting

3.04 INSTALLATION - TENNIS COURT COLOR SURFACING

A. Install in accordance with manufacturer's instructions.

B. Verify that fencing, drainage, adjacent landscaping, lighting, net posts, center strap anchors, and any curb and gutter work is completed prior to color surfacing.

C. Surface Preparation: Concrete shall have a wood float or broom finish. DO NOT STEEL TROWEL CONCRETE. DO NOT ALLOW ANY CURING AGENTS OR HARDENERS TO BE USED. Concrete must cure for 28 days. Thoroughly remove all dirt, dust, mud, oil, and foreign matter.

D. The court(s) shall be flooded to check for depressions and irregularities. All depressions ponding water that covers the thickness of a nickel shall be outlined with a construction crayon and filled after acid treating the surface.

E. Concrete Preparer: Concrete surface must be treated with concrete Preparer solution. After drying, all latent material must be removed from the surface.

F. All depressions requiring correction shall be filled with Court Patch Binder according to specifications using the following mix:
   1. 100 lbs. 60 –80 mesh silica sand (dry).
   2. 3 gallons Plexipave court Patch Binder.
   3. 1 to 2 gallons Portland Cement (depending on temperature and humidity).
   4. Tack Coat – Tack coat is necessary under patches only and shall be as follows:
      a. Plexipave Court Patch Binder diluted 1 part Court patch Binder to 2 parts water and allowed to dry prior to patching. After patching, the surface shall not vary more than 1/8 inch in 10 ft. measured in any direction.

G. Primer Coat: Mix and apply California Ti-Coat epoxy primer according to Specification 10.17. NOTE: Plexibond may be used as an alternate for priming concrete courts.

H. Acrylic Filler Coat: In order to provide a smooth, dense underlayment for the textured color surfacing, one or more applications of California Acrylic Resurfacer shall be applied to the surface according to specifications utilizing the following mix:
   1. Acrylic Resurfacer – 55 gallons
   2. Water - 20-40 gallons
   3. Liquid yield = 112-138 gallons
   4. Sand (60 – 80 mesh) 600-900 lbs.

I. Fortified Plexipave Textured Coats shall be applied by a rubber blade squeegee on the clean, dry surface in 3 applications. To obtain the proper application consistency, the Fortified Plexipave shall be mixed as follows:
   1. Plexipave Color Base – 30 gallons
   2. Plexichrome – 20 gallons
   3. Water – 20 gallons
   4. The finished surface shall have a uniform appearance and be free from ridges and tool marks. Colors shall be as selected by the Architect.

J. Playing Lines – Textured playing lines shall be accurately located, marked and painted with Plexicolor Line Paint, as specified by the U.S. Tennis Association.

3.05 INSTALLATION - TENNIS COURT CHAIN LINK FENCING

A. Install according to the Chain Link Manufacturers Institute recommendations, these specification or the Design Engineer, whichever is greater.

3.06 INSTALLATION - TENNIS COURT EQUIPMENT

A. Install according to the manufacturer's recommendation for each component.

3.07 ADJUSTING

A. Align gates flush with the plane of the fence.

3.08 CLEANING

A. Upon completion, remove all containers, surplus material and debris, and leave the site in a clean and orderly condition acceptable to the Owner.

END OF SECTION

SECTION 32 2950
ATHLETIC FIELD SITE PREPARATION

PART 1 - GENERAL

1.01 SUMMARY

A. Work specified in this section includes, but is not necessarily limited to, the following:

1. Layout and engineering;
2. Remove miscellaneous site elements

1.02 RELATED WORK SPECIFIED IN OTHER SECTIONS

Section 32 2951 Athletic Field Earthwork & Subgrade

1.03 EXISTING SITE CONDITIONS

A. Refer to drawings for topographical and existing condition information.

B. Refer to site Geotechnical Report for existing soils conditions and recommendations.

C. Owner not responsible for changes in the topography after survey record drawing verification was made or for accuracy of survey information.

D. Carefully maintain bench marks, monuments and other reference points. If disturbed or destroyed, replace as directed. It is the responsibility of the Contractor to familiarize themselves with all records of existing utilities in area of site work.

E. The Contractor shall contact the appropriate utility agencies for identification of underground utility location. The Contractor shall contact “DIG TESS” services at 800.344.8377.

1.04 TEMPORARY EROSION AND SILTATION CONTROL

A. All work shall conform to City of Tomball Erosion and Sedimentation Control requirements including installation of siltation control, such as filter fabric fences, check dams, sedimentation basins, etc.

1.05 EXISTING UTILITIES

A. The Contractor shall call for utilities locate prior to commencing with demolition activities. DIG TESS services at 800.344.8377.

B. The Contractor shall coordinate all existing utilities prior to proceeding with demolition activity. Protect any active pipes encountered; notify Project Landscape Architect of their existence and record on “as-built” drawings.

1.06 DUST CONTROL

A. Protect persons and property from damage and discomfort caused by dust. Water as necessary to quell dust.

1.07 ROADWAY PROTECTION

A. Provide wheel-cleaning stations to clean wheels and undercarriage of trucks before leaving site, as necessary to prevent dirt from being carried onto public streets. If streets are fouled, they must be cleaned immediately in conformance with City of Tomball requirements, as applicable. This requirement applies to all vehicle movements for the entire period of construction.

1.08 TRAFFIC REGULATION

A. Conduct operations in such a manner to avoid unnecessary interference to existing traffic. Minimize heavy vehicle traffic to and from site during peak traffic hours. Do not park vehicles in traffic lanes. Provide flagmen as required. Conform to City of Tomball traffic control requirements.

B. Contractor shall be responsible for all traffic control and emergency call outs resulting from Contractor operations.

C. Maintain fire lanes, roadways and alleys to existing buildings continuously, as required by the Fire Department having jurisdiction.

D. Existing walkways and roadways leading past the construction shall remain clear and safe. Provide barriers, flashing lights, walkways, guard rails and night lighting as required for safety and control.

1.09 DIMENSIONS AND LAYOUTS

A. The Contractor shall be responsible for furnishing, setting and marking all line, grade, and location stakes, including off-sets and general construction staking, together with clearing limits.

B. There shall be on site, when work requiring control is being performed, all necessary equipment, supplies and instruments related thereto. A qualified layout engineer, surveyor, or technical specialist must be assigned to the Contractor's crew for this work. This equipment and personnel must be available at no additional cost to the Owner for verifying layout and certifying the accuracy of work on the site.

C. The Contractor is responsible for preserving all benchmarks and stakes and replacing any that are displaced or missing as a result of the Contractor's operations.

D. The Contractor is responsible for review of all Owner and City records relative to the existing underground utilities. The Contractor is responsible to avoid damaging these facilities and shall repair all recorded utilities at no additional cost to the Owner.

E. The Contractor shall notify the Owner's Representative immediately of underground utilities encountered, which are not shown on the Owner's records.

PART 2 – PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.01 FIELD LAYOUT AND ENGINEERING

A. The Contractor shall be responsible for the layout of all the demolition work required to construct all work in accordance with the drawings and specifications.

3.02 EXISTING CONDITIONS

A. Provide, erect and maintain barricades, coverings, or other types of protection necessary to prevent damage to existing trees indicated to remain in place.

B. Do not shut off or cap utilities without prior notice. Coordinate work with Division 1 requirements. Maintain storm drains and sewers open for free drainage.

1. Provide storm drain inlet protection at catch basins in accordance with plans, if applicable.

C. Objectionable Noises: Limit use of air hammers and other noisy equipment as much as possible. Conform to Owner's requirements regarding noise control.

D. Maintain vehicular and pedestrian traffic routes:

1. Ensure minimum interference with roads, sidewalks and adjacent facilities.

2. Do not close or obstruct streets, sidewalks, alleys or passageways without permission from Owner.

3. If required by Owner or City, provide alternate routes around closed or obstructed traffic ways.

3.03 CLEARING AND GRUBBING

A. Completely remove all growth and underbrush as required for new construction.

B. Grub or otherwise prepare areas where clearing has occurred to receive construction or other improvements.

3.04 DEMOLITION

A. Completely remove all growth and dispose of on-grade slabs, pavement, structures, fencings, and other obstructions as applicable. See notes on drawings for items to be removed. Pavements and sidewalks designated for removal shall be broken up, loaded, and disposed of by the Contractor. Care shall be taken in removing pavement, structure, and all items to be removed so that damage does not occur to the existing improvements to remain in place and that all removals are accomplished by making a neat vertical saw cut at the boundaries of the area to be removed. Adjacent materials, designated to remain that are damaged by the Contractor's operations, shall be removed and new materials shall be furnished and installed to match existing, at no additional cost to the Owner.

B. Utilities: Cap ends of all piping to be abandoned in place. Remove all piping designated for removal, including underground piping and exposed piping.

C. Piping: Some utility piping and structures are to remain until new services are in operation and shall be protected during construction. Damage to existing utilities that are to remain shall be repaired at no additional cost to the Owner. In the event the Contractor encounters utility lines not shown on the site plan or otherwise indicated to be saved, removed or abandoned, the location of such lines shall be marked in the field and the Project Landscape Architect shall be notified in writing.

D. Carefully dismantle and remove items, if any, to be salvaged. The salvaged items shall then be labeled, bundled, and delivered to a storage site specified by the Owner's Representative.

3.05 DISPOSAL OF MATERIALS

A. The Contractor, in a manner consistent with all government regulations, shall dispose the refuse resulting from clearing and grubbing.

1. No burning permitted.
2. Do not leave refuse material on the project site, shoved onto abutting private properties, or buried in embankments or trenches.
3. Do not deposit debris in stream, body of water, street or alley, or upon private property except by written consent of the private property owner.
4. Maintain hauling routes clean and free of debris resulting from work of this section.

END OF SECTION 32 2950

SECTION 32 2951

ATHLETIC FIELD EARTHWORK & SUBGRADE

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. Furnish all labor, material and equipment for the earthwork indicated. Work includes but is not limited to the following:

1. Stripping, removal, and off-site disposal of the organic material from the project areas;
2. Layout and engineering;
3. Excavation and offsite disposal of the of all excess soil materials;
4. Subgrade scarification, stabilization, moisture conditioning, and re-compaction of the existing underlying soil materials;
5. Surface water and erosion control;
6. Management of the construction sequencing and scheduling relative to soil moisture content and the use of onsite material as fill;
7. Compaction, compaction testing, and establishment of subgrade.
8. The Contractor shall coordinate the prior installation of all new utility piping, irrigation piping, subsurface drainage piping and all items that fall below finished subgrade elevations with the installation of the stabilization procedure.
9. Removal of existing grass and plant organic surface material from all work areas to be graded or disturbed with on off-site disposal;
10. Excavation of the field event areas and off-site disposal of all excess materials.

1.02 STANDARD SPECIFICATIONS

A. All sections of the standard specifications applicable to any, and all parts of this project shall govern, except as specifically modified in these contract documents.

1. Standard Specifications for Road, Bridge, and Municipal Construction, Texas Department of Transportation, American Public Works Association (TXDOT/APWA)
2. American Society for Testing and Materials

1.03 EXISTING SITE CONDITIONS

A. Refer to drawings for topographical survey and existing condition information.

B. A Geotechnical Report has been prepared and is available from the Owner for review.

C. Owner not responsible for changes in the topography after survey record drawing verification was made or for accuracy of survey information.

D. Carefully maintain bench marks, monuments and other reference points. If disturbed or destroyed, replace as directed. It is the responsibility of the Contractor to familiarize themselves with all records of existing utilities in area of site work.

E. The Contractor shall contact the appropriate utility agencies for identification of underground utility location. The Contractor shall contact “DIG TESS” services at 800.344.8377.

1.04 SUBMITTALS

A. The Contractor shall submit a written earthwork plan to the Project Landscape Architect for approval prior to commencing with any mass excavation or filling. The plan must be coordinated with the Contractor's construction schedule and shall reflect and address the

historical weather conditions during the proposed scheduling of the earthwork and grading phases.

The plan shall also include:

1. Sequencing of the earthwork, utility installation and grading activities,
2. Proposed equipment to be utilized,
3. Surface water diversion and control,
4. Proposed protection methods for excavated stockpiled fill materials and trenches,
5. Soil drying procedures,
6. Phasing of the earthwork activities to minimize the utility service interruption to the school, and
7. Any other information pertinent to which the earthwork and grading will be performed.

B. The Contractor shall submit product information and installation procedures for the soil treatment to the Project Landscape Architect for approval.

1.05 TEMPORARY EROSION AND SILTATION CONTROL

A. All work shall conform to City of Tomball Erosion and Sedimentation Control requirements including installation of siltation control such as filter fabric fences, check dams, sedimentation basins, etc.

1.06 EXISTING UTILITIES

A. The Contractor shall call for utilities locate prior to commencing with earthwork and demolition activities. “DIG TESS” services at 800.344.8377.

B. The Contractor shall coordinate all existing utilities prior to proceeding with demolition and earthwork activity. Protect any active pipes encountered; notify Project Landscape Architect of their existence and record on "as-built" drawings.

C. Extreme care shall be taken to protect the existing electrical and telephone services at the middle schools. This area shall be hand excavated to verify the elevation of these services prior to proceeding with earthwork activities.

D. Should uncharted piping or other utilities be encountered, consult the utility or Owner immediately for instructions.

E. Repair all damaged utilities to the satisfaction of the Project Landscape Architect. Contact Project Landscape Architect for determination of responsibility.

1.07 DUST CONTROL

A. Protect persons and property from damage and discomfort caused by dust. Water as necessary to quell dust.

1.08 ROADWAY PROTECTION

A. Provide wheel-cleaning stations to clean wheels and undercarriage of trucks before leaving site, as necessary to prevent dirt from being carried onto public streets. If streets are fouled, they must be cleaned immediately in conformance with the City of Tomball requirements, as applicable. This requirement applies to all vehicle movements for the entire period of construction.

1.09 TRAFFIC REGULATION

A. Conduct operations in such a manner to avoid unnecessary interference to existing traffic. Minimize heavy vehicle traffic to and from site during peak traffic hours. Do not park vehicles in traffic lanes. Provide flagmen as required. Conform to the City of Tomball traffic control requirements.

B. Contractor shall be responsible for all traffic control and emergency call outs resulting from Contractor operations.

C. Maintain fire lanes, roadways and alleys to existing buildings continuously, as required by the fire department having jurisdiction.

D. Existing walkways and roadways leading past the construction shall remain clear and safe. Provide barriers, flashing lights, walkways, guard rails and night lighting as required for safety and control.

PART 2 – MATERIALS (Not Applicable)

PART 3 – EXECUTION

3.01 FIELD LAYOUT AND ENGINEERING

A. The General Contractor shall be responsible for the vertical and horizontal layout of all work and control points required to construct all work in accordance with the drawings and specifications.

3.02 SEQUENCING AND SCHEDULING

A. Submit proposed sequencing schedule for Project Landscape Architect's review and verification. Refer to Submittals section.

B. All new cut and fill areas shall be seal rolled at the end of each day to minimize moisture penetration.

3.03 EXCAVATED MATERIALS

A. Strip surface to be disturbed of existing grass, brush, and any other organic plant material and dispose of offsite.

B. All excess soil materials excavated to establish the required subgrade elevations shall be removed and disposed of offsite. The synthetic turf fields and rubberized running track areas will then be proof-rolled in coordination with the Owner’s testing firm, using a tandem axle dump truck to find soft or pumping soils. These soft and pumping soils to be removed and disposed of offsite. All over excavated areas to be recompacted using fill that must be select material to be free of organic matter, clay, concrete and other extraneous material, compactable to a minimum of 95% standard compaction. Fill shall be placed and compacted in lifts of eight (8") inch maximum loose depth. Review the site Geotechnical Report for compliance.

C. All items of concrete, debris, piping, etc., are to be disposed of offsite at Contractor's expense and pre-arranged location. The Contractor shall make efforts to have the concrete and asphalt concrete paving recycled.

3.04 SUBGRADE

A. Synthetic Turf Fields and Track, Subgrade: After initial proof rolling and subgrade establishment, for the synthetic turf field areas, installation of all site utilities, irrigation piping, conduits, sub-drainage pipe, etc. that will be installed below subgrade should be installed prior to the installation of stabilization procedure as directed by Geotechnical Reported and final subgrade approval. Follow track and field recommendations for 1” PVR as called out in the Alpha Testing report dated August 3rd, 2023, page 8, section 6.5 Subgrade Preparation for Track and Field and Other Athletic Fields.

B. All scarified areas are to be compacted to 95% of Standard dry density by mechanical means.

END OF SECTION 32 2951

SECTION 32 2952

ATHLETIC FIELD STORM DRAINAGE

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. Install new storm drainage piping and make all connections shown on the drawings.

B. Install new storm drain catch basins as shown on the drawings.

C. The Contractor shall coordinate the installation of all new utility piping with all existing utilities and new utilities.

D. The Contractor shall coordinate the installation of the field storm drainage system with subgrade stabilization procedure. Items falling below subgrade shall be installed prior to stabilization.

1.02 STANDARD SPECIFICATIONS

A. Standard Specifications for Road, Bridge, and Municipal Construction, Texas Department of Transportation, American Public Works Association (TXDOT/APWA)

B. American Public Works Association (APWA)

C. American Standard Testing Materials (ASTM)

D. American Association of State Highway and Transportation Officials (AASHTO)

E. American Concrete Institute

1.03 DIMENSIONS AND LAYOUT

A. The Contractor will be responsible for furnishing, setting and marking all line, grade and location stakes, including offsets and general construction staking.

B. There shall be onsite, when work requiring control is being performed all necessary equipment, supplies and instruments related thereto. A qualified layout engineer, surveyor, or technical specialist must be assigned to the Contractor's crew for this work. This equipment and personnel must be available, at no additional cost, to the Project Landscape Architect for the purpose of approving layout and certifying the accuracy of work on the site.

C. The Project Landscape Architect prior to commencing construction and on a continuing basis must approve all of this work, materials, methods and personnel for each phase requiring accuracy control.

D. The Contractor is responsible for preserving all benchmarks and stakes and the replacement of any that are displaced or missing.

E. The Contractor is responsible for review of all Owner's records relative to the existing underground utilities. The Contractor is responsible to avoid damaging these facilities and shall repair all damaged, recorded utilities at their own expense.

F. The Contractor shall contact the various utility agencies that may have underground services in this area before work commences to have the underground components marked. The Contractor shall contact "DIGALERT" service at 800.245.4545. Refer to Section 3229 51, Athletic Field Earthwork & Subgrade.

1.04 SUBMITTALS

A. Submit to the Project Landscape Architect for approval:

1. Product data for storm drainage
2. Product data for catch basin and frame and grate materials

3. Product data for trench drain and grate materials

1.05 RELATED WORK IN OTHER SECTIONS

Section 32 29 51 Athletic Field Earthwork & Subgrade

PART 2 – MATERIALS

2.01 STORM DRAINAGE PIPE AND FITTINGS

A. Storm drainage piping shall be smooth wall CPEP as shown on the plans.

B. The CPEP pipe shall have a smooth interior wall and shall conform to the provisions of AASHTO M294 - Type S. The pipe and fittings shall be made from virgin polyethylene compounds which conform to the Cell Class 324420C as defined in ASTM D3350. Fittings and couplers shall meet the requirements of AASHTO M294-881. Couplers shall be split type.

C. The PVC pipe shall conform with the provisions of ASTM D3034-SDR35. The jointing shall be by rubber gaskets conforming to requirements of ASTM 1869, or solvent cemented. All fittings to be of the same material as the pipe. The fittings shall utilize same rubber gaskets as pipe except at special connections requiring solvent weld or flexible couplings.

2.02 CATCH BASIN INLETS

A. Catch basins and manholes to be pre-cast concrete.

B. Minimum wall thickness shall be four (4") inches .

C. Bottoms to be integrally cast with entire unit.

D. Internal dimensions to be a minimum of:

1. Catch Basin (Type 1) - (26" x 22" x 40") inch min depth
2. Catch Basin (Type 2) – (48” dia x 72”) inch min depth
3. Provide riser sections as required to provide designated invert and rim elevations.

E. Units to be provided with locking frame and grate.

2.03 CONNECTIONS

A. All connections to be grouted watertight on both sides of catch basin. Mortar to be one-part Portland cement, ASTM C-150, Type 1; 1-1/2 parts plaster sand; clean water.

2.04 FRAMES, GRATINGS AND COVERS

A. All frames, gratings, and covers to be cast iron with locking mechanism for lids or grates to frames.

PART 3 - EXECUTION

3.01 TRENCHING

A. Excavation shall be made to alignment, elevation, grade and slope as indicated on the drawings.

B. Trenching shall be accomplished utilizing equipment with slope and depth control, such as "laser plane control system", so as to ensure accuracy in the bottom of the trench and placement of the pipe. No high points above designated invert or calculated trench bottom elevation will be permitted.

C. No sloughing of site material or loose excavated soil will be permitted in trenches.

3.02 TRENCHES

A. Trenches shall be in straight lines as indicated on the drawings.

B. Where feasible, trench width at the top shall be no greater than 24". If sloughing of trench side is encountered, a cribbing form will be required to maintain trench side stability.

C. The trench shall be kept free from water until pipe is laid and backfilled.

D. All surface water is to be diverted so as not to enter the trench.

E. Boulders, rocks, roots and other obstructions shall be entirely removed or cut out to the width of the trench and to a minimum depth of 6" below the elevation of bottom of pipe. Backfill shall be with select site soil mechanically compacted to a minimum 95% density.

F. All loose and excess excavated material is to be removed and disposed of off-site at Contractor's pre-arranged location.

3.03 PIPE INSTALLATION

A. Pipe to be installed in accordance with manufacturer's recommendations.

B. All connections are to be made with approved fittings as recommended and furnished by the manufacturer.

3.04 BEDDING AND BACKFILL

A. Bedding and backfill for the onsite storm drainage installation shall be either select site material free of organic matter or other extraneous material or imported granular material as required.

B. Bedding and backfill for the storm drainage installation under areas of the running track, synthetic turf field area or field events shall be cement-stabilized cement or lean concrete, with a minimum psi of 1000. Cement sand backfill shall consist of not less than 1.1 sacks of cement per ton of sand with sufficient water to hydrate the cement. The materials shall be placed in layers six (6”) inch maximum and compacted to 95% maximum density at optimum moisture.

C. No foreign material will be permitted inside the laid pipe.

3.05 CATCH BASIN INSTALLATION

A. These units shall be installed on a minimum 10" base of gravel or crushed rock.

B. Wall sides to be plumb.

C. The catch basin rim elevations shall be installed within the tolerance of +0.00' and - 0.10' from the rim elevations shown on the plan.

D. The finish grade around the catch basin inlet must slope to drain storm water into the catch basin, refer to grading plan. No depressions will be permitted adjacent to the catch basin rim.

3.06 TEMPORARY EROSION AND SILTATION CONTROL

A. Procedures shall conform to City of Tomball regulations and requirements. Measures must be taken during and following construction to prevent erosion. These measures shall include installation of filter fabric between grate and rings of all catch basin inlets, fabric fencing, barriers, check dams, etc.

END OF SECTION 32 2952

SECTION 32 2953

ATHLETIC FIELD SITEWORK CONCRETE

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. Furnish all labor, material and equipment for the concrete work indicated below and shown on the drawings. Work includes but is not limited to:

1. Construct concrete turf edge anchors for the synthetic turf fields as shown in the plans and in association with trench drains.
2. Assist Engineer in acquiring test cylinders for compression testing.
3. Install concrete paving as shown in the plans.

1.02 STANDARD SPECIFICATIONS

A. Standard Specifications for Road, Bridge, and Municipal Construction, Texas Department of Transportation, American Public Works Association (TXDOT/APWA)

B. American Concrete Institute (ACI)

C. American Society of Testing and Materials (ASTM)

1.03 RELATED WORK IN OTHER SECTIONS

Section 32 2951	Athletic Field Earthwork & Subgrade
Section 32 2966	Athletic Field Furnishings
Section 32 2964	Infilled Synthetic Turf

PART 2 - PRODUCTS

2.01 CONCRETE

A. Refer to APWA Section 5-05, "Cement Concrete Pavement."

B. Expansion Joints: Provide expansion joints at 20' o.c. maximum in two perpendicular directions, or approved equivalent, equally spaced unless otherwise shown in the drawings.

C. Joint Filler: Use non-staining, non-extruding, compressible and resilient, closed cell joint filler of neoprene foam conforming to ASTM D1752, Type RE-42. Joint filler will contain or have been treated with oil, grease or bituminous materials are prohibited. Test joint filler for compatibility with proposed sealant.

1. Acceptable joint filler: Neoprene Sponge Rubber joint Filler by the Burke Company, or other accepted by Project Representative.
2. Joint Sealant: ASTM C920, Grade NS, Class 25, Type M; multi-component, chemical curing, non-staining, non-bleeding, capable of continuous water immersion, non-sagging type; color to be selected.

D. Preformed Expansion Joint Strips: Vinylex Corporation “VP 1391”, or approved ½: wide vinyl joint strip with removable cap.

E. Control Joints: Provide control joints midway between expansion joints unless otherwise called for in the plans.

F. Reinforcing: Utilize reinforcing as specified in the details.

G. Cast-in-place Concrete components

1. Aggregate: Clean, hard, durable particles of natural sand conforming to ASTM C33 for fine aggregate. Clean, uniformly hard, durable particles of gravel or crushed stone conforming

to ASTM C33 for coarse aggregate.

2. Cement: Conform to requirements of ASTM C150. Use Type I or, at Contractor's option, Type III. Any change in type or admix use shall be at approved locations.
3. Ready-mixed Concrete: Conform to requirements of ASTM C94.
4. Maximum Size of Coarse Aggregate: Conform to requirements of ACI 301, Paragraph 3.6.
5. Minimum Cement Content: Six sacks per cubic yard.
6. Admixtures: Conform to requirements of ACI 301 and ASTM C260 for air entrainment. Use of accelerators or water-reducing retarders is prohibited.
7. Maximum Water Content: Six gallons of water per sack of cement. Free of injurious amounts of oil, acids, alkali, salts, vegetable matter, and fit to drink.
8. Minimum Concrete Compressive Strengths: A minimum compressive strength of 3,500 PSI shall be achieved in 28 days using Type I cement and in seven days using Type III cement, unless otherwise shown on drawings.
9. Slump in Inches: Unless otherwise shown on drawings, conform to ASTM C143 procedures for concrete to be vibrated: Maximum = 4", Minimum = 1".
10. Control Joints: Not less than 3/8" thick x 3/8" minimum depth with tooled edges.

2.02 FORMWORK

A. Forms: Wood, plywood, metal, other verified material to provide continuous, straight, structurally sound formwork and to produce specified concrete finish. Wood to be defect-free or properly corrected to provide straight lines and smooth, even surfaces.

B. Form-coating compound: Commercial formulation form-coating compound that will not bond with, stain, nor adversely affect concrete surfaces requiring bond or adhesion, nor impede the wetting of surfaces to be cured with water or curing compounds, nor interfere with subsequent applications of finish such as paints or stains.

C. Miscellaneous: Verified-type material and hardware for forming chamfers, recesses, openings, control joints, etc.

D. Design of Formwork

1. Design of formwork is Contractor's responsibility. Conform to shape, lines, and dimensions shown on the drawings. Design for adequate strength to sustain all construction loads without deformation or deflection.
2. Make joints tight to prevent leakage of mortar. Properly brace and tie together to maintain position and shape. Truss for support if adequate foundation for shores cannot be provided. Fabricate accurately to minimize development of irregularities at panel joints. Construct to accommodate control, expansion, or other type joints shown on the drawings or as specified.
3. Coordinate with all other trades to accommodate their work.

PART 3 – EXECUTION

3.01 SUBGRADE ESTABLISHMENT

A. Establish subgrade at elevations required to achieve the slopes and finish grade elevations designated on the drawings. The Contractor shall schedule the Project Landscape Architect for a subgrade inspection prior to installation of the concrete.

B. The subgrade shall be compacted to a minimum of 95% maximum dry density. Subgrade should be proof-rolled with a tandem axle dump truck or similar vehicle and stabilized. Refer to project Geotechnical Report for subgrade construction.

C. The subgrade shall be moistened to minimize absorption of water from fresh concrete.

3.02 FORMWORK INSTALLATION

A. Thoroughly clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt or other debris just before concrete is placed.

B. Prepare form surfaces by coating the contact surfaces of forms with a form-coating compound before reinforcement is placed. Form tolerance with respect to grade shall be not greater than ¼" deviation in 10 LF from design grade.

C. The form-coating compounds shall be thinned only with thinning agent of type, and in amount and under conditions of the form-coating compound manufacturer's directions. Do not allow excess form-coating material to accumulate in the forms or to come into contact with concrete surfaces against which fresh concrete will be placed. Apply in compliance with manufacturer's instructions.

D. Coat steel forms with a non-staining, rust-preventative form oil or otherwise protect against rusting. Rust-stained steel formwork is not acceptable.

E. Place and secure forms to correct location, dimension and profile. Assemble formwork to permit easy stripping and dismantling without damaging concrete.

F. Place joint fillers vertical in position, in straight lines. Secure to formwork during concrete placement.

3.03 CONCRETE MIXING AND PLACING

A. Conform to the requirements of ACI 301, Chapters 7 and 8, and ACI 304. Clean and free of all foreign matter, and all mixing and transporting equipment and subgrade and forms to receive concrete. Clean reinforcement of deleterious coatings.

B. Notice of intention to place concrete shall be given to the Project Landscape Architect at least 24 hours before an intended pour.

C. Conform to ACI 305 "Recommended Practice for Hot Weather Concreting". Take steps to reduce concrete temperature and water evaporation by proper attention to ingredients, production methods, handling, placing, protection and curing.

D. Conveying: Conform to ACI 301, Paragraph 8.2. Convey concrete from mixer to place of final deposit by methods preventing separation or loss of materials. Use pump, crane bucket, wheelbarrow, or buggies to deliver concrete to placing location. Chuting is permitted only by methods to ensure a practically continuous flow of concrete at delivery end to prevent material separation.

E. For walkways, curbing and slabs provide light broom finish and provide tooled or chamfer edges as shown in the details.

F. Curing Materials

1. Absorptive Cover: Burlap cloth made from jute or kenaf weighing approximately 9 oz. per square yard, complying with AASHO M182, Class 3.
2. Moisture-retaining Cover: Either waterproof paper, Polyethylene film, or Polyethylene-coated burlap, complying with ASTM C171.
3. Membrane-forming Curing Compound: ASTM C309, Type I, unless other type acceptable to the Project Landscape Architect.

3.04 FORMWORK REMOVAL

A. All formwork shall be removed after proper curing of concrete. Protect surfaces of concrete during removal operations.

B. Formwork not supporting weight of concrete may be removed after cumulatively curing at not less than 50 degrees F for 24 hours after placing concrete, provided concrete is sufficiently hard to not be damaged by form removal operations and provided curing and protection operations are maintained.

3.05 REUSE OF FORMWORK

A. Clean and repair surfaces of forms to be reused in work. Split, frayed, delaminated or otherwise damaged form-facing materials will not be acceptable for reuse. Apply new form-coating material as necessary, as specified for new formwork.

3.06 REPAIR OF SURFACE DEFECTS

A. General: Conform to ACI 301, Chapters 9 and 13. After removal of forms, repair or patch concrete not formed as shown, out of alignment or level beyond required tolerances or that shows surface defects, to condition as verified by Project Landscape Architect. Immediately after form removal, patch all tie holes and repairable defective areas.

B. Honeycombed areas shall be removed to sound concrete but not less than one (1") inch minimum depth. Dampen area and to six (6") inch width around same; let evaporate only to loss of sheen. Provide a bond of neat cement and water slurry well brushed into area to be patched. Provide patching mixture of 1:2 (cement:sand) or verified proprietary patching mixture or color to match adjacent surfaces; use water quantity only as required for mixing and placing. Leave patched surface slightly high; after one hour, float to level with adjacent surface. Keep patched areas damp for seven (7) days.

3.07 PROTECTION

A. Protect freshly-placed concrete from premature drying and excessive cold or hot temperature and maintain without drying at a relatively constant temperature for a time necessary for hydration of cement and proper hardening. Provide protection from vandalism.

B. Protect all concrete during curing period from all damaging mechanical disturbances, more especially load stresses, heavy shock and excessive vibration. Protect finish surfaces from all damage.

3.08 TOLERANCES

A. The surface elevation, in the finished condition, shall not deviate more than 1/8" from specified elevations. Trueness measurement to be taken from 10' long straight edge placed in all directions.

3.09 CLEANUP

A. At project completion, leave all work clean, defect-free, with uniform finish and color.

END OF SECTION 32 2953

SECTION 32 2954

ATHLETIC FIELD ASPHALT CONCRETE PAVING

PART 1 – GENERAL

1.01 SCOPE OF WORK

A. Include all labor, material, transportation and services to complete installation of the aggregate base and asphalt paving as shown on the drawings for the running track and perimeter areas including:

1. Final subgrade establishment
2. Base course aggregate
3. Track asphalt concrete paving

1.02 STANDARD SPECIFICATIONS

A. All sections of the standard specifications applicable to any and all parts of this project shall govern, except as specifically modified in these Contract Documents.

1. Standard Specifications for Road, Bridge, and Municipal Construction, Texas Department of Transportation, American Public Works Association (TXDOT/APWA)
2. American Society for Testing and Materials (ASTM)
3. American Association of State Highway and Transportation Officials, (AASHTO).

1.03 RELATED WORK SPECIFIED IN OTHER SECTIONS

Section 32 2951	Athletic Field Earthwork & Subgrade
Section 32 2968	Rubberized Track Surfacing

1.04 SUBMITTALS

A. Submit to the Project Landscape Architect for approval:

1. Base course aggregate sieve analysis
2. Equipment and procedures to be utilized for the asphalt installation.
3. Asphalt mix design or composition.
4. Previous experience of the proposed asphalt installer with running track asphalt paving installations.

PART 2 – MATERIALS

2.01 ASPHALT CONCRETE PAVING

A. All machine-placed shall be a Class D.

B. All hand-placed asphalt concrete pavement shall be a Class D.

C. Thickness of running track and field event area pavement to be minimum (3.5") inch compacted depth, placed on a geotechnical prepared compacted subgrade. The running track asphaltic concrete pavement shall be installed in two (2) lifts. The first lift shall be a minimum two (2") inches compacted depth of class D. The final lift to be a minimum (1.5”) compacted depth of class D.

D. Weather limitations: Construct asphalt paving only when atmospheric temperature is above 40

degrees F., when underlying base is dry and weather is not

E. Grade control: Establish and maintain the required lines and grades and cross-slope.

2.02 AGGREGATE BASE MATERIAL

A. For asphalt concrete base, maximum size 3/4" uniformly graded from coarse to fine. Use crushed rock or clean gravel.

2.03 ASPHALTIC CONCRETE

A. Use asphalt mix formula of asphalt concrete producer accepted by the Texas State Highway Department; for specification of Class "D" for machine-placed and hand placed asphaltic concrete.

PART 3 – EXECUTION

3.01 SUBGRADE

A. Establish subgrade and thoroughly compact to minimum 95% of maximum dry density. Refer to site Geotechnical Report for subgrade preparation compliance.

3.02 AGGREGATE BASE

A. Place 8” aggregate base on stabilized subgrade as called out in the geotechnical report. Apply aggregate base and compact to a uniformly smooth hard surface with a minimum thickness as called out in the Geotechnical Report or greater as required to conform to lines, grades and cross sections as shown or directed.

B. The grade tolerance of the compacted first lift of asphalt shall be +1/4" and -0". The asphalt concrete base shall not deviate from the true surface in excess of 1/4" on a 10' straight edge in all directions.

C. For the track and field event surfaced areas, the surface elevation of the final lift of paving, in the compacted condition, shall not deviate more than 1/8" from specified elevations. Trueness measurement to be taken from 10' long straight edge placed in all directions.

D. All edges to be straight or a continuous smooth line tapered at a 45 degree angle where free-standing or adjacent to soil area. No reverse slopes or birdbaths will be allowed. The complete surface of the asphalt shall be of uniform texture, smooth uniform as to grade, and free from defects of all kinds. Verify elevation requirements prior to commencing paving.

3.03 HAND PLACING

A. Spread, tamp, and finish mixture using hand tools in areas where machine spreading is not practical.

B. Place mixture at rate that will ensure handling and compacting before mixture temperature drops below 230 degrees.

C. Edges must have a straight or continuous smooth line.

3.04 QUALITY CONTROL

A. Prior to acceptance, all pavement shall be exposed to a "flood" test. When deviations in excess of the tolerances noted above or obvious depressions (birdbaths) are found, the pavement surface shall be corrected by the addition of asphalt concrete mixture of an appropriate class to low places or the removal of material from high places by methods satisfactory to the Project

Landscape Architect or by removal and replacement of the asphaltic concrete.

B. Corrections of defects shall be carried out until there are no deviations anywhere greater than the allowable tolerances. All areas in which the surface of the completed pavement deviates more than twice the allowable tolerances described above shall be removed and replaced to the Project Landscape Architect's satisfaction.

C. When any corrections are made, the entire area shall have a seal coat applied except for those areas where a rubberized surfacing shall be applied, so as to produce a new, non-repaired appearing surface. All costs involved in making the corrections of the defects described above shall be borne by the Contractor, and no additional compensation shall be made for this work.

3.05 CLEANING

A. After completion of paving operations, clean surfaces of excess or spilled asphaltic materials.

3.06 PROTECTION

A. Protect asphaltic paving from all damage of every kind. Do not permit vehicular traffic on asphaltic paving until it has cooled and hardened and in no case sooner than six hours after placing.

B. Provide barricades and warning devices as required. Protect soil and other site features where asphalt is being laid.

END OF SECTION 32 2954

SECTION 32 2955

ATHLETIC FIELD FENCING

PART 1 – GENERAL

1.01 SCOPE OF WORK

A. Provide chain-link fences and gates as complete units controlled by a single source including necessary erection accessories, fittings, and fastenings completely installed and functioning for softball field only. Work in this section is for the baseball and softball field and track field only. All chain link posts, rails, and all hardware shall include a powder coated black matt finish. All chain link fabric shall include a black class 2b PVC fusion bonded coating.
B. Furnish and install fence caps / fence guard, yellow in color.
C. Furnish and Install windscreen made of lats for both the baseball and softball field on all chain-link wing fencing and outfield chain-link fencing.
D. Furnish and install barrier netting on the backstop and wing fencing as shown in the plans. Baseball backstop to be 50’ feet high and softball to be 40’ feet high.
E. Furnish and install 40” inches tall knock down pad on the entire backstop low wall.
F. Furnish and install bullpen rail at both the home dugouts for the baseball and softball field. Rail to include full pad system
G. Furnish and install Dugout Ball Stopper System at all the dugouts for the baseball and softball field. Mount on New Dugouts.

1.02 RELATED WORK

Section 32 29 53 Athletic Field Sitework Concrete

1.03 SUBMITTALS

A. Product Data: The Contractor shall submit four (4) copies of the manufacturer's technical data and installation instructions for metal fencing and gates.
B. Shop Drawings: The Contractor shall submit shop drawings showing elevations and details of assembly.

1.04 MATERIALS STANDARDS

A. Materials standards shall adhere to Standards for Galvanized Steel Chain-link Fence Fabric, Standards for Industrial Steel Specifications for Fence Posts and Accessories, Standards for chain-link Fence Installation; as published by Chain-link Fence Manufacturer's Institute (CLFMI); American National Standard Institute (ANSI).
    1. Standards for Galvanized Steel Chain-link Fence Fabric
    2. Standards for Industrial Steel Specifications for Fence Posts and Accessories
    3. Standards for Chain-link Fence Installation as published by Chain-link Fence Manufacturer's Institute (CLFMI)
    4. American National Standard Institute (ANSI).

PART 2 – MATERIALS

2.01 GENERAL

A. Dimensions shown for pipe are outside dimensions.

2.02 STEEL FENCING

A. Typical Fabric: No. 9 ga. (0.158") finished size steel wires, two (2") inch mesh, and with knuckle both top and bottom.
B. Furnish one (1) piece fabric widths for fencing up to 10' feet high.
C. Furnish Beacon Athletics Yellow Fence Cap - Pre-slit poly tubing 4-1/2" DIA, fully UV-protected. Install on top of chain-link and wood fence per manufacturer’s instructions.

2.03 FRAMING AND ACCESSORIES

A. End, Corner and Pull Posts: All posts shall be standard steel pipe, straight, true and un-spliced. Minimum sizes and weights as follows:
   1. Four (4') feet and six (6') feet height, 2.875" o.d. steel pipe, 5.79 lbs. per l.f.

B. Line Posts: All posts shall be standard steel pipe, straight, true and up to 20 ft. length to be unspliced. Minimum sizes and weights as follows:
   1. Space 10' feet o.c. maximum, unless otherwise indicated.
   2. Six (6') feet fabric height, 2.375" o.d. steel pipe, 3.65 lbs. per l.f.

C. Top, Bottom and Intermediate Rails: Manufacturer's longest lengths, with expansion type couplings, approximately six (6") inches long, for each joint. Provide means for attaching top rail securely to each gate corner, pull and end post. Rails shall be 1.66 o.d. pipe, 2.27 lbs. per l.f.

D. Post Brace Assembly: Manufacturer's standard adjustable brace at end and gate posts and at both sides of corner and pull posts, with horizontal brace located at mid-height of fabric. Use same material as top rail for brace, and truss to line posts with 0.375" diameter rod and adjustable tightener.

E. Post Tops: Weather-tight closure cap (for tubular posts), one cap for each post. Furnish caps with openings to permit passage of top rail.

F. Stretcher Bars: One-piece lengths equal to full height of fabric, with minimum cross-section of (3/15" x 3/4") inches. Provide one (1) stretcher bar for each gate and end post, and two (2) for each corner and pull post.

G. Stretcher Bar Bands: Space not over 15" inches o.c., to secure stretcher bars to end, corner, pull, and gate-posts. Use off-set bands for all post sizes four (4") inches and greater to provide a true fabric and rail alignment.

H. Tension Wire: Shall be Marcelled (spiraled or crimped) #7 gauge, 0.177" inches in diameter, conforming to ASTM A-824. Color to be black and match fabric.

I. Wire Ties: For tying fabric to line posts, use wire ties spaced 18" inches o.c. For tying fabric to rails and braces, use wire ties spaced maximum 18" inches o.c. Hog style or Easy Twist spin wire ties will not be permitted.

2.04 GATES

A. Gate Posts: Furnish four (4.0") inches o.d. posts, nine (9.11) lbs/lf, for supporting a single gate leaf of nominal five (5'), seven (7'), or 10' feet lengths.

B. Fabricate swing and rolling gate perimeter frames of minimum 1-5/8" o.d. pipe. Metal and finish to match framework. Provide horizontal and vertical members to ensure proper gate operation and for attachment of fabric, hardware and accessories.

C. Assemble gate frames by welding or with special fittings and rivets, for rigid connections. Use same fabric as for fence, unless otherwise indicated. Install fabric with stretcher bars at vertical and top and bottom edges. Attach stretchers to gate frames at not more than 15" inches o. c. Attach hardware to provide security against removal or breakage. Install diagonal cross bracing consisting of 3/8" diameter adjustable length truss rods on gates to ensure frame rigidity without sag or twist, as required.

2.05 GATE HARDWARE

A. Furnish the following hardware and accessories for each gate.
   1. Hinges: Size and material to suit gate size, non-lift-off type, offset to permit 180° gate opening.
   2. Latch: Forked type or plunger-bar type to permit operation from either side of gate, with padlock eye as integral part of latch. Latches shall be Fulcrum type or approved equal.
   3. Gate-stops: Provide gate stops at open and closed gate positions, for double leaf gates and at open position for single leaf gates, except for batting cage gates. Gate stops shall be mushroom type of flush plate with anchors. Set stop in concrete, to engage drop rod or plunger bar.

2.06 NETTING

A. Backstop Pole: Furnish and install a standard Tie-Back Baseball/Softball Backstop Netting

System. The backstop pole system shall be a Sportsfield Specialties TNTBS36 (Softball Field) and a Sportsfield Specialties TNTBB36 (Baseball Field) or approved Equal.
Netting: Furnish and install barrier netting on top of designated sections of the backstop wall. The netting shall be knotted nylon, 1-3/4" mesh with a 530 lb. minimum breaking strength. The netting shall be reinforced on all edges. The edges shall include grommets for attachment to the support cable and chain-link fencing. The netting shall be Sportsfield Specialties, Nets of Texas or approved equal.

2.07 BASEBALL/SOFTBALL OUTFIELD FENCE

A. Furnish an eight (8') feet to 15' feet Type M prefinished MTL panel outfield fence with specified corrugated steel tubing supports. See Detail seven (7), F207.
B. Color to be chosen by the Owner.

2.08 STANDARD BACKSTOP PADDING

A. 18 oz, two (2") inch thick foam. Each panel is made of two (2') foot folding sections. Brass grommets 12" inches apart on all side.
B. Pads to be Kelly Green.
C. Beacon Athletics 800.747.5985 or approved equal

2.09 HOME DUGOUT RAIL WITH PADDING

A. Heavy Duty ALL-WELDED Galvanized pipe railing, DURA-Dip UV treated Nylon or Dyneema netting, and vinyl covered SF padding.
B. Pads to be Kelly Green and square.
C. Netting Professionals 8440620-2702 or approved equal.

2.10 DUGOUT BALLSTOPPER SYSTEM

A. Install Dugout Ball Stopper System by AAE Sports (800)523-5471 at each dugout for both baseball and softball.
B. Install per manufacturer's directions.

PART 3 – INSTALLATION

3.01 FENCE INSTALLATION

A. Excavation: Drill holes for posts of diameters shown in firm, undisturbed or compacted soil. Excavate holes to minimum diameter and depth as shown on the drawings. Excavate hole depths approximately four (4") inches lower than post bottom. Refer to drawings for depth.
B. Setting Posts: Center and align posts in holes four (4") inches above bottom of excavation. Place concrete around posts and vibrate or tamp for consolidation. Check each post for vertical and top alignment, and hold in position during placement and finishing operations. No concrete or concrete grout is to extend beyond limits of footing hole.
C. Top Rails: Run rail continuously through post caps, bending to radius for curved runs. Provide expansion couplings as recommended by fencing manufacturer.
D. Brace Assemblies: Install braces so posts are plumb when diagonal rod is under proper tension.
E. Fabric: Leave approximately one (1") inch between finish grade and bottom selvage. Fabric is to be installed so that baseballs cannot roll underneath the fabric. Pull fabric taut and tie to posts and rails. Install fabric on the field side of fence, and anchor to framework so that fabric remains in tension after pulling force is released.
F. Stretcher Bars: Thread through or clamp to fabric four (4") inch o.c., and secure to posts with metal bands spaced 14" inches o.c. maximum.
G. Tie Wires: Use U-shaped wire, conforming to diameter of pipe to which attached, clasping pipe and fabric firmly with ends twisted at least two (2) full turns. Bend wire to minimize hazard to

persons or clothing.

H. Fasteners: Install nuts for tension bands and hardware bolts on side of fence opposite fabric side. Peen ends of bolts or score threads to prevent removal of nuts.
I. Fence caps / fence covers: Beacon Athletics Model #125-515-409, yellow in color. Install on all six (6') foot outfield and wing fencing.

3.02 GATE INSTALLATION

A. Install gates plumb, level, and secure for full opening without interference. The clear opening shall be equal to or larger than the size specified on the drawings. Install ground-set items in concrete for anchorage, as recommended by fence and turnstile manufacturer. Adjust hardware for smooth operation and lubricate where necessary.

3.03 NETTING INSTALLATION

A. Securely fasten the top of the netting to a new 3/8" diameter steel cable and the bottom of the netting to the new chain-link fencing fabric.
B. The netting shall be fastened with metal "hog ring" type fasteners on 18" maximum centers.

END OF SECTION 32 29 55

SECTION 32 2961

ATHLETIC FIELD SUBSURFACE DRAINAGE

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. Furnish and install complete subsurface drainage systems for the synthetic turf stadium field as indicated on the drawings.

B. Trench to line and grade as shown on the drawings utilizing laser controlled equipment.

C. Dispose of excavated trench material.

D. Install corrugated polyethylene collector tubing.

E. Remove all loose material from lateral trench bottom.

F. Place a minimum two (2)" depth of specified washed pea gravel bedding for perforated piping.

G. Install perforated corrugated tubing lateral system plumbed to collector piping.

H. Bed and backfill perforated tubing trenches with specified washed pea gravel.

I. Upon completion of this work, restore subgrade to specified condition and tolerances, compacted to 95% density with no loose material on surface.

1.02 STANDARD SPECIFICATIONS

A. Standard Specifications for Road, Bridge, and Municipal Construction, Texas Department of Transportation, American Public Works Association (TXDOT/APWA)

B. United States Department of Agriculture, Soil Conservation Service, Engineering Standard 606.

1.03 RELATED WORK IN OTHER SECTIONS

Section 32 2951	Athletic Field Earthwork & Subgrade
Section 32 2963	Athletic Field Permeable Aggregate

1.04 SUBMITTALS

A. Submit to the Project Landscape Architect for approval:

1. Pea gravel sieve analysis
2. 3/4 inch washed drainage gravel
3. Product data for perforated and non-perforated tubing
4. Product data for all fittings and connections

PART 2 - PRODUCTS

2.01 PERFORATED AND NON-PERFORATED TUBING

A. The piping shall be corrugated polyethylene drainage tubing. The perforated collector tubing shall be smooth interior wall ADS N-12 or approved equal.

B. Material shall conform to requirements of Type III, Grade 4, Class "C" polyethylene as specified in ASTM D1248.

C. Dimensions:

1. Inside diameter variance shall not exceed -0.0% or +5%.
2. Lengths shall be in coiled configuration with a -0.0% tolerance.

D. Tubing shall conform to U.S. Department of Agriculture Soil Conservation Service, Engineering Standard 606.

E. For perforated tubing, water inlet areas shall be slotted with a width of 1/16" to a maximum of 3/32” uniformly spaced circumferential slots located on the inner depression of the corrugation, totaling a minimum of 1.25 square inches per lineal foot. The perforations shall provide a clear opening. Tubing with perforations that are punched with a flap type opening or that are not uniform will be rejected.

F. Fittings and Connections:

1. Fittings shall be as furnished by the manufacturer of the pipe.
2. Connections of tubing lengths shall be with split coupling or snap-in-type couplings utilizing polyethylene or construction tape.
3. Tubing is to be inserted into sockets for the full socket length. "Slip-fit" connections will not be permitted.
4. All split coupling connections are to be fully taped. All connections at fittings and connections are to be taped at interface of exposed joint.

2.02 PEA GRAVEL

A. Pea-gravel bedding for perforated pipe shall be clean, washed, uniformly graded 3/8" to 1/8".

The pea gravel material graduation must meet the following sieve analysis:

Sieve Size	Percent Passing
1/ 2”	100
3/ 8"	80 - 100
# 4	0 - 50
# 8	0 - 10
# 100	0 - 0.6
# 200 (wet sieve)	0 - 0.5
# 270 (wet sieve)	0 - 0.3

2.03 TESTING

A. The Owner will be performing testing of materials delivered to the job site for the purpose of verifying compliance with the contract documents. The Owner’s testing is for this purpose only and not for construction quality control by the Contractor.

B. The Contractor shall coordinate directly with the Owner’s testing firm relative to the delivery schedules of the imported materials.

C. The Contractor shall provide testing and surveillance as required to assure materials and work fully comply with contract requirements.

D. The Contractor at a price equal to the Owner’s contract testing agreement shall pay for owner’s tests that do not meet specifications. The Contractor shall pay directly to the testing organization upon invoice to the owner, which has been approved by the Project Landscape Architect.

PART 3 - EXECUTION

3.01 TRENCHING

A. Coordination: It is the responsibility of the Contractor to ensure that electrical conduits and wash water piping are installed at a sufficient depth below subgrade before the trenching for the subsurface drainage system to avoid conflicts between systems.

B. Excavation shall be made to the alignment, elevation, grade and slope as indicated on the drawings.

C. Trenching shall be accomplished utilizing equipment with slope and depth control, such as "Laser Plane Control System", so as to ensure accuracy in the bottom of the trench.

D. No high points above designated invert or calculated trench bottom elevation will be permitted. No sloughing of site material or loose excavated soil will be permitted to remain in the trenches.

E. Surplus excavated soil shall be removed from the field area. Excavated material may not remain on subgrade. Excess soil material shall be disposed of off site.

F. Provide a smooth, even subgrade after removal of the trench material. Subgrade to be compacted to 95% density. Leave no loose material on the subgrade.

3.02 PLACEMENT

A. Excavation below invert grade must be established to a depth so as to provide for specified placement of pea gravel bedding at bottom of pipe elevation prior to laying the tubing.

B. Pea-gravel bedding for perforated pipe shall be clean, washed, uniformly graded 3/8" to 1/8".

C. No foreign material will be permitted inside, alongside, under, or on top of, installed tubing.

3.03 BACKFILL

A. The backfill for all perforated pipe shall be clean washed pea gravel, uniformly graded 3/8" to 1/8".

B. All trenches to have backfill material "crowned" a minimum of two (2)" above subgrade to protect from foreign material and provide for ease of location identification. Crowns with foreign material contamination shall be removed prior to placement of base aggregate.

C. Specified bedding shall not be placed until Project Landscape Architect approves the trench.

D. Trench backfill shall not be placed before Project Landscape Architect approves perforated pipe placement.

E. During placement of specified trench backfill, pipe must be held in place with a hand device to prevent displacement and provide for achieving specified invert elevation. Do not damage pipe or allow pipe to be displaced by placement of backfill material.

F. Non-perforated pipes to be backfilled with cement stabilized sand or lean concrete. See Athletic Field Storm Drainage Section.

3.04 CONNECTIONS

A. All connections are to be made with approved fittings as recommended by the tubing manufacturer and approved by the Project Landscape Architect.

B. Tubing is to be inserted into sockets for the entire length. Tape all connections utilizing polyethylene or construction tape. Tape alone shall not be acceptable when connecting separate pieces of pipe together.

C. No foreign material will be permitted inside the installed tubing.

D. Cap the ends of all lateral runs as shown on the drainage plan. All open ends during construction are to be temporarily capped or plugged. Tape shall not be used in lieu of end caps.

E. Connection of laterals to collector drains shall be made with a combination reducing tee and reducing saddle tee or end tee as applicable, utilizing snap connections.

3.05 EQUIPMENT MOVEMENT

A. No trucks or equipment will be allowed to drive over the top of the trenches except track-equipped machinery utilized in spreading imported granular materials. Backfilled trenches are to be staked and "flagged" three (3)' above grade a maximum 20' spacing for identity.

END OF SECTION 32 2961

SECTION 32 2963

ATHLETIC FIELD PERMEABLE AGGREGATE

PART 1 – GENERAL

1.01 SCOPE OF WORK

A. Include all labor, material transportation and services to complete installation of the permeable aggregate base as shown on the drawings for the field including:

1. Final subgrade establishment
2. Impervious structural soil-bearing fabric
3. Permeable aggregate

1.02 STANDARD SPECIFICATIONS

A. All sections of the standard specifications applicable to any and all parts of this project shall govern, except as specifically modified in these Contract Documents.

1. American Society for Testing and Materials (ASTM)
2. American Association of State Highway and Transportation Officials (AASHTO)

1.03 RELATED WORK IN OTHER SECTIONS

Section 32 2951 Athletic Field Earthwork & Subgrade

1.04 SUBMITTALS

A. Submit to the Project Landscape Architect for approval:

1. Impervious structural fabric product data
2. Permeable aggregate sieve analysis (Both Bottom Course and Top Course)
3. Permeable aggregate infiltration rate (Both Bottom Course and Top Course)
4. Equipment and procedures to be utilized for the permeable aggregate installation.

1.05 QUALIFICATIONS

A. The Subcontractor responsible for field base establishment, field subsurface drainage, and field permeable aggregate placement and compaction shall be submitted to the Project Landscape Architect for Approval. specific prequalification requirements are included as follows:

1. Subcontractor shall be and has been actively and directly engaged in constructing similar natural or synthetic field projects for a period of five (5) or more years and shall provide proof of five (5) or more full size (80,000 sf) sports field base installations completed in the past three (3) years.
2. The Contractor’s experience shall include completion of high school, college, or professional level competition fields. The playing field system shall include earthwork, wash-water or irrigation systems, drainage and subsurface drainage systems and base aggregate placement and compaction.
3. Provide a listing of all construction contracts (whether completed or in progress) entered into or performed by the Subcontractor within the past five years for projects similar in scope, time and complexity to the work called for under this Contract; include the names of the contracts, and the names and contact information of the owners.

PART 2 - PRODUCTS

2.01 IMPERVIOUS STRUCTURAL SOIL-BEARING FABRIC

A. Fabric:

1. Material: An approved 30 mil flexible polyethylene liner manufactured by GSE Lining Technology or equal.
2. Physical Properties:

a.	Tensile Strength, lbs., (ASTM D-75-1):	122 lbs.
b.	Tensile Elongation:	780%
c.	Thickness, (nominal):	30 miles
d.	Grab Strength:	170 lbs.
e.	Tear Resistance:	18 lbs.
f.	Puncture Resistance:	40 lbs.
g.	ESCR:	1500 hours
h.	Dimensional Stability:	2% change

3. Liner to be seamed and sealed using an approved Poly-Flex neoprene flashing cement or liner welding.

2.02 BASE COURSE PERMEABLE AGGREGATE

A. The base course permeable aggregate shall be installed below the top course permeable aggregate as applicable.

B. Aggregate to be open-graded, fractured, friction course. To ensure free drainage, material is to be clean with minimal fines. The compacted top course permeable aggregate shall have a minimum infiltration rate of 40 inches per hour. Soft limestone or other soft material will not be tolerated. The drainage aggregate shall not lose more than 12% by weight when tested for weathering stability using ASTM C-88 sodium sulfate soundness test. The drainage aggregate shall also be tested using the L.A. Abrasion test, ASTM C-131, with a percentage lost by weight not exceeding 40. Sandstone will not be allowed.

C. Base course material to be a minimum of 75% fractured with at least one fractured face by mechanical means on each individual particle larger than 1/4". A sand and gravel source may acceptable for this material.

D. Gradation: Aggregate to meet the following particle size limitations:

Sieve Size	Percent Passing by Weight
1-1/4"	100
1"	90 - 100
3/4"	80 - 100
1/2"	50 - 80
3/8"	40 - 60
No. 4	15 - 40
No. 8	10 - 25
No. 30	5 - 15
No. 100	0 - 7.5
No. 200 (Wet Sieve)	0 - 2.0

Note: The material must comply with both the sieve and infiltration rate requirements.

2.03 TOP COURSE PERMEABLE AGGREGATE

A. The top course permeable aggregate shall be installed over the base course permeable aggregate in the synthetic turf areas.

B. Aggregate to be open-graded, fractured, friction course. To ensure free drainage, material is to be clean with minimal fines. The compacted permeable aggregate is to be a minimum infiltration rate of 20 inches per hour. Soft limestone or other soft material will not be tolerated. The drainage aggregate shall not lose more than 12% by weight when tested for weathering stability using ASTM C-88 sodium sulfate soundness test. The drainage aggregate shall also be tested using the L.A. Abrasion test, ASTM C-131, with a percentage lost by weight not exceeding 40.

   Sandstone material will not be allowed.

C. Top course material to be 100% fractured crushed rock material. A quarry source is required for this material.

D. Gradation: Aggregate to meet the following particle size limitations:

Sieve Size	Percent Passing by Weight
3/4"	100
1/2"	90 - 100
3/8"	80 - 100
No. 4	55 - 75
No. 8	30 - 50
No. 30	5 - 25
No. 100	2 - 10
No. 200 (Wet Sieve)	0 - 4.0
No. 270 (Wet Sieve)	0 - 3.0

Note: The material must comply with both the sieve and infiltration rate requirements.

2.04 TESTING

A. The Owner will be performing testing of materials delivered to the job site for the purpose of verifying compliance with the Contract Documents. The Owner's testing is for this purpose only and not for construction quality control by the Contractor.

B. The Contractor shall coordinate directly with the Owner's testing firm relative to the delivery schedules of the imported materials. Sampling will be scheduled each day deliveries occur.

C. The Contractor shall provide testing and surveillance as required to assure materials and work fully comply with Contract requirements.

D. The Contractor, at a price equal to the Owner's contract testing agreement, shall pay for Owner's tests that do not meet the Specifications. The Contractor shall pay directly to the testing organization upon invoice to the Owner, which has been approved by the Project Landscape Architect.

PART 3 - EXECUTION

3.01 SUBGRADE ESTABLISHMENT

A. No work shall be performed in this section until subgrade is 100% completed and accepted by the Project Landscape Architect.

B. Finish subgrade shall be compacted to a minimum 98% maximum dry density. Review site Geotechnical Report for compliance.

C. Subgrade shall be established to within the tolerance of +0.00’ or -0.10’ of the design subgrade elevation.

3.02 IMPERVIOUS STRUCTURAL SOIL-BEARING FBRIC INSTALLATION

A. No loose material is allowed on subgrade prior to placement of structural fabric. Loose material is to be removed prior to placement.

B. Fabric to be laid on smooth, compacted, subgrade surface over the entire surface area, including below drainage lateral piping.

C. Placement of structural-bearing fabric requires approval of subgrade conditions to the Project Landscape Architect.

D. Structural fabric must be flat on stabilized subgrade for full width.

E. Dimensions to be a minimum width of 12.5’ and minimum continuous length of 150 lf.

F. When the length of the fabric is not continuous, the lateral seam shall have a minimum overlap of 24”.

G. Fabric shall not be folded or turned up along the edges.

H. The fabric shall be field cut as necessary to meet specified tolerances of distance from drainage trenches.

I. Fabric shall be placed under trenches. In no instance shall fabric cover drainage lateral piping.

J. Stabilization: Immediately upon laying, the fabric is to be covered with base aggregate. No loaded trucks are to be permitted to move over fabric-covered surfaces until a minimum of 4” of aggregate has been placed, except if specifically approved by the Project Landscape Architect. The Contractor must execute strict, direct, 100%, control of all vehicle movement on site.

K. Seam Welding: The seams shall be completed per manufacturer’s recommendations. The seams shall be clean of dust, mud, moisture and debris prior to hot welding. Tee seams will not be allowed. A master welder shall be on site to supervise all other welders.

3.03 EQUIPMENT MOVEMENT

A. No trucks or equipment will be allowed to drive over the top of the drainage pipe or trenches except track-equipped machinery utilized in spreading base aggregate materials, or where a 12” depth base aggregate temporary roadway has been established. Backfilled trenches are to be staked and “flagged” 3’ above grade at 20’ minimum intervals for identity.

B. In the event non-track traffic is observed or evidenced to cross piping or trenches, the Contractor shall, at their own expense, expose the drainpipe in the area directed for observation by the Project Landscape Architect, repair any damage promptly and reinstall backfill per the Specifications.

3.04 AGGREGATE PLACEMENT

A. Moisture Content: Aggregate to contain 3.5% to 4.0% moisture content to ensure that fines do not migrate and to facilitate proper compaction. Contractor must ensure that aggregate leaving the source plant meets this requirement and is required to apply water to aggregate on site to attain and maintain this minimum moisture content in stockpile and during all placement operations.

B. Prior to aggregate placement, remove any foreign material or contamination from the surface of the structural fabric and drainage trench or lateral piping.

C. Surface must be free of standing water and subgrade stabilized with structural fabric in place prior to placement.

D. Materials to be placed in layers not exceeding 6” compacted in depth. Each layer must be

spread uniformly with equipment that will not cause perceptible separation in gradation (segregation), preferably a self-propelled paving machine.

E. Should there occur, during any stage of the spreading or stockpiling, a separation of the material particles, the Contractor must immediately remove and dispose of segregated material and correct or change handling procedures to prevent any further separation.

3.05 AGGREGATE COMPACTION

A. Each layer shall be compacted to a minimum density of not less than 95% of maximum dry density as determined by ASTM D-698 and measured using a nuclear method.

B. Use static tandem drum-type roller of not less than five (5) tons weight.

3.06 AGGREGATE TOLERANCES

A. The Contractor shall utilize a laser plane system for grade control.

B. The surface of the permeable aggregate shall not deviate from designated compacted grade with the range of -0.00” and +0.25”.

C. Upon completion of the fine grading, compaction and Contractor confirmation of conformance with the tolerances, the Contractor shall notify the Project Landscape Architect and schedule an inspection for approval. The Contractor shall have a laser plane system available to the Project Landscape Architect for the inspections. **The Contractor shall not be authorized to place synthetic turf over the permeable aggregate until it has been inspected and approved by the Project Landscape Architect.**

END OF SECTION 32 2963

SECTION 32 2964

INFILLED SYNTHETIC TURF

PART 1 – GENERAL

1.01 SCOPE OF WORK

A. Scope of work to include all labor, material, equipment, transportation and services to install complete new vertical draining infilled synthetic turf surfacing system for the designated field area. System to be, as herein specified, including, but not specifically limited to, the following:

1. Independent testing of synthetic turf materials prior to shipment to project site.
2. Review and acceptance or certification of the existing permeable aggregate top course as it applies to installation of turf system, permeability and warranty implementation.
3. Installation of complete vertical draining infilled synthetic turf surfacing system on softball and baseball fields including bullpens.
4. Installation of complete vertical draining infilled synthetic turf surfacing system with shock pad for the track football field.
5. Furnish and install pre-manufactured interlocking drainage base shock pad layer.
6. Installation of all inlaid or tufted (as applicable) field lines and markings as indicated on the drawings.
7. Provide extra turf materials to the Owner for future repair and protective purposes.
8. Provide all appropriate maintenance and repair manuals and warranty package to Owner.
9. Provide a tow behind sweeper unit and field drag to the Owner for field maintenance.
10. Provide extra four (4), (4’ x 6’) feet home plate box batting removable rectangles with Velcro attachments. Rectangles to include four (4”) inch white box markings. Turf to be 70 oz face weight or more.
11. Provide extra two (2), (8’x 6’) feet catcher box removable rectangles with Velcro attachments for both baseball and softball. Turf to be 70 oz face weight or more.
12. Provide two (2) extra throwing circles with white circle, removable with Velcro attachments for softball. Turf to be 70 oz face weight or more.
13. Provide two (2) extra pitching mound replacement areas for baseball pitching mound. Turf to be 70 oz face weight or more.
14. Provide four (4) extra cut outs of (10’ x 10’) feet for each base on both the softball and baseball field slide path areas. Turf to be 70 oz face weight or more.
15. Installation of a complete synthetic turf ¾” short pile height with minimum 50 oz face weight surfacing system with 5mm supplemental pad with no infill for complete batting cage flooring.
16. Install hitting mats in batting cages for both baseball and softball.
17. Install full size “TISD” white letters in each endzone of football field, matching Tomball High School. Install offsetting light green to dark green panels every 5 yards.
18. Install offsetting light green to dark green panels at baseball and softball field matching Tomball High School. Install Full size outfield school logo at both baseball and softball, matching Tomball High School. Install full size color logo behind home plate at Baseball. Mascot to be named in the future.

1.02 PRE-APPROVED VENDORS

A. The following vendors has been pre-approved by the Owner:

1.	Hellas	Hellas Construction	512.250.2910
2.	Shaw Industries	Paragon Sports/Shaw	817.916.5000
3.	AstroTurf	AstroTurf / Symmetry	281.433.0415
4.	FieldTurf	FieldTurf	512.925.9788

B. All vendors that are not included as a pre-approved product shall submit a substitution request. The substitution requests must be submitted a minimum of 10 days prior to the bid opening.

C. Product evaluation for any system shall include, but not be limited to, the following criteria (listed alphabetically and not in order of priority):

1. Aesthetics Relative to Those of a Natural Turf Field
2. Ball Bounce & Ball Roll Characteristics
3. Experience with Infill Synthetic Turf Soccer, Lacrosse, Softball, & Baseball Fields
4. Footing Characteristics including Traction, Rotational Resistance, & Slip Resistance
5. Infill Material Stability including Surface Stability & Vertical Deformation
6. Pricing for Each Synthetic Turf Option and the Corresponding Alternates

D. Substitution requests must include the following information for evaluation by the Owner and Project Landscape Architect.

1. Vendor Background and Experience: Describe your firm's history. Include information identifying the firm's annual volume and the firm's stability in the marketplace. Also include the firm's record relating to installation schedules and performance. Provide additional information regarding local representation, and post-installation support.
2. Product Manufacturer Background and Experience: Describe the history and experience of the product manufacturer with this specific product including years of experience and a count and listing of North American and worldwide synthetic turf field installations. The list shall include field locations, client, client contact names, address, telephone, material installed, date of installation, and general Contractor (if any).
3. Product Installer Background and Experience: Describe the history and experience of the product installer with this specific product including years of experience and a count and listing of field installations. The list shall include field locations, client, client contact names, address, telephone, material installed, date of installation, and general Contractor (if any). If the installer is not the manufacturer or vendor of the product, describe the experience the installer has with this specific product.
4. Product Samples: Provide the following samples with the substitution request.
   a. Two (2) – (8"x 12") inch samples each of green turf without infill material showing backing with perforations.
   b. Two (2) – (8" x 12") inch samples each of turf with the infill material.
   c. Two (2) samples of the proposed infill material.
5. Product Specification: Provide specification for the proposed synthetic turf product. Note any required deviations from the Infilled Synthetic Turf Technical Specifications included in this section.
6. Product Performance: The samples submitted with the proposal will be reviewed and evaluated. As a supplement to the samples, provide a written description of the following performance criteria for the proposed synthetic turf surfacing system:
   a. Abrasive characteristics
   b. Weekly, Monthly, and Annual Maintenance Requirements
   c. Playability for Football and Soccer

d. Wet and Dry Traction

7. References: Supply a minimum of three (3) references, including contact name and telephone number, for other installations of this product.

1.03 APPROVED FIBER MANUFACTURERS

A. The following fiber manufacturers are pre-approved for the infilled synthetic turf systems for the synthetic turf field:

Tencate, Hellas, FieldTurf, Shaw or Preapproved equal

B. The synthetic turf vendor shall provide written documentation in the form of a signed affidavit certifying the source of the fiber used for the field including both green and any other colors used for the lines and markings.

1.04 MINIMUM QUALIFICATIONS

A. The manufacturer of the synthetic turf system must have produced a minimum of 20 successful infilled synthetic turf soccer or football fields of full size and outdoors within the past two (2) years. Also, the manufacturer of the synthetic turf system, if not listed above or pre-approved, must have produced a minimum of 10 successful infilled synthetic turf soccer or football fields with the identical product including infill composition to that proposed for this project and of full size and outdoors within the past year.

B. Installer of the synthetic turf system must have installed a minimum of 10 successful infilled synthetic turf football or soccer fields of full size within the past two (2) years.

C. The contractor or subcontractor responsible for the field base establishment, field surface drainage, and field permeable aggregate placement and compaction shall be submitted to the Landscape Architect for approval. Specific qualification requirements are included as follows:

1. Subcontractor shall be and has been actively and directly engaged in construction similar natural or synthetic field projects for a period of five (5) or more years and shall provide proof of 10 or more full size (75,000 SF) sports field base installation completed in the past three (3) years, or have complete at least one (1) field for the current client. The contractor's experience shall include completion of high school, university, college or professional level competition fields. The playing field system shall include earthwork, stabilization, wash water or irrigation systems, drainage and subsurface drainage systems and base aggregate placement and compaction. Provide a listing of all construction contracts (whether completed or in progress) entered into or performed by the subcontractor within the past five (5) years for projects of similar scope, time and complexity to the work called for under this contract; include the names of contracts, and the names and contact information of the owners.

1.05 RELATED WORK SPECIFIED IN OTHER SECTIONS

Section 32 2963	Athletic Field Permeable Aggregate
Section 32 2966	Athletic Field Furnishings

1.06 STANDARD SPECIFICATIONS

A. The National Collegiate Athletic Association Football Rulebook (latest edition);

B. The National Collegiate Athletic Association Soccer Rulebook (latest edition);

C. For standards: Applicable American Society for Testing Materials (ASTM), (latest edition).

1.07 POST AWARD SUBMITTALS

A. Shop Drawings: Within 14 calendar days after issuance of Notice to Proceed, submit to the Project Landscape Architect five (5) copies of complete and detailed drawings showing all component parts of the synthetic turf system. The shop drawings shall be drawing to scale (1" = 30' minimum) and shall include:

1. edging details
2. insert details including backing material
3. seam details
4. seam layout
5. gluing patterns
6. dimensional shop drawing for all field lines, markings and boundaries

B. Synthetic Turf Samples: Within 14 calendar days after issuance of Notice to Proceed submit to the Project Landscape Architect:

1. Two (2), 6"x 12" samples each of each green turf showing backing with perforations.
2. Two (2), 6" x 12" samples each of turf showing method of seam makeup with perforations. One (1) sample to have example of inlaid lines.
3. Two (2), 6” x 12” samples each of the other colors proposed for use on the field for lines and markings.
4. Two (2), 1-pound samples of the proposed infill material.

C. Manufacturer's Specifications and Warranty:
1. Within 14 calendar days after issuance of Notice to Proceed submit to the Project Landscape Architect five (5) copies each of selected manufacturer’s material specifications and installation instructions. Include detailed specifications of manufacturer’s provisions for achieving permeability, stating rate in infiltration and permeability in inches per hour of system materials for the vertical draining system.
2. Within 28 calendar days after Notice to Proceed, submit to the Project Landscape Architect five (5) sample copies of warranty package herein specified for review.

D. Testing and Quality Control: Within 14 calendar days after issuance of Notice to Proceed, submit to the Project Landscape Architect the following test results for the system specified. An independent testing laboratory experience with testing of synthetic turf or carpeting materials shall certify these tests. The qualifications of the testing laboratory to be utilized for the submittal and the pre-shipment testing shall be submitted to the Project Landscape Architect for approval. Applicable minimum material ASTM tests:
1. Dynamic Cushion Test - ASTM F355, Procedure A, (system); ASTM F355 procedure A at the 24” drop.
2. Yarn and fabric characteristics.
3. Pill Burn Test – ASTM D2859

E. Maintenance and Operating Data:
1. Prior to acceptance and/or occupancy by the Owner, furnish to the Project Landscape Architect five (5) copies in hard cover form of maintenance and operating data with imprinted Project, Owner, Project Landscape Architect, Contractor and Turf Subcontractor names, and date of turf system installation.
2. In addition, provide descriptions of any equipment recommended for maintenance and repair, citing specific vendors for each unit.
3. Use and Limitations - Provide a separate page stating approved activity usage for the turf and activities not recommended relative to warranty.
4. Index - Index with tab dividers for data as follows: Materials installed with their characteristics; General maintenance; Small repair procedures; Minor seam repair; Discussion of precautions to be practiced, general maintenance, and uses to avoid to protect the turf surface and to maintain installation's warranty.

F. Submit the name of the synthetic turf testing laboratory for approval by Project Landscape Architect. Testing Laboratory will be totally independent of the synthetic turf contractor. The synthetic turf contractor will have no current or prior working relationship or ownership of any kind in the Testing Laboratory.

G. In-situ Shock Absorbing Pad Submittals: Within 21 calendar days after issuance of Notice to Proceed, submit to Project Landscape Architect:
1. The proposed mix formula with total component weights,
2. An outline of equipment and installation process to be utilized for the installation,
3. Written evidence of a two (2)-year minimum experience record of manufacturer /supplier/installation team in the installation of similar projects to the work under this section including a list of locations, client contact names, address, telephone, material installed, date of installation, as well as the name of the proposed superintendent with a resume

including a list of his/her previous successful elastic layer installations.

4. In-Situ Shock Absorbing Pad vendor/installers with less than this minimum experience record **are not** acceptable.

1.08 PRE-SHIPMENT SUBMITTALS

A. Prior to shipment of the synthetic turf materials to the job site, synthetic turf material from every sixth (6^{th}) roll shall be randomly sampled and the tested by an independent testing laboratory experience with testing synthetic turf materials. The testing laboratory shall be completely independent with no ties to the turf manufacturer. The testing shall include the following:

Item	ASTM	Property
1.	FTIR Spectrograph	Pile Composition
2.	D418	Pile Weight
3.	D418	Total Weight
4.	D418	Pile Height
5.	D418	Backing Perforation Diameter and Spacing
6.	D1335	Tuft Bind (without infill)
7.	D1682	Grab/Tear Strength.

B. Copies of the test results shall be transmitted to the Owner and Project Landscape Architect directly from the testing laboratory. The synthetic turf materials shall not be shipped to the site without written authorization from the Project Landscape Architect after the Owner and Project Landscape Architect have approved the test results.

C. Samples of the synthetic turf material tested from every sixth (6^{th}) roll shall also be transmitted to the Project Landscape Architect for approval by the independent testing laboratory prior to shipment of the synthetic turf materials to the job site. Sample size shall be minimum 12” x 12”.

D. All fees and costs associated with the pre-shipment sampling and testing shall be paid by the Contractor.

1.09 CERTIFICATION OF THE BASE

A. The Synthetic Turf Contractor shall furnish to the Owner, prior to the synthetic turf installation, a written certification of the acceptability by the turf vendor of the permeable aggregate for installation and warranty validation.

1.10 TURF SYSTEM HOLD HARMLESS

A. The synthetic turf manufacturer and installer shall not infringe upon any current or pending patents held by other synthetic turf manufacturers or installers.

B. The Contractor, the Synthetic Turf Contractor, and the synthetic turf manufacturer shall hold the Owner, Owner’s Representative, and the Project Landscape Architect harmless from infringement of any current or future patent issued for the synthetic turf surfacing system, installation methods and vertical draining characteristics. A notarized statement shall be provided as part of the submittal package.

1.11 WARRANTY OF SYNTHETIC TURF

A. Warranty shall cover, in general, the usability of the turf surface, accessories, use characteristics, and suitability of the installation. All items covered by warranty are to be replaced or repaired with new materials, including installation at the sole expense of the warranting Synthetic Turf Contractor for the period of eight (8) years to the Owner, for the

designated uses enumerated as follows:

1. Soccer
2. Football
3. Baseball/Softball
4. Lacrosse
5. Marching band
6. Physical exercises
7. Physical education activities
8. Pneumatic rubber-tired maintenance and service vehicles
9. Pedestrian traffic and other similar uses
10. Ceremonial and Entertainment Events
11. Wheelchairs

B. A principal of the applicable firm, duly-authorized to make contracts, shall sign the turf vendor warranty. If the turf vendor is not the manufacturer, the manufacturing firm shall also sign the warranty. The term "Synthetic Turf Contractor" contained herein means the firm furnishing warranty. "Owner" is the Tomball Independent School District. Warranty period shall be a minimum of eight (8) years from date of acceptance of the installed system by the Owner.

1.12 FORM OF WARRANTY OF SYNTHETIC TURF SYSTEM

A. Provide the following language as a supplement to the vendor warranty.

B. Synthetic Turf Contractor hereby warrants to Owner, subject to the limitations and conditions set forth below, that its synthetic turf system consisting of synthetic turf described as _____, and the adhesives used in the installation, is free from defects in material and workmanship and shall, for a period of eight (8f) years as applicable from the date of acceptance by the Owner, remain serviceable for multiple sports activities.

C. Synthetic Turf Contractor warrants to the Owner that its synthetic turf materials shall not fade, fail, shrink, wrinkle, or reflect excessive wear. Synthetic Turf Contractor shall, at their sole expense and cost, replace such areas of the synthetic turf system not performing to these standards for the life of the warranty.

D. Definitions

1. The term "not fade" in the context of this warranty shall mean that the synthetic turf material shall remain a uniform shade of green and other colors installed, with no significant loss of color.
2. The term "not fail" or "excessive wear" as used in the context of this warranty shall mean that the length and weight of the face yarn or pile material in the synthetic turf surface above the infill materials shall not have been decreased by more than 10% per year according to ASTM D418, nor exceed 50% during the warranty period. In the event that the synthetic turf system does not retain its fiber height or shock absorbency and is consequently no longer serviceable during the warranty period, the Synthetic Turf Contractor shall, at their sole expense, replace such portion of the system that is no longer serviceable.
3. The term "serviceable" in the context of this warranty shall mean that the synthetic turf system shall have a maximum "G" value according to ASTM F1936-98 and Procedure A, ASTM F355, not to exceed 130G's at any location upon installation and shall not exceed 175G's throughout life of the warranty period. This shall be determined by conducting dynamic cushioning tests at the locations designated in ASTM F1936-98 and at corners of the soccer penalty boxes at opposite sides of the field. Any increase from 130G's to allowable 175G's maximum shall be at a relative uniform rate not to exceed 15 G's in any

single yearly period.

E. Where applicable, the fabric seams shall remain attached to the underlying surface over the warranty period and shall not separate or become unglued or unattached, as applicable.

F. Synthetic Turf Contractor warrants to the Owner that the permeable synthetic system shall drain vertically a minimum of 20 inches precipitation per hour without visible surface ponding.

G. Synthetic Turf Contractor shall replace with new materials, at their sole expense, any damage to the synthetic turf system that extends more than three (3)-feet beyond the location of foreign combustibles, which may ignite and fire-damage the synthetic turf system. The Synthetic Turf Contractor shall not be held liable for any incidental or consequential damages. These warranties and the Synthetic Turf Contractor's obligations here-under are expressly conditioned upon;

1. The Owner making all minor repairs to the synthetic turf system upon the discovery of the need for such repairs;
2. The Owner maintaining and properly caring for the synthetic turf system in accordance with the Synthetic Turf Contractor's maintenance manual and instructions;
3. The Owner complying with the dynamic and static load specifications established by the Synthetic Turf Contractor.

H. The warranty is not to cover any defect, failure, damage or undue wear in or to the synthetic turf system caused by or connected with abuse, neglect, deliberate acts, act of God, casualty, static or dynamic loads exceeding Synthetic Turf Contractor's recommendations, footwear having cleats, spikes, or similar projections other than conventional baseball, football, soccer, or rugby shoes having cleats of not more than 1/2" in length, and other conventional running track shoes having spikes of not more than 1/4" in length, or use of improper cleaning methods.

I. Synthetic Turf Contractor shall be allowed to examine the synthetic turf system regarding any claim that the Owner makes to be present at any time, to analyze the results of all tests conducted by the Owner or others, and to conduct such tests of their own. Synthetic Turf Contractor shall not be responsible for any costs or expenses incurred by the Owner or others with respect to such tests, except the Synthetic Turf Contractor shall pay for costs of all tests and analysis conducted or directed by their representative.

J. In the event the Synthetic Turf Contractor does not respond to the Owner’s written notice within 10 days of receipt of notice or does not submit, schedule and execute corrective work within 30 days, the Owner has the option of having the work performed at the expense of the Synthetic Turf Contractor.

K. Sample form of warranty herein set forth is a suggested form for use for the work under this section. Manufacturer’s standard form of warranty may be used provided all conditions specified are incorporated. All claims by the Owner under this warranty must be made in writing to Synthetic Turf Contractor’s address at_____within 30 days after the Owner learns of the defect giving rise to the claim. This warranty shall constitute a contract made in the State of Texas and shall be governed by the laws thereof.

The Synthetic Turf Contractor’s warranty is for direct vendor warranty of the field.

1.13 WARRANTY TESTING

A. The turf is to be tested for dynamic cushioning (“G” Test) by an experienced independent testing laboratory acceptable to the Project Landscape Architect or Owner at the completion of the installation shortly prior to acceptance inspection by the Owner/Project Landscape Architect, at the anniversary date of the first year, second year, fourth year, sixth year, and 60 days prior to the anniversary date of the warranty expiration. Testing Laboratory will be totally independent of the synthetic turf contractor. The synthetic turf contractor will have no current or prior working relationship or ownership of any kind in the Testing lavatory. If conditions of the Specifications and/or Warranty are not met, the Synthetic Turf Contractor has the option of corrective work or replacement. In the event corrective work does not meet the requirements of

the Specifications after a second attempt to bring the system within these limits, then the Synthetic Turf Contractor is to replace non-conforming areas or sections solely at the Owner's discretion and direction.

B. Tests shall be performed in accordance with ASTM F-1936-98 and F355.

C. Test locations as designated in F-1936-98, Paragraph 8.1. Included in the report shall be the measured depth of the infill material at all test locations.

D. All costs for the stated testing shall be paid by the Synthetic Turf Contractor.

E. If the Synthetic Turf Contractor does not have the tests performed within 10 days of specified times listed, the Owner has the option of ordering the testing work at the expense of the Synthetic Turf Contractor.

PART 2 - MATERIALS

2.01 GENERAL

A. Infilled Synthetic Turf: The turf system shall be a vertical-draining permeable synthetic turf system. The turf system shall consist of a synthetic grass like surface pile, which shall be tufted into a synthetic backing.

B. All backing layers and coatings shall be firmly bonded together. Coating materials must be completely cured and bonded to the other backing layers. Synthetic turf panels or rolls that do not meet this requirement will be rejected.

C. The entire system shall be resistant to weather, insects, rot, mildew, and fungus growth, and be non-allergenic and non-toxic. The entire system shall be constructed to maximize dimensional stability, to resist damage and normal wear and tear from its designated use, and to minimize ultraviolet degradation.

D. All adhesives used in bonding the system together shall be resistant to moisture, bacterial and fungus attacks, and resistant to ultraviolet rays at any location upon installation.

2.02 DYNAMIC CUSHIONING REQUIREMENTS

A. The dynamic cushioning of the system shall not exceed a maximum value of 130 G's per ASTM, F1936-98 snf ASTM, F355, Procedure A at any location upon installation.

2.03 PERMEABILITY REQUIREMENTS OF THE SYNTHETIC TURF SYSTEM

A. The system shall drain vertically a minimum of 20 inches precipitation per hour without visible surface ponding.

2.04 SYNTHETIC TURF PILE SURFACE

A. The pile surface shall provide good traction in all types of weather with the use of conventional "sneaker-type shoes" and composition, molded-sole athletic shoes.

B. The pile surface shall be suitable for both temporary and permanent line markings using rubber-base paint where applicable.

C. Pile surface shall be nominally uniform in length for all portions of the field. Synthetic turf panels or rolls with irregular pile heights or with "J hooked" fibers that extend more than 1/4 inch above the surrounding fibers will be rejected.

2.05 SYNTHETIC TURF FABRIC SURFACE

A. The fabric surface shall be constructed and installed in minimum 15-foot widths with no longitudinal or transverse seams, except for head or tee seams at field boundaries and inlaid

lines within a finished roll assembly. The seams shall be 15'-0" spacing.

B. Rolls that do not lay evenly and with full dimension width will be rejected. No fitted pieces will be allowed to true alignment.

C. The color shall be uniform with no visible deviations in shade permitted. Rolls that do not meet this requirement will be rejected.

2.06 SYNTHETIC TURF SYSTEM MATERIAL COMPONENTS

A. Pile fibers shall resemble freshly-grown natural grass in appearance, texture and colors.

B. Fabric backing for the infilled synthetic turf systems can be loose laid and anchored at the perimeter of the fields as shown in the details or adhered to the base.

C. All turf seams shall be cemented with a supplemental backing material or sewn with high strength polyester fiber cord or nylon. For cemented seams, use either open graded nylon or polyester scrim/backing material or non-permeable backing material. If the non-permeable backing material exceeds 12 inches in width it shall be perforated in accordance with paragraph 2.07 of this section. Perforations shall be drilled from the surface after the adhesive has set.

2.07 SYNTHETIC TURF PERFORATIONS

A. Synthetic turf with tufted fibers and a coated backing must include perforations in the backing for vertical drainage.

B. Perforations in turf backing to be a minimum of 3/16" diameter clear opening and shall be spaced a maximum of 4" uniformly on-center.

C. The turf shall be perforated with a minimum of 95% integrity over entire surface. Holes must be full diameter, completely through the underside of the turf backing with no material residue or fragmented fibers remaining.

D. Project Landscape Architect shall approve the turf perforations prior to shipment, upon shipment onsite, or during on-site perforating operations as applicable.

2.08 LINES AND MARKINGS

A. A complete field lining, marking and field boundary system with team area limits, etc., shall be provided with the initial installation of the surfacing system. Layouts shall be accurately surveyed and marked prior to installation.

B. All lines, numbers and field markings shall be tufted in or installed as synthetic turf inlays. Wherever possible, lines shall be tufted into the turf panels in lieu of inlays. All markings shall be uniform in color, providing a sharp contrast with the turf color, and shall have sharp and distinct edges. Markings shall be true and shall not vary more than 7/32” from specified width and location.

C. Manufacturer shall guarantee the synthetic turf is adaptable to painted lines in the event painting is utilized in the future.

D. For cemented seams, use supplemental backing material. The supplemental backing material shall bridge all inlaid lines and markings a minimum of 4 inches on each side of the seam. Supplemental backing material that is greater than 12 inches in width shall be perforated in accordance with paragraph 2.07 of this section. Perforations shall be drilled from the surface after the adhesive has set.

E. Minimum Lining and Marking Requirements: All lines, numbers and field markings shall be tufted in or installed as synthetic turf inlays without the use of paint.

2.09 MINIMUM SPECIFICATIONS FOR SYNTHETIC TURF SYSTEM MATERIALS

A. The minimum material will be verified and enforced and will be the basis for Owner's testing.

Material that fails to meet these minimum specifications will be rejected. The material specifications in this section are minimums. The manufacturer of the synthetic turf fiber and fabric may elect to exceed these specifications to ensure compliance with all requirements and the warranty as specified in this section.

B. Color of synthetic turf to be green as approved by Owner with white field markings as called for in Section 2.08 for the lines and markings. The fiber used for the lines and markings shall be of the same composition as that used for the green field areas.

2.10 MINIMUM TURF MATERIAL SPECIFICATIONS

A. Pile fiber shall be monofilament/slit film fiber with for the football stadium field and a blended mono/slit film with extruded monofilament nylon rootzone for baseball and softball, 100% polyethylene athletic quality yarn designed specifically for outdoor use and stabilized to resist the effects of ultra-violet degradation, heat, wear, water and airborne pollution.

B. Fiber shall be certified to have less than 50 ppm or less of lead from both the fiber supplier and the turf vendor.

Outfield Areas/Football Field

Item ASTM	Property	Minimum Specifications
1. D1577	Yarn Denier/ Ply	10800 / 6,000
2. D1577	Core Filament Thickness	330 U Micron(MONO)
3. D1577	Base Filament Thickness	100 U Micron(SLIT)
4. D1577	Monofilament Width	1.40 mm
5. D2256	Yarn Breaking Strength	20 lbs
6. D2256	Yarn Elongation to Break	50%
7. D789	Yarn Melting Point	248° F.

Infield Areas

Item ASTM	Property	Minimum Specifications
1. D1577	Yarn Denier/ Ply	10800/10000
2. D1577	Yarn Denier/Ply	5400/8 (Nylon MONO)
3. D1577	Core Filament Thickness	300 U Micron(MONO)
4. D1577	Base Filament Thickness	110 U Micron(SLIT)
5. D1577	Monofilament Width	1.40 mm
6. D2256	Yarn Breaking Strength	20 lbs
7. D2256	Yarn Elongation to Break	50%
8. D789	Yarn Melting Point	248° F.

C. Fiber Wear Simulation: Fiber shall exhibit no splitting or appreciable degradation after a minimum of 12,000 cycles of simulated Lisport wear testing and shall remain serviceable without appreciable face weight loss after a minimum of 40,000 cycles of simulated Lisport wear testing.

D. Fabric Composition: Shall consist of true monofilament 100% polyethylene yarn tufted into polypropylene backings coated with high-grade polyurethane. Coating and backing materials shall assure suitable tuft bind strength, dimensional stability, and long-term wearing properties.

E. The following minimum specifications shall apply:

Base Bid Synthetic Turf System for Football, Green Outfield Areas, Warning Track and Bullpens:

Item	*ASTM*	*Property*	*Minimum Specifications*
1.	D418	Pile Weight	52 oz/sq yard
2.	D418	Primary Backing	6.5 oz/sq yard total
3.	D418	Back Coating	20 oz/sq yard
4.	D418	Total Weight	78.5 oz/sq yard
5.	D418	Pile Height	2.00”
6.	D1335	Tuft Bind (without infill)	8 lbs.
7.	D1682	Grab/Tear Strength	200 lbs.
8.	D2859	Pill Burn Test	Pass
9.	D5793	Stitch Gauge	½”

F. The following minimum specifications shall apply:

Base Bid Synthetic Turf System is for the Dirt-Colored Turf, Infield Green for Baseball Mounds, Batters’ Boxes and Bullpen Mounds:

Item	*ASTM*	*Property*	*Minimum Specifications*
1.	D418	Pile Weight	60 oz/sq yard
2.	D418	Primary Backing	6.5 oz/sq yard total
3.	D418	Back Coating	20 oz/sq yard
4.	D418	Total Weight	86.5 oz/sq yard
5.	D418	Pile Height	1.5” infield/2” grass
6.	D1335	Tuft Bind (without infill)	8 lbs.
7.	D1682	Grab/Tear Strength	200 lbs.
8.	D2859	Pill Burn Test	Pass
9.	D5793	Stitch Gauge	3/8”

2.11 INFILL MATERIALS

A. The synthetic turf shall utilize a combination of silica sand and 100% ambient rubber materials. The maximum sand content shall not exceed 30% by volume for football. The exact infill material ratio may be altered to provide strength, shock attenuation, and to provide permeability by the vendor/installer as approved by the Project Landscape Architect.

B. Infill material shall be applied in a dried condition when the turf is dry. It shall be applied in uniform layers effectively dragged to distribute the material uniformly to the backing of the turf. The layers shall be installed to provide a profile with 100% sand at the bottom and 100% rubber on the surface. Rubber infill shall be from a domestic source. Only automotive or truck tires manufactured in North America within the last 10 years may be used for SBR infill material. No foreign material to be utilized.

C. Sand to be graded silica sand, a minimum of 80% rounded, compaction resistant, washed and dried. The sand gradation shall meet the following wet sieve analysis:

Sieve Size	Percent Passing
#8	100
#16	100

#20	90 - 100
#30	35 - 65
#40	0 - 20
#50	0 - 5
#100	0 – 1
#200	0 – 0.5

D. Rubber shall be processed SBR free of any tire cord and steel materials. The infill material gradation shall meet the following size requirements:

2.0 – 1.5 mm	0% - 10%
1.5 – 1.0 mm	10% - 30%
1.0 – 0.5 mm	40% - 80%
0.5 – 0.0 mm	0% - 10%

E. Infill material shall be applied in a dried condition when the turf is dry. It shall be applied in uniform layers effectively dragged to distribute the material uniformly to the backing of the turf.

F. SBR rubber shall be certified to have less than 50 ppm or less of lead from both the rubber supplier and turf vendor.

G. The application rate shall provide a total minimum weight of 4.0 lbs of rubber infill material per square foot of turf area.

2.12 FIELD SWEEPER UNITS

A. The synthetic turf vendor shall provide a tow-behind sweeper units to the Owner for future field maintenance activities. The sweeper units shall include brushes as recommended by the synthetic turf vendor.

B. Supply one (1) sweeper per site, for a total of three (3).

C. Unit will come with the 6’ towable magnet.

D. The sweeper units shall be LitterKat Synthetic Turf Sweeper or approved equal as recommended by the synthetic turf supplier. (Phone 888-298-8852)

2.13 FIELD DRAG BRUSHES

A. The synthetic turf vendor shall provide one dragging platform to the Owner for future field maintenance activities. The drag brushes shall be a minimum 72” wide by 36” with heavy-duty brushes suitable for use on infilled synthetic turf.

B. Supply one (1) platform per site, for a total of three (3).

C. The dragging brush shall include a towing mechanism compatible with a field utility vehicle. The brushing platform shall include an electrical lift.

D. The dragging brush shall be Greens Groomer model 720SDE (Phone 888-298-8852) or approved equal as recommended by the synthetic turf supplier.

2.14 ALTERNATE FIELD EQUIPMENT

A. The synthetic turf vendor may request to substitute equipment for those specific units specified, provided an equivalent function is provided to the specified equipment.

2.15 BASEBALL AND SOFTBALL HITTING MATS FOR BATTING CAGES

A. Synthetic turf vendor shall supply baseball (6X12) and softball (7x12) green hitting mats for all hitting stations. One (1) per tunnel. The mats shall be minimum 5mm thick turf mat with reinforced urethane foam back and permanent white lines with plate.

B. The mats shall be Beacon Athletics Pro-Model Hitting Mats (800-747-5985) or approved equal.

2.16 FIELD DRAINAGE UNDERLAYMENT – RESILIENT POLYPROPYLENE COMPOSITE

A. The field underlayment should be comprised of a high crystalline polypropylene composite formed to provide interlocking panels.

B. The field underlayment shall be a minimum thickness of 20 mm and shall include interlocking panels approximately 16 square feet in area per panel.

C. The field underlayment shall be permeable allowing for both vertical and horizontal water movement. The minimum lateral permeability rate shall be 0.5 gallons per minute per foot on the field base with the design slope.

D. Field underlayment shall be the SP20 Brock USA LLC or approved equal. Contact: 2840 Wilderness Place, Boulder CO; Telephone 303.544.5800.

PART 3 - EXECUTION

3.01 CERTIFICATION OF FIELD BASE INSTALLATION

A. The Synthetic Turf Contractor shall perform an inspection of the existing permeable aggregate and submit written certification of acceptance of the base for the installation of the synthetic turf system.

B. Summary of certification shall include, but not be limited to:

1. Acceptance of the base construction "finish surfaces" as totally suitable for the application of work specified under this section.
2. Verification and certification of the infiltration and permeability rates of the permeable aggregate as applying to the warranty.

C. All discrepancies between the required materials, application and tolerance requirements noted by the turf installer shall be brought immediately to the attention of the Contractor and the Project Landscape Architect. Failure of the turf installer to immediately inform the Contractor and Project Landscape Architect of any prior work that does not meet the required specifications will result in the turf installer being required to perform any work needed to bring the base to acceptable condition.

3.02 SYNTHETIC TURF INSTALLATION

A. Perform all work in strict accordance to the drawings, shop drawings and manufacturer's specifications and instructions.

B. Verification: The Contractor is responsible for inspecting, verifying, and accepting all installed work of this section.

C. Environmental Conditions: Do not apply adhesive materials or infill material when:

1. Ambient air temperature is below 50^{o} degrees F.
2. Material temperatures are below 50^{o} degrees F.
3. Rain is falling or pending
4. Conditions exist, or are pending, that will be unsuitable to the installation of the system.

D. Preparation:

1. Accept base onto which the synthetic turf surfacing system and the anchoring system are to be applied, as specified above.
2. Immediately prior to application of the synthetic turf, the base shall be thoroughly cleaned of all foreign material, soil, or any other substances that may be detrimental to permeability and the installation of the turf system.

3.03 INSPECTION OF MATERIALS

A. Prior to installation, and immediately upon delivery of synthetic turf system materials to the project site, the Synthetic Turf Contractor shall inspect material as follows:
   1. For damaged or defective items;
   2. Measure turf pile height and thickness of each roll;
   3. Measure backing perforation diameter and spacing;
   4. Reject damaged materials and all materials out of tolerance with this specification.

B. After installation, inspect project area for acceptable seaming, adhesive bonding, uniformity of color of turf, bubble-free surface smoothness as laid, field lines and markings, insert installations, edge details. Remove and/or repair deficient workmanship prior to requesting the Project Landscape Architect's inspection pursuant to completion and acceptance of the work.

3.04 OWNER'S TEST

A. Owner may have samples of the turf submitted and tested for verification of conformance to specifications. Turf system acceptance is subject to the results of these tests.

B. Any material so tested and found not conforming to specification will be rejected and replaced with material conforming to the specification at Synthetic Turf Contractor's expense. Resubmittal shall be required.

3.05 TURF INSTALLATION

A. The fabric surface shall be constructed and installed in 15 -foot minimum widths with no longitudinal or transverse seams, except for head or tee seams at field boundaries and inlaid lines within a finished roll assembly.

B. No head seams shall be permitted inside of the soccer field boundaries. A single head seam will be permitted in the quarter turned panels outside of the soccer sidelines.

C. Rolls that do not lay evenly and with full dimension width will be rejected. No fitted pieces will be allowed to true alignment.

D. Bonding of Material Surfaces: The bonding or fastening of all system material components shall provide a permanent, tight, secure and hazard-free, athletic playing surface. System material components include:
   1. Bonding all seams and inlaid line and markings
   2. Bonding and seaming must maintain their integrity for total length of warranty period.

E. Seams (Joint)
   1. All turf seams shall be cemented with a supplemental backing material or sewn with high strength polyester fiber cord or nylon.
   2. For cemented seams, the supplemental backing material shall bridge all seams a minimum of four (4) inches on each side of the seam. Supplemental backing material that is greater than 12 inches in width shall be perforated in accordance with paragraph 2.07 of this Section. Perforations shall be drilled from the surface after the adhesive has set.
   3. Backing layers must lie flat on the field base to provide a uniform pile surface.
   4. The width between fiber rows at the seam locations shall not exceed that of the tufting gauge of the turf materials.
   5. All sewn seams shall be brushed to provide full coverage of fiber over the thread.
   6. All cemented seams shall be brushed to eliminate any adhesive materials from the fibers.

F. Turf Edges: Turf edges to be as shown on the edge fastening detail and specified herein.

3.06 SYNTHETIC TURF EDGE ANCHOR INSTALLATION

A. Anchor synthetic turf along the sides and ends into the pressure treated nailer board lumber as shown in the details.

3.07 LINING / MARKING INSTALLATION

A. Complete field markings shall be provided with the initial installation of the surfacing system. Provide lines and markings in conformance with these specifications. Layouts shall be accurately surveyed and marked prior to installation.

B. If overlapping backing materials are utilized for the inlaid lines and markings resulting in a non- permeable surface in excess of 12 inches wide, the backing materials shall be perforated in conformance with Section 2.07 from the surfacing after gluing and prior to installation of the infill material.

3.08 INFILL INSTALLATION

A. The infill material shall be applied in a dry condition and when the synthetic turf is dry.

B. The synthetic turf installer shall not infringe upon any current or pending patents held by other synthetic turf manufacturers or installers with the installation of the infill materials.

C. For 100% rubber infill installations, the rubber infill material shall be applied in uniform layers with a minimum of five (5) applications. For sand and rubber infill systems, the infill materials will be installed with a minimum of eight (8) applications.

D. The infill installation shall not result in fiber material trapped below the surface of the infill material. If fiber is trapped below the surface, a portion or all of the infill material must be removed and reinstalled.

E. The infill material shall be installed at a uniform depth across the entire field area. Infill depths shall not vary by more than 10mm across the field area.

F. The brushing of the infill material shall provide fiber fibrillation resulting in a natural surface appearance. If in Owner's opinion more fibrillation is desired, the Synthetic Turf Contractor shall provide additional brushing of the surface to provide the desired level of fibrillation.

G. The infill materials shall water settled to provide accelerated consolidation of the infill material prior to use by the Owner. Water is available from quick coupling valves located around the field. The Synthetic Turf Contractor shall utilize portable sprinkler heads to evenly apply a minimum of one (1) inch of water over the entire field area for water settlement. Upon completion of the initial water settlement, the surface will be inspected the Owner and Project Landscape Architect for footing stability and infill consolidation. The Synthetic Turf Contractor shall provide any additional water settling as required by the Owner and Project Landscape Architect to achieve the desired level of infill stability and consolidation.

3.09 CLEANING

A. Remove all excess materials of all types, equipment, debris, etc., from the site immediately after completion of the work. Remove all stains and other blemishes from all finished surfaces. Leave work in clean, new appearing condition, ready for use by Owner.

B. The Contractor shall inspect the entire field area with a hand-held metal detector to identify any construction materials or tools left on the field. All such materials shall be removed prior to Owner occupancy of the field.

3.10 PROTECTION

A. Adequate protection of materials and work from damage will be the responsibility of the installer during installation and until acceptance of their work. Synthetic Turf Contractor will

be responsible for protection after the acceptance of the work until final acceptance of all contract work by the Owner. All material damaged prior to acceptance by the Owner shall be replaced at no cost to the Owner.

3.11 EXTRA MATERIALS

A. Deliver to Owner all extra materials herein specified. Receive Owner's written receipt for all materials. Deliver receipt to Project Landscape Architect.

B. Infill Materials: Provide four (4), 33-gallon rubber trash containers with lids per site of each infill material used. Total 7 sites.

C. Turf for Future Repairs for all seven (7) sites: Material may be roll ends or cutoffs; however, each piece of fabric shall be at least 5’ x 10’. At least one (1) green turf piece shall be at least 10’ x 15’.

D. The following are minimum areas for the extra synthetic turf materials to be provided by the Synthetic Turf Contractor to the Owner:

Minimum Quantities:

1. Green Turf: 500 sf
2. White Turf: 100 lf of 4” wide lines
3. Colored Turf: 100 sf

3.12 FIELD UNDERLAYMENT INSTALLATION

A. Perform all work in strict accordance to the drawings, shop drawings and manufacturer's installations and instructions.

B. Verification: The Contractor is responsible for inspecting, verifying, and accepting all installed work of this section.

C. Preparation:

1. Accept elevated slab base onto which the field underlayment system is to be installed and noted above.
2. Immediately prior to application of the field underlayment, the elevated slab shall be thoroughly cleaned of all foreign material, soil, or any other substances.

3.13 SYNTHETIC TURF INSTALLATION

A. Perform all work in strict accordance to the drawings, shop drawings and manufacturer's specifications and instructions.

END OF SECTION 32 2964

SECTION 32 2965
ATHLETIC FIELD CONDUITS & UTILITY VAULTS

PART 1 – GENERAL

1.01 SCOPE OF WORK

A. Furnish all labor, material and equipment for the work indicated below and shown on the drawings. Work includes but is not limited to:
   1. Trenching and conduit
   2. Utility Vaults

B. The wiring for the new conduits shall be installed by the Owner. All conduits shall include a nylon pull rope.

1.02 CODES AND ORDINANCES

A. All equipment furnished and work performed shall be in accordance with national, state and city electrical codes, established safety codes and other applicable local codes and ordinances.

1.03 PERMITS

A. The Contractor shall obtain all permits and pay all fees.

1.04 RELATED WORK IN OTHER SECTIONS

Section 32 2951 Athletic Field Earthwork & Subgrade

1.05 FIELD DIMENSION AND LAYOUT

A. The Contractor will be responsible for furnishing, setting, and marking of all line, grade, and location stakes, including offsets and general construction staking. The Landscape Architect will provide reference points.

B. There shall be onsite at all times when work requiring control is being performed, all necessary equipment, supplies and instruments related thereto. A qualified layout specialist must be assigned to the Contractor's crew for this work. This equipment and specialist must be available at no additional cost to the Landscape Architect for the purpose of approving layout and certifying work progress onsite.

C. The Project Landscape Architect, prior to commencing construction and on a continuing basis, must approve all layout work, materials and methods for each phase requiring accuracy control.

1.06 SUBMITTALS

A. Product Information: The Contractor shall submit copies of catalog information of all equipment for approval.

B. As-Built Drawings: Contractor shall furnish accurate as-built drawings of the junction boxes and conduits. The drawing shall be a blueprint to scale. Drawings shall show installed manufacturer's name and catalog number. The as-built drawing shall be turned over to the Landscape Architect for review at or before the professional review (punchlist) of the project.

PART 2 – PRODUCTS

2.01 DESCRIPTION

A. All materials and equipment shall be new or proven quality and be a standard product of a reputable manufacturer. Storage at the job site shall be in a manner which will prevent any damage or corrosion.

2.02 CONDUIT AND FITTINGS

A. Conduit used in underground runs shall be Schedule 40 heavy wall rigid PVC, UL labeled with fittings of the same materials.

B. The conduits shall be capped during construction by means of manufactured seals to prevent entrance of water and debris. The conduits shall be cleaned and shall include a nylon pull rope.

2.03 UTILITY VAULTS

A. Vaults shall be installed where shown or required by code. Vaults shall be aluminum with gasketed and bolted cover. The cover shall be recessed forming a deep pocket for the placement of synthetic surfacing materials. This provides a “zero” surface elevation change in the playing surface.
B. Vaults boxes shall be 18” x 30”.
C. There shall be two (2) handholes built into the cover, one (1) solid and one slotted.
D. Hand hole lids will have a toggle lock.
E. Utility Vaults shall be Sports Edge, Combox 3000 or approved equal.
F. Boxes outside the areas without synthetic turf or rubberized surface covering shall have solid lids matching the particular paving grade.

PART 3 – EXECUTION

3.01 TRENCH EXCAVATION

A. Trenches shall be excavated to the line and grade indicated in the plans and specifications. Except for unusual circumstances where approved by the Landscape Architect, the trench site shall be excavated to only such width as is necessary for adequate working space. The top width of the trench will generally not exceed 18" for sizes 2-1/2" and smaller. The trench shall be kept free from water until all connections are completed. No water is to be permitted in the trenches until jointing material has set in the case of solvent and weld joints. Surface water shall be diverted so as not to enter the trench. Boulders, rocks, roots and other obstructions shall be entirely removed or cut out to the width of the trench and to a depth 6" below the bottom of the pipe.
B. Coordinate trench depths to provide a minimum of 8" clearance below the new subsurface drainage system.
C. Trenches, where applicable, shall be excavated to a depth to provide 12" cover minimum below finish subgrade over conduits.

3.02 CONDUIT INSTALLATION

A. Provide all trenching, excavation and backfilling and compaction required for the installation of all conduits.
B. Furnish and install plastic marker tape the entire length of all underground conduit runs. The Marker Tape shall be 3” minimum width, bright red or yellow color installed a minimum of 12” above the top conduit run.

3.03 UTILITY VAULT INSTALLATION

A. Each conduit entering the box shall be neatly upswept and shall terminate not less than 5 inches or more than 10” below the lid.
B. All boxes shall be set on a 6” free draining pea gravel base and be leveled to match grade. The lid shall be set flush with finish grade. Conduits into the boxes shall have bell ends installed.
C. The utility vaults shall be installed immediately inside the running track on the field side of the trench drain.
D. The hand holes shall be installed outside the perimeter of the running track in the asphalt paving areas as shown.

3.04 BACKFILLING

A. Use select soil backfill material. The backfill material shall be placed and compacted around and under the conduits by hand tools to height of 6" above the top of all conduits. Backfill is to be compacted to 95% minimum density by mechanical tamping. Trench must be free of water during backfilling operation.

B. All backfill around junction boxes shall be mechanically compacted to 95% minimum density with moisture added.

END OF SECTION 32 2965

SECTION 32 2966

ATHLETIC FIELD FURNISHINGS

PART 1 – GENERAL

1.01 SCOPE OF WORK

A. Include all labor, material, equipment, transportation, and services to install various items as shown on the drawings and herein specified.
B. Furnish and install six (6) new football goal posts. Construct football goal post footing with sleeve or anchoring plate as applicable. One set install for the turf stadium field and 2 sets for the grass practice fields.
C. Furnish and assemble three (3) pairs of portable soccer goals and nets. Soccer goal anchor straps must be installed at all locations to prevent the goals from tipping over.
D. Furnish and install one (1) set of base anchors and one (1) set each of plates, bases, and plugs for all the baseball and the softball infields.
E. Furnish and install four (4) foul poles.
F. Furnish and install four (4) baseball/softball batting cages.
G. Furnish and install six (6) baseball pitching rubbers and six (6) home plates for baseball bullpens.
H. Furnish and install and eight (8) home plates for the batting cages.
I. Furnish and install eight (8) softball pitching rubbers and eight (8) home plates for the softball bullpens.
J. Furnish and install two (2) new take off boards per single runway direction with landing pit for a total of eight (8).
K. Furnish and install two (2) new pole vault boxes and covers.
L. Furnish and install two (2) shot put toe boards.
M. Furnish and install two (2) shot put cages with netting.
N. Furnish and install two (2) discus cages with netting and two discus rings.
O. Furnish and install long jump/triple jump land pit covers for four (4) landing pits.

1.02 RELATED WORK IN OTHER SECTIONS

Section 32 29 54	Athletic Field Asphaltic Concrete Paving
Section 32 29 63	Athletic Field Permeable Aggregate
Section 32 29 68	Rubberized Track Surfacing

1.03 SUBMITTALS

A. The Contractor shall submit for approval: Manufacturer's production information, installation instructions and maintenance recommendations for all components.
B. The Contractor shall submit for approval of current sieve analysis and the source of the jump pit sand materials proposed for use on the project. The sieve analysis shall include the same sieve sizes as those indicated in the specifications and shall be wet sieves as designated in the specifications.

1.04 TESTING

A. The Owner will be performing testing of materials delivered to the job site for the purpose of verifying compliance with the contract documents. The Owner's testing is for this purpose only and not for construction quality control by the Contractor.
B. The Contractor shall coordinate directly with the Owner’s testing firm relative to the delivery schedules of the imported sand materials.
C. The Contractor shall provide testing and surveillance as required to assure materials and work fully comply with contract requirements.

PART 2 - MATERIALS

2.01 FOOTBALL GOAL POSTS

A. Ground Sleeve: The ground sleeve shall be constructed of eight (8") inch outside diameter Schedule 40 galvanized steel pipe. The ground sleeve shall be a minimum of five (5') feet long.
B. Main Standard (Gooseneck): The main standard shall be constructed from six (6") feet diameter Schedule 40, 6061-T6 aluminum pipe. The pipe shall be curved to provide an eight (8') feet horizontal offset from the ground sleeve to the crossbar with a five (5') feet radius bend.
C. Crossbars: The crossbar shall be constructed from minimum six (6") inch outside diameter Schedule 40 6061-T6 aluminum pipe. The crossbar shall extend 23'-4" in accordance with the UIL requirements.
D. Uprights: The upright shall be constructed from minimum four (4") inch outside diameter Schedule 40 6061-T6 aluminum pipe. The uprights shall extend (20') feet above the crossbar. The uprights shall not cause an excessive harmonic) or rattling sound in windy conditions.
E. Provide one (1) set round post protector pads for six (6") inch diameter posts. Pads to be six (6") inch thick cylindrically high-density polyurethane foam with rear cut out for fitting onto post. A minimum nylon reinforced vinyl covert is to be provided to completely enclose foam pad with Velcro closure. Pads to be (6') feet high. Color shall be determined by the Owner.
F. Posts, crossbars and uprights to have two (2)-coat catalyzed polyurethane finish. Color to be yellow.
G. Manufacturer Reference: Football Goal Posts to be Triman Tele-Goal, Aluminum Athletic Equipment #ASG-HS/8; Sportsfield Specialties Inc. #GP 4380, with anchors, ground sleeves and sleeve caps, or equal.

Triman Tele-Goal, Inc.
P.O. Box 247
Dania, Florida 33004
(800) 822-6886
Aluminum Athletic Equipment
4 Portland Road
West Conshohocken, PA 19428
800.523.5471
Sportsfield Specialties, Inc.
13 Ironwood Circle
Coto de Caza, CA 92679
949.713.5506

2.02 PORTABLE SOCCER GOALS

A. General: Soccer goals to be in full compliance with National Federation of State High School Associates. Goals to provide an 8' x 24' front inside opening. Goals to be portable.
B. Crossbar and Uprights: The crossbars and uprights shall consist of a single length of 4.5 inch OD 6063 T-5 aluminum D shaped tubing or 4-3/8 inch OD Rams Aluminum tubing.
C. The goals shall be finished with a white polyester powder coat finish.
D. Each goal shall have a wheel kit.
E. All hardware and fasteners shall be stainless steel.
F. The goals shall include 4mm polyethylene twine nets.
G. Warranty: Goals to be warranted by manufacturer for a minimum period of 5 years.
H. Manufacturer Reference: Soccer goals to be Scoremaster DM2400, Contact (888) 726-7627, Kwik Goal 2B3 Pro Premier International with 3B1121 net. Contact (215) 536-2200, P.W. Athletic Co. #2231-00A (800) 687-5768, or approved equal.

2.03 BASEBALL AND SOFTBALL PLATES AND BASES

A. Bases shall include Hollywood type ground anchors.
B. All bases and plates shall have attachment to anchors.
C. All bases shall conform to the size and dimension requirements of NFSHSA and UIL and shall have anchor attachments.

D. Home plates shall have black beveled edges.
E. Manufacturer's Reference: Plates and bases shall be Western Athletic, Bolco or approved equal.

Item	Western Athletic	Bolco
Bases	WABBP	200-ML
Ground Anchors	BBP4	205-BA
Ground Anchor Rubber Plugs	BBP6	230-sp
Home Plate	WAHP	300-AS
Pitcher's Plate	BBPB	450-C1

2.04 FOUL POLES

A. Foul poles shall be constructed from four (4") inch OD aluminum poles with a two (2') feet wide and a 12' feet long metal mesh fabric that attaches to the inside of the pole. The pole shall extend 20' feet above grade.
B. Foul poles shall include three (3') feet ground sleeves.
C. The foul poles shall be painted with two (2) coats of white paint
D. Foul Poles shall be Patterson Williams Foul Poles #1273 Northwest Recreation 800.448.4858, or approved equal.

2.05 BATTING CAGES

A. The batting cages shall include powder coated steel frame and prefabricated netting.
B. The baseball batting cages shall be 70' feet long, 12' feet wide, and 12' feet high and the softball cages shall be 55' feet long, 12' feet wide and 12' feet high.
C. The batting cages shall each include heavy-duty polyethylene netting.
D. The baseball batting cages shall be Sportsfield Specialties LGBBTTN-BT Baseball Triple Overhead Tension Batting Tunnel Equipment and Accessories or approved equal.

2.06 TAKE-OFF BOARDS

A. Unit shall consist of an aluminum tray, 8" x 48" x 2" permanent recess installation in the track and a 2-3/4" thick dual surface board made up of a reversible top layer of 3/4" marine plywood fastened to 1-1/2" thick aluminum channel. The exposed aluminum channel shall be covered with 1/2" of beige EPDM rubber granules and polyurethane installed by the rubberized surfacing Contractor.
B. Manufacturer Reference: Take-off board trays to be Aluminum Athletic Equipment Model 8ST with take off boards to be Aluminum Athletic Equipment Model CTB; Sportsfield Specialities Model No. TFLT008SS, or approved equal.
C. Furnish and install two (2) take-off boards and trays per track as indicated in the plans.

2.07 POLE VAULT BOX

A. Pole vault box shall be stainless steel. Box shall meet IAAF Rule No. 17221 with width 23.62". Pole vault box shall be guaranteed for the products lifetime.
B. Pole vault box cover shall be stainless steel to fit and match box. New rubberized surfacing shall be applied to the top surface of the cover.
C. Manufacturer Reference: Vault boxes shall be Aluminum Athletic Equipment Model SSVB; Sportsfield Specialties Inc. FFPV002SS or equal. Vault box covers shall be Aluminum Athletic Equipment Model SSVC, Sportsfield Specialties Inc. FFPV003AL or equal.
D. Furnish and install one () vault box and one (1) cover per track as indicated in the plans.

2.08 SHOT PUT TOE BOARDS

A. Unit shall be curved of 3.5' interior radius, 4'0" arc along the inside surface, 4" in height, and 4-1/2" in width.
B. Board to be of cast aluminum material.
C. Manufacturer Reference: The shot put stop board shall be Aluminum Athletic Equipment Model ATB; Sportsfield Specialties TFSPT002AL Inc. or equal.

2.09 SHOT PUT CAGE

A. Furnish and install a protective shot put cage and netting as shown in the plans.
B. The cage will consist of four (4) 4" O.D. aluminum posts, 16' in length, installed in ground sleeves with drain tubing as indicated in the details.
C. The protective netting shall be attached at the top and bottom of the posts. The netting shall be comprised of 1-3/4" square mesh 14' x 56', reinforced around all edges, and of sufficient strength to withstand repeated impacts from shot throws. An additional protective net, 7' high, of the same material as the primary net shall be furnished and installed around the outer side of the support posts. This net shall be firmly attached at the top and bottom to the support posts. Primary netting shall be installed with hoists to allow for removal and attachment from ground level.
D. Manufacturer Reference: The discus cage shall be Aluminum Athletic Equipment Model #SC-14, or approved equal. Aluminum Athletic Equipment, 4 Portland Road, West Conshohocken, PA 19428, (800) 523-5471

2.10 DISCUS CIRCLE

A. The recessed concrete discus pad shall include 1" wide aluminum discus circle inside the recess.
B. Manufacturer Reference: The discus circle shall be Aluminum Athletic Equipment Model DC, or approved equal. Aluminum Athletic Equipment, 4 Portland Road, West Conshohocken, PA 19428, (800) 523-5471

2.11 DISCUS CAGE

A. Furnish and install a protective discus cage and netting as shown in the plans.
B. The cage will consist of six (6) 4" O.D. aluminum posts, 16' in length, installed in ground sleeves with drain tubing as indicated in the details.
C. The protective netting shall be attached at the top and bottom of the posts. The netting shall be comprised of 1-3/4" square mesh 14' x 56', reinforced around all edges, and of sufficient strength to withstand repeated impacts from discus throws. An additional protective net, 7' high, of the same material as the primary net shall be furnished and installed around the outer side of the support posts. This net shall be firmly attached at the top and bottom to the support posts. Primary netting shall be installed with hoists to allow for removal and attachment from ground level.
D. Manufacturer Reference: The discus cage shall be Aluminum Athletic Equipment Model HSDC, or approved equal. Aluminum Athletic Equipment, 4 Portland Road, West Conshohocken, PA 19428, (800) 523-5471

2.12 ALUMINUM JUMP PIT COVERS

A. Units shall be 23.4 ft. x 9.84 ft., with modular aluminum cover panels including structure and support system.
B. The jump pit covers shall be Sportsfield Specialties Inc., Model #6820 Cover Set, or equal.

PART 3 – EXECUTION

3.01 FOOTBALL GOAL POST INSTALLATION

A. Construct goal post footings as shown on the drawings complete with sleeve inserts or anchor plates as recommended by the manufacturer.
B. Locate footings and sleeve inserts as shown to provide proper horizontal and transverse alignment of crossbar 10’ feet directly above and parallel to inside edge of end zone.
C. Provide temporary support when setting goal posts.
D. The Contractor shall prime and repaint any areas of the goal posts damaged during delivery of installation.

3.02 PORTABLE SOCCER GOAL INSTALLATION

A. Assemble soccer goal per manufacturer's installation instructions.
B. Install new goal nets per manufacturer's installation instructions.
C. Install soccer goal anchors and straps per manufacturer's installation instructions.

3.03 BASEBALL AND SOFTBALL PLATES AND BASES INSTALLATION

A. Install base anchors and plates in accordance with the manufacturer's instructions and as shown in the details. Carefully locate bases and plates within (1") inch of dimensions shown on the plans.

3.04 FOUL POLE INSTALLATION

A. Set foul pole ground sleeve in concrete footings in accordance with the manufacturer's recommendations.
B. The foul poles shall be set plum with vertical and shall be located within one (1") inch of the surveyed foul line for each field.

3.05 BATTING CAGE INSTALLATION

A. Batting cages supports shall be set in concrete footings as shown in the details in accordance with the manufacturer's recommendations.
B. Install netting according to manufacturer's suggested installation methods.

3.06 TAKE-OFF BOARD INSTALLATION

A. Install four take off boards at each runway, eight (8) total as dimensioned and detailed on the drawings.
B. Install take off boards and trays recessed so that the board is flush with surface of the concrete paving. Rubberized surface is to be applied to aluminum side of board. Rubberized to be cut with sharp edges producing 1/16" clearance between board and runway surfacing.
C. All boards to be notched at each end at centerline of board to facilitate removal from tray.

3.07 POLE VAULT BOXES AND CONCRETE SLABS

A. Install vault boxes in concrete in as shown on the detail drawings. Construct 4' x 5' x 12" concrete pads with specified aluminum vault box insert. Top of vault box insert to match level of rubberized surface. Top of concrete to slope away from vault box to match the surrounding grade as applicable.
B. Measuring line at bottom of vault box shall be aligned with the centerline of the support slabs for the upright standards as shown on the detail drawings.
C. Slabs: Install 30" x 6' x 12" concrete vault support slabs for upright standards as shown on the drawings. Align centerline of slab with measuring line of vault box as shown on the detail drawings. Edges of slab shall be flush with the surrounding finish grade.

3.08 SHOT PUT TOE BOARD INSTALLATION

A. Construct concrete shot put pad as shown on the drawings.
B. Provide a light broom finish to the concrete pads (1/64" or 1mm roughness).
C. Paint 2" wide white circle on pad as shown on the drawings.
D. The stop board shall be firmly attached to the new concrete pad per the manufacturer's instructions.

3.09 SHOT PUT CAGE INSTALLATION

A. Install discus cage per manufacturer's installation instructions and as shown on the drawings.
B. The posts shall be set plumb with vertical in new concrete footings. The footings shall include sleeves for removal of the posts.
C. Install new nets for inspection by the Owner and Project Landscape Architect. Upon approval, remove the nets, label, and provide to the Athletic Director for storage.

3.10 DISCUS PAD INSTALLATION

A. Construct concrete discus pad as shown on the drawings with trowel led crown and drainage slots. Set discus ring in concrete pad. Provide cuts in the ring at the drainage slot locations.
B. Provide a light broom finish to the concrete pad (1/64" or 1mm roughness).

3.11 DISCUS CAGE INSTALLATION

A. Install discus cage per manufacturer's installation instructions and as shown on the drawings.
B. The posts shall be set plumb with vertical in new concrete footings. The footings shall include sleeves for removal of the posts.
C. Install new nets for inspection by the Owner and Project Landscape Architect. Upon approval, remove the nets, label, and provide to the Athletic Director for storage.

3.12 ALUMINUM JUMP PIT COVERS

A. Install aluminum jump pit covers on two (2) jump pits per manufacturers' instructions and recommendations. Set covers to be flush with surrounding surfaces. No tripping hazards.

END OF SECTION 32 29 66

SECTION 32 2968

RUBBERIZED TRACK SURFACING

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. Include all labor, material, equipment, transportation, and services to install complete all-weather rubberized running track and field event surfacing as shown on the plans and as specified herein.

B. The system shall include the following:

1. The repaired area surfacing shall be a base matt system. It shall include a rubber base matt bound with polyurethane paved over asphaltic concrete.
2. Install RED structural spray coat per specifications to all new rubber surfaces, Topcoat of the running track and field events rubber surfaces to be of two (2) applications and three applications at high jump, long jump and pole vault runways.

C. Provide striping and painted track marking for the track, long jump and pole vault field event runways.

D. Coordination and cooperation with all other contractors performing work relating to and affecting the work of this section.

E. Review of and acceptance of installed work of other trades directly affecting the work of this section.

F. The surface of all rubberized surfaces must have homogeneous texture. All areas, such as abutting seams that do not have uniform texture must be cut out and resurfaced with acceptable texture and finish appearance.

G. Apply rubberized surfacing system to the long jump take off boards, and pole vault box covers.

H. Warranty package.

1.02 RELATED WORK IN OTHER SECTIONS

A. Section 32 2700 Track Asphaltic Paving

1.03 STANDARD SPECIFICATIONS

A. Track and Field Rules, latest edition of the National Federation of State High School Associations (NFSHSA) and UIL Requirements.

1.04 PRE-APPROVED VENDORS/INSTALLERS

A. The following vendors/installers are pre-approved for installation of the rubberized running track and field event surfacing.

1. Hellas
2. Beynon
3. Rekortan
4. Fisher
5. Conipur

1.05 SUBMITTALS

A. Experience, References, and Installation:

1. All vendors which are not pre-approved shall submit written evidence of a two (2)-year minimum successful experience record of Manufacturer/Supplier/Installation team in the installation of a minimum of six (6) similar projects that include poured-in-place, two-component elastomeric polyurethane synthetic track surfacing. List locations, client, client contact names, address, telephone, material installed, date of installation, general contractor (if any), whether a new project or a resurfacing. The material manufacturer must have a minimum of five (5) years of experience with compound two (2) -part polyurethane for athletic surfaces. Track vendors/ installers, with less than this minimum experience record, are not acceptable.
2. A minimum of 30 calendar days prior to the scheduled commencement of the surfacing installation, the Contractor shall submit to the Project Landscape Architect the name of track marking subcontracting firm and surveyor, their proposed foremen and key personnel, along with their experience record. The Project Landscape Architect must approve the marking subcontractor.

B. Track Striping Shop Drawings

1. The Contractor shall submit a minimum of 30 calendar days prior to the scheduled commencement of the surfacing installation, complete and detailed track striping and marking plan with calculations showing all conditions of installation, connection to other work, dimensions, size, shape, color, and location of all lines and markings, including hurdle markers, lane numbers, relay exchange zones, etc. Drawings shall show the entire track on one sheet at 1"=20' scale.
2. This shop drawing is for Owner/Project Landscape Architect review. The Contractor is not to proceed with painting until the drawing is approved by Project Landscape Architect or, as may be required, resubmitted for approval with revisions.

C. Manufacturer's Specifications: Within 21 calendar days after Notice to Proceed, the Contractor/Vendor shall submit to the Project Landscape Architect for approval five copies of each of the selected manufacturer's surfacing material specifications and installation instructions.

D. Sample Warranty Package: Within 21 calendar days after Notice to Proceed, submit to the Project Landscape Architect for review five (5) sample copies of the surfacing warranty package herein specified.

E. Maintenance and Operating Data:

1. Furnish to the Project Landscape Architect, in manual form, four (4) copies of maintenance and operating data prior to final acceptance.
2. Manual shall be enclosed in a hard cover with the following information appearing on the outside of the cover: Project name, Owner's name, Project Landscape Architect's name, Rubberized Surfacing, Consultant's name, Prime Contractor's name, Year of project completion
3. Index manual with tab dividers for data as follows:
    a. Materials installed with their characteristics
    b. General maintenance
    c. Lining and marking installation
    d. Lining and marking removal
    e. Small repair procedures
    f. Discussion on precautions to be practiced and general maintenance and procedures to be avoided to prolong surface life and to maintain installation's warranty.

g. Copy of warranty document

1.06 QUALITY CONTROL

A. Area and Base Acceptance:

1. The Surfacing Subcontractor/Installer (if applicable) shall inspect, verify and accept in writing to the Prime Contractor, with a copy to the Project Landscape Architect, all installed work of other trades directly affecting the work of this section.
2. Installer must examine the areas and conditions in which rubberized surfacing is to be installed. The asphaltic concrete or concrete paved base shall be inspected for conformity with the lines and grades.
3. The installer is to coordinate the required curing of any new asphalt concrete paving with the Prime Contractor prior to placing the first lift of rubberized surfacing.

B. Track Marking Certification

1. Upon completion of the track markings, the Contractor shall furnish an acceptable document or certificate of accuracy to the Owner attesting to the accuracy of the track markings and measurements and shall include copies of the computations, calculations, and drawings that were used to obtain this accuracy.
2. This certificate shall also be signed by the Professional Engineer or surveyor licensed in the State of Texas in charge with their seal indicating registration number.

1.07 TESTS

A. The Owner reserves the right to submit the surface system to various tests to verify if the surfacing system meets the minimum specifications or manufacturer's submitted specifications. Any section of the system so tested that is found to be out of specification shall be removed and replaced to the proper specification, at the sole expense of the Contractor.

1.08 WARRANTY

A. In addition to the general warranty specified in the General Conditions of the specifications, an additional four-year vendor warranty (five (5) year total) for the rubberized surfacing system shall be provided to the Owner by the track surfacing vendor, protecting Owner against all manufacturing, material and installation defects associated with materials and workmanship under this section. Warranty to extend from date of final acceptance by Owner.

B. Warranty shall cover in general the usability of the installed surfacing system, accessories use characteristics, suitability of the installation for the period specified, and for the designated uses enumerated as follows:

1. Track and field events with spiked shoes
2. Physical exercises
3. Physical education activities
4. Marching band
5. Cheerleading activities
6. Access to adjacent football/soccer field
7. Pneumatic rubber-tired maintenance and service vehicles
8. Pedestrian traffic and other similar uses
9. Community running and jogging
10. Wheelchair traffic

C. Conditions Warranty: Warranty shall agree to promptly repair or replace work, which deteriorates excessively or otherwise fails to perform as required due to failures of materials and workmanship. Striping and other painted markings are excluded from the warranty. For the purposes of this warranty, excessive deterioration is defined as a loss of fifty (50%) of the wearing surface or granular loss. Failure of material and workmanship is defined to include, but is not limited to, delaminating of the track from its asphaltic concrete base, or from integral layers of surfacing material, and leaching of binders or other surfacing components. All defects are to be promptly repaired. If the warrantor does not initiate repair work within 21 calendar days from receipt of complaint in writing, adverse weather conditions accepted, the Owner shall have the right to order the work performed by others and the warrantor shall be liable for costs accruing to the Owner.

D. The parent company or corporation of the track surface installation firm shall issue the warranty. The warranty shall be signed by an authorized principal of the applicable firm, duly-authorized to make contracts.

E. A separate warranty from the General Contractor, the Track Installer and/or the Striping Subcontractor shall be issued for the marking and striping guaranteeing applied painting for a period of two (2) years from fading in color and intensity plus cracking or separating from the track surface.

PART 2 - PRODUCTS

2.01 BASE MATT COMPOSITION

A. A primer shall be applied to the asphaltic concrete pavement base prior to installation of the base matt. The primer shall be polyurethane base as specified by the surfacing system manufacturer.

B. The base mat shall be composed of SBR rubber granules and single component polyurethane binder. The base matt shall be comprised of a maximum of 80% SBR and a minimum of 20% single component polyurethane by weight. The paved-in-place base layer shall be installed to a minimum depth as follows:

1. The base matt layer shall be a minimum of 12.0mm thick.

C. SBR Rubber Granules:

1. The granules shall be recycled styrene butadiene rubber (SBR) cryogenically processed. There shall be no traces of fiber or steel with granulate.
2. Granulate particles shall meet the following gradation requirements:

Particle Size	Percentage by Weight
0-1.0mm	3.5%
1.0-2.0mm	15-25%
2.0-3.0mm	30-40%
3.0-4.0mm	30-40%
Larger than 4.0mm	0-5%

D. Polyurethane Binder:

1. For the base layer utilize single component polyurethane.
2. No mercury, lead or other heavy metals are to be present.
3. No solvent or fillers are to be added.

2.02 STRUCTURAL SPRAY SYSTEM TOP COAT

A. The top coat shall be comprised of two structural spray coats. The structural spray coats shall

be comprised of a blend of pigmented EPDM rubber granules and pigmented single component polyurethane. The two structural spray coats shall be applied at a rate totaling 3.0 lbs/sy and providing a minimum 1.5mm thickness for all areas except the long jump and pole vault runways which shall have three spray applications with a total of 4.5 lbs/sy and providing a minimum 2.25mm thickness.

B. The binder for the structural spray coats shall be a single component pigmented polyurethane. No mercury, lead or other heavy metals are to be present. No solvent or fillers are to be added.

C. The granulate for the structural spray shall be composed of peroxide cured Ethylene Propylene Dien Polimerisat (EPDM) rubber. For the first structural spray coat half of the granules are to be graded from 0.5 mm to 1.5 mm in size and half of the granules are to be 1.0 mm to 3.0 mm in size. For the second structural spray coat, all the granules are to be graded from 0.5 mm to 1.5 mm in size. The EPDM granules shall meet the following requirements:

1. The granules shall be composed of peroxide cured Ethylene Propylene Dien Polimerisat (EPDM) rubber.
2. Materials to have shore hardness from 55 to 60.
3. Granules shall have a specific density of 1.6 +/- 0.08.
4. Sulphur cured rubber is unacceptable.

D. The structural spray coat EPDM rubber granules and single component polyurethane shall be pigmented red.

2.03 PHYSICAL PROPERTIES OF SYSTEM

A. The new synthetic track surfacing system shall exhibit the following minimum performance standards as required by IAAF:

Thickness	> 13mm
Force Reduction	35 to 50%
Modified Vertical Deformation	*0.6 to 1.8mm*
Friction	> 47 TRRL Skid Resistance
Tensile Strength	> 0.5MPa
Elongation at Break	> 40%

B. The new synthetic track surfacing system shall exhibit the following minimum performance standards per ASTM:

Tensile Strength (D-412-61T)	300psi
Impact Resilience (D-2632)	0%
Compression Set (D-395-b)	90% - 95%
Compression Modulus (D-575-49):	10% and 50% 8kp/90kp
Gliding Behavior	Wet 0% - Dry 0%
Resistance to oil and normal cleaning solutions	Favorable

2.04 TRACK LINING AND MARKING

A. The Contractor shall retain a Professional Engineer or surveyor licensed in the State of Texas to layout the track markings. Calculate locations of specified event markings. The calculations shall be made to the nearest 1/10,000th of a foot and angles to the nearest second.

B. A complete track lining and marking system shall be provided.

C. All lines and markings are to have true sharp edges with no weeping.

D. Marking Paint: The paint shall be polyethylene based, specifically manufactured to be compatible with and formulated for application on polyurethane synthetic track surfaces.

E. Provide layouts in accordance with NFSHSA for the following events:

Event	*Notes*
100 METER HURDLES	
110 METER HURDLES	
300 METER HURDLES	1 Turn Stagger
400 METER HURDLES	2 Turn Stagger
100 METER DASH	Both directions
200 METER DASH	1 Turn Stagger
400 METER DASH	2 Turn Stagger
800 METER RUN	3 Turn Stagger
1600 METER RUN	Waterfall start
3200 METER RUN	Waterfall start
4 x 100 METER RELAY	2 Turn Stagger
4 x 200 METER RELAY	3 Turn Stagger
4 x 400 METER RELAY	3 Turn Stagger

F. Other markings shall include:

1. Relay Exchange Zones: Colors as recommended in NFSHSA and UIL; solid equilateral triangles with side dimensions equal to clear distance between lane lines at both ends of exchange zone in each lane.
2. Lane Numbers: Five (5) sets of lane numbers "1" through "8", inclusive, with shadowing as approved by the Project Landscape Architect. Separate templates are to be utilized for shadowing. Lane numbers shall be not less than 3" stroke and not less than 24" high. Install lane numbers in straight-aways only, no numbers in turns.
3. Hurdle Marks shall be set for both directions (Sim to Dash).
4. Lane lines shall be white.
5. Long Jump and Pole Vault Runways shall have a 2” white lines on the outside of the runways for the entire length of the runway.

PART 3 - EXECUTION

3.01 PREPARATION

A. Accept the conventional asphaltic concrete or concrete base onto which the surfacing is to be applied.

B. Immediately prior to application, all base construction shall be thoroughly cleaned of all dirt, debris or any other substances that will be detrimental to the installation.

C. Apply such priming material as may be necessary to assure complete bond of polyurethane to the asphaltic concrete and concrete base surfaces.

D. Contractor must protect all adjacent areas from any contamination or over spray from rubberized surfacing installation procedures. Tape plastic sheeting to concrete edging or adjacent exposed asphalt concrete paving, to protect synthetic turf and adjacent areas.

3.02 INSTALLATION

A. General:

1. Only experienced, specialized personnel are to be utilized in the installation of surfacing materials and applying the line and marking points. The Superintendent and the supervisory or technical personnel must be employees of the vendor/installer firm.
2. Install in strict accordance with the specifications, drawings, approved shop drawings and manufacturer's specifications and instructions, when applicable.

B. Environmental Conditions: Materials are not to be placed when:

1. Ambient air temperature is below 50 degrees F.
2. Material temperatures are below 50 degrees F.
3. Surfaces are wet or damp.
4. Precipitation is falling or pending.
5. Conditions exist or are pending that will be unsuitable for the installation of the system.

C. Equipment: The components shall be blended in a clean and dry, specifically designed, mixing machine with automatic proportioning controls to guarantee exact proportions of the polyols and isocyanates and the auxiliary components (rubber) which control the reactions and balance of the varying climatic conditions during the laying process.

D. Base Matt Installation:

1. The base layer shall be mechanically mixed to obtain a homogeneous mixture of 20% polyurethane and 80% SBR rubber granulate.
2. Base material to be placed utilizing a mechanically operated finisher with an electrically heated, oscillating finishing screed bar.
3. The base layer shall be placed with a minimum finished thickness of 12mm or 10mm as applicable.

E. Structural Spray Coat Installation:

1. Contractor must protect all adjacent areas from any contamination or over spray from rubberized surfacing installation procedures. Tape plastic sheeting to edging or adjacent exposed paving to protect synthetic turf and adjacent areas.
2. The structural spray coat top layer shall be mechanically mixed to obtain a pigmented homogeneous mixture of 40% EPDM rubber and 60% urethane.
3. The top layer shall be applied in two (2) uniform applications of a minimum thickness of 1.50 mm.
4. The top layer in the long jump/triple jump runways, pole vault runways shall be applied in three (3) uniform applications of a minimum thickness of 2.25 mm.

F. The completed surface of the track and field events shall be of uniform texture and grade and be free from defects of any kind.

G. The finished rubberized track and field event surfacing shall not vary more than +3.0mm and -0.0 mm in 3 meters, measured in any direction as gauged from a straight edge. No reverse slopes or depressions will be allowed. The completed surface of the track and field events shall be of uniform texture and grade and be free from defects of any kind.

H. Contractor must protect all adjacent areas from any contamination from track installation procedures. Discoloring of any surfaces will be cause for required replacement if cleaning is deemed unacceptable by the Project Landscape Architect.

3.03 CLEANING

A. Remove all excess materials of all kinds, equipment, and debris from the site immediately after

completion of the work.

B. Remove all paint splatters, spots, stains, and other blemishes from all finished surfaces. Rubberized surfaces must have a new, uniform appearance.

C. Leave work in clean condition ready for use by the Owner.

3.04 PROTECTION

A. Adequate protection from damage of materials and work will be the responsibility of the installer during installation and until acceptance of their work. The General Contractor will be responsible for protection after the acceptance of the work until final acceptance of all contract work.

B. All damaged material prior to, during and after installation shall be replaced at no cost to the Owner.

END OF SECTION 32 2968

SECTION 32 3113
CHAIN LINK FENCES AND GATES

PART 1 – GENERAL

1.01 DESCRIPTION

A. Work included: Provide chain link fence system where shown on the Drawings, as specified herein, and as needed for a complete and proper installation.

B. Related work:
   1. Documents affecting work of this Section include, but are not necessarily limited to, General Conditions, Supplementary Conditions, and Sections in Division 01 of these Specifications.

1.02 QUALITY ASSURANCE

A. Use adequate numbers of skilled workmen who are thoroughly trained and experienced in the necessary crafts and who are completely familiar with the specified requirements and the methods needed for proper performance of the work of this Section.

1.03 SUBMITTALS

A. Comply with pertinent provisions of Section 01 3000 – Administrative Requirements.

B. Product data: Within 15 calendar days after the Contractor has received the Owner's Notice to Proceed, submit:
   1. Materials list of items proposed to be provided under this Section;
   2. Manufacturer's specifications and other data needed to prove compliance with the specified requirements;
   3. Shop Drawings in sufficient detail to show fabrication, installation, anchorage, and interface of the work of this Section with the work of adjacent trades;
   4. Manufacturer's recommended installation procedures which, when approved by the Architect, will become the basis for accepting or rejecting actual installation procedures used on the Work.
   5. Samples: Accompanying the submittal described above, submit Samples of each sealant, each backing material, each primer, and each bond breaker proposed to be used.

1.04 PRODUCT HANDLING

A. Comply with pertinent provisions of Section 01 6000 – Product Requirements.

PART 2 – PRODUCTS

2.01 DIMENSIONAL DATA

A. General:
   1. Pipe sizes indicated are commercial pipe sizes.
   2. Tube sizes indicated are nominal outside dimensions.
   3. H-section sizes indicated are normal flange dimensions.
   4. Roll-formed section sizes indicated are the nominal outside dimensions.

2.02 GALVANIZING

A. On steel framework and appurtenances, provide galvanized finish with not less than the following weight of zinc per sq. ft.
   1. Pipe: 1.8 oz, complying with ASTM A120.
   2. H-sections and square tubing: 2.0 oz, complying with ASTM A123.
   3. Hardware and accessories: Comply with Table 1 of ASTM A153.
   4. Fabric: 2.0 oz, complying with class II of ASTM A121.

2.03 FABRIC

A. Provide number 9 gage or 0.148" wires in 2" or 2-1/4" mesh (match existing), with top knuckled and bottom selvages twisted and barbed.

B. Provide fabric in one piece widths.

2.04 FABRIC - VINYL-COATED

A. Nine-gauge (9 Ga. Core wire) black resin clad fabric shall have a polyvinyl chloride coating, minimum wall thickness of .015 inches over a galvanized substrate. The base metal shall have a minimum breaking strength of five hundred fifty pounds (550 lbs.) and a zinc coat weight of .1503 pounds per square foot of uncoated wire surface. Top and bottom selvage of the fabric shall be knuckled with one and three-quarters inch (1-3/4") mesh.

2.05 POSTS, RAILS, AND ASSOCIATED ITEMS

A. Where vinyl coated fabric is specified, all post, rails and associated items shall be vinyl coated to match.

B. End, corner, slope, and pull posts: Provide at least the following minimum sizes and weights:
   1. Material and dimensions:
      a. Pipe, 2.875" outside dimension, Lbs. per lin ft: 5.79
      b. Tubing, 2-1/2" square, Lbs per lin ft: 5.70
      c. Roll-formed section, 3-1/2" x 3-1/2", Lbs per lin ft: 5.14

C. Line posts: Provide minimum sizes and weights as follows:
   1. Material and dimensions:
      a. Pipe, 2.375" outside dimension, Lbs. per lin ft: 3.65
      b. H-section, 2.25" x 1.95" x 0.143", Lbs per lin ft: 10.10

D. Gate posts: Provide gate posts for supporting single gate leaf, or one leaf of a double gate installation, for nominal gate widths as follows:
   1. Material and dimension:
      a. Pipe, 4" outside dimension: Lbs. per lin ft: 9.10
      b. Tubing, 3" square:, Lbs. per lin ft: 9.10
      c. H-section, 4", Lbs. per lin ft: 14.00
         1) Over 13 feet wide, and up to 18 feet wide: Use 6.625" outside diameter pipe weighing 14.0 lbs. per lin ft.
         2) Over 18 feet wide: Use 8.625" outside diameter pipe weighing 24.70 lbs. per lin ft.

E. Top rails:
   1. Use 1.660" outside diameter pipe weighing 1.80 lbs. per lin ft; or
   2. Use 1.625" x 1.25" roll-formed sections weighing 1.35 lbs. per lin ft.
   3. Provide in manufacturer's longest lengths, with expansion type couplings approximately 6" long for each joint.
   4. Provide means for attaching top rail securely to each gate, corner, pull, slope, and end post.

F. Post brace assemblies:
   1. Provide at end and gate posts, and at both sides of corner, slope, and pull posts, with the horizontal brace located at mid-height of the fabric.
   2. Use 1.660" outside diameter pipe weighing 1.80 lbs. per lin ft for horizontal brace.
   3. Use 3/8" diameter rod with turnbuckle for diagonal truss.

G. Tension wire: Provide number 7 gage galvanized coiled spring wire at bottom of fabric.

H. Post tops:
   1. Provide steel, wrought iron, or malleable iron, designed as weathertight closure cap.
   2. Provide one cap for each post.
   3. Provide caps with openings to permit through passage of top rail.

I. Stretcher bars:
   1. Provide one-piece lengths equal to full height of fabric, with a minimum cross-section of 3/16"x 3/4".

2. Provide one stretcher bar for each gate and end post, and two for each corner, slope, and pull post, except where fabric is woven integrally into the post.

J. Stretcher bar bands:
1. Provide steel, wrought iron, or malleable iron, spaced not over 15" on centers, to secure stretcher bars to end, corner, pull, slope, and gate posts.
2. Bands may be used also with special fittings for securing rails to end, corner, pull, slope, and gate posts.

2.06 GATES

A. General:
1. Fabricate gate perimeter frames of tubular members.
2. Provide additional horizontal and vertical members to assure proper operation of the gate, and for attachment of fabric, hardware, and accessories.
3. Space so frame members are not more than 8 feet apart.
4. Fabricate gate frames from:
a. Materials and dimension:
1) Pipe 1.90" outside diameter, Lbs. per lin ft: 2.72
2) Tubing, 2" square, Lbs. per lin ft: 2.60

B. Fabrication:
1. Assemble gate frames by welding with special malleable or pressed steel fittings and rivets for rigid connections.
2. Use same fabric as used in the fence.
3. Install fabric with stretcher bars at vertical edges as a minimum.
4. Attach stretchers to gate frame at not more than 15" on centers.
5. Attach hardware with rivets or by other means which will provide security against removal and breakage.
6. Provide diagonal cross-bracing consisting of 3/8" diameter adjustable length truss rods on gates where required to provide frame rigidity without sag or twist.

C. Gate hardware: Provide following for each gate:
1. Hinges:
a. Pressed or forged steel, or malleable iron, to suit the gate size; non-lift-off type, offset to permit 180 degree opening.
b. Provide 1-1/2 pr of hinges for each leaf over 6 feet in nominal height.
2. Latches:
a. Provide forked type or plunger-bar type to permit operation from either side of the gate.
b. Provide padlock eye as integral part of latch.
3. Keeper: Provide keeper for vehicle gates, which automatically engages the gate leaf and holds it in the open position until manually released.
4. Double gates:
a. Provide gate stops for double gates consisting of mushroom or flush plate, with anchors.
b. Set in concrete to engage the center drop rod or plunger bar.
c. Provide locking device and padlock eyes as an integral part of the latch, requiring one padlock for locking both gate leaves.

2.07 MISCELLANEOUS MATERIALS AND ACCESSORIES

A. Wire ties:
1. For tying fabric to line posts, use number 9 gage wire ties spaced 12" on centers.
2. For tying fabric to rails and braces, use number 9 gage wire ties spaced 24" on centers.
3. For tying fabric to tension wire, use number ll gage hog rings spaced 24" on centers.
4. Manufacturer's standard wire ties will be acceptable if of equal strength and durability.

B. Concrete: Comply with provisions of Section 03 3000 – Cast-in-Place Concrete for 2500 psi concrete.

PART 3 – EXECUTION

3.01 SURFACE CONDITIONS

A. Examine the areas and conditions under which work of this Section will be performed. Correct conditions detrimental to timely and proper completion of the Work. Do not proceed until unsatisfactory conditions are corrected.

3.02 GUARANTEE

A. The contractor shall furnish a written guarantee warranting all materials, devices, and workmanship to be free of defects for a period of one year from the date of completion and acceptance. Any defects in materials, devices, and workmanship which become apparent within the guarantee period shall be repaired or replaced by the contractor at his own expense, and at no additional cost to the Owner.

3.03 INSTALLATION

A. General:
   1. Install posts at a maximum spacing of 10 feet on centers.
   2. Install corner or slope posts where changes in line or grade exceed a 30 degree deflection.

B. Excavating:
   1. Drill holes for post footings in firm, undisturbed or compacted soil, strictly adhering to the dimensions and spacing shown.
   2. Post hole dimensions:
      a. Provide 30" deep by 8" diameter foundations for line posts for 5 foot fabric height and less.
      b. Provide 36" deep by 8" diameter foundations for line posts for fabric heights exceeding 5 feet.
      c. Provide 36" deep by 12" diameter foundations for all other posts.
   3. Spread soil from excavations uniformly adjacent to the fence line, or on adjacent areas of the site if so directed.
   4. When solid rock is encountered near the surface, drill into rock at least 12" for line posts and at least 18" for end, pull, gate, and corner posts. Drill hole at least 1" greater diameter than the largest dimension of the post to be placed.
   5. If solid rock is below soil overburden, drill to full depth required, except penetration into rock need not exceed minimum depths specified above.

C. Setting posts:
   1. Remove loose and foreign materials from sides and bottoms of holes, and moisten soil prior to placing concrete.
   2. Center and align posts in holes.
   3. Place concrete around posts in a continuous pour, and vibrate or tamp for consolidation.
   4. Check each post for vertical and top alignment, and hold in position during placement and finishing operations.
   5. Trowel tops of footings, and slope or dome to direct water away from posts.
   6. Extend footings for gate posts to the underside of bottom hinge.
   7. Set keeps, stops, sleeves, and other accessories into concrete as required.
   8. Keep exposed concrete surfaces moist for at least seven days after placement, or cure with membrane curing material or other curing method approved by the Architect.
   9. Grout-in those posts which are set into sleeved holes, concrete constructions, or rock excavations, using non-shrink Portland cement grout or other grouting material approved by the Architect.

D. Concrete strength:

1. Allow concrete to attain at least 75% of its minimum 28-day strength before rails, tension wires, and/or fabric is installed.
2. Do not, in any case, install such items in less than seven days after placement of concrete.
3. Do not stretch and tension fabric and wire, and do not hang gates, until concrete has attained its full design strength.

E. Rails and bracing:
1. Install fence with a top rail and bottom tension wire.
2. Install top rails continuously through post caps or extension arms, bending to radius for curved runs.
3. Provide expansion couplings as recommended by the fencing manufacturer.
4. Provide bracing to the midpoint of the nearest line post or posts at all end, corner, slope, pull, and gate posts.
5. Install tension wires parallel to the line of fabric by weaving through the fabric, and tying to each post with not less than number 6 gage galvanized wire, or by securing the wire to the fabric.

F. Installing fabric:
1. Leave approximately 2" between finish grade and bottom selvage.
2. Excavate high points in the ground to clear the bottom of the fence.
3. Place and compact fill to within 1" of the bottom of the fabric in depressions.
4. Pull fabric taut and tie to posts, rails, and tension wires.
5. Install fabric on outward side facing side of fence, and anchor to framework so that the fabric remains in tension after pulling force is removed.
6. Install stretcher bars by threading through or clamping to fabric on 4" centers, and secure to posts with metal bands spaced 15" on centers.

G. Installing gates:
1. Install gates plumb, level, and secure for full opening without interference.
2. Install ground-set items in concrete for anchorage in accordance with the fence manufacturer's recommendations as approved by the Architect.
3. Lubricate and adjust the hardware for smooth operation.

H. Miscellaneous:
1. Use U-shaped tie wires, conforming to diameter of pipe to which attached, clasping pipe and fabric firmly with ends twisted at least two full turns.
2. Bend ends of wire to minimize hazards to persons and clothing.
3. Fasteners:
   a. Install nuts for tension band and hardware bolts on side of fence opposite fabric side.
   b. Peen the ends of bolts to prevent removal of nuts.
4. Repair coatings damaged in the shop or field erection, using a hot-applied repair compound applied in accordance with its manufacturer's recommendations as approved by the Architect.

END OF SECTION

SECTION 32 3119
DECORATIVE METAL FENCES AND GATES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Decorative steel fences.

1.02 RELATED REQUIREMENTS

A. Section 03 3000 - Cast-in-Place Concrete.

1.03 REFERENCE STANDARDS

A. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process 2020.

B. ASTM F2408 - Standard Specification for Ornamental Fences Employing Galvanized Steel Tubular Pickets 2016.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Preinstallation Meeting: Conduct a preinstallation meeting one week prior to start of work of this section; require attendance by affected installers.

1.05 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements, for submittal procedures.

B. Product Data: Submit manufacturer's data sheets on each product to be used, including:
   1. Preparation instructions and recommendations.
   2. Storage and handling requirements and recommendations.
   3. Installation methods.

C. Shop Drawings:
   1. Indicate plan layout, spacing of components, post foundation dimensions, hardware anchorage, gates, and schedule of components.

D. Manufacturer's Warranty.

1.06 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section with minimum five years experience.

B. Installer Qualifications: Experienced with type of construction involved and materials and techniques specified and approved by fence manufacturer.

1.07 DELIVERY, STORAGE AND HANDLING

A. Store materials in a manner to ensure proper ventilation and drainage. Protect against damage, weather, vandalism and theft.

1.08 WARRANTY

A. See Section 01 7800 - Closeout Submittals, for additional warranty requirements.

B. Correct defective Work within a five year period after Date of Substantial Completion.

C. Provide twenty year manufacturer warranty for defects in material finish, including cracking, peeling, chipping, blistering or corroding.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Decorative Metal Fences and Gates:
   1. Ameristar Perimeter Security, USA: www.ameristarfence.com.
   2. Fortress Fence Products: www.FortressFence.com
   3. Master-Halco, Inc.: www.fenceonline.com
   4. Substitutions: See Section 01 6000 - Product Requirements.

2.02 FENCES

A. Fences: Complete factory-fabricated system of posts and panels, accessories, fittings, and fasteners; finished with electrodeposition coating, and having the following performance characteristics:

B. Steel: ASTM A653/A653M; tensile strength 45,000 psi, minimum.
   1. Hot-dip galvanized; ASTM A653/A653M, G60.
   2. 62 percent recycled steel, minimum.

2.03 WELDED STEEL FENCE

A. See drawings for fence elevations, configuration and locations.

B. Material sizes given are minimum sizes and shall be designed by the fence manufacturer.

C. Provide fence meeting requirements for Industrial class as defined by ASTM F2408.

D. Fence Panels: Fusion welded; 6 feet high by 8 feet long.
   1. Panel Style: Two rail.
   2. Attach panels to posts with manufacturer's standard panel brackets.

E. Posts: Steel tube.
   1. Size: 2-1/2 inches square by 16 gage, 0.0598 inch, with manufacturer's standard cap.

F. Rails: Manufacturer's standard, steel channel, nominal 1-1/2 inch square by 14 gage, 0.0747 inch with pre-punched picket holes.

G. Pickets: Steel tube.
   1. Spacing: 3-3/4 inch clear, nominal.
   2. Size: 3/4 inch square by 18 gage, 0.0478 inch.
   3. Style: Flush top rail.

H. Flexibility: Capable of following variable slope of up to 1:2.

I. Color: Black.

PART 3 EXECUTION

3.01 EXAMINATION

A. Do not begin installation until substrates have been properly prepared.

B. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

3.02 PREPARATION

A. Clean surfaces thoroughly prior to installation.

3.03 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Set fence posts in accordance with the manufacturer recommended spacing.

C. When cutting rails immediately seal the exposed surfaces by:
   1. Removing metal shavings from cut area.
   2. Apply zinc-rich primer to thoroughly cover cut edge and drilled hole; allow to dry.
   3. Apply two coats of custom finish spray paint matching fence color.
   4. Failure to seal exposed surfaces in accordance with manufacturer's instructions will negate manufacturer's warranty.

D. Space gate posts according to the manufacturers' drawings, dependent on standard out-to-out gate leaf dimensions and gate hardware selected.
   1. Identify the necessary hardware required for the application on the manufacturer's gate drawings.
   2. Provide gate hardware by the manufacturer of the gate and install in compliance with manufacturer's recommendations.

3.04 TOLERANCES

A. Maximum Variation From Plumb: 1/4 inch.

B. Maximum Offset From Indicated Position: 1 inch.

C. Minimum Distance from Property Line: 6 inches.

3.05 CLEANING

A. Leave immediate work area neat at end of each work day.

B. Clean jobsite of excess materials; scatter excess material from post hole excavations uniformly away from posts. Remove excess material if required.

C. Clean fence with mild household detergent and clean water rinse well.

D. Remove mortar from exposed posts and other fencing material using a 10 percent solution of muriatic acid followed immediately by several rinses with clean water.

E. Touch up scratched surfaces using materials recommended by manufacturer. Match touched-up paint color to factory-applied finish.

3.06 PROTECTION

A. Protect installed products until completion of project.

B. Touch-up, repair, or replace damaged products before Date of Substantial Completion.

END OF SECTION

SECTION 33 0500
COMMON WORK RESULTS FOR UTILITIES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. This Section includes the following:
1. Piping joining materials.
2. Transition fittings.
3. Dielectric fittings.
4. Sleeves.
5. Identification devices.
6. Grout.City
7. Flowable fill.
8. Piped utility demolition.
9. Piping system common requirements.
10. Equipment installation common requirements.
11. Painting.
12. Concrete bases.
13. Metal supports and anchorages.

1.03 DEFINITIONS

B. Exposed Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions.

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

D. ABS: Acrylonitrile-butadiene-styrene plastic.

E. CPVC: Chlorinated polyvinyl chloride plastic.

F. PE: Polyethylene plastic.

G. PVC: Polyvinyl chloride plastic.

1.04 ACTION SUBMITTALS

H. Product Data: For the following:
1. Dielectric fittings.
2. Identification devices.

1.05 INFORMATIONAL SUBMITTALS

I. Welding certificates.

1.06 QUALITY ASSURANCE

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

K. Steel Piping Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."

2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

L. Comply with ASME A13.1 for lettering size, length of color field, colors, and viewing angles of identification devices.

1.07 DELIVERY, STORAGE, AND HANDLING

M. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.

N. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

1.08 COORDINATION

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

P. Coordinate installation of identifying devices after completing covering and painting if devices are applied to surfaces.

Q. Coordinate size and location of concrete bases.

PART 2 - PRODUCTS

2.01 PIPING JOINING MATERIALS

A. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
1. ASME B16.21, nonmetallic, flat, asbestos free, 1/8-inch maximum thickness, unless otherwise indicated.
a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.
2. AWWA C110, rubber, flat face, 1/8-inch-thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.

B. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.

C. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.

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

E. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated; and AWS A5.8, BAg1, silver alloy for refrigerant piping, unless otherwise indicated.

F. Welding Filler Metals: Comply with AWS D10.12/D10.12M for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

G. Solvent Cements for Joining Plastic Piping:
1. ABS Piping: ASTM D 2235.
2. CPVC Piping: ASTM F 493.
3. PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.
4. PVC to ABS Piping Transition: ASTM D 3138.
5. Fiberglass Pipe Adhesive: As furnished or recommended by pipe manufacturer.

2.02 TRANSITION FITTINGS

A. Transition Fittings, General: Same size as, and with pressure rating at least equal to and with ends compatible with, piping to be joined.

B. Transition Couplings NPS 1-1/2 (DN 40) and Smaller:
   1. Underground Piping: Manufactured piping coupling or specified piping system fitting.
   2. Aboveground Piping: Specified piping system fitting.

C. AWWA Transition Couplings NPS 2 (DN 50) and Larger:
   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:
   2. Manufacturers: Subject to compliance with requirements.
   3. Description: AWWA C219, metal sleeve-type coupling for underground pressure piping.

D. Plastic-to-Metal Transition Fittings:
   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:
   2. Manufacturers: Subject to compliance with requirements.
   3. Description: PVC one-piece fitting with manufacturer's Schedule 80 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint or threaded end.

E. Plastic-to-Metal Transition Unions:
   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:
   2. Manufacturers: Subject to compliance with requirements.
   3. Description: MSS SP-107, PVC four-part union. Include brass or stainless-steel threaded end, solvent-cement-joint or threaded plastic end, rubber O-ring, and union nut.

F. Flexible Transition Couplings for Underground Nonpressure Drainage Piping:
   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:
   2. Manufacturers: Subject to compliance with requirements.
   3. Description: ASTM C 1173 with elastomeric sleeve, ends same size as piping to be joined, and corrosion-resistant metal band on each end.

2.03 DIELECTRIC FITTINGS

A. Dielectric Fittings, General: Assembly of copper alloy and ferrous materials or ferrous material body with separating nonconductive insulating material suitable for system fluid, pressure, and temperature.

B. Dielectric Unions:
   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:
   2. Manufacturers: Subject to compliance with requirements.
   3. Description: Factory fabricated, union, NPS 2 (DN 50) and smaller.
      a. Pressure Rating: 150 psig minimum at 180 deg F.
      b. End Connections: Solder-joint copper alloy and threaded ferrous; threaded ferrous.

C. Dielectric Flanges:

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:
2. Manufacturers: Subject to compliance with requirements.
3. Description: Factory-fabricated, bolted, companion-flange assembly, NPS 2-1/2 to NPS 4 (DN 65 to DN 100) and larger.
    a. Pressure Rating: 150 psig minimum.
    b. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

D. Dielectric-Flange Kits:
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:
2. Manufacturers: Subject to compliance with requirements.
3. Description: Nonconducting materials for field assembly of companion flanges, NPS 2-1/2 (DN 65) and larger.
    a. Pressure Rating: 150 psig minimum.
    b. Gasket: Neoprene or phenolic.
    c. Bolt Sleeves: Phenolic or polyethylene.
    d. Washers: Phenolic with steel backing washers.

E. Dielectric Couplings:
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:
2. Manufacturers: Subject to compliance with requirements.
3. Description: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining, NPS 3 (DN 80) and smaller.
    a. Pressure Rating: 300 psig at 225 deg F.
    b. End Connections: Threaded.

F. Dielectric Nipples:
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:
2. Manufacturers: Subject to compliance with requirements.
3. Description: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining.
    a. Pressure Rating: [300 psig (2070 kPa) at 225 deg F (107 deg C)] <Insert pressure and temperature>.
    b. End Connections: Threaded or grooved.

2.04 SLEEVES

A. Mechanical sleeve seals for pipe penetrations are specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."

B. Galvanized-Steel Sheet Sleeves: 0.0239-inch (0.6-mm) minimum thickness; round tube closed with welded longitudinal joint.

C. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized, plain ends.

D. Cast-Iron Sleeves: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

E. Molded PVC Sleeves: Permanent, with nailing flange for attaching to wooden forms.
F. PVC Pipe Sleeves: ASTM D 1785, Schedule 40.
G. Molded PE Sleeves: Reusable, PE, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.

2.05 IDENTIFICATION DEVICES

A. General: Products specified are for applications referenced in other utilities Sections. If more than single type is specified for listed applications, selection is Installer's option.
B. Equipment Nameplates: Metal permanently fastened to equipment with data engraved or stamped.
   1. Data: Manufacturer, product name, model number, serial number, capacity, operating and power characteristics, labels of tested compliances, and essential data.
   2. Location: Accessible and visible.
C. Stencils: Standard stencils prepared with letter sizes complying with recommendations in ASME A13.1. Minimum letter height is 1-1/4 inches for ducts, and 3/4 inch for access door signs and similar operational instructions.
   1. Material: Fiberboard, Brass.
   2. Stencil Paint: Exterior, oil-based, alkyd-gloss black enamel, unless otherwise indicated. Paint may be in pressurized spray-can form.
   3. Identification Paint: Exterior, oil-based, alkyd enamel in colors according to ASME A13.1, unless otherwise indicated.
D. Snap-on Plastic Pipe Markers: Manufacturer's standard preprinted, semirigid, snap-on type. Include color-coding according to ASME A13.1, unless otherwise indicated.
E. Pressure-Sensitive Pipe Markers: Manufacturer's standard preprinted, color-coded, pressure-sensitive-vinyl type with permanent adhesive.
F. Pipes with OD, Including Insulation, Less Than 6 Inches: Full-band pipe markers, extending 360 degrees around pipe at each location.
G. Pipes with OD, Including Insulation, 6 Inches and Larger: Either full-band or strip-type pipe markers, at least three times letter height and of length required for label.
H. Lettering: Manufacturer's standard preprinted captions as selected by Architect.
I. Lettering: Use piping system terms indicated and abbreviate only as necessary for each application length.
   1. Arrows: Either integrally with piping system service lettering to accommodate both directions of flow, or as separate unit on each pipe marker to indicate direction of flow.
J. Plastic Tape: Manufacturer's standard color-coded, pressure-sensitive, self-adhesive vinyl tape, at least 3 mils thick.
   1. Width: 1-1/2 inches on pipes with OD, including insulation, less than 6 inches; 2-1/2 inches for larger pipes.
   2. Color: Comply with ASME A13.1, unless otherwise indicated.
K. Valve Tags: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch sequenced numbers. Include 5/32-inch hole for fastener.
   1. Material: 0.032-inch- thick, [polished brass] [or] [aluminum].
   2. Material: 0.0375-inch- thick stainless steel.
   3. Material: 3/32-inch- thick plastic laminate with 2 black surfaces and a white inner layer.
   4. Material: Valve manufacturer's standard solid plastic.
   5. Size: 1-1/2 inches in diameter, unless otherwise indicated.
   6. Shape: As indicated for each piping system.

L. Valve Tag Fasteners: Brass, wire-link, or beaded chain; or brass S-hooks.

M. Engraved Plastic-Laminate Signs: ASTM D 709, Type I, cellulose, paper-base, phenolic-resin-laminate engraving stock; Grade ES-2, black surface, black phenolic core, with white melamine subcore, unless otherwise indicated. Fabricate in sizes required for message. Provide holes for mechanical fastening.
   1. Engraving: Engraver's standard letter style, of sizes and with terms to match equipment identification.
   2. Thickness: 1/16 inch unless otherwise indicated.
   3. Thickness: 1/16 inch, for units up to 20 sq. in. or 8 inches in length, and 1/8 inch for larger units.
   4. Fasteners: Self-tapping, stainless-steel screws or contact-type permanent adhesive.

N. Plastic Equipment Markers: Manufacturer's standard laminated plastic, in the following color codes:
   1. Green: Cooling equipment and components.
   2. Yellow: Heating equipment and components.
   3. Brown: Energy reclamation equipment and components.
   4. Blue: Equipment and components that do not meet criteria above.
   5. Hazardous Equipment: Use colors and designs recommended by ASME A13.1.
   6. Terminology: Match schedules as closely as possible. Include the following:
      a. Name and plan number.
      b. Equipment service.
      c. Design capacity.
      d. Other design parameters such as pressure drop, entering and leaving conditions, and speed.
   7. Size: 2-1/2 by 4 inches for control devices, dampers, and valves; 4-1/2 by 6 inches for equipment.

O. Plasticized Tags: Preprinted or partially preprinted, accident-prevention tags, of plasticized card stock with mat finish suitable for writing.
   1. Size: 3-1/4 by 5-5/8 inches.
   2. Fasteners: Brass grommets and wire.
   3. Nomenclature: Large-size primary caption such as DANGER, CAUTION, or DO NOT OPERATE.

P. Lettering and Graphics: Coordinate names, abbreviations, and other designations used in piped utility identification with corresponding designations indicated. Use numbers, letters, and terms indicated for proper identification, operation, and maintenance of piped utility systems and equipment.
   1. Multiple Systems: Identify individual system number and service if multiple systems of same name are indicated.

2.06 GROUT

A. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.
   1. Characteristics: Post hardening, volume adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
   2. Design Mix: 5000-psi, 28-day compressive strength.
   3. Packaging: Premixed and factory packaged.

2.07 FLOWABLE FILL

A. Description: Low-strength-concrete, flowable-slurry mix.

1. Cement: ASTM C 150, Type I, portland.
2. Density: 115- to 145-lb/cu. ft.
3. Aggregates: ASTM C 33, natural sand, fine and crushed gravel, or stone, coarse.
4. Aggregates: ASTM C 33, natural sand, fine.
5. Admixture: ASTM C 618, fly-ash mineral.
6. Water: Comply with ASTM C 94/C 94M.
7. Strength: 100 to 200 psig at 28 days.

PART 3 - EXECUTION

3.01 PIPED UTILITY DEMOLITION

A. Refer to Section 024119 "Selective Demolition" for general demolition requirements and procedures.

B. Disconnect, demolish, and remove piped utility systems, equipment, and components indicated to be removed.
1. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
2. Piping to Be Abandoned in Place: Drain piping. Fill abandoned piping with flowable fill, and cap or plug piping with same or compatible piping material.
3. Equipment to Be Removed: Disconnect and cap services and remove equipment.
4. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make operational.
5. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.

C. If pipe, insulation, or equipment to remain is damaged in appearance or is unserviceable, remove damaged or unserviceable portions and replace with new products of equal capacity and quality.

3.02 DIELECTRIC FITTING APPLICATIONS

A. Dry Piping Systems: Connect piping of dissimilar metals with the following:
1. NPS 2 and Smaller: Dielectric unions.
2. NPS 2-1/2 to NPS 12: Dielectric flanges.

B. Wet Piping Systems: Connect piping of dissimilar metals with the following:
1. NPS 2 and Smaller: Dielectric.
2. NPS 2-1/2 to NPS 4: Dielectric nipples.
3. NPS 2-1/2 to NPS 8: Dielectric nipples.
4. NPS 10 and NPS 12: Dielectric flange kits.

3.03 PIPING INSTALLATION

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

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

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

D. Install piping to permit valve servicing.
E. Install piping at indicated slopes.
F. Install piping free of sags and bends.
G. Install fittings for changes in direction and branch connections.
H. Select system components with pressure rating equal to or greater than system operating pressure.
I. Sleeves are not required for core-drilled holes.
J. Permanent sleeves are not required for holes formed by removable PE sleeves.
K. Install sleeves for pipes passing through concrete and masonry walls and concrete floor and roof slabs.
    1. Cut sleeves to length for mounting flush with both surfaces.
        a. Exception: Extend sleeves installed in floors of equipment areas or other wet areas [2 inches above finished floor level.
    2. Install sleeves in new walls and slabs as new walls and slabs are constructed.
        a. PVC or Steel Pipe Sleeves: For pipes smaller than NPS 6.
        b. Steel Sheet Sleeves: For pipes NPS 6 and larger, penetrating gypsum-board partitions.
L. Verify final equipment locations for roughing-in.
M. Refer to equipment specifications in other Sections for roughing-in requirements.

3.04 PIPING JOINT CONSTRUCTION

A. Join pipe and fittings according to the following requirements and utilities Sections specifying piping systems.
B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
D. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
    1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
    2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
E. Welded Joints: Construct joints according to AWS D10.12/D10.12M, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.
F. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.
G. Grooved Joints: Assemble joints with grooved-end pipe coupling with coupling housing, gasket, lubricant, and bolts according to coupling and fitting manufacturer's written instructions.
H. Soldered Joints: Apply ASTM B 813 water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy (0.20 percent maximum lead content) complying with ASTM B 32.
I. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.
J. Pressure-Sealed Joints: Assemble joints for plain-end copper tube and mechanical pressure seal fitting with proprietary crimping tool to according to fitting manufacturer's written instructions.

K. Plastic Piping Solvent-Cemented Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
   1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
   2. ABS Piping: Join according to ASTM D 2235 and ASTM D 2661 appendixes.
   3. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.
   4. PVC Pressure Piping: Join schedule number ASTM D 1785, PVC pipe and PVC socket fittings according to ASTM D 2672. Join other-than-schedule-number PVC pipe and socket fittings according to ASTM D 2855.
   5. PVC Nonpressure Piping: Join according to ASTM D 2855.
   6. PVC to ABS Nonpressure Transition Fittings: Join according to ASTM D 3138 Appendix.

L. Plastic Pressure Piping Gasketed Joints: Join according to ASTM D 3139.

M. Plastic Nonpressure Piping Gasketed Joints: Join according to ASTM D 3212.

N. Plastic Piping Heat-Fusion Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join according to ASTM D 2657.
   1. Plain-End PE Pipe and Fittings: Use butt fusion.
   2. Plain-End PE Pipe and Socket Fittings: Use socket fusion.

O. Bonded Joints: Prepare pipe ends and fittings, apply adhesive, and join according to pipe manufacturer's written instructions.

3.05 PIPING CONNECTIONS

A. Make connections according to the following, unless otherwise indicated:
   1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
   2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.
   3. Install dielectric fittings at connections of dissimilar metal pipes.

3.06 EQUIPMENT INSTALLATION

A. Install equipment level and plumb, unless otherwise indicated.

B. Install equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference with other installations. Extend grease fittings to an accessible location.

C. Install equipment to allow right of way to piping systems installed at required slope.

3.07 PAINTING

A. Painting of piped utility systems, equipment, and components is specified in Section 099113 "Exterior Painting," Section 099123 "Interior Painting," and Section 099600 "High-Performance Coatings."

B. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

3.08 IDENTIFICATION

A. Piping Systems: Install pipe markers on each system. Include arrows showing normal direction of flow.
   1. Stenciled Markers: According to ASME A13.1.
   2. Plastic markers, with application systems. Install on insulation segment if required for hot noninsulated piping.
   3. Locate pipe markers on exposed piping according to the following:

4. Near each valve and control device.
5. Near each branch, excluding short takeoffs for equipment and terminal units. Mark each pipe at branch if flow pattern is not obvious.
6. Near locations where pipes pass through walls or floors or enter inaccessible enclosures.
7. At manholes and similar access points that permit view of concealed piping.
8. Near major equipment items and other points of origination and termination.

B. Equipment: Install engraved plastic-laminate sign or equipment marker on or near each major item of equipment.
1. Lettering Size: Minimum 1/4-inch-high for name of unit if viewing distance is less than 24 inches, 1/2-inch-high for distances up to 72 inches, and proportionately larger lettering for greater distances. Provide secondary lettering two-thirds to three-fourths of size of principal lettering.
2. Text of Signs: Provide name of identified unit. Include text to distinguish among multiple units, inform user of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations.

C. Adjusting: Relocate identifying devices that become visually blocked by work of this or other Divisions.

3.09 CONCRETE BASES

A. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to seismic codes at Project.
1. Construct concrete bases of dimensions indicated, but not less than 4 inches (100 mm) larger in both directions than supported unit.
2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around the full perimeter of base.
3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
5. Install anchor bolts to elevations required for proper attachment to supported equipment.
6. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
7. Use 3000-psi, 28-day compressive-strength concrete and reinforcement.

3.10 ERECTION OF METAL SUPPORTS AND ANCHORAGES

A. Refer to Section 055000 "Metal Fabrications" for structural steel.

B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor piped utility materials and equipment.

C. Field Welding: Comply with AWS D1.1/D1.1M.

3.11 GROUTING

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

B. Clean surfaces that will come into contact with grout.

C. Provide forms as required for placement of grout.

D. Avoid air entrapment during placement of grout.

E. Place grout, completely filling equipment bases.

F. Place grout on concrete bases and provide smooth bearing surface for equipment.

G. Place grout around anchors.
H. Cure placed grout.

END OF SECTION

SECTION 33 1110
PVC WATER PIPE

PART 1 – GENERAL

1.01 DESCRIPTION

A. This specification covers the requirements to install polyvinyl chloride (PVC) water pipe and ductile iron fittings for the water line, including excavation, sheeting, shoring, dewatering, pipe laying, jointing, testing, backfilling and any other work that is required or necessary to complete the installation as shown on the Plans and as specified herein.

1.02 SUBMITTALS

A. Comply with pertinent provisions of Division 1.

B. The Contractor shall submit descriptive information and evidence that the materials and equipment the Contractor proposes for incorporation into the Work is of the kind and quality that satisfies the specified functions and quality.

1.03 QUALITY ASSURANCE

A. All PVC pipe and fittings shall be from a single Manufacturer. The supplier shall be responsible for the provisions of all test requirements specified in ASTM D3034 or ASTM F789 and/or ASTM F758 as applicable.

PART 2 – PRODUCTS

2.01 POLYVINYL CHLORIDE (PVC) PIPE AND FITTINGS

A. Polyvinyl chloride pipe for water lines, unless otherwise specifically shown on the Plans, or approved in writing, shall be AWWA C900, C905, or C909 Class 150 psi with a dimension ratio of 18 (DR-18), for water lines and shall be extruded, be of rubber gasket type, and be furnished in 20-foot nominal laying lengths. All such pipe shall bear a mark denoting approval by the Underwriters' Laboratories of Chicago, Illinois, so that it will be acceptable to the Texas State Fire Insurance Commission for use in fire protection lines without penalty. All joints shall be of the type which provides a recession in the bell for the employment of a single rubber gasket to be placed before the insertion of the succeeding spigot. Each size of polyvinyl chloride pipe shall have the same outside diameter as the corresponding size of cast iron pipe.

B. Fittings shall be ductile iron, mechanical joint or flanged type and shall be Class 250 in accordance with AWWA Specifications C110-77, C-111-80, and C115-75. Flanges shall be faced and drilled in accordance with ASA Standard B16.1, Class 125 unless otherwise shown on the Plans or in the Special Conditions. All fittings shall be tar coated on the outside surface and shall have an interior cement lining with seal coat per AWWA Specifications C104-80 unless otherwise shown or specified.

C. The Contractor shall obtain installation instructions, including support spacing and solvent welding, from the supplying Manufacturer, shall comply with the instructions, and shall meet the requirements of ASTM D-2855, Standard Recommended Practice for making Solvent Cemented Joints with PVC Pipe and Fittings. The PVC solvent cement shall comply with ASTM D-2564 and shall be furnished by the pipe and fitting Manufacturer for the class and type of pipe supplied to the project.

D. Water line pipe joints across the fault line and inside of the influence zone, as marked on the design plans and as part of the Fault Study, shall be Flex-Tend Force Balanced Flexible Expansion Joints by EBAA Iron or approved equal product.

PART 3 – EXECUTION

3.01 HANDLING AND CUTTING PIPE

A. Pipe and fittings are slightly brittle. Care shall be taken in shipping, handling and laying to avoid damaging the pipe and fittings. Extra care will be necessary during cold weather

construction.

B. Any pipe or fitting showing a crack or which has received a blow that may have caused an incipient fracture, even though no such fracture can be seen, shall be marked as rejected and removed at once from the work.
C. All pipe ends shall be square after cutting.
D. While stored, pipe shall be adequately supported from below at not more than three (3) foot intervals to prevent deformation. Pipe shall not be stacked higher than six (6) feet. Pipe and fittings shall be stored in a manner which will keep them at ambient outdoor temperatures and out of direct sunlight. Temporary shading as required to meet this requirement shall be provided. Simple covering of the pipe and fittings which allows temperature buildup when exposed to direct sunlight will not be permitted.

3.02 JOINTING POLYVINYL CHLORIDE (PVC) PIPE AND FITTINGS

A. PVC pipe and fittings shall be jointed in accordance with the recommendations of the latest ASTM Standards and detailed instructions of the Manufacturer.

3.03 INSTALLING POLYVINYL CHLORIDE (PVC) PIPE AND FITTINGS

A. Unless otherwise specified on the Plans, polyvinyl chloride pipe shall be installed to clear all utility lines and shall have three (3) feet minimum cover. For water lines to be constructed under a future roadway, the cover may be increased to allow for future paving grades. The depth of cover, where shown on the Plans, is that distance from the top of the pipe to the approximate proposed grade line.
B. No single piece of pipe shall be laid unless it is generally straight. The centerline of the pipe shall not deviate from a straight line drawn between the centers of the openings at the ends of the pipe by more than 1/16-inch per foot of length. If a piece of pipe fails to meet this requirement check for straightness, it shall be rejected and removed from the site. Laying instructions of the Manufacturer shall be explicitly followed.
C. Any pipe or fittings discovered to be defective after laying shall be removed and replaced with a sound piece.
D. The Engineer or the City may examine each bell and spigot end to determine whether any preformed joint has been damaged prior to installation. Any pipe having defective joint surfaces shall be rejected, marked as such, and immediately removed from the job site.
E. All pipe shall be sound and clean before laying. When laying is not in progress, including lunch time, the open ends of the pipe shall be closed by watertight plugs or other approved means. Good alignment shall be preserved in laying.
F. Pipe and fittings shall be installed in accordance with the instructions of the Manufacturer, ASTM D2321 and as specified herein. As soon as the excavation is complete to normal grade of the bottom of the trench, embedment material shall be placed, compacted and graded to provide firm, uniform and continuous support for the pipe. Bell holes shall be excavated so that only the barrel of the pipe bears upon the bedding. The pipe shall be laid accurately to the lines and grades indicated on the Plans. The specified embedment shall be accurately shaped and trimmed to receive the pipe barrel and each pipe section, when in place, shall have a uniform bearing on the subgrade for the full length of the pipe barrel. Pipe shall not be laid unless the subgrade is free of water and in a satisfactory condition. Embedment material shall be placed evenly on each side of the pipe to mid-diameter and hand tools shall be used to force the embedment material under the haunches of the pipe and into the bell holes to give firm continuous support for the pipe. Embedment material shall then be placed to 12-inches above the top of the pipe. Next, the varying depths of select material backfill above the embedment material backfill shall be placed according to the Plan Details and carefully compacted. Generally, the compaction shall be done evenly on each side of the pipe and compaction equipment shall not be operated directly over the pipe until sufficient select material backfill has been placed to ensure that such compaction equipment will not have a damaging effect on the pipe. Equipment used in compacting the varying depths of select

material backfill shall be approved by the pipe Manufacturer's representative prior to use. Adjustments of the pipe to line and grade shall be made by scraping away or filling in with granular material, and not by wedging or blocking up the bell.

G. Perforated PVC Pipe and fittings shall be installed in accordance with the instructions of the Manufacturer, ASTM F758 and as specified herein. As soon as the excavation for the trench is complete to normal grade of the bottom of the trench, geotextile fabric shall be laid and then the pea gravel bedding shall be carefully placed (so not to damage the geotextile fabric) and graded to provide uniform and continuous support for the pipe. Bell holes shall be excavated so that only the barrel of the pipe bears upon the bedding. Before the perforated pipe is laid on the trench, the perforated pipe shall be wrapped around and closed according to the Manufacturer's closure recommendations with the geotextile fabric. The pipe shall be laid accurately to the lines and grades indicated on the Plans. Blocking under the perforated PVC pipe will not be permitted. Pea gravel shall be placed evenly on each side of the pipe to mid-diameter and hand tools shall be used to gently place the pea gravel under the haunches of the pipe and into the bell holes to give firm continuous support for the pipe. Making sure not to damage the geotextile fabric, pea gravel shall then be carefully placed above the top of the perforated pipe varying from two to three (2-3) feet depending on the Plans. Once the remaining pea gravel has been placed, overlap or close the geotextile fabric according to the Manufacturer's recommendations or six (6) inches minimum overlap. Then one (1) foot of topsoil shall be placed over the pea gravel to the ground level with proper grass sodding on top.

H. Joints shall not be "pulled" or "cramped". Each joint of pipe shall be completed in compliance with Manufacturer's recommendations.

I. Before any joint is made, the pipe shall be checked to assure that a close joint with the next adjoining pipe has been maintained and that the inverts are matched and conform to the required grade. The pipe shall not be driven down to grade by striking it.

J. Precautions shall be taken to prevent flotation of the pipe in the trench.

K. When moveable trench bracing such as trench boxes, moveable sheeting, shoring or plates are used to support the sides of the trench, care shall be taken in placing and moving the boxes or supporting bracing to prevent movement of the pipe, or disturbance of the pipe bedding and backfill or embedment material. Trench boxes, moveable sheeting, shoring or plates shall not be allowed to extend below mid-diameter of the pipe. As trench boxes, moveable sheeting, shoring or plates are moved, embedment material shall be placed to fill any voids created and the embedment material and backfill shall be recompacted to provide uniform side support for the pipe.

3.04 CONCRETE AND BLOCKING

A. 2,500 psi concrete shall be placed for blocking at each change in direction in the pipeline, as shown in the Standard Details and in such manner as will substantially brace the pipe against undisturbed trench walls. In no event shall this quantity of concrete blocking be less than those shown in the Plans. Concrete blocking, made from Type I cement, shall have been in place four (4) days prior to testing the pipeline as hereinafter specified. Tests may be made in two (2) days after completion of blocking if Type III cement is used.

B. At all points where wet connections are made to existing lines, the existing lines shall be adequately blocked and the tapping connection fittings shall be supported by blocking up to the spring line with 2,500 psi concrete.

3.05 LEAKING TESTING AND STERILIZATION

A. General

1. All leakage testing and sterilization shall be per Utility Owner's requirements. Contractor to coordinate with Utility Owner for procedures, timing, and witnessing of testing and sterilization. This section outlines minimum requirements and guidelines for testing and sterilization.

2. After the pipe has been laid and backfilled and the backfill has been otherwise consolidated, all newly laid pipe, or any valved section thereof, shall be subjected to the hydrostatic pressure specified below for that particular type of pipe. The duration of the hydrostatic test shall be at least two (2) hours. Unless otherwise specified or noted on the Plans. All meters, fixtures, devices or appliances which are connected to the pipeline system and which might be damaged if subjected to the specified test pressure shall be disconnected and the ends of the branch lines plugged or capped during the testing procedures.
3. Each valved (capped or plugged) section of pipe shall be filled slowly with water and all air shall be expelled. If permanent air vents are not located at all high points, the Contractor shall install, at his own expense, corporation or blow-off cocks at such points so that air can be expelled as filling takes place. After verification that all air has been expelled, the cocks shall be closed and the pipe kept filled until tested. All exposed pipe, fittings, valves, hydrants and joints shall be examined while under test pressure and all visible leaks shall be stopped. Any cracked or defective pipe, fittings, valves or hydrants discovered during testing shall be removed and replaced by the Contractor. Replacement shall be with sound material and the test shall be repeated until satisfactory to the Engineer.

B. Special Requirements: Where any section of pipeline is provided with concrete reaction blocking, the hydrostatic pressure shall not be made until at least five (5) days have elapsed after installation of the blocking. However, if high-early-strength cement is used in the concrete, two (2) days shall have elapsed prior to testing.

C. Leakage Test: A Leakage Test will be conducted on each valved section over the entire Project. The leakage test shall be at 150 psi for at least four (4) hours.

D. Allowable Leakage
1. The allowable hydrostatic leakage rate shall be based on the following formula:

$L = SD\sqrt{P}/133{,}200$

L = testing allowance in gallons per hour
S = length of pipe tested in feet
D = nominal diameter of the pipe in inches
P = average test pressure during the hydrostatic test in pounds per square inch (gauge)

Table 6A - Hydrostatic testing allowance per 1,000 ft of pipeline* - *gph*†

	Nominal Pipe Diameter – in.																	
Avg Test Pressure psi	3	4	6	8	10	12	14	16	18	20	24	30	36	42	48	54	60	64
450	.48	.64	.95	1.27	1.59	1.91	2.23	2.55	2.87	3.18	3.82	4.78	5.73	6.69	7.64	8.60	9.56	10.19
400	.45	.60	.90	1.20	1.50	1.80	2.10	2.40	2.70	3.00	3.60	4.50	5.41	6.31	7.21	8.11	9.01	9.61
350	.42	.56	.84	1.12	1.40	1.69	1.97	2.25	2.53	2.81	3.37	4.21	5.06	5.90	6.74	7.58	8.43	8.99
300	.39	.52	.78	1.04	1.30	1.56	1.82	2.08	2.34	2.60	3.12	3.90	4.68	5.46	6.24	7.02	7.80	8.32
275	.37	.50	.75	1.00	1.24	1.49	1.74	1.99	2.24	2.49	2.99	3.73	4.48	5.23	5.98	6.72	7.47	7.97
250	.36	.47	.71	.95	1.19	1.42	1.66	1.90	2.14	2.37	2.85	3.56	4.27	4.99	5.70	6.41	7.12	7.60
225	.34	.45	.68	.90	1.13	1.35	1.58	1.80	2.03	2.25	2.70	3.38	4.05	4.73	5.41	6.03	6.76	7.21
200	.32	.43	.64	.85	1.06	1.28	1.48	1.70	1.91	2.12	2.55	3.19	3.82	4.46	5.09	5.73	6.37	6.80
175	.30	.40	.59	.80	.99	1.19	1.39	1.59	1.79	1.98	2.38	2.98	3.58	4.17	4.77	5.36	5.96	6.36
150	.28	.37	.55	.74	.92	1.10	1.29	1.47	1.66	1.84	2.21	2.76	3.31	3.86	4.41	4.97	5.52	5.88
125	.25	.34	.50	.67	.84	1.01	1.18	1.34	1.51	1.68	2.01	2.52	3.02	3.53	4.03	4.53	5.04	5.37
100	.23	.30	.45	.60	.75	.90	1.05	1.20	1.35	1.50	1.80	2.25	2.70	3.15	3.60	4.05	4.50	4.80

If the pipeline under test contains sections of various diameters, the testing allowance will be the sum of the testing allowance for each size.

†Calculated on the basis of Eq. 1.

a. These formulas are based on a testing allowance of 11.65 gpd/mi/in. (1.079 L/d/km/mm) of nominal diameter at a pressure of 150 psi (1,034 kPa).
b. When testing against closed metal-seated valves, an additional testing allowance per closed valve of 0.0078 gal/h/in. (1.2 mL/h/mm) of nominal valve size shall be allowed.
c. When hydrants are in the test section, the test shall be made against the main valve in the hydrant.
d. Acceptance of installation. Acceptance shall be determined on the basis of testing allowance. If any test of laid pipe discloses a testing allowance greater than that specified, repairs or replacements shall be accomplished in accordance with the specifications.
e. All visible leaks are to be repaired regardless of the allowance used for testing.

2. If such testing discloses leakage in excess of this specified allowable, the Contractor, at his expense, shall locate and correct all defects in the pipeline until the leakage is within the specified allowance. All known leaks, regardless of this test, shall be repaired.

E. Pressure Test: After satisfactorily completing the leakage test, each valved section over the entire project, shall be tested at 200 psi for a sufficient period (approximately 10 min) to discover all leaking or defective materials and/or workmanship.

F. Disinfecting Water Mains: The Contractor shall disinfect all water mains before the new facilities are placed into service. Disinfection must be performed in accordance with AWWA C651, latest revision and water samples must be submitted to a laboratory approved by the Texas Department of Health. Sample must be collected by the Contractor or his representative in the presence of the City or his representative. The Contractor shall be responsible for delivering the samples to an approved laboratory for testing. Sample results must indicate the facility is free of microbiological contamination before it is placed into service. It shall be the Contractor's responsibility to obtain a current copy of AWWA C651 to determine the correct forms of chlorine for disinfection, the basic disinfection procedure, preventive and corrective measures during construction, methods of chlorination, final flushing procedures, procedures for bacteriological tests, procedures for redisinfection and disinfection procedures when cutting into existing mains. The Contractor, at its expense, will supply the concentrated chlorine disinfecting material, the City's personnel will supervise and direct the overall sterilization procedure. The Contractor, at his own expense, shall provide all other equipment, supplies and necessary labor to perform the sterilization under general supervision by the City.

G. General

1. All valves shall be arranged to prevent the strong disinfecting dosage from flowing back into the existing water supply piping. The new pipeline shall then be completely filled with disinfecting solution by feeding the concentrated chlorine and approved water from the existing system uniformly into the new piping in such proportions that every part of the line has a minimum concentration of chlorine as prescribed in AWWA C651.
2. Unless otherwise identified, all quantities called for herein refer to measurements by the testing procedures in the current edition of "Standard Methods of Examination of Water and Wastewater". The chlorine concentration of each step in the sterilization procedure shall be verified by chlorine residual determinations. This disinfecting solution shall be retained in the piping for at least twenty-four (24) hours, and all valves, hydrants, etc., shall be operated to disinfect all their parts. After this retention period, the water shall contain no less than the chlorine residual prescribed in AWWA C651 throughout the treated section of the pipeline.
3. This heavily chlorinated water shall then be carefully flushed from the line until the chlorine concentration is not higher than the residual generally prevailing in the existing distribution system, or approximately 1.0 parts per million. Proper planning and appropriate preparations to handle, dilute and dispose of this strong chlorine solution

without causing injury or damage to the public, the water system, the environment must be approved by the City before flushing of the line may begin, and the flushing shall be witnessed by an authorized representative of the City.

H. Bacteriological Testing
   1. After final flushing of the strong disinfecting solution, water samples from the line shall be tested for bacteriological quality, at the Contractor's expense, and must be found free of coliform organisms before the pipeline may be placed in service. One (1) test sample shall be drawn from the end of the main and additional samples collected at intervals of not more than one-thousand (1,000) feet along the pipeline. A minimum of three (3) samples must be collected.
   2. The Contractor, at his own expense, shall install sufficient sampling taps at proper locations along the pipeline. Each sampling tap shall consist of a standard corporation cock installed in the line and extended with a copper tubing gooseneck assembly. After samples have been collected, the gooseneck assembly shall be removed and retained for future use.
   3. Samples for bacteriological analysis shall be collected only from suitable taps, in sterile bottles. Collection of the test samples shall be made in the presence of City personnel. If the initial disinfection fails to produce acceptable sample tests, the disinfection procedure shall be repeated (without extra compensation) until satisfactory test results have been obtained, before the piping may be placed in service.

END OF SECTION

SECTION 33 1215
VALVES, HYDRANTS, AND APPURTENANCES

PART 1 – GENERAL

1.01 DESCRIPTION

A. This specification covers the requirements to provide all buried valves, valves in manholes and underground vaults, hydrants and appurtenances complete with actuators and all accessories as shown on the Plans and as specified herein.

1.02 SUBMITTALS

A. Comply with pertinent provisions of Division 1.
B. The Contractor shall submit descriptive information and evidence that the materials and equipment the Contractor proposes for incorporation into the Work is of the kind and quality that satisfies the specified functions and quality.

1.03 REFERENCE STANDARDS

A. Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified.
B. American Water Works Association (AWWA)
   1. AWWA C500 - Gate Valves, three (3)-inch through 48-inch NPS, for Water and Sewage Systems.
   2. AWWA C502 - Dry-Barrel Fire Hydrants.
   3. AWWA C509 - Resilient-Seated Gate Valves, three (3) inch through 12-inch NPS, for Water and Sewage Systems.
C. American National Standards Institute (ANSI)
   1. ANSI B16.1 - Cast-Iron Pipe Flanges and Flanged Fittings.
   2. ANSI C111 - Rubber-Gasket Joints for Ductile-Iron and Gray-Iron Pressure Pipe and Fittings.
D. American Society for Testing and Materials (ASTM)
   1. ASTM A48 - Gray Iron Castings.
   2. ASTM A126 - Gray Iron Castings for Valves, Flanges and Pipe Fittings
   3. ASTM A153 - Zinc Coating (Hot-Dip) on Iron and Steel Hardware
   4. ASTM A276 - Standard Specification for Stainless and Heat Resisting Steel Bars and Shapes.
   5. ASTM A536 - Ductile Iron Castings.
E. Steel Structures Painting Council (SSPC)
   1. SSPC SP-6 - Commercial Blast Cleaning
F. Where reference is made to one (1) of the above standards, the revision in effect at the time of bid opening shall apply.

1.04 DELIVERY, STORAGE AND HANDLING

A. Deliver materials to the site to ensure uninterrupted progress of the work.
B. Protect threads and seats from corrosion and damage. Rising stems and exposed stem valves shall be coated with a protective oil film which shall be maintained until time of use.
C. Provide covers for all openings.
   1. All valves three (3) inches and larger shall be shipped and stored on site until time of use with wood or plywood covers on each valve end.
   2. All valves smaller than three (3) inches shall be shipped and stored as above except that heavy card board covers may be furnished instead of wood.
D. Store equipment to permit easy access for inspection and identification. Any corrosion in evidence at the time of Owner acceptance shall be removed, or the valve shall be removed from the job.
E. Store all equipment in covered storage off the ground.

1.05 COORDINATION

A. Review installation procedures under other Sections and coordinate with the work which is related to this Section including buried piping installation and site utilities.
B. Contractor shall coordinate the location and placement of concrete thrust blocks when required.

1.06 GENERAL

A. All valves shall open counter-clockwise.
B. The use of a Manufacturer's name and/or model or catalog number is for the purpose of establishing the standard of quality and general configuration desired.
C. Valves shall be of the size shown on the Plans or as noted, and as far as possible equipment of the same type shall be identical and from one Manufacturer.
D. Valves shall have the name of the maker, nominal size, flow directional arrows, working pressure for which they are designed and standard to which they are manufactured cast in raised letters on some appropriate part of the body.
E. Unless otherwise noted, valves shall have a minimum working pressure of 200 psi or be of the same working pressure as the pipe they connect to, whichever is higher, and suitable for the pressures noted where they are installed.
F. Valves shall be of the same nominal diameter as the pipe or fittings they are connected to. Except as otherwise noted, joints shall be mechanical joints, with joint restraint where the adjacent piping is required to be restrained.
G. Valves shall be constructed for buried service.

PART 2 – PRODUCTS

2.01 VALVE BOXES

A. All gate valves shall be provided with extension shafts (where the operating nut is greater than five (5) feet below grade), operating nuts and valve boxes as follows:
   1. Extension shafts shall be steel and the operating nut shall be two (2) inches square. Shafts shall be designed to provide a factor of safety of not less than four (4). Operating nuts shall be pinned to the shafts.
   2. Valve boxes shall be a heavy-pattern cast iron, three (3) piece, telescoping type box with dome base suitable for installation on the buried valves. Inside diameter shall be at least 5¼-inches. Barrel length shall be adapted to the depth of cover, with a lap of at least six (6) inches when in the most extended position. Covers shall be cast iron with integrally-cast direction-to-open arrow and "WATER" shall be cast in the cover when used on a water line or "SEWER" when used on a wastewater force main. Aluminum or plastic are not acceptable. A means of lateral support for the valve extension shafts shall be provided in the top portion of the valve box. The valve box lid shall be furnished with a pentagon-head bolt for locking.
   3. The upper section of each box shall have a bottom flange of sufficient bearing area to prevent settling. The bottom of the lower section shall enclose the stuffing box and operating nut of the valve and shall be oval.
   4. An approved operating key or wrench shall be provided.
   5. All fasteners shall be Type 304 stainless steel.

2.02 RESILIENT SEATED GATE VALVES

A. Valves shall be manufactured in accordance with AWWA C509. Acceptable Gate Valves are:
   1. American Flow Control – Series 2500
   2. Mueller – 2360 Series
   3. Clow
B. Valves shall be provided with a minimum of two (2) O-ring stem seals.
C. Bonnet and gland bolts and nuts shall be either fabricated from a low alloy-steel for corrosion resistance or electroplated with zinc or cadmium. The hot-dip process in accordance with ASTM A153 is not acceptable.

D. Wedges shall be totally encapsulated with rubber.

E. Units shall be, in addition, UL and FM approved.

F. Resilient wedge gate valves shall be furnished and installed in sizes and shall be manufactured in accordance with the latest AWWA C-509 and cast iron shall conform to the latest ASTM A-126 standards. Gate valves furnished under these specifications shall be of the solid wedge, resilient seat type with cast iron/ductile iron body and bronze stem designed for 250 pounds per square inch working pressure. All gate valves shall be tested hydrostatically to 400 pounds per square inch. Gate valves shall meet the latest AWWA standard specifications (C-509).

G. The seat shall be made of Styrene Butadiene rubber and provide a positive water tight seal. The seat shall be permanently bonded or mechanically attached to the wedge with stainless steel screws. If bonded, ASTM P-429 requirements shall be followed. Non-rising stem gate valves shall be equipped with “O” ring type packing gland consisting of at least two (2) “O” rings. The thrust collar shall work in an “O” ring seal lubricant reservoir or against bearings or washers, above and below constructed of Delrin or approved equal material. Gate valve stems, shall be fabricated from solid bronze rod having a tensile strength of not less than 60,000 pounds per square inch, and a minimum yield strength of 30,000 pounds per square inch.

H. Cast iron body shall be of iron with an even grain and shall possess a tensile strength of not less than 32,000 pounds per square inch. All bronze castings, except the stem, shall have a tensile strength of not less than 30,000 pounds per square inch. The entire internal valve body surfaces shall be coated with a factory applied two (2) component epoxy system or approved equal. The seating surface shall be machined or otherwise constructed to provide a smooth, even surface for the resilient seat. All valves shall open left (counter clockwise) and have a two (2) inch square wrench nut unless specified otherwise.

2.03 TAPPING SLEEVES AND TAPPING VALVES

A. Tapping sleeves shall be of cast iron epoxy coated, designated for working pressure not less than 200 psi. Armored end gaskets shall be provided for the full area of the sleeve flanges. Sleeves shall be as manufactured by A.P. Smith Division of U.S. Pipe, Mueller, Clow, or equal. Nuts and bolts shall be Type 304 stainless steel.

B. Size-on-Size tapping sleeve shall be ductile iron or cast iron.

C. Tapping valves shall conform to the requirements specified above for gate valves except that one (1) end shall be flanged and one (1) mechanical. Tapping valves shall be provided with an oversized opening to permit the use of full size cutters. Tapping valves shall be Ford B81-777 or equal.

2.04 CHECK VALVES

A. Controlled Closing Swing Check Valves (lever & weight)

1. Check valves shall be of the controlled closing swing type. The controlled closing swing check valves shall be guaranteed to operate under severe conditions as check valves. The valve shall be designed to open smoothly, provide full pipe line flow, permit minimum head loss and close at a controlled rate of speed for the final predetermined portion of its stroke. All bolts and nuts used in the assembly shall be steel, commercial.
2. The valve body shall be Cast Iron ASTM A126-B/ductile iron ASTM A536. The disc arm and chamber level shall be of heavy steel construction and keyed to the hinge shaft. The hinge shaft shall be of 18-8 stainless steel and of adequate diameter to withstand a complete hydraulic unbalance pressure of 125 psi on the valve disc. A single cushioning device mounted on the external side of the valve shall control the valve closure by way of the interchange of oil to and from an oil reservoir. The use of air or gas pressurized oil reservoir shall not be permitted. The oil plunger assembly shall be rigidly attached to the valve body by shoulder bolts or dowel pins to prevent fretting.
3. The Manufacturer, if required by the Engineer or the City, shall submit design calculations

of principle component stresses to substantiate the integrity of the valve for the working pressure involved.

4. The valve when closed shall be tight seating by way of a resilient replaceable seat against a bronze seat ring in the body.
5. Valves shall be as manufactured by GA Industries or Series 6000 as manufactured by APCO. The City reserves the right to inspect all valves before shipment is made. Any failure of valves to operate satisfactorily during the first year of installation due to faulty workmanship or defective material shall be replaced and made good by the Manufacturer. Under these specifications, any valve stuffing box that leaks for any reason or because of excessive wear or deterioration of packing, shall be reason for classification as defective material.

A. Slanted / Tilted Check Valves

1. Slanted or tilted check valves shall be furnished and installed where shown on the Plans.
2. The body of the valve shall be ductile iron or cast iron with access ports to the disc. The disc shall be cast iron. The seat and disc rings shall be bronze. Pivot pins and bushings shall be bronze or stainless steel. The valve shall include a localized indicator of the position of the valve.
3. The valves shall include a top mounted oil dash pot to prevent slamming of the disc. The dash pot shall control the last 10% of closure of the disc. The speed of closure within this 10% shall be adjustable.
4. Valves shall be APCO Slanting Disc, Valmatic or Golden Anderson Tilted Disc or approved equal.

2.05 FLANGES

A. A. Flanges shall be cast solid and faced accurately at right angles to the axis of the casting. Dimensions and drilling of flanges shall be in accordance with the American Standard Association for a working pressure of 125 pounds per square inch. Special drilling shall be provided where necessary.

2.06 FIRE HYDRANTS

A. Fire hydrants shall be dry-barrel type conforming to the requirements of the latest revision of AWWA C502. Hydrants shall be designed such that the hydrant valve closes with line pressure preventing loss of water and consequent flooding in the event of traffic damage.

B. Hydrants shall have six (6)-inch mechanical joint inlet connections, two 2½-inch hose connections and one 41/2-inch pumper connection. Threads for the hose and pumper connections shall be in accordance with National Standard Thread. Hydrants shall be according to Manufacturer's standard pattern. Hydrants shall be equipped with "O" ring packing. Each nozzle cap shall be provided with a Buna-N rubber washer.

C. Hydrants shall be so arranged that the direction of outlets may be turned 90 degrees without interference with the drip mechanism or obstructing the discharge from any outlet. The body of the hydrant shall be equipped with a breakable flange, or breakable cast iron flange bolts, just above the grade line.

D. A bronze or rustproof steel nut and check nut shall be provided to hold the main hydrant valve on its stem.

E. Hydrant valve opening shall have an area at least equal to that area of a 41/2-inch minimum diameter circle and be obstructed only by the valve rod. Each hydrant shall be able to deliver 500 gallons minimum through its two 2½-inch hose nozzles when opened together with a loss of not more than two (2) psi in the hydrant.

F. Hydrants shall be designed for installation in a trench that will provide minimum cover as noted on Plans and for the flange to be 3 ½-inches above ground surface. Hydrant extensions shall be as manufactured by the company furnishing the hydrants and of a style appropriate for the hydrants as furnished.

G. Hydrants shall be provided with an automatic and positively operating, non-corrodible drain or drip valve so as to drain the hydrant completely when the main valve is shut. A drain valve

operating by springs or gravity is not acceptable.

H. Operating stems whose threads are located in the barrel or waterway shall be of manganese bronze, everdur, or other high-quality non-corrodible metal, and all working parts in the waterway shall be bronze to bronze.
I. Hydrants shall open by turning operating nut to left (counter-clockwise) and shall be marked with a raised arrow and the word “open” to indicate the direction to turn stem to open hydrant.
J. Hydrants shall be furnished with caps, double galvanized steel hose cap chain, galvanized steel pumper hose cap chain, a galvanized steel chain holder and any other hooks and/or appurtenances required for proper use.
K. Hydrant operating nut shall be AWWA Standard pentagonal type measuring 1½-inch point to flat.
L. Hydrants shall be hydrostatically tested as specified in AWWA C502.
M. Hydrants Manufacturer and Type shall be per City requirements
N. All iron work to be set below ground, after being thoroughly cleaned, shall be painted with two (2) coats of asphalt varnish specified in AWWA C502. Iron work to be left above ground shall be factory primed and painted per City requirements using a high-grade enamel paint of quality and color to correspond to the present standard of the City.
O. Fire hydrants shall be installed on the same side of the street or roadway as the water main and shall be installed plumb and true.
P. Heel and thrust blocks shall be placed in undisturbed soil as shown in the details of the Plans.
Q. Double blue reflector “HYE – LITES” brand as manufactured by pavement markers ink shall be installed at the centerline of the street or roadway perpendicular to the hydrant.

2.07 CORPORATION STOPS

A. Corporation stops shall be brass, not less than 1-inch in diameter and shall be installed where shown, specified or required.
B. Provide corporation stops as manufactured by the following:
   1. Ford Company

2.08 COMBINATION AIR-VACUUM RELIEF VALVES

A. The air-vacuum release valves shall be installed as shown on the Plans. The valve body shall be of cast iron ASTM A126-B; the floats, float guide, and stem shall be of Type 316 stainless steel. The resilient seat shall be of Buna N. The valve shall be suitable for 150 psig working pressure. Valve shall have standard NPT inlets and outlet ports with diameters as indicated on the Plans. Valve shall be Model 200A Series by APCO Valve and Primer Corporation, Schaumburg, IL, or approved equal.

PART 3 – EXECUTION

3.01 SURFACE PREPARATION AND SHOP COATINGS

A. The interior ferrous metal surfaces, except finished or bearing surfaces, shall be blast cleaned in accordance with SSPC SP-6 and painted with two (2) coats of an approved two (2) component coal tar epoxy coating specifically formulated for potable water use. The coating used must appear on the current edition of the United States Environmental Protection Agency’s list entitled “Accepted Categories and Subcategories of Coatings, Liners and Paints for Potable Water Usage.”
B. Exterior ferrous metal surfaces of all buried valves and hydrants shall be blast cleaned in accordance with SSPC SP-6 and given two (2) shop coats of a heavy coat tar enamel or an approved two (2) component coat tar epoxy paint.

3.02 INSPECTION AND PREPARATION

A. During installation of all valves and appurtenances, the Contractor shall verify that all items are clean, free of defects in material and workmanship and function properly.
B. All valves shall be closed and kept closed until otherwise directed by the Engineer or the City.

3.03 INSTALLATION OF BURIED VALVES AND VALVE BOXES

A. Buried valves shall be cleaned and manually operated before installation. Buried valves and valve boxes shall be set with the stem vertically aligned in the center of the valve box. Valves shall be set on a firm foundation and supported by tamping pipe bedding material under the sides of the valve. The valve box shall be supported during backfilling and maintained in vertical alignment with the top flush with finish grade. The valve box shall be set so as not to transmit traffic loads to the valve.

B. Before backfilling, all exposed portions of any bolts shall be coated with two (2) coats of bituminous paint.

3.04 INSTALLATION OF TAPPING SLEEVES AND VALVES

A. Contact utility owner to coordinate and obtain permission prior to tapping a line. The required procedures and time table shall be followed exactly.

B. Installation shall be made under pressure and flow shall be maintained. The diameters of the tap shall be a minimum of ¼-inch less than the inside diameter of the branch line.

C. The entire operation shall be conducted by workers experienced in the installation of tapping sleeves and valves. The tapping machine shall be furnished by the Contractor.

D. Determine the location of the line to be tapped to confirm that the proposed location will be satisfactory and that no interference will be encountered such as joints or fittings. No tap or sleeve will be made closer than three (3) feet from a pipe joint.

E. A tapping sleeve and valve with boxes shall be set squarely centered on the line to be tapped. Adequate support shall be provided under the sleeve and valve during the tapping operation. Thrust blocks or other permanent restraint shall be provided behind all tapping sleeves. Proper tamping of supporting pipe bedding material around and under the valve and sleeve is mandatory for buried installations.

F. After completing the tap, the valve shall be flushed to ensure that the valve seat is clean. All proper regulatory procedures (including disinfection) shall be followed exactly.

3.05 INSTALLATION OF FIRE HYDRANTS

A. Fire hydrants shall be set at the locations as shown on the Plans and bedded on a firm foundation. Hydrants and connecting pipe shall have at least the same depth of cover as the distributing pipe. The hydrants shall be set upon a slab of concrete not less than four (4)-inches thick and 15-inches square. During backfilling, additional screened gravel shall be brought up around and six (6) inches over the drain port. Each hydrant shall be set in true vertical alignment and properly braced.

B. 2,500 psi concrete thrust blocks shall be placed between the back of the hydrant inlet and undisturbed soil at the end of the trench. Minimum bearing area shall be as shown on the Plans. Eight (8) mil. Polyethylene film shall be placed around the hydrant elbow before placing concrete. CARE SHALL BE TAKEN TO ENSURE THAT CONCRETE DOES NOT PLUG THE DRAIN PORTS.

C. All connections from the main to the fire hydrants shall be anchoring mechanical joints designed to prevent movement due to thrust or pressure.

D. The hydrant shall be tied to the pipe with suitable rods or clamps, and shall be coated with Koppers 300 or approved equal at a minimum of 8 mil. thick. Bolts shall have a zinc bolt cover per AWWA. Hydrant paint shall be touched up as required after installation.

E. Fire hydrants shall be factory primed and painted as required by City using a high-grade enamel.

3.06 FIELD TESTS AND ADJUSTMENTS

A. Conduct a functional field test of each valve, including actuators and valve control equipment, in presence of Engineer or the Representative of the City to demonstrate that each part and all components together function correctly. All testing equipment required shall be provided

by the Contractor at his/her sole expense.

END OF SECTION

SECTION 33 3112
WASTEWATER POLYVINYL CHLORIDE (PVC) PIPE AND FITTINGS

PART 1 – GENERAL

1.01 DESCRIPTION

A. This specification covers the requirements to install and test polyvinyl chloride (PVC) pipe and fittings, including excavation, sheeting, storing, dewatering, pipe laying, jointing, testing, backfilling, and any other work that is required or necessary to complete the installation as shown in the Plans as specified herein.

1.02 SUBMITTALS

A. Comply with pertinent provisions of Division 1.

B. The Contractor shall submit descriptive information and evidence that the materials and equipment the Contractor proposes for incorporation into the Work is of the kind and quality that satisfies the specified functions and quality.

1.03 REFERENCE STANDARDS

A. All PVC pipe and fittings shall be from a single Manufacturer. The Supplier shall be responsible for the provisions of all test requirements specified in ASTM D3034 or ASTM F789 as applicable.

B. Inspections of the pipe may also be made by the Engineer or other representatives of the City after delivery. The pipe shall be subject to rejection at any time on account of failure to meet any of the Specification requirements, even though sample pipes may have been accepted as satisfactory at the place of manufacture. Pipe rejected after delivery shall be marked for identification and shall be removed from the job at once.

PART 2 – PRODUCTS

2.01 POLYVINYL CHLORIDE (PVC) WASTEWATER PIPE AND FITTINGS

A. Pipe and fittings shall be Type PSM, PVC SDR 26 or 35, as indicated on the Drawings, with full diameter dimensions and shall conform to ASTM D3034, or Type PS-46 PVC conforming to ASTM F789, for sizes 4 through 15-inch and shall conform to ASTM F679 for sizes 18 through 27-inch. Straight pipe shall be furnished in lengths of not more than 13-feet and wyes shall be furnished in lengths of not more than three (3) feet. Saddle wyes will not be allowed.

B. PVC pipe and fittings shall have bell and spigot push-on joints. The bell shall consist of an integral wall section with a solid cross-section elastomeric gasket securely locked in place to prevent displacement during assembly. Elastomeric gaskets shall conform to ASTM F477.

C. All fittings and accessories shall have bell and/or spigot configurations compatible with the pipe.

D. Wastewater pipe joints across the fault line and inside of the influence zone, as marked on the design plans and as part of the Fault Study shall be Flex-Tend Flexible Expansion Joints by EBAA Iron or approved equal product.

PART 3 – EXECUTION

3.02 HANDLING AND CUTTING PIPE

A. Pipe and fittings are slightly brittle. Care shall be taken in shipping, handling and laying to avoid damaging the pipe and fittings. Extra care will be necessary during cold weather construction.

B. Any pipe or fitting showing a crack or which has received a blow that may have caused an incipient fracture, even though no such fracture can be seen, shall be marked as rejected and removed at once from the work.

C. All pipe ends shall be square after cutting.

D. While stored, pipe shall be adequately supported from below at not more than three (3) foot

intervals to prevent deformation. Pipe shall not be stacked higher than six (6) feet. Pipe and fittings shall be stored in a manner which will keep them at ambient outdoor temperatures and out of direct sunlight. Temporary shading as required to meet this requirement shall be provided. Simple covering of the pipe and fittings which allows temperature buildup when exposed to direct sunlight will not be permitted.

3.03 JOINTING POLYVINYL CHLORIDE (PVC) WASTEWATER PIPE AND FITTINGS

D. PVC wastewater pipe and fittings shall be jointed in accordance with the recommendations of the latest ASTM Standards and detailed instructions of the Manufacturer.

3.04 INSTALLATION OF POLYVINYL CHLORIDE (PVC) PIPE AND FITTINGS

A. No single piece of pipe shall be laid unless it is generally straight. The centerline of the pipe shall not deviate from a straight line drawn between the centers of the openings at the ends of the pipe by more than 1/16-inch per foot of length. If a piece of pipe fails to meet this requirement check for straightness, it shall be rejected and removed from the site. Laying instructions of the Manufacturer shall be explicitly followed.

B. Any pipe or fittings discovered to be defective after laying shall be removed and replaced with a sound piece.

C. The Engineer or the City may examine each bell and spigot end to determine whether any preformed joint has been damaged prior to installation. Any pipe having defective joint surfaces shall be rejected, marked as such, and immediately removed from the job site.

D. All pipe shall be sound and clean before laying. When laying is not in progress, including lunch time, the open ends of the pipe shall be closed by watertight plugs or other approved means.

E. Pipe and fittings shall be installed in accordance with the instructions of the Manufacturer, ASTM D2321 and as specified herein. As soon as the excavation is complete to normal grade of the bottom of the trench, bedding shall be placed, compacted and graded to provide firm, uniform and continuous support for the pipe. Bell holes shall be excavated so that only the barrel of the pipe bears upon the bedding. The pipe shall be laid accurately to the lines and grades indicated on the Plans. The specified embedment shall be accurately shaped and trimmed to receive the pipe barrel and each pipe section, when in place, shall have a uniform bearing on the subgrade for the full length of the pipe barrel. Pipe shall not be laid unless the subgrade is free of water and in a satisfactory condition. Adjustments of the pipe to line and grade shall be made by scraping away or filling in with granular material, and not by wedging or blocking up the bell. Blocking under the pipe will not be permitted. The bedding as shown in the details of the Plans shall be placed evenly on each side of the pipe to mid-diameter and hand tools shall be used to force the bedding under the haunches of the pipe and into the bell holes to give firm continuous support for the pipe. The bedding shall then be placed to 12-inches above the top of the pipe. The initial three (3) feet of backfill above the bedding backfill shall be placed in eight (8) inch layers and carefully compacted. Generally, the compaction shall be done evenly on each side of the pipe and compaction equipment shall not be operated directly over the pipe until sufficient backfill has been placed to ensure that such compaction equipment will not have a damaging effect on the pipe. Equipment used in compacting the initial three (3) feet of backfill shall be approved by the pipe Manufacturer's representative prior to use.

F. Joints shall not be "pulled" or "cramped". Each joint of pipe shall be completed in compliance with Manufacturer's recommendations.

G. Before any joint is made, the pipe shall be checked to assure that a close joint with the next adjoining pipe has been maintained and that the inverts are matched and conform to the required grade. The pipe shall not be driven down to grade by striking it.

H. Precautions shall be taken to prevent flotation of the pipe in the trench.

I. When moveable trench bracing such as trench boxes, moveable sheeting, shoring or plates are used to support the sides of the trench, care shall be taken in placing and moving the

boxes or supporting bracing to prevent movement of the pipe, or disturbance of the pipe bedding and the backfill. Trench boxes, moveable sheeting, shoring or plates shall not be allowed to extend below mid-diameter of the pipe. As trench boxes, moveable sheeting, shoring or plates are moved, screened material shall be placed to fill any voids created and the screened material and backfill shall be re-compacted to provide uniform side support for the pipe.

J. Pipe stubs for manhole connections shall not exceed 3.25-feet in length unless directed otherwise by the Engineer or the City. Install caps where required. When connecting to an existing manhole, the opening for the connection of the wastewater pipe and the manhole shall be cored using an approved coring machine to the dimensions and size required to install the flexible “SEAL BOOT” resilient connector that meets the requirements of ASTM C-923. The connection shall be watertight when complete.

K. Wastewater mains will be installed in straight trenches from manhole to manhole or manhole to cleanout. There will be no curvilinear installations of wastewater mains.

3.05 TESTING

A. Scope: After sewers and manholes have been installed and backfilled, subject newly laid gravity lines and manholes to a leakage test. Contractor to furnish all labor, materials, tools and equipment to test lines. Take such precautions as required to prevent damage to lines and appurtenances being tested. Repair any damage resulting from test at Contractor’s expense. If required, conduct test in presence of Engineer or designated City Representative.

B. Test Procedures for Leakage Test of Gravity Sewer: Contractor, at his option, may test lines by hydrostatic or low pressure air test as specified below. However, the Engineer may direct a specific test be performed in specified areas of the Project.

C. Exfiltration Test (for Gravity Sewer)

1. Preparation: Seal ends of line section being tested with water tight plugs, equipped with pipe riser inserted and braced in the inlet of the manholes. Fill section with water 24-hours prior to start of test. Fill slowly from downstream manhole in test section so that no air is trapped in the line. Leave outlets of stacks and service lines exposed and unplugged until after exfiltration test has been made. Outlets terminating below level of test water surface to be temporarily extended upward by installing additional lengths of pipe. After completion of satisfactory test, remove lengths of pipe added for test.
2. Duration of Test: Test for 24-hours. Minimum head of either two (2) feet measured above the crown, inside pipe at upper end of section or four (4) feet measured above trench water table, whichever is higher, so that a net positive of two (2) feet is used for testing.
3. Allowable Leakage: Allowable leakage or exfiltration in any individual section under construction shall not exceed 25 gallons per inch of inside diameter per mile of pipe per 24 hours.

D. Low Pressure Air Test of Plastic Gravity Flow Wastewater Lines

1. General:
   Wastewater lines, at the discretion of the ENGINEER, shall be air tested between manholes. Backfilling to grade shall be completed before the test and all laterals and stubs shall be capped or plugged by the Contractor so as not to allow air losses, which could cause an erroneous, test result. Manholes shall be plugged so they are isolated from the pipe and cannot be included in the test.

   All plugs used to close the sewer for the air test shall be capable of resisting the internal pressures and must be securely braced. Place all air testing equipment above ground and allow no one to enter a manhole or trench where a plugged sewer is under pressure.
   Release all pressure before the plugs are removed. The testing equipment used must include a pressure relief device designed to relieve pressure in the sewer under test at 10 psi or less and must allow continuous monitoring of the test pressures in order to avoid excessive pressure. Use care to avoid the flooding of the air inlet by infiltrated ground water. (Inject the air at the upper plug if possible.) Use only qualified personnel to conduct

the test.

2. Ground Water
   Since the presence of ground water will affect the test results, test holes shall be dug to the pipe zone at intervals of not more than 100 feet and the average height of ground water above the pipe (if any) shall be determined before starting the test.
3. Test Procedure
   The ENGINEER may, at any time, require a calibration check of the instrumentation used. Use a pressure gauge having minimum divisions of 0.10 psi and an accuracy of 0.0625 psi. (One ounce per square inch.) All air used shall pass through a single control panel.
   Clean the sewer to be tested and remove all debris where indicated. Wet the sewer prior to testing. The average back pressure of any groundwater shall be determined (0.433 psi) for each foot of average water depth (if any) above the sewer.

   Add air slowly to the section of sewer being tested until the internal air pressure is raised to 4.0 psig greater than the average back pressure of any ground water that may submerge the pipe. After the internal test pressure is reached, allow at least 2 minutes for the air temperature to stabilize, adding only the amount of air required to maintain pressure. After the temperature stabilization period, disconnect the air supply. Determine and record the time in seconds that is required for the internal air pressure to drop from 3.5 psig to 2.5 psig greater than the average backpressure of any ground water that may submerge the pipe. Compare the time recorded with the specification time for the size and length of pipe as given in the following table:

Table for Low Pressure Air Testing of Plastic Pipe:

Minimum Specified Time Required For 1.0 psig Pressure Drop for Size and Length of Pipe Indicated								
Diameter of Pipe, (in.)	Specification Time (min: sec) for length shown							
	100 ft	150 ft	200 ft	250 ft	300 ft	350 ft	400 ft	450 ft
4	3:46	3:46	3:46	3:46	3:46	3:46	3:46	3:46
6	5:40	5:40	5:40	5:40	5:40	5:40	5:42	6:24
8	7:34	7:34	7:34	7:34	7:36	8:52	10:08	11:24
10	9:26	9:26	9:26	9:53	11:52	13:51	15:49	17:48
12	11:20	11:20	11:24	14:15	17:05	19:56	22:47	25:38
15	14:10	14:10	17:48	22:15	26:42	31:09	35:36	40:04
18	17:00	19:13	25:38	32:03	38:27	44:52	51:16	57:41
21	19:50	26:10	34:54	43:37	52:21	61:00	69:48	78:31
24	22:47	34:11	45:34	56:58	68:22	79:46	91:10	102:33
27	28:51	43:16	57:41	72:07	86:32	100:57	115:22	129:48
30	35:37	53:25	71:13	89:02	106:50	124:38	142:26	160:15
33	43:05	64:38	86:10	107:43	129:16	150:43	172:21	193:53
36	51:17	76:55	102:34	128:12	153:50	179:29	205:07	230:46

NOTES: 1. Specification times are as given in UNI-B-6 RECOMMENDED PRACTICE FOR LOW- PRESSURE TESTING OF INSTALLED PIPE -- by Uni-Bell PVC Pipe Association, 2655 Villa Creek Dr., Ste. 155, Dallas Texas 75234.

Any drop in pressure, from 3.5 psig to 2.5 psig (adjusted for groundwater level), in a time less than that required by the above table shall be cause for rejection. When the line tested includes more than one size pipe, the minimum time shall be that given for the largest size pipe included.

E. Deflection Testing
   1. Deflection tests shall be performed on all flexible pipes. For pipes with inside diameters less than 27-inches, a rigid mandrel shall be used to measure deflection. The test shall be conducted after final backfill has been in place at least 30 days in the presence of a representative of the City's Utilities Department. No pipe shall exceed a deflection of five percent (5%). If a pipe should fail to pass the deflection test, the problem shall be corrected and a second test shall be conducted after the final backfill has been in place an additional 30 days. Test shall be performed without mechanical pulling devices.
   2. Mandrel Sizing: The rigid mandrel shall have an outside diameter (O.D.) equal to 95% of the inside diameter (I.D.) of the pipe. The inside diameter of the pipe, for the purpose of determining the outside diameter of the mandrel, shall be the average outside diameter of the pipe minus two minimum wall thickness for O.D. controlled pipe and the average inside diameter for the I.D. Controlled pipe, all dimensions shall be per appropriate standard. Statistical or other "tolerance packages" shall not be considered in mandrel sizing.
   3. Mandrel Design: The rigid mandrel shall be constructed of a metal or rigid plastic material that can withstand 200 psi without being deformed. The mandrel shall have nine or more "runners" or "legs" as long as the total number of legs is an odd number. The barrel section of the mandrel shall have a length of at least 75% of the inside diameter of the pipe. A proving ring shall be provided and used for each size mandrel in use.

F. Repairs of Lines:
   Remove and replace or make approved corrective repairs to any section of line or manhole which has leakage that exceeds above amounts. Repair any individual leaks that may appear whether or not overall section meets leakage requirements. Individual leaks will ordinarily be revealed by looking through sewer with a light while groundwater level is over sewer, during water tamping operations or immediately after water leakage is emptied from sewer.

G. Retest:
   Sewers and/or manholes failing to meet requirements of leakage test will, after repair by Contractor, be tested again for leakage. No sewer or manhole will be accepted until leakage is less than allowable amount.

H. Video Inspection
   1. The use of a television camera for inspection prior to placing the sewer in service will be performed if required by the Owner. Video inspection is at the cost of the Contractor, and copies of the videotapes will be presented to the City prior to final acceptance. One (1) copy of the videotapes shall be submitted to the City.
   2. Post construction video of the gravity wastewater lines will be evaluated on a case-by-case basis for acceptance. Preparation for videotaping of wastewater line shall be as follows:
      a. Flush and clean the gravity wastewater line prior to videotaping.
      b. The videotape shall display the station, in accordance with the Plans and Standards, and counter on the screen. Manhole numbers and stations shall correspond to the contract documents.
      c. If debris is evident in the line during the video, the line will be flushed and cleaned to allow a clean video.
      d. All manholes will be identified at the beginning and end of the video corresponding to contract documents with upstream and downstream ends identified.

END OF SECTION

SECTION 33 3913
WASTEWATER CONCRETE MANHOLES

PART 1 – GENERAL

1.01 DESCRIPTION

A. This specification covers the requirements to install precast concrete manholes, frames and covers, and appurtenances as shown on the Plans and as specified herein.

1.02 SUBMITTALS

A. Comply with pertinent provisions of Division 1.
B. The Contractor shall submit descriptive information and evidence that the materials and equipment the Contractor proposes for incorporation into the Work is of the kind and quality that satisfies the specified functions and quality.

1.03 REFERENCE STANDARDS

A. American Society for Testing and Materials (ASTM)
   1. ASTM A48 - Specification for Gray Iron Castings.
   2. ASTM A615 - Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.
   3. ASTM C33 - Specification for Concrete Aggregates.
   4. ASTM C150 - Standard Specification for Portland Cement.
   5. ASTM C478 - Standard Specification for Precast Reinforced Concrete Manhole Sections.
   6. ASTM D4101 - Specification for Propylene Plastic Injection and Extrusion Materials.
B. American Concrete Institute (ACI)
   1. ACI 318 - Building Code Requirements for Reinforced Concrete.
   2. ACI 350R - Concrete Sanitary Engineering Structures.
C. American Association of State Highway and Transportation Officials (AASHTO)
   1. Standard Specifications for Highway, Streets and Bridges.
D. Occupational Safety and Health Administration (OSHA)
E. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.04 QUALITY ASSURANCE

A. All material shall be new and unused.
B. Materials' quality, manufacturing process and finished sections are subject to inspection and approval by Engineer or other City representative.
C. Materials will be examined for compliance with ASTM specifications, these Specifications and approved Manufacturer's drawings. Additional inspection criteria shall include: appearance, dimensions(s), blisters, cracks and soundness.
D. Materials shall be rejected for failure to meet any Specification requirement. Mark for identification rejected materials and remove from work site immediately. Rejected materials shall be replaced at no cost to Owner.
E. Repair minor damage to precast concrete sections by approved method, if repair is authorized by Engineer or the City.

PART 2 – PRODUCTS

2.01 GENERAL

A. Reference to a Manufacturer's name and model or catalog number is for the purpose of establishing the standard of quality and general configuration desired.
B. Like items of materials/equipment shall be the end products of one Manufacturer in order to provide standardization for appearance, operation, maintenance, spare parts and Manufacturer's service.
C. Provide lifting lugs or holes in each precast section for proper handling.

2.02 PRECAST CONCRETE MANHOLE SECTIONS

A. Precast concrete base sections, riser sections, transition top sections, flat slab tops and grade rings shall conform to ASTM C478 and meet the following requirements:
   1. Bottom slab thickness shall be 12-inches.
   2. Base, riser and transition top sections shall have tongue and groove joints.
   3. Sections shall be cured by an approved method.
   4. Precast concrete sections shall be shipped after concrete has attained 3,000 psi compressive strength.
   5. Design precast concrete base, riser, transition top, flat slab top and grade ring for a minimum HS-20 loading plus earth load. Calculate earth load with a unit weight of 130 pounds per cubic foot.
   6. Mark date of manufacture, name and trademark of Manufacturer on the inside of each precast section.
   7. Construct and install precast concrete base as shown on the Plans.
   8. Provide integrally cast knock-out panels in precast concrete manhole sections at locations, and with sizes shown on Plans. Knock-out panels shall have no steel reinforcing.

B. Manhole diameter shall be as shown on the Plans, but not less than the diameter of the largest connecting pipe plus two (2) feet.

C. Pipe Sections:
   1. Pipe sections shall conform to current specifications for Precast Reinforced Manhole Sections, ASTM Designation C478.
   2. Minimum wall thickness for the manhole risers shall be as listed under Wall “B” in the “Class Tables” of ASTM C76 for Class III pipe.

D. Joints
   1. Joints shall conform to the joint specifications in ASTM C478, C76, and ASTM C443. All manhole sections, including the bottom section, shall be furnished with “O-ring” type rubber gasket joints. The joints shall be furnished and installed with the bell down to resist groundwater infiltration. All joints shall be sealed with mortar or an approved non-shrink grout on the inside and the outside of the manhole. Grade rings shall be mortared to each other and on the inside and outside to provide a waterproof seal.

E. Manhole Steps
   1. Unless specifically approved by the City, manhole steps shall not be provided.

2.03 MANHOLE FRAME AND COVER

A. Manhole frames and covers shall be of good quality, strong, tough, even grained cast iron, smooth, free from scale, lumps, blisters, sand holes and defects of any kind which render them unfit for the service for which they are intended. Manhole covers and frame seats shall be machined to a true surface. Castings shall be thoroughly cleaned and subject to hammer inspection. Cast iron shall conform to ASTM A48, Class 30.

B. Manhole covers shall have a diamond pattern, pickholes and the word SEWER as appropriate cast in three (3) inch letters. Manhole frame and covers shall be Neenah Foundry, Western Iron Works, Vulcan Foundry, or equal.

2.04 JOINTING PRECAST MANHOLE SECTIONS

A. Seal tongue and groove joints of precast manhole sections with rubber “O”-ring gasket. O-ring gasket shall conform to ASTM C443.

B. Completed joint shall withstand 15 psi internal water pressure without leakage or displacement of gasket or sealant.

2.05 PIPE CONNECTIONS TO MANHOLE

A. Connect pipe to manhole in the following ways:

1. Flexible sleeve - Integrally cast sleeve in precast manhole section or install sleeve in a formed or cored opening. Fasten pipe in sleeve with stainless steel clamp(s). Coat stainless steel clamp(s) with bituminous material to protect from corrosion. Flexible sleeve shall be Lock Joint Flexible Manhole Sleeve; Kor-N-Seal connector; PSX Press-Seal Gasket or equal.
2. Compression gasket - Integrally cast compression gasket in precast manhole section. Insert pipe into compression gasket. Compression gasket shall be A-Lok, or equal.

PART 3 – EXECUTION

3.01 MANHOLE INSTALLATION

A. Manholes shall be constructed to the dimensions shown on the Plans and as specified herein. Protect all work against flooding and flotation.
B. Place manhole base on a bed of screened gravel eight (8) inches in depth as shown on the Plans. Set manhole base so that a maximum grade adjustment of eight (8) inches is required to bring the manhole frame and cover to final grade. Use precast concrete grade rings to adjust manhole frame and cover to final grade.
C. Set precast concrete barrel sections plumb with a ¼-inch maximum out of plumb tolerance allowed. Seal joints of precast barrel sections with either a rubber “O” ring set in a recess or preformed flexible joint sealant in sufficient quantity to fill 75 percent of the joint cavity. Fill the outside and inside joint with non-shrink mortar and finished flush with the adjoining surfaces. Caulk the inside of any leaking barrel section joint with non-shrink grout.
D. Allow joints to set for 14 hours before backfilling unless a shorter period is specifically approved by the Engineer or the City.
E. Plug holes in the concrete barrel sections required for handling with a non-shrinking grout or non- shrinking grout in combination with concrete plugs. Finish flush on the inside.
F. Core holes in precast sections to accommodate pipes prior to setting manhole sections in place to prevent jarring which may loosen the mortar joints.
G. Backfill carefully and evenly around manhole sections.

3.02 MANHOLE PIPE CONNECTIONS

A. Construct manhole pipe connections, including pipe stubs, as specified above. Close or seal pipe stubs for future connections with a gasketed watertight plug.

3.03 SETTING MANHOLE FRAME AND COVER

A. Set manhole covers and frames in a full mortar bed. Utilize precast concrete grade rings, a maximum of eight (8) inches thick, to assure frame and cover are set to the finished grade. Set manhole frame and cover to final grade prior to placement of permanent paving.

3.04 MANHOLE TESTING

A. If required, Contractor shall schedule testing such that Engineer or the City’s representative can observe each test.

B. Test Procedures for Hydrostatic Test for Manholes
1. Manholes shall be tested for leakage separately and independently of the wastewater lines by vacuum testing, or other methods acceptable to the Engineer. If a manhole fails a leakage test, the manhole must be made water tight and retested. The maximum leakage for hydrostatic testing shall be 0.025 gallon per vertical foot per hour. Alternative test methods must ensure compliance with the above allowable leakage. Hydrostatic exfiltration testing shall be performed as follows: all wastewater lines coming into the manhole shall be sealed with an internal pipe plug, then the manhole shall be filled with water and maintained full for at least one (1) hour. For concrete manholes, a wetting period of 24-hours may be used prior to testing in order to allow saturation of the concrete.

C. Test Procedures for Vacuum Testing Manholes

1. Where groundwater is present, manholes shall be tested by vacuum. Manholes testing by vacuum shall be performed by the Contractor in compliance with these specifications.
2. Manholes shall be tested after installation of all connections (existing and/or proposed) in place. All lift holes shall be plugged with an approved non-shrink grout and all drop connections and gas sealing connections shall be installed prior to testing. The lines entering the manhole shall be temporarily plugged with the plugs braced to prevent them from being drawn into the manhole. The plugs shall be installed in the lines beyond the drop- connections, gas sealing connections, etc. The test head shall be placed inside the frame at the top of the manhole and inflated in accordance with the manufacturer's recommendations. A vacuum of 10-inches of mercury shall be drawn, and the vacuum pump shall be turned off. With the valve closed, the level of vacuum shall be read after the required test time. If the drop in the level is less than one (1) inch of mercury (final vacuum of nine (9) inches of mercury), the manhole will have passed the vacuum test. The required test time shall be 90- seconds.
3. Manholes which have a final vacuum of nine (9) inches of mercury after the time indicated will be accepted. If there has been no pressure loss during the first 75-seconds the test may be stopped and the manhole will be accepted. Any manhole which fails the vacuum test as described above shall be repaired with an approved non-shrink grout or other material acceptable to the Engineer and the City based on the material from which the manhole is constructed. The manhole shall be retested as described above until a successful test is made.

3.05 CLEANING

A. Thoroughly clean all new manholes of all silt, debris and foreign matter of any kind, prior to final inspections.

END OF SECTION

SECTION 33 4100
STORM UTILITY DRAINAGE PIPING

PART 1 - GENERAL

1.01 SUMMARY

A. This Section includes gravity-flow, nonpressure storm drainage outside the building, with the following components:
   1. Site storm sewer drainage piping, fittings, accessories, and bedding.
   2. Catch basins, paved area drains, site surface drains and stormwater detention facilities.
   3. Connection of building storm water drainage system.
   4. Precast concrete, Cast-in-place concrete manholes.

B. All public work to be performed and materials to be used within the street right-of-way, shall be in accordance with the City of Conroe Design Standards. In the event of a discrepancy between the above-referenced standards, the plans, and/or any portion of this specification section, the order of precedence will be the plans, the City Design Standards, and then these specifications. The Contractor shall contact the engineer in the event of a discrepancy.

1.02 DEFINITIONS

A. PVC: Polyvinyl chloride plastic.
B. HDPE: High density polyethylene.
C. RCP: Reinforced concrete pipe

1.03 PERFORMANCE REQUIREMENTS

A. Gravity-Flow, Non-pressure, Drainage-Piping Pressure Rating: 10-foot head of water (30 kPa). Pipe joints shall be at least silttight, unless otherwise indicated.

1.04 SUBMITTALS

A. Product Data: For the following:
   1. Pipe materials, fittings, and accessories.
   2. Drains.

B. Shop Drawings: For the following:
   1. Manholes: Include plans, elevations, sections, details, and frames and covers. Catch Basins and Stormwater Inlets. Include plans, elevations, sections, details, and frames, covers, and grates.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Do not store plastic manholes, pipe, and fittings in direct sunlight.
B. Protect pipe, pipe fittings, and seals from dirt and damage.
C. Handle manholes according to manufacturer's written rigging instructions.
D. Handle catch basins and stormwater inlets according to manufacturer's written rigging instructions.

1.06 PROJECT CONDITIONS

A. Interruption of Existing Storm Drainage Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:
   1. Notify Engineer and Owner no fewer than two days in advance of proposed interruption of service.

PART 2 – PRODUCTS

2.01

PVC PIPE AND FITTINGS

A. PVC Sewer Pipe and Fittings; NPS 6” to 12” ASTM D 3034, SDR 26, with bell-and-spigot ends for gasketed joints with ASTM F 477, elastomeric seals.

2.02 CONCRETE PIPE AND FITTINGS

A. Reinforced-Concrete Sewer Pipe and Fittings: ASTM C 76 (ASTM C 76M), with groove and tongue ends and gasketed joints with ASTM C 443 (ASTM C 443M), rubber gaskets.
   1. Class III, Wall B.

2.03 HDPE PIPE AND FITTINGS

A. Pipe shall have a smooth interior and exterior corrugations.
   1. 4-through 10-inch (100 to 250 mm) shall meet AASHTO M252m, Type S.
   2. 12- through 60-inch (300 to 1500 mm) shall meet AASHTO M294, Type S or ASTM F2306.

B. Pipe shall be joined with joints meeting the requirements of AASHTO M252, AASHTO M294, or ASTM F2306.

C. 4-through 60-inch (100 to 1500mm) shall be watertight according to the requirements of ASTM D3212. Gaskets shall be made of polyisoprene meeting the requirements of ASTM F477. Gaskets shall be installed by the pipe manufacturer and covered with a removable, protective wrap to ensure the gasket is free from debris. A joint lubricant available from the manufacturer shall be used on the gasket and bell during assembly.

D. 12- through 60-inch (300 to 1500 mm) diameters shall have a reinforced bell with a bell tolerance device. The bell tolerance shall be installed by the manufacturer.

E. Fittings shall conform to AASHTO M252, AASHTO M294, or ASTM F2306.

F. To assure watertightness, field performance verification may be accomplished by testing in accordance with ASTM C969. Appropriate safety precautions must be used when field-testing any pipe material.

G. Installation shall be in accordance with ASTM D2321 and manufacturer’s published installation guidelines, with the exception that minimum cover in trafficked areas for 4- through 48-inch (100 to 1200 mm) diameters shall be one foot. (0.3 m) and for 60-inch (1500 mm) diameters, the minimum cover shall be 2 ft. (0.6 m) in single run applications.

2.04 NONPRESSURE-TYPE PIPE COUPLINGS

A. Comply with ASTM C 1173, elastomeric, sleeve-type, reducing or transition coupling, for joining underground nonpressure piping. Include ends of same sizes as piping to be joined, and corrosion-resistant-metal tension band and tightening mechanism on each end.

B. Sleeve Materials:
   1. For Concrete Pipes: ASTM C 443 (ASTM C 443M), rubber.
   2. For Cast-Iron Soil Pipes: ASTM C 564, rubber.
   3. For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.
   4. For Dissimilar Pipes: ASTM D 5926, PVC, or other material compatible with pipe materials being joined.

2.05 CLEANOUTS AND PLUGS

A. Installation shall be in accordance with the details and at locations shown on the drawings.

B. All cleanouts shall have a 2’ x 2’ x 6” thick concrete apron.

2.06 MANHOLES

A. Standard Precast Concrete Manholes: ASTM C 478 (ASTM C 478M), precast, reinforced concrete, of depth indicated, with provision for sealant joints.

1. Diameter: 48 inches (1200 mm) minimum, unless otherwise indicated.
2. Ballast: Increase thickness of precast concrete sections or add concrete to base section, as required to prevent flotation.
3. Base Section: 6-inch (150-mm) minimum thickness for floor slab and 4-inch (102-mm) minimum thickness for walls and base riser section and having separate base slab or base section with integral floor.
4. Riser Sections: 4-inch (102-mm) minimum thickness, and lengths to provide depth indicated.
5. Top Section: Eccentric-cone type unless concentric-cone or flat-slab-top type is indicated. Top of cone of size that matches grade rings.
6. Joint Sealant: ASTM C 990 (ASTM C 990M), bitumen or butyl rubber.
7. Steps: Individual FRP steps or FRP ladder, wide enough to allow worker to place both feet on 1 step and designed to prevent lateral slippage off of step. Cast or anchor steps into sidewalls at 12- to 16-inch (300- to 400-mm) intervals. Omit steps if total depth from floor of manhole to finished grade is less than 60 inches (1500 mm).
8. Grade Rings: Reinforced-concrete rings, 6- to 9-inch (150- to 225-mm) total thickness, to match diameter of manhole frame and cover.
9. Manhole Frames and Covers: Ferrous; 28-inch ID by 7- to 9-inch (175- to 225-mm) riser with 4-inch- (102-mm-) minimum width flange and 30-inch-diameter cover. Include indented top design with lettering cast into cover, using wording equivalent to "STORM SEWER."
    a. Material: ASTM A 536, Grade 60-40-18 ductile iron, unless otherwise indicated.

B. Cast-in-Place Concrete Manholes: Construct of reinforced-concrete bottom, walls, and top; designed according to ASTM C 890 for A-16 (ASSHTO HS20-44), heavy-traffic, structural loading; of depth, shape, dimensions, and appurtenances indicated.
1. Ballast: Increase thickness of concrete, as required to prevent flotation.
2. Resilient Pipe Connectors: ASTM C 923 (ASTM C 923M), cast or fitted into manhole walls, for each pipe connection.
3. Steps: Individual FRP steps or FRP ladder, wide enough to allow worker to place both feet on 1 step and designed to prevent lateral slippage off of step. Cast or anchor steps into sidewalls at 12- to 16-inch (300- to 400-mm) intervals. Omit steps if total depth from floor of manhole to finished grade is less than 60 inches (1500 mm).
4. Adjusting Rings: Interlocking rings with level or sloped edge in thickness and diameter matching manhole frame and cover. Include sealant recommended by ring manufacturer.
5. Grade Rings: Reinforced-concrete rings, 6- to 9-inch (150- to 225-mm) total thickness, to match diameter of manhole frame and cover.
6. Manhole Frames and Covers: Ferrous; 28-inch ID by 7- to 9-inch (175- to 225-mm) riser with 4-inch- (102-mm-) minimum width flange and 30-inch-diameter cover. Include indented top design with lettering cast into cover, using wording equivalent to "STORM SEWER."
    a. Material: ASTM A 536, Grade 60-40-18 ductile iron, unless otherwise indicated.
    b. Protective Coating: Foundry-applied, SSPC-Paint 16, coal-tar, epoxy-polyamide paint; 10-mil (0.26-mm) minimum thickness applied to all surfaces, unless otherwise indicated.

2.07 CONCRETE

A. General: Cast-in-place concrete according to ACI 318/318R, ACI 350R, and the following:
1. Cement: ASTM C 150, Type II.
2. Fine Aggregate: ASTM C 33, sand.
3. Coarse Aggregate: ASTM C 33, crushed gravel.

4. Water: Potable.

B. Portland Cement Design Mix: 4000 psi (27.6 MPa) minimum, with 0.45 maximum water-cementitious materials ratio.
   1. Reinforcement Fabric: ASTM A 185, steel, welded wire fabric, plain.
   2. Reinforcement Bars: ASTM A 615/A 615M, Grade 60 (420 MPa), deformed steel.

C. Ballast and Pipe Supports: Portland cement design mix, 3000 psi (20.7 MPa) minimum, with 0.58 maximum water-cementitious materials ratio.
   1. Reinforcement Fabric: ASTM A 185, steel, welded wire fabric, plain.
   2. Reinforcement Bars: ASTM A 615/A 615M, Grade 60 (420 MPa), deformed steel.

2.08 CATCH BASINS

A. Installation shall be in accordance with the details and at locations shown on the drawings.

2.09 STORMWATER INLETS

A. Curb Inlets: Made with vertical curb opening, of materials and dimensions according to the details and at locations shown on plans.

B. Frames and Grates: Heavy-duty frames and grates according to the details and at locations shown on plans.

PART 3 – EXECUTION

3.01 EARTHWORK

A. Excavation, trenching, and backfilling are specified in Division 31 Section "Earth Moving."

3.02 PIPING APPLICATIONS

A. Pipe couplings and special pipe fittings with pressure ratings at least equal to piping rating may be used in applications below, unless otherwise indicated.
   1. Use nonpressure-type flexible couplings where required to join gravity-flow, nonpressure sewer piping, unless otherwise indicated.
      a. Unshielded flexible couplings for same or minor difference OD pipes.
      b. Unshielded, increaser/reducer-pattern, flexible or rigid couplings for pipes with different OD.
      c. Ring-type flexible couplings for piping of different sizes where annular space between smaller piping's OD and larger piping's ID permits installation.

B. Special Pipe Fittings: Use for pipe expansion and deflection. Pipe couplings and special pipe fittings with pressure ratings at least equal to piping rating may be used in applications below, unless otherwise indicated.

C. Gravity-Flow, Nonpressure Sewer Piping: As shown on plans.

3.03 PIPING INSTALLATION

A. General Locations and Arrangements: Drawing plans and details indicate general location and arrangement of underground storm drainage piping. Location and arrangement of piping layout take design considerations into account. Install piping as indicated, to extent practical. Where specific installation is not indicated, follow piping manufacturer's written instructions.

B. Install piping beginning at low point, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements.

C. Install manholes for changes in direction unless fittings are indicated. Use fittings for branch connections unless direct tap into existing sewer is indicated.

D. Install proper size increasers, reducers, and couplings where different sizes or materials of pipes and fittings are connected. Reducing size of piping in direction of flow is prohibited.
E. Tunneling: Install pipe under streets or other obstructions that cannot be disturbed by tunneling, jacking, or a combination of both.
F. Install gravity-flow, nonpressure drainage piping according to the following:
   1. Install piping NPS 6 (DN 150) and larger with restrained joints at tee fittings and at changes in direction. Use corrosion-resistant rods, pipe or fitting manufacturer's proprietary restraint system, or cast-in-place concrete supports or anchors.
   2. Install piping with 36-inch (915-mm) minimum cover.
   3. Install PVC sewer piping according to ASTM D 2321 and ASTM F 1668.
   4. Install reinforced-concrete sewer piping according to ASTM C 1479 and ACPA's "Concrete Pipe Installation Manual."
      a. Install HDPE pipe according to ASTM D2321.

3.04 PIPE JOINT CONSTRUCTION

A. Where specific joint construction is not indicated, follow piping manufacturer's written instructions.
B. Join gravity-flow, nonpressure drainage piping according to the following:
   1. Join PVC sewer piping according to ASTM D 2321 and ASTM D 3034 for elastomeric-seal joints or ASTM D 3034 for elastomeric gasket joints.
   2. Join reinforced-concrete sewer piping according to ACPA's "Concrete Pipe Installation Manual" for rubber-gasket joints.
   3. Join dissimilar pipe materials with nonpressure-type flexible or rigid couplings.
C. Join dissimilar pipe materials with pressure-type couplings.

3.05 CLEANOUT INSTALLATION

A. Install cleanouts and riser extension from sewer pipe to cleanout at grade. Use cast-iron soil pipe fittings in sewer pipes at branches for cleanouts and cast-iron soil pipe for riser extensions to cleanouts. Install piping so cleanouts open in direction of flow in sewer pipe.
   1. Use heavy-duty, top-loading classification cleanouts in vehicle-traffic service areas.
   2. Use extra-heavy-duty, top-loading classification cleanouts in fire lane areas.
B. Set cleanout frames and covers in earth in cast-in-place concrete block, 24 by 24 by 6 inches deep. Set with tops 1 inch (25 mm) above surrounding earth grade.
C. Set cleanout frames and covers in concrete pavement with tops flush with pavement surface.

3.06 DRAIN INSTALLATION

A. Install type of drains in locations indicated.
   1. Use heavy-duty, top-loading classification drains in vehicle-traffic service areas.
   2. Use extra-heavy-duty, top-loading classification drains in roads areas.
B. Embed drains in 4-inch (102-mm) minimum depth of concrete around bottom and sides.
C. Fasten grates to drains if indicated.
D. Set drain frames and covers with tops flush with pavement surface.
E. Assemble trench sections with flanged joints.
F. Embed trench sections in 4-inch (102-mm) minimum concrete around bottom and sides.

3.07 MANHOLE INSTALLATION

A. General: Install manholes, complete with appurtenances and accessories indicated.
B. Install precast concrete manhole sections according to ASTM C 891.
C. Construct cast-in-place manholes as indicated.

3.08 CATCH BASIN INSTALLATION

A. Construct catch basins to sizes and shapes indicated.
B. Set frames and grates to elevations indicated.

3.09 STORMWATER INLET AND OUTLET INSTALLATION

A. Construct inlet head walls, aprons, and sides of reinforced concrete, as indicated.
B. Install outlets that spill onto grade, anchored with concrete, where indicated.
C. Install outlets that spill onto grade, with flared end sections that match pipe, where indicated.
D. Construct energy dissipaters at outlets, as indicated.

3.10 CONCRETE PLACEMENT

A. Place cast-in-place concrete according to ACI 318/318R.

3.11 FIELD QUALITY CONTROL

A. Inspect interior of piping to determine whether line displacement or other damage has occurred. Inspect after approximately 24 inches (610 mm) of backfill is in place, and again at completion of Project.
   1. Submit separate reports for each system inspection.
   2. Defects requiring correction include the following:
      a. Alignment: Less than full diameter of inside of pipe is visible between structures.
      b. Deflection: Flexible piping with deflection that prevents passage of ball or cylinder of size not less than 92.5 percent of piping diameter.
      c. Crushed, broken, cracked, or otherwise damaged piping.
      d. Infiltration: Water leakage into piping.
      e. Exfiltration: Water leakage from or around piping.
   3. Replace defective piping using new materials, and repeat inspections until defects are within allowances specified.
   4. Reinspect and repeat procedure until results are satisfactory.
B. Test new piping systems, and parts of existing systems that have been altered, extended, or repaired, for leaks and defects.
   1. Do not enclose, cover, or put into service before inspection and approval.
   2. Test completed piping systems according to authorities having jurisdiction.
   3. Schedule tests and inspections by authorities having jurisdiction with at least 24 hours' advance notice.
   4. Submit separate report for each test.
C. Replace leaking piping using new materials, and repeat testing until leakage is within allowances specified.

3.12 CLEANING

A. Clean interior of piping of dirt and superfluous materials. Flush with potable water.

END OF SECTION

Huckabee MORE THAN ARCHITECTS