

2. Space panels 1/8-inch at edges and ends.
 3. Utilize framing clips along long edges.
- B. Fastening: As indicated and as follows:
1. Roof Sheathing:
 - a. Install with the grain of the outer plies or long dimension at right angles to framing supports.
 1. Stagger end joints and locate over the centerlines of supports.
 2. Allow 1/8-inch spacing at panel ends and 1/4-inch at panel edges.
 3. Utilize Panel Edge Clips along long edges of sheathing, between framing members.
 - b. Nail or Screw to framing.
 1. Nailing:
 - a. Nail panels with 8-penny common nails or 4-penny annular rings or screw-type nails spaced 6 inches O.C. at supported edges and 12 inches O.C. at intermediate bearings.
 - b. Set nails no less than 3/8 inches from edges.
 2. Screwing:
 - a. Where framing is metal trusses: Use appropriate screw type spaced as specified above for nails.
 3. Do not use staples in roof sheathing.
 - c. Where the support spacing exceeds the maximum span for an unsupported edge, provide adequate blocking, tongue-and-groove edges, or panel edge clips, in accordance with APA E30.

3.05 PROTECTION – ENGINEERED PANEL PRODUCTS

- A. Protect installed sheathings from moisture damage.
1. Replace panels that show warped or swelling.

END OF SECTION

SECTION 07190

VAPOR BARRIER

PART 1 - GENERAL

1.01 THE REQUIREMENT

- A. The Contractor shall furnish and install a vapor barrier to be placed under all reinforced concrete placed against soil as specified herein or shown on the Drawings.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 03300 - Cast-in-Place Concrete

PART 2 - PRODUCTS

2.01 VAPOR BARRIER

- A. Vapor Barrier: A reinforced laminate membrane with a minimum tensile strength of 75 lbs/in. in accordance with ASTM D-882, vapor transmission rating of 0.02 perms in accordance with E-9, and a puncture resistance of 25 lbs in accordance with ASTM D 4833.
- B. Adhesive/Tape: Type approved by the Manufacturer of the vapor material.
- C. Penetration sealing: Provide manufacturer's recommended penetration seals at all pipe, conduit, and similar penetrations.

2.02 ACCEPTABLE MANUFACTURERS

- A. Subject to compliance with the Specifications, provide products from one of the following manufacturers:
 1. Viper Vapercheck 10 by Insulation Solutions, Inc.
 2. Griffon Tape-85, by Reef Industries, Inc.
 3. Or Equal

PART 3 - EXECUTION

3.01 VAPOR BARRIER

- A. Vapor barrier shall be placed on top of 4 inches minimum of compacted structural fill stone, free of debris and protrusions, as shown on the Drawings for structural slabs.
- B. Lap edges 12 inches and seal with adhesive tape. Lap with seams perpendicular to and lapped in the direction of placement. Do not penetrate vapor barrier.

- C. Protect from damage until concrete is placed. Punctures and tears in vapor barrier shall be repaired using patches of the material which overlaps puncture or tear a minimum of 12 inches seal with tape or adhesive.
- D. Penetrations through vapor barrier, such as pipe, drains, conduits and similar penetrations, shall be sealed in strict accordance with manufacturer's recommended instructions.

END OF SECTION

SECTION 07210
THERMAL INSULATION

PART 1 - GENERAL

1.01 SUMMARY

- A. Furnish labor, materials, tools, equipment, and services for Building Insulation in accordance with provisions of Contract Documents.
- B. Section 01 81 13. Completely coordinate with work of other trades.

1.02 REFERENCES

A. Referenced Standards:

- 1. ASTM International [ASTM]
 - a. C518 Standard Test Method for Steady-State Thermal Transmission Properties [Heat Flow Meter Apparatus].
 - b. C553 Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.
 - c. C825 Standard Specification for Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing.
 - d. C1104/C1104M Standard Test Method for Determining the Water Vapor Sorption of Unfaced Mineral Fiber Insulation.
 - e. D99 Standard Test Method for Coefficient of Linear Thermal Expansion of Plastics Between -30 deg C and 30 deg C with a Vitreous Silica Dilatometer.
 - f. E84 Standard Test Method for Surface Burning Characteristics of Building Materials.
 - g. E90 Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements.
 - h. E91/E91M Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials.
 - i. E119 Standard Test Methods for Fire Tests of Building Construction and Materials.
 - j. E136 Standard Test Method for Assessing Combustibility of Materials Using a Vertical Tube Furnace at 750 deg C
 - k. E105/E105M Standard Test Methods for Thickness and Density of Sprayed Fire-Resistive Material [SFRM] Applied to Structural Members.
- 2. National Fire Protection Association [NFPA]:

- a. NFPA 288 Standard Test Method for Determining Ignitability of Exterior Wall Assemblies Using a Radiant Heat Energy Source
- NFPA 285 Standard Fire Test Method for Evaluation of Fire Propagation Characteristics of Exterior Wall Assemblies Containing Combustible Components

1.03 SUBMITTALS

A. Action Submittals:

1. Product Data: Manufacturers' product data sheets, details and installation instructions including components and accessories, indicating product complies with specifications.

B. Informational Submittals:

1. Evaluation Reports: For foam-plastic insulation, from ICC-ES.

1.04 QUALITY ASSURANCE

- A. Surface-Burning Characteristics: As determined □ testing identical products according to ASTM E 84 □ a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Protect insulation materials from physical damage and from deterioration due to moisture, soiling, and other sources. Store inside and in a dry location. Comply with manufacturer's written instructions for handling, storing, and protecting during installation.
- B. Protect foam-plastic board insulation as follows:
 1. Do not expose to sunlight except to necessary extent for period of installation and concealment.
 2. Protect against ignition at all times. Do not deliver foam-plastic board materials to Project site before installation time.
 3. Quickly complete installation and concealment of foam-plastic board insulation in each area of construction.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Mineral Fiber Insulation:

1. Base:
 - a. Thermafiber, Inc., an Owens Corning company
2. Optional:

- a. Rockwool.
- Johns Manville.
- c. Knauf.

B. Fiberglass Batt Insulation:

- 1. Base:
 - a. Owens-Corning.
- 2. Optional:
 - a. CertainTeed
 - Johns Manville.
 - c. Knauf Insulation.

C. Other Materials:

- 1. Base:
 - a. As indicated.

D. Other manufacturers desiring approval comply with Section 01010.

2.02 SECTION 01 81 13.MATERIALS

A. Mineral Fiber Insulation:

- 1. Unfaced, non-combustible, water repellent, semi-rigid fiber insulation board.
- 2. Temperature Resistance: Per ASTM C112.
 - a. Over 2000 deg F.
- 3. Surface Burning Characteristics per ASTM E84.
 - a. Flame Spread: 0.
 - Smoke Developed: 0.
- 4. Moisture Resistance: Absorbs less 0.03 percent volume, per ASTM C1104.
- 5. R-value: 4.2 per inch.
 - Density 4.5 pcf.
- 7. Non-corrosive per ASTM C115.
- 8. Thickness: As noted in drawings.
- 9. Base Product: Thermafiber RainBarrier 45 Insulation.
- 10. Mechanical fasteners including clips/pins:

- a. Pronged hangers and slotted washers or arrow pointed hangers.
 - Size pins to fit insulation thickness.
 - c. Base Product: GEMCO as manufactured □□ Goodloe E. Moore.
 - 1□ Gemco pronged hanger with pronged washer.
11. Mastic for use with mechanical fasteners:
- a. Base Product: As approved □□ fastener manufacturer.

B. Unfaced Fiberglass Batt Insulation

- 1. Inorganic fibers and resinous binders formed into flexible blankets or semi-rigid sheets.
- 2. Un-faced, Type I in accordance with ASTM C155.
- 3. Minimum Surface Burning Characteristics per ASTM E84: Flame Spread: Less than 25□Smoke Developed: Less than 50.
- 4. Combustion characteristics: Noncombustible□unfaced per ASTM E136.
- 5. Manufactured without urea-formaldehyde binders.
- Nominal Thickness / Thermal Resistance Value, measured at 75 deg F:
 - a. Nominal Thickness: □-1/2 inches / R-19.
 - Nominal Thickness: 3-5/8 inches / R-13.
 - c. Nominal Thickness: 8-1/4 inches / R-25.
 - d. Nominal Thickness: 10-1/4 inches / R-30.
 - e. Nominal Thickness: 13 inches / R-38.
- 7. Minimum 25 percent total recovered material content per EPA/CPG guidelines.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Verify suitability of substrate to accept installation.
- B. Installation indicates acceptance of responsibility for performance.

3.02 INSTALLATION

- A. General:
 - 1. Insulate full thickness over surfaces to be insulated.
 - 2. Fit tightly around obstructions, fill voids.

3. Cover penetrations with insulation.
 4. Comply with manufacturer's instructions for installation unless more stringent requirements are specified.
 5. Consult manufacturer's technical representative if installation instructions are not applicable.
 - Where rigid insulation is indicated over 2 inches thick, apply in double layer with staggered joints to achieve total thickness.
 7. Do not use broken or torn pieces of insulation.
 8. Provide minimum cover of 5/8 inches type □ gypsum wallboard or approved ignition carrier over exposed foam surfaces.
- B. Un-Faced Batt Insulation and Vapor Retarder in Exterior Stud Wall Systems:
1. Installing Batts:
 - a. Friction fit un-faced batts between studs.
 - Tight cut ends.
 - c. Where specified thickness of batts is less than the depth of framing, install retaining devices to prevent sagging.

3.03 PROTECTION

- A. Protect installed insulation from damage due to harmful weather exposures, physical abuse, and other causes. Provide temporary coverings or enclosures where insulation is subject to abuse and cannot be concealed and protected by permanent construction immediately after installation.

END OF SECTION

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SECTION 07301

ROOFING UNDERLAMENT, HIGH-TEMPERATURE

Grace Ice & Water Shield HT Grace Ice & Water Shield HT designed for use in demanding high temperature HT applications where temperature resistance up to 200F is required. Excludes applications in high altitudes where copper, zinc or Cor-Ten roof coverings will be used.

PART 1 - GENERAL

1.01 SUMMARY

- A. This Section specifies a self-adhering sheet membrane used as underlayment for sloped roofs.
 - 1. High temperature application, 200F resistance, Grace Ice & Water Shield HT.
- B. Related Sections: Refer to the following specification sections for coordination:
 - 1. Section 051000 - Rough Carpentry
 - 2. Section 07320 - Roof Tiles.
- C. Referenced Standards Comply with the requirements of the following standards published by ASTM International to the extent referenced in this section.
 - 1. ASTM D412 - Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers - Tension.
 - 2. ASTM D411 - Standard Test Methods for Felt.
 - 3. ASTM D 903 - Standard Test Method for Peel or Stripping Strength of Adhesive Bonds.
 - 4. ASTM D1970 - Standard Specification for Self-Adhering Polymer Modified Bituminous Sheet Materials Used as Steep Roofing Underlayment for Ice Dam Protection.
 - 5. ASTM D3777 - Standard Practice for Rubber—Measurement of Dimensions.
 - 6. ASTM E911 - Standard Test Methods for Water Vapor Transmission of Materials.
 - 7. ASTM G90 – EMMAqua test.

1.02 SUBMITTALS

- A. Product Data: Submit manufacturer's product data and installation instructions.

1.03 QUALITY ASSURANCE

- A. Regulator Requirements: Comply with requirements of authorities having jurisdiction and applicable codes at the location of the project.
- B. Manufacturer: Minimum 10 years experience producing roofing underlayment.
- C. Installer: Minimum 2 years experience with installation of similar underlayment.

1.04 DELIVERY, STORAGE AND HANDLING

- A. Deliver materials and products in unopened factory sealed packages. Protect from damage.
- B. Cover materials and store in dry condition between temperatures of 40 and 90 degrees F (5 and 32 degrees C). Use within one year of date of manufacture. Do not store at elevated temperatures as that will reduce the shelf life of the product.

PART 2 - PRODUCTS

2.01 MANUFACTURER

- A. Manufacturer: GCP Applied Technologies, Inc., 2 Whittemore Avenue, Cambridge, MA 02140, Toll Free 800-333-3720, www.gcpat.com.

2.02 MATERIALS

- A. Self-Adhering Sheet Membrane Roof Underlayment: Provide Grace Ice and Water Shield HT by GCP Applied Technologies, Inc with the following characteristics:
 1. Material: Cold applied, self adhering membrane composed of an innovative and proprietary rubberized asphalt adhesive and interwound with a disposable release sheet. An embossed, slip resistant surface is provided on the high performance film with UV barrier properties.
 2. Membrane Thickness: 40 mils (1.02 mm) per ASTM D3707 Method A.
 3. Membrane Tensile Strength: MD 33 lbf/in, CD 31 lbf/inch per ASTM D412 Die C Modified.
 4. Membrane Elongation: 250% per ASTM D412 Die C Modified.
 5. Low Temperature Flexibility: Unaffected at -20 degrees F (-29 degrees C) per ASTM D1970.
 6. Adhesion to Plywood: 5.0 lbf/in. width (87 N/m) per ASTM D903.
 7. Maximum Permeance: 0.05 perms (2.9 ng/sqms Pa) per ASTM E911.
 8. Maximum Material Weight Installed: 0.22 pounds/sqft (1.1 kg/sq m) per ASTM D4011.
 9. Service Temperature: 200 degrees F (115.6 degrees C) per ASTM D1204
 10. Compatibility: Suitable for use under all types of sloped roofing with the exception high altitude climates where zinc, copper or Cor-Ten roof coverings are used.
 11. Adhesive: Rubberized asphalt adhesive containing post-consumer recycled content, contains no calcium carbonate, sand or fill ash.
 12. Exposure: Can be left exposed for a maximum of 120 days from date of installation per ASTM G90 – EMMA Qua test.
 13. Primer: Water-based Perm-A-Barrier WB Primer by GCP Applied Technologies, Inc.
 14. Code and Standards Compliance: Grace Ice and Water Shield HT meets the following requirements:

- a. ASTM D1970.
- ICC-ES ESR-3121, per AC 48 Acceptance Criteria for Roof Underlaments used in Severe Climate Areas.
- c. Underwriters Laboratories Inc. R13399 - Class A fire classification under fire-glass shingles and Class C under organic felt shingles per ASTM E108/UL 790
- d. Underwriters Laboratories Inc. Classified Sheathing Material Fire Resistance Classification with Roof Designs: P225, P227, P230, P237, P259, P508, P510, P512, P514, P701, P711, P717, P722, P723, P732, P734, P73□, P742, P803, P814, P818, P824
- e. Miami-Dade County Code Report NOA □15-0728.11
- f. Florida State Approval Report No. FL289-R3
- g. CCMC Approval No. 13□71-L

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Prior to start of installation, inspect existing conditions to ensure surfaces are suitable for installation of roofing underlayment. Verify flashing has been installed. Starting work indicates installers acceptance of existing conditions.

3.02 INSTALLATION

- A. Installation: Install roofing underlayment on sloped surfaces at locations indicated on the Drawings, but not less than at hips, ridges, eaves, valleys, sidewalls and chimneys, and surfaces over interior space within 3□ inches [914 mm] from the inside face of the exterior wall. Strictly comply with manufacturer's installation instructions including but not limited to the following:
 - 1. Schedule installation such that underlayment is covered □□ roofing within the published exposure limit of the underlayment.
 - 2. Do not install underlayment on wet or frozen substrates.
 - 3. Install when surface temperature of substrate is a minimum of 40 degrees F [5 degrees C] and rising.
 - 4. Remove dust, dirt, loose materials and protrusions from deck surface.
 - 5. Install membrane on clean, dry, continuous structural deck. Fill voids and damaged or unsupported areas prior to installation.
 - Prime concrete and masonry surfaces using specified primer at a rate of 500-□00 square feet per gallon [12-15 sqm/L] Priming is not required for other suitable clean and dry surfaces.
 - 7. Install membrane such that all laps shed water. Work from the low point to the high point of the roof at all times. Apply the membrane in valleys before the membrane is applied to the eaves. Following placement along the eaves, continue application of the membrane up the roof. Membrane may be installed either vertically or horizontally after the first horizontal course.

8. Side laps minimum 3-1/2 inches (89 mm) and end laps minimum 1 1/2 inches (38 mm) following lap lines marked on underlayment.
9. Patch penetrations and damage using manufacturer's recommended methods.

3.03 CLEANING AND PROTECTION

- A. Protection: Protect from damage during construction operations and installation of roofing materials. Promptly repair any damaged or deteriorated surfaces.
- B. Repair minor damage to eliminate all evidence of repair. Remove and replace work which cannot be satisfactorily repaired in the opinion of the Architect.
- C. Provide temporary protection to ensure work being without damage or deterioration at time of final acceptance. Remove protective film and reclean as necessary immediately before final acceptance.

END OF SECTION

SECTION 07320

BARREL STYLE METAL TILE

PART 1 - GENERAL

1.01 SECTION INCLUDES:

- A. Metal Barrel Tile facsimile roofing panels.
- B. Roof trim, flashing, and other accessories required providing a complete and weather tight roofing system.

1.02 RELATED SECTIONS:

To include and/or coordinate with related work specified elsewhere:

- A. Section 05140 – Structural Aluminum
- B. Section 07220 – Roof Insulation
- C. Section 07301 – Roofing Underlayment High Temperature
- D. Section 07000 – Flashing and Roofing Accessories
- E. Section 07920 – Sealants and Caulking

1.03 REFERENCES:

- A. ASTM A53/A53M – Standard Specification for Steel Sheet, Zinc-Coated Galvanized or Zinc-Iron Alloy-Coated Galvannealed the Hot-Dip Process.
- B. ASTM A755/A755M – Standard Specification for Steel Sheet, Metallic Coated the Hot-Dip Process and Pre-painted the Coil Coating Process for Exterior Exposed Building Products.
- C. ASCE 7-98 – Minimum Design Loads for Buildings and Other Structures American Society of Civil Engineers.
- D. Miami-Dade County Protocol TAS 301 for Laboratory tests and test reports.

1.04 PERFORMANCE REQUIREMENTS

- A. Panel system shall be designed to safely resist the positive and negative loads as specified.
- B. Design and size components to withstand load caused by wind pressures as specified in ASCE 7-98 per S.F.B.C.
- C. Tested in accordance with Miami-Dade Protocol TAS 301.
 - 1. Accelerated Testing of coating 2,000 hours per ASTM G23.
 - 2. Salt Spray Testing of coating 1,000 hours per ASTM B117.

3. Fire Testing per ASTM E108 or UL790. (Not required if system is assembled with an approved fire carrier.)
 4. Uplift Resistance Test per TAS 125. (UL 580 Class 90 or higher. The permanent deformation area, at any location, shall not exceed the area of a 1" diameter circle.)
 5. Wind Driven Rain Test per TAS 100. (If system is to include a valve assembly and/or horizontal joints, the valve assembly and/or two horizontal joints shall be incorporated in TAS 100 test.)
- D. System Movement – Accommodate movements due to thermal expansion and contraction, dynamic loading, and deflection of structural support system without damage to panel system or loss of weatherproofing capability
- E. Fabricate panels in full length with no end laps when panel lengths are 30'-0 or less. The use of end laps shall be acceptable for length's greater than 30'-0. Manufacturer's details for end lap conditions shall be strictly adhered to.
- F. All panels shall be fastened to the framing members or substrate in accordance with manufacturer instructions.
- G. Roof panels, fasteners, closures, flashings, and all accessories shall be the product of a single manufacturer.
- H. All trim and flashings components shall be fabricated in lengths of 10'-0" to minimize joint details. Allowance for thermal expansion and contraction of trim and flashing components shall be incorporated in their design.
- I. Drainage – Provide positive drainage to exterior to prevent moisture from entering building enclosure or condensation occurring within exterior building envelope.

1.05 SUBMITTALS

- A. Submit under provisions of Section 0130, "Submittals".
- B. Manufacturer's Certifications: Certified statement that the manufacture has a minimum of seven (7) years experience in the roll forming process of metal panel systems.
- C. Product Data: Manufacturer's current product specifications and installation instructions.
- D. Test Reports: Submit the following test reports, certified by an independent testing laboratory or independent professional engineer, to verify that the proposed materials will meet the performance criteria of the specification.
 1. Fastener pull-out test and calculations.
 2. Coating quality
- E. Shop Drawings: Prior to fabrication, contractor is to submit drawings showing a small-scale roof plan and/or elevations, as required. Show details of trim and flashing conditions, fastening and anchoring methods, weatherproofing techniques,

terminations, and penetrations of metal roofing work. Panel installation shall not start until drawing approval by architects.

- F. Selection Samples: Submit samples of the following: metal panel, fasteners, closures, sealant and actual metal chips with full range of colors (minimum of twenty available for Architect's selection).
- G. Verification Samples: Submit two samples of each type of metal panel required, not less than 12-inches, and illustrating finished panel profile, color, gloss, and texture.
- H. Upon bid proposal contractor is to provide qualifications and/or exceptions to the drawings and specifications.
- I. Contract Closeout Submission: Coordinate with Section 01700. Submit specified warranties, maintenance instructions, and other closeout submissions pertaining to this section.

1.0 QUALITY ASSURANCE

- A. All panels are to be factory formed and packaged as per manufacturer's requirements.
- B. Specification is based upon the products of Florida Metal Roofing Products, Inc. No other manufacturer of metal panel systems shall be accepted as an alternate product.
- C. Manufacturer Qualifications: Minimum of 7 years of experience in factory fabrication and roll forming of metal panels.
- D. Installer Qualifications: Company specializing in the type of work required for this project, with not less than 2 years of documented experience applying this type of panel system with successful completion of projects of similar scope.
- E. Pre-installation Meeting: Convene meeting between panel installer, general contractor, and architect not less than one week prior to beginning installation to review the following: acceptable substrates, materials, colors, gauges, changes in scope of work, etc.
- F. Regulator Requirement: All local building code requirements are to be followed for both design and installation of metal panel system.
- G. Field Measurements: The installer must obtain actual project field verifications to ensure dimensional correctness. These verifications must be performed prior to providing the manufacturer with a bill of material.
- H. Source Quality Control: Provide actual test criteria and/or calculations where applicable pertinent to design criteria within project specifications.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Comply with provisions of Section 0100.
- B. Order materials based on field measurements, not on construction drawings.
- C. Package panels at factory.

- D. Installer shall coordinate with general contractor as to scheduled delivery time after receipt of field verified bill of material from manufacturer as it related to actual project scheduling.
- E. Delivery of materials shall be made only when suitable facilities for storage and protection are made available.
- F. Upon receipt of delivery of metal panel system and prior to signing the delivery ticket, the installer is to examine each shipment for damage and for completion of the consignment.
- G. Protect materials from damage during transit and at storage facility or project site.
- H. Store in a dry environment to prevent water damage from the elements and condensation. Store panels to allow for positive drainage in the event that materials are exposed to moisture.
- I. Do not expose panels and/or flashings with stripable protective film to direct sunlight or extreme heat.
- Do not allow storage of other trade materials or staging of other work on finished product.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Design is based on products manufactured by Florida Metal Roofing Products, Inc., 1225 Hill Avenue, Mangonia Park, FL 33407. Phone 561-833-FMRP 377 and Fax 561-833-375. Miami-Dade County NOA 1-0125.09
- B. Provide panels, fasteners, closures, flashings, and accessories supplied by a single manufacturer.
- C. Substitutions: No substitutions are to be accepted.

2.02 PANEL SYSTEM

- A. Roof Panel Systems: Provide factory formed metal panel systems with all necessary components to ensure a weather tight installation, including but not limited to ridges, hips, valleys, eaves, rakes, corners, and miscellaneous flashings.
- B. Materials: Florida Metal's Barrel Style Metal Tile Panel
 1. Gauge: 24 Gauge (.025" min.) G90 Galvanized Steel
 2. Panel Width: 44-inches with a 40-inch coverage
 3. Panel Length: Panel length as indicated on drawings
 4. Tile Configuration: 2-1/2-inch high barrel style with a 5/8-inch step located between 12-inches and 14-inches.

5. Texture: Smooth or Embossed

- Finish: Kynar 500/Hylar 5000 □30 Gloss□

2.03 MATERIALS

- A. Pre-coated Galvanized Steel Sheet: ASTM A 755/A 755M□ASTM A □53/A □53M, Structural □ualit□Grade 33/230, G90 Coating Designation, pre-coated with Kynar 500®/Hylar 5000®finish.
- B. Aluminum Sheet: ASTM B 209, minimum □ield strength 17,000 psi □17 Mpa□ Pre-finish as specified under panel t□pe.
- C. Fluoropolymer Coating: Provide multi-coat PVDF Kynar 500® or Hylar 5000®finish s□stem on e□posed metal surfaces.
 - 1. The pre-finished coating s□stem fluoropolymer Kynar 500® or Hylar 5000® must reflect the following performance characteristics in accordance with ASTM procedures:
 - a. Dr□Film Thickness □Nominal□ ASTM D-1400-87, D-1005-84 □990□Edd□ current device or micrometer – consists of 0.2 □/-0.05 mil primer on □oth sides with a 0.8 □/-0.1 mil 70□ Kynar 500®or 70□ Hylar 5000®topcoat.
 - Gloss: ASTM D-523-89 at □0□- Standard shall have a gloss of 30.
 - c. Pencil Hardness: ASTM D-33□3-92a Eagle Tur□oise Drafting Lead HB minimum.
 - d. Forma□ilit□T-Bend: ASTM D-4145-90 No cracking or tape removal of film at 1-T □end □aluminum□2-T □end □coated steel□
 - e. Forma□ilit□Mandrel: ASTM D-522-93a 180° bend around a 1/8" mandrel – No cracking or loss of adhesion.
 - f. Adhesion: ASTM D-3359-93 Rev. impacted 1/16" crosshatch – No adhesion loss.
 - g. Reverse Impact: ASTM D-2794-93 Impact in in./l□ □ 1.5 □ metal thickness in inches □aluminum□or 3 □ metal thickness in inches □coated steel□– No cracking or loss of adhesion.
 - h. Abrasion Resistance, Falling Sand Test: ASTM D-9□8-93 Liters to expose 5/32" of su□strate – □7 liters □/- 10 liters.
 - i. Acid Pollutants Resistance Test: ASTM D-1308 Procedure 7.2 □Independent of Su□strate□ 10□ Hydrochloric Acid 24 hour – No visi□e change, 20□ Hydrochloric Acid 18 hour – No visi□e change, 20□ Sulfuric Acid 18 hour – No visi□e change, 25□ Sodium Hydro□ide 1 hour – No visi□e change, 20□ Muriatic Acid 15 minutes – No visi□e change.

- Humidity Test: ASTM D-2247-92 100% Relative Humidity at 90°F – Passes 3,000 hours □ aluminum □ with no blisters □ passes 2,000 hours □ coated steel □ with no blisters.
 - k. Salt Spray Test: ASTM B-117 1,000 hours –
 - l. Aluminum – Scribe: 10 – No Creepage, Field: 10 No Blisters
 - m. Coated Steel – Scribe: 7 – 1/16" Blisters, Field: 10 – No Blisters.
 - n. Accelerated Weathering: ASTM G-23 2,000 hours, Chalk: □8, Color: 2ΔE
2. The exterior color of 70% Fluoropolymer Finish shall be chosen from manufacturer's standard colors.

2.04 ACCESSORIES

- A. Provide formed accessories of same gauge and finish as the primary panel system, unless otherwise indicated on the drawings, compliant with specified requirements.
- B. All flashing components shall be fabricated in a minimum of 10'-0" lengths.
- C. Sealants:
 - 1. As specified in Section 07920.
 - 2. Apply sealant where necessary to complete a weather tight roof system.
 - 3. Consult manufacturer for sealant recommendations.
- D. Fasteners: As recommended □ manufacturer for project conditions and panel type.

2.05 FABRICATION

- A. Panels shall be factory fabricated.
- B. Fabricate panels up to 30'-0 long in one piece without transverse seams. Panels over 30'-0 may be fabricated with seams; use manufacturer's standard end lap details.
- C. Factory – fabricate trim and flashing components in minimum 10'-0" lengths, with allowance for thermal movement in joint design □ unless project site conditions prohibit such.
- D. Clips and related accessory items to be supplied □ panel manufacturer as a single source responsibility.
- E. Form all components true to shape, accurate in size, square, free from distortion or defects. Cut panels to precise lengths indicated on approved shop drawings.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Inspect substrates to verify that they are in proper condition, spaced correctly, plumb, and are ready to receive panels and accessories.
 - 1. Notify the architect in writing if substrates are not suitable for application of panel system.
 - 2. Do not proceed with installation until substrates are acceptable.
- B. Verify actual dimensions in field prior to ordering material.

3.02 INSTALLATION

- A. Install metal panels and accessories in strict accordance with manufacturer's instructions, shop drawings, and applicable building codes.
- B. Protect surfaces from coming in contact with cementitious materials and dissimilar metals with a neutral coating such as titanium paint.
- C. Fasten panels to structural supports as per manufacturer's recommendations.
- D. Entire system shall be installed plumb, level, and true to line.
- E. Full interlock or overlap panels dependent upon panel design with adjacent panels apply sealant as recommended by panel manufacturer to achieve weather tight installation.
- F. Roll formed panels designed for eave to ridge installation should be installed with no transverse seams.
- G. Workmanship complies with standards established by the Architectural Sheet Metal Community.
- H. Care should be taken during handling of panels to prevent bending, twisting, abrasion, scratching, denting, etc.
- I. Do not allow shavings, metal dust, or chips to fall on panels.

3.03 ADJUSTING AND CLEANING

- A. Remove all protective masking from material immediately after installation.
- B. Touch up only minor abrasions with matching paint provided by panel manufacturer. Remove and replace panels that cannot be satisfactorily touched up.
- C. Sweep and remove chips, shavings, and dust from roof on a daily basis during installation period. Leave installed work clean, free of grease, finger marks and stains.
- D. Upon completion of installation, remove scraps and debris from project site.

3.04 PROTECTION

- A. Provide protection as required to assure that completed work of this section will be without damage or deterioration at date of substantial completion.
- B. Protect work area as required to protect from damage to other trades.
- C. Safety clothing, equipment, and precaution must be utilized according to safety standards.

END OF SECTION

SECTION 0700

FLASHING AND ROOFING ACCESSORIES

PART 1 - GENERAL

1.01 THE REQUIREMENT

- A. The Contractor shall furnish and install roofing sheet metal work and related items necessary for a complete installation, as indicated on the Drawings and specified herein, including, but not limited to the following: base flashings, pitch pans, scuppers, and other sheet metal work in conjunction with roof drainage pipe and stack flashings, and similar items where furnished by equipment suppliers; flashings for ducts, exhaust piping, equipment piping, conduit, etc., penetrating roofing that may be required.

1.02 SUBMITTALS

- A. Submit shop drawings and samples for review in accordance with Section 01300 entitled "Submittals". Provide sizes, shapes, thicknesses and types of materials, finishes, fabrication details, anchors, connections and expansion joints in relation to adjacent work.
- B. Submit a 12-inch square sample of wall flashing, angle clamping bar and other metal work specified. Deliver samples to a field location as directed by the Engineer.

1.03 APPLICABLE STANDARDS

- A. Except as otherwise shown or specified, comply with applicable manual of SMACNA Sheet Metal and A/C Contractors National Association.
- B. Except as otherwise shown or specified, comply with the recommendations and instructions of the manufacturer of the sheet metal being installed.
- C. All materials and installation shall conform to or exceed the requirement of all local codes.

1.04 GUARANTEE

- A. The roofing guarantee specified in Section entitled "Built-Up Bituminous Roofing" shall cover flashings and accessories specified in this section. The flashing and edge details shall be as required by the roofing manufacturer to satisfy conditions of the guarantee. The details shown on the Drawings are intended to provide minimum standards required for the guarantee.
- B. All roofing accessories, including flashing, fasteners, roof vents, curb details and other miscellaneous metals and accessories required for the installation shall be supplied by the roofing manufacturer or from other sources acceptable to the manufacturer selected for the installation so that the system guarantee will include all edges, penetrations and other details of the installation.

PART 2 - PRODUCTS

2.01 FLASHING

- A. Flashing shall be 0.040-inch aluminum, minimum. The system shall be Presto Lock Facia System or Johns Manville, or equal.
- B. Coping system shall be Presto Lock coping System or Johns Manville, or equal.

2.02 CANT STRIPS

- A. Cant Strips shall be Fes-Cant Plus Cant Strip or Johns Manville or equal. Strips shall be a high density, laminated board made of high strength fibers and expanded perlites.

2.03 ROOF VENTS

- A. Roof vents shall be provided for all roofing applications. One vent per 1000 square feet of applications shall be provided. One vent per 1000 square feet of roofing area shall be provided. The vents roofing area shall be provided. The vents shall be FP-10 One Wall Roof Vents or Johns Manville or equal.

2.04 PLASTIC CEMENT

- A. Plastic cement shall conform to ASTM D 2822 and shall be supplied by the roofing manufacturer.

2.05 FASTENERS

- A. Nails, bolts, and nuts, screws, washers, etc., shall be stainless steel and shall be supplied by the roofing manufacturer.

2.06 ANCHORS

- A. Anchors for fastening items to concrete shall be stainless steel machine screws or bolts and Rawl plug inserts of Phillips Red Head concrete anchors of the size and type noted or required.

2.07 BITUMINOUS PLASTIC CEMENT

- A. Bituminous plastic cement shall conform to FS SS-C-153.

2.08 ASPHALTIC MATERIAL

- A. Asphalt primers shall conform to FS S-A-701. Coating asphalt shall have brushing consistency conforming to FS SS-R-451.

2.09 SCUPPERS, GUTTERS AND DOWNSPOUTS

- A. Material: Minimum 0.050 inch thick aluminum.
- B. Design: Manufacture gutters tapered and notched to provide telescoping joint. Design gutters and downspouts to accommodate expected thermal movement.
- C. Supports and Fasteners: Provide manufacturers standard straps, brackets and fasteners, spaced at maximum 40-inches on center or as recommended by the

manufacturer. Finish of supports, brackets and fasteners shall match gutter and downspout.

- D. Accessories: Provide end caps, flashing, trim, and other items required for a complete installation.
- E. Finish: Baked on Kynar, with 20 year warranty.
- F. Color: Color for the downspout shall be selected by the Engineer from the Supplier's standard color chart.

PART 3 - EXECUTION

3.01 SHIPPING, HANDLING AND STORAGE

- A. Store materials off the ground to avoid damage. Protect from bitumen spillage and repair or replace damage at no additional cost to the City.

3.02 JOB CONDITIONS

- A. Coordination: Coordinate with the roofing system, sheet metal, plumbing, electrical, HVAC and mechanical subcontractors to insure that all items are in place prior to commencement of work.
- B. Climatic Conditions: Proceed with the roofing and associated work only when existing and forecasted weather conditions will permit the work to be performed as scheduled.

3.03 SHEET METAL INSTALLATION

- A. General: Coordinate metal flashing and trim work with the installation of roofing, waterproofing, piping, existing building, and other adjoining and substrate work. Surfaces to be coated shall be smooth and clean. The installer must examine the substrate and the conditions under which the metal flashing will be installed, and notify the Contractor in writing of any unsatisfactory conditions. Do not proceed with installation until unsatisfactory conditions have been corrected in a manner acceptable to the installer. Flanges or gravel stops, vent and other flashings, shall be bedded in hot asphalt, set on top of the roofing plies and reinforced with felt strips as specified. Work shall be water tight, with lines, arises and angles sharp and true. Surfaces shall be free from waves and buckles.
- B. Fabrication: Fabricate and install work described herein in accordance with the applicable standard described and illustrated in the National Association, Inc. publication "Architectural Sheet Metal Manual".
- C. Flashings: Base and all other flashings shall be watertight and of a condense type.
- D. Scuppers: Scuppers and the like, shall be fabricated as indicated on the Drawings, or equal, and properly installed.
- E. Accuracy: Fabricate and install work with lines and corners of exposed units true and accurate. Form exposed faces flat and free from buckles, excessive waves and avoidable tool marks, considering the temper and reflectivity of the metal. Provide uniform, neat seams with minimum exposure of solder welds, and sealant. Except as

otherwise shown, fold back the sheet metal to form a hem on the concealed side of exposed edges.

- F. Fasteners: Conceal fasteners and expansion provisions wherever possible in exposed work, and locate so as to minimize the possibility of leakage. Cover and seal work as required for a tight installation. Fasten sheet metal items as indicated or required to provide rigid, secure installation free of warp. Fastenings shall be made in such a manner as not to impair the watertight integrity of the installation. Exposed face nailing will not be permitted.
- G. Laps: For embedment of metal flanges in roofing or composition flashing or stripping, extend flanges for a minimum of 4-inch embedment. Lap seams of sheet metal in direction of flow. Single lock flat seams, heliarc weld or double-lock and mallet flat. Lap seams occurring in members sloping 45 degrees or greater shall be lapped 4-inch minimum and be bedded in flashing cement. Provide loose-locked expansion joints a maximum of 20 feet and a minimum of 8 feet from corners. On vertical surfaces, lap 2 piece flashings a minimum of 3 inches.
- H. Protection: Separate dissimilar metals from each other by painting each metal surface in the area of contact with a heavy application of bituminous coating, or other permanent separation as recommended by the manufacturers of the dissimilar metals. The flashing subcontractor shall advise the Contractor of required procedures for protection of the completed flashing and trim. Furnish such advice for period of installation of other work, and also for the remainder of the construction period.

3.04 COORDINATION

- A. Coordinate flashing work with the work of other trades. Adjacent work shall be kept clean and shall not be injured or defaced in any way.

3.05 PROTECTION AND CLEANING

- A. The Contractor shall protect the work of other trades. Work damaged by an operation under this section shall be repaired or replaced at no expense to the City. All soiled adjoining surfaces shall be carefully cleaned.
- B. All debris and surplus material resulting from work under this section shall be removed from the premises.

END OF SECTION

SECTION 07920

SEALANTS AND CAULKING

PART 1 - GENERAL

1.01 THE REQUIREMENT

- A. The Contractor shall provide sealant and caulking work required for a complete installation as is indicated on the Drawings and specified herein. The required applications of sealants and caulking include, but are not necessarily limited to, the following general locations:
1. Masonry joints, exterior and interior.
 2. Joints at penetrations of walls, decks, piping, doors, windows, louvers and other services and equipment.
 3. Joints between items of equipment and other construction.
 4. Joints in concrete.

1.02 SUBMITTALS

- A. Submit shop drawings and color samples of sealant for review in accordance with the Section entitled "Submittals".
- B. Submit a two year guarantee on sealant type caulking work against joint failure. Joint failure is defined as leaks of air or water, evidence of loss of cohesion, fading of sealant material, migration of sealant, evidence of loss of adhesion between sealant and joint edge.

1.03 ACCEPTABLE MANUFACTURERS

- A. The following list of manufacturer products are acceptable for this Section, subject to conformance with the specified requirements: Tremco, Thiokol, Dymoric or equal.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Primer: Where required by sealant manufacturer, the primer shall be a compound designed to insure the adhesion of sealant. Material shall be provided by the sealant manufacturer and shall be selected for compatibility with substrate.
- B. Sealant
1. Type 1: Multi-component, non-sag, low-modulus polyurethane rubber sealant meeting ASTM C-920, Type M, Grade NS, Class 25, use NT, M, A, and O. Capable of withstanding 50% in extension or compression such as Sikaflex-2C NS/SL, Sika Corporation, or approved equal.

2. Type 2: Single component polyurethane sealant meeting ASTM C-920, Type S, Grade NS, Class 25, Use NT, M, A, and O. Capable of withstanding 25% in extension or compression such as Sikaflex 1A by Sika Corporation or approved equal.
 3. Type 3: Single component, low-modulus moisture curing silicone meeting ASTM C 920, Type S, Grade NS, Class 25, Use NT, M, G, and A. Capable of withstanding 50% extension and compression. Pecora 890 by Pecora Corporation, or approved equal.
 4. Type 4: Single component, mildew resistant, moisture-curing silicone meeting ASTM C-920, Type S, Grade NS, Class 25, Use NT, M, G, and A. Pecora 898 by Pecora Corporation, or approved equal.
 5. Type 5: Single component, acrylic latex meeting ASTM C-834. AC-208 Silicone by Pecora Corporation, or approved equal.
 6. Type 6: High grade butyl sealant meeting Federal Specification TT-S-00-1057. BC-158 by Pecora Corporation or approved equal.
 7. Type 7: Multi-component chemical resistant polysulfide sealant conforming to ASTM C-920, Type M, Grade NS, Class 25 such as Sonolastic Two Part by BASF Construction Chemicals, or approved equal.
 8. Type 8: Non-sag, Multi Component, traffic grade polyurethane sealant meeting ASTM C920, Type 19, Grade NS, Class 25, use T, M, A, and O. DuraTread by Pecora Corporation or approved equal.
- C. Joint Backing shall be closed cell foam. Material shall be nonreactive with caulking materials and non-oil. Minimum density shall be 3.24 pcf. Use no asphalt or bitumen-impregnated fiber with sealants.
- D. Joint cleaner shall be as recommended by sealant or caulking compound manufacturer.
- E. Joint Primer shall be as recommended by sealant manufacturer.
- F. Bond Breaker tape shall be either polyethylene or plastic as recommended by the sealant manufacturer.
- G. Color: Where manufacturer's standard colors do not closely match materials being sealed, provide a custom color.

PART 3 - EXECUTION

3.01 GENERAL

- A. Comply with sealant manufacturer's printed instructions except where more stringent requirements are shown or specified and except where manufacturer's technical representative directs otherwise.

3.02 SHIPPING, HANDLING AND STORAGE

- A. Store and handle materials so as to prevent the inclusion of foreign matter or the damage of materials from water or leakage. Procure and store in original containers until ready for use. Material showing evidence of damage will be rejected.
- B. Store and handle materials so as to prevent the inclusion of foreign matter or the damage of materials from water or leakage. Procure and store in original containers until ready for use. Material showing evidence of damage shall be rejected.

3.03 INSTALLATION

- A. Employ only proven installation techniques, which will insure that sealants will be deposited in uniform, continuous ridges without gaps or air pockets, with complete "wetting" of the joint bond surface equally on opposite sides. Except as otherwise indicated, the Contractor shall fill the sealant recess to a concave surface, slightly below adjoining surfaces. Where horizontal joints are between a horizontal surface and a vertical surface, fill joint to form a slight cove, so that joint will not trap moisture and dirt.
- B. Install sealants to depths as specified, or if not, as recommended from the sealant manufacturer and as follows:
 - 1. Moving joints: For normal moving joints sealed with elastomeric sealants but not subject to traffic, fill joints to a depth equal to 50% of joint width, but not more than 1/2-inch deep or less than 1/4-inch deep.
 - 2. Sealed joints: For joints sealed with non-elastomeric sealants and caulking compounds, fill joints to a depth in the range of 75% to 125% of joint width.
 - 3. Thresholds: Set thresholds in full bed of caulking compound remove excess materials.

3.04 SCHEDULE

A. Schedule of Sealants

Application	Sealant	Color
Vertical and horizontal joints ordered on both sides from concrete, masonry, precast concrete, EIFS, or other porous building material.	Type 2	To closely match adjacent surfaces or mortar and as selected from the City
Vertical and horizontal joints ordered on both sides from painted metals, anodized aluminum, mill finished aluminum, PVC, glass or other non-porous building material.	Type 3	To closely match adjacent surfaces and as selected from the City
Masonry expansion and control joints less than 1" wide.	Type 2	To closely match adjacent surfaces and as selected from the City
Masonry expansion and control joints equal or greater than 1 1/4 inches wide and not to exceed 2".	Type 1	To closely match adjacent surfaces and as selected from the City

Application	Sealant	Color
Interior – wood trim and finish joints.	Type 5	Color to be selected by City
Sanitary areas, joints in ceramic tile, around plumbing fixtures, countertops, and back splashes. See Note 1.	Type 4	To closely match adjacent surfaces and as selected by the City
Perimeter sealing of doors, windows, louvers, piping, ducts, and electrical conduit. See Note 2.	Type 2 OR Type 3	To closely match adjacent surfaces and as selected by the City
Below thresholds.	Type 6	Manufacturer's standard
Submerged in liquids. See Note 4.	Type 1	Manufacturer's standard
Submerged in liquids with high concentration of chlorine (2 ppm)	Type 7	Manufacturer's standard
Horizontal joints exposed to vehicular or pedestrian traffic.	Type 8	To closely match adjacent surfaces.
Other joints indicated on the drawings or customarily sealed but not listed.	Type recommended by manufacturer	To closely match adjacent surfaces and as selected by the City

Note 1: Sealant for Laboratory Countertop shall be as recommended by countertop manufacturer.
 Note 2: Provide UL approved sealants for penetrations thru fire-rated walls and as specified in Section 07270.
 Note 3: Sealants which will come in contact with potable water shall meet the requirements of NSF 61.
 Note 4: Where sealant will be immersed in liquid chemicals verify compatibility prior to installation of sealant.

3.05 PROTECTION OF ADJOINING SURFACES

- A. Prime or seal the joint surfaces wherever shown or recommended by the sealant manufacturer. Do not allow primer/sealer to spill or migrate onto adjoining surfaces.

3.06 SEALANT BACKER ROD

- A. Install sealant backer rod for liquid elastomeric sealants, except where shown to be omitted or recommended to be omitted by sealant manufacturer for the application shown.

3.07 BOND BREAKER

- A. Install bond breaker tape wherever shown and wherever required by manufacturer's recommendations to insure that elastomeric sealants will perform properly.

3.08 SPILLAGE

- A. Sealants or compounds shall not overflow or spill onto adjoining surfaces, or to migrate into the voids of adjoining surfaces. Masking tape or other precautionary devices shall be used to prevent staining of adjoining surfaces.

3.09 CURING

- A. Sealants and caulking compounds shall be cured in compliance with manufacturer's instructions and recommendations, to obtain high early bond strength, internal cohesive strength, and surface durability.

3.10 CLEANING

- A. Excess and spillage of compounds shall be promptly removed as the work progresses. Adjoining surfaces shall be cleaned by whatever means may be necessary to eliminate evidence of spillage. Do not damage the adjoining surfaces or finishes.

END OF SECTION

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SECTION 08120

ALUMINUM DOORS AND DOOR FRAMES

PART 1 - GENERAL

1.01 THE REQUIREMENTS

- A. The Contractor shall furnish and install all flush aluminum doors, aluminum frames, and related items, complete and operable, including all finish hardware and appurtenant work, all in accordance with the requirements of the Contract Documents.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 07920 - Sealants and Caulking
- B. Section 08710 - Finish Hardware

1.03 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

- A. Without limiting the generality of other requirements of the Specifications, all work specified herein shall conform to or exceed the requirements of the Florida Building Code and the applicable requirements of the following documents to the extent that the provisions of such documents are not in conflict with the requirements of this Section.
- B. Products and their installation shall be in accordance with the following trade standards as applicable.
 - 1. Aluminum Association System AA M21C22A42 and AA M21C22A41.
 - 2. Architectural Aluminum Manufacturers Association (AAMA) Specifications 2GD A2HP.
 - 3. National Association of Architectural Metal Manufacturers (NAAMM)
 - 4. Manufacturer's published recommendations and Specifications.
 - 5. Flamespread shall conform to ASTM E 84 (HPMA Test T 1113)
 - 6. Sealants shall conform to TT S 001 57, ASTM C 834, TT S 001 543A.

1.04 CONTRACTOR SUBMITTALS

- A. Submittals shall be in accordance with the requirements of Section 01300 entitled "Submittals."
- B. The submittal shall include the following:
 - 1. Product cut sheets for frames, anchors, door panels and all finish hardware.
 - 2. A complete schedule indicating the masonry openings versus the proposed doors, door frames, window frames and the associated door hardware. Prior to the submittal, all openings shall be field-verified by the Contractor.

3. A complete hardware schedule conforming to Section 08710 entitled "Finish Hardware", in compliance with Product Approval.
 4. Installation details, edge distances, material, size, and spacing of anchorage.
 5. Locking arrangement.
 - Sealants.
 7. Types, finishes and locations of door louvers with construction details.
 8. Window construction details and assembly methods, including glass types.
 9. Florida Product Approval for use in the High Velocity Hurricane Zone.
- C. The Engineer will review and return the submittals to the Contractor. The Contractor shall then submit the accepted package to the Building Departments having jurisdiction over the work for approval. No fabrication or installation shall begin until the Building Department approval is obtained from the Contractor. All permit fees shall be paid for by the Contractor and included in the bid price. The City will not assume responsibility for any cost or schedule impacts due to the approval process of the Building Department. It is the Contractor's responsibility to customize the submittals based on the Building Department's published submittal processes.

1.05 PRODUCT APPROVAL NOTICES

- A. A prototype of all products supplied under this section shall have a Product Approval Notice. A copy of the notices with all drawings shall be submitted for review. The notice shall indicate that the following tests were conducted on the prototype for small missile impact and large missile impact:
1. Impact Test – Florida Building Code Test Protocols TAS 201, Impact Test Procedure – Large and Small Missile
 2. Uniform Static Pressure Test - Florida Building Code Test Protocols TAS 202, Criteria for Testing Impact and Non-Impact Resistant Building Envelope Components using Uniform Static Air Pressure.
 3. Cyclic Wind Pressure Test - Florida Building Code Test Protocols TAS 203. Criteria for testing products subject to Cyclic Wind Pressure Loading.

1.06 DELIVERY, STORAGE AND HANDLING

- A. The Contractor shall deliver, store, and handle doors, windows and frames in a manner to prevent damage and deformation. Store on pallets at the job site and undercover to form weather tight enclosure. Spacers shall be provided between doors and frames to prevent metal-to-metal contact.

PART 2 - PRODUCTS

2.01 FLUSH ALUMINUM DOORS

- A. Flush aluminum doors shall be as manufactured by Cline Aluminum Doors, Alutech Corporation or equal. All doors shall be products of a single manufacturer.
- B. Doors shall be completely flush in design constructed with tubular aluminum frame rails and tubular aluminum grid sections with face sheets.
- C. Doors shall have an internal frame system comprised of 1 1/2 inch x 4 inch minimum tubular sections. All internal members shall be anodized.
- D. All voids between sub-frames shall be filled with a core laminated between face sheets as required by the door manufacturer to meet the requirements of the Florida Product Approval.
- E. All doors shall be completely reinforced for the specified hardware. The reinforcements shall be aluminum alloy 6061 T6 and shall not be less than 0.125 inches thick.
- F. The minimum thickness of door components shall be as follows:
 - 1. Face sheet 0.040 inches
 - 2. Beveled lock rail edge 0.125 inches
 - 3. Hinge rail edge 0.125 inches
 - 4. Internal grid sections 0.080 inches
- G. Doors shall be provided with a finish specified on the drawings.
- H. Entrance door weatherstripping required at frames, head, and bottom sweep strip shall be metal backed, pile cloth.
- I. All screws shall be stainless steel. Exposed screws shall be heat treated, stainless steel of color to match the aluminum finish.

2.02 ALUMINUM DOOR FRAMES

- A. Aluminum frames shall be extruded from 6063-T5 or 6063-T6 aluminum alloy and shall have a minimum wall thickness of 0.125 inch. Door frames shall be provided with an anodized finish.
- B. All frame frame, header and mullion joints shall be accurately milled to hairline cracks. All corners shall be mechanically joined with an interlocking aluminum channel clip and flat head stainless steel screws.
- C. All frames shall be adequately reinforced to receive the hardware. Reinforcements shall be 6061-T6 aluminum and shall not be less than 0.1875-inch thick.
- D. Frames shall be drilled and tapped for field installation of hardware.

- E. Frames shall be constructed in accordance with Governmental Specifications CS-230-00.

2.03 ANCHORS

- A. For cast-in-place concrete, anchor frame frames with 1/2-inch minimum concrete screws spaced in accordance with Product Approval.

PART 3 - EXECUTION

3.01 GENERAL

- A. Workmanship and installation shall be in accordance with referenced standards. Field dimensions, conditions, and coordination with adjoining work shall be verified prior to fabrication.
- B. All framing materials shall be screwed in place using blocking, anchor plugs, or straps as required.
- C. Where moldings are jointed, they shall be accurately cut and fit to result in a tight closed joint.

3.02 SHIPPING, HANDLING AND STORAGE

- A. The Contractor shall deliver, store and handle doors and frames to avoid damage from impact, abrasion, and moisture. He shall store doors in a space having controlled humidity, and shall not proceed with installation until temperature and humidity approximate that of the occupied structure.
- B. Each door shall be marked with a stamp, brand or label which identifies the manufacturer.

3.03 FRAME INSTALLATION

- A. Frames shall be installed plumb, level and true to line, rigidly secured in openings. Frames in masonry walls shall be set prior to beginning masonry work. Frames shall be filled with cement grout as masonry work progresses. Anchors shall be provided as previously specified.

3.04 DOOR INSTALLATION

- A. Doors shall be installed plumb, level and true to line. Hardware shall be applied and adjusted to achieve quiet and smooth operation. Installation shall be in accordance with the manufacturer's recommendations.
- B. Doors shall fit snugly and close without forcing or binding. Door clearance shall not exceed 1/8 inch at frames and heads and meeting stiles at pairs of doors. Clearance between bottom of door and finished floor material or threshold shall not exceed 1/4 inch. Frames shall be manufactured and machined to within 1/32 inch for all dimensions.

3.05 PROTECTION

- A. Aluminum to be placed adjacent to masonry or dissimilar metals shall be protected with an isolating coating of bitumastic and/or felt.
- B. Finished installation shall be protected until time of final acceptance. Damaged doors and frames shall be repaired or replaced at no additional cost to the City.

3.06 GUARANTEE

- A. The Door and Window manufacturers shall guarantee the workmanship and material on the doors and windows including hardware for a minimum period of three years.

END OF SECTION

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SECTION 08525
ALUMINUM WINDOWS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Aluminum windows.

B. Related Sections include but are not necessarily limited to:

1. Section 07900 - Joint Sealants.
2. Section 08800 - Glass and Glazing.

1.02 QUALITY ASSURANCE

A. Referenced Standards:

1. American Architectural Manufacturers Association (AAMA)
 - a. 904, Voluntary Specification for Multi-Bar Hinges in Window Applications
 - b. 1503, Voluntary Test Method for Thermal Transmittance and Condensation Resistance of Windows, Doors and Glazed Wall Sections.
 - c. 2005, Voluntary Specification, Performance Requirements and Test Procedures for Superior Performing Organic Coatings on Aluminum Extrusions and Panels.
2. ASTM International (ASTM)
 - a. A924, Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process.
 - b. C1363, Standard Test Method for the Thermal Performance of Building Assemblies by Means of a Hot Box Apparatus.
 - c. 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.
 - d. E330, Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights, and Curtain Walls by Uniform Static Air Pressure Difference.
 - e. E331, Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference.
3. American Welding Society (AWS)
 - a. D1.2, Structural Welding Code - Aluminum.

1.03 DEFINITIONS

A. Installer or Applicator:

1. Installer or applicator is the person actually installing or applying the product in the field at the Project site.
2. Installer and applicator are synonymous.

1.04 SUBMITTALS

A. Shop Drawings:

1. Product technical data for framing system and major accessories including:
 - a. Acknowledgement that products submitted meet requirements of standards referenced.
 - b. Hardware being provided by window manufacturer.
 - c. Glass being provided by window manufacturer in factory glazed units.
 - d. Manufacturer's installation instructions.
2. Elevation drawings indicating window dimensions and details.

B. Samples:

1. After initial color selection, provide 2 x 3 inches minimum sample of each color and finish selected.

C. Informational Submittals:

1. Qualifications of testing laboratory
2. Test results.
3. Warranty

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Store units in vertical position off ground with wood spacers between each unit.

1.06 WARRANTY

A. Five Year warranty of weathertightness of installation.

1. Air and water integrity and structural adequacy of units and hardware, including sealants and sealing within and around perimeter of installation.
2. Signed print by manufacturer, installer, and contractor.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:

1. Thermalbroken windows:
 - a. Wausau Metals Corp., 2250-T Series.
 - b. Kawneer Company Inc., 8225-T Series.
 - c. EFCO Windows, Series 510.

2.02 MATERIALS

- A. Extruded Aluminum: 6063-T5 alloy
- B. Sealants: As specified in Section 07900.
- C. Thermal Insulator: Poured in place polyurethane, self-adhering to adjacent aluminum surfaces.
- D. Weatherstripping: Sponge neoprene.

2.03 ACCESSORIES

- A. Flashing:
 1. Minimum 0.040 inches aluminum.
 2. Finish to match window frames.
 3. Mill finish if concealed.

2.04 FABRICATION

- A. General:
 1. Fully degrease and clean members prior to assembly or application of protective coatings.
 2. Weld methods recommended by manufacturer and AWS D1.2 to avoid discoloration at welds.
 3. Grind exposed welds smooth and restore finish.
 4. Ease corners of cut edges to a radius of approximately 1/4 inches.
 5. Conceal fasteners wherever possible.
 6. Fit and assemble work at shop to maximum extent possible.
 7. Maintain true continuity of line and accurate relation of planes and angles.

8. Provide secure attachment and support at mechanical joint, with hairline fit of contacting members.
 9. Reinforce work as necessary to withstand wind loadings and to support system.
 10. Separate dissimilar metal with paint or preformed separators to prevent corrosion.
 - a. See Section 09901.
 11. Separate metal surfaces at moving joints with plastic inserts or other nonabrasive concealed inserts to permanently prevent freeze-up of joint.
 12. Reinforce frames for hardware.
 13. Structural steel reinforcement hot-dip galvanized after fabrication meeting G-90, ASTM A924, requirements.
- B. Thermal Insulator: Provide minimum 1/4 inches separation between exterior and interior metal surfaces after ridge is removed.
- C. Weatherstripping:
1. Thermal broken type windows:
 - a. Casement and protected:
 - 1 Provide two rows of fin type extruded neoprene weatherstrips extending around perimeter of sash at both inner and outer overlap contacts.
 - 2 Provide corners which are securely staked and joined.
 - 3 Provide units which are easily replaceable.
- D. Fasteners:
1. Finish exposed fasteners to match finish of system.
 2. Provide Phillips flat head screws where exposed.
- E. Finish: AAMA 2005 Fluoropolymer paint color to be selected from full range of manufacturer colors.

2.05 SOURCE QUALITY CONTROL

- A. General Test Requirements:
1. Utilize independent testing laboratories specifically qualified to conduct all performance tests required.
 2. Performance tests may be conducted in manufacturer's laboratories provided they are witnessed and certified by qualified independent testing laboratory personnel.
 3. Perform all tests on "Test Unit":

- a. Full-sized window unit for project or a minimum 5'8" feet unit mounted in test chamber in exact accordance with test conditions including anchorage system, sealing, etc.
 - Test unit to be completely assembled and glazed.
 - 1□ Thermal tests made conducted on 4'8" feet unit.
 4. Test air infiltration first, water resistance second.
 - a. Other tests made in an order.
 5. Test data on vertical pivot windows will be accepted for fixed windows for condensation resistance, thermal, temperature exposure and acoustical tests provided the fixed windows are the same as the vertical windows tested in the following respects:
 - a. Same frame section or same family of extrusions
 - Same basic metal mass inside and outside.
 - c. Identical thermal break.
 - d. Same type of glazing.
- B. Test Requirements:
1. Air infiltration test:
 - a. With sash and ventilators closed and locked, test in accordance with ASTM E283.
 - Air infiltration, in CFM/FT of crack length, at pressure differential of 0.24 psf as follows:
 - 1□ Fixed windows: 0.03 maximum, all others 0.10 maximum.
 2. Water resistance test:
 - a. Mount glazed unit in its vertical position, continuously supported around outside perimeter with sash and ventilators closed and locked.
 - Test in accordance with ASTM E331.
 - c. No uncontrolled leakage allowed, with pressure differential of 0.24 psf.
 3. Uniform load deflection test:
 - a. Test in accordance with ASTM E330.
 - Subject unit to load of 25 psf applied to outside of window and 25 psf applied to inside of window.
 - c. Maximum allowable deflection of an unsupported span: $L/175$.

- d. No glass breakage, permanent damage to fasteners, hardware parts, support arms or activating mechanisms, or any other damage which would cause window to be inoperative will be allowed.
4. Uniform load structural test:
- a. Test in accord with ASTM E330.
 - Subject unit to loads indicated below.
 - c. Stabilize pressure and maintain it for minimum period of 10 seconds.
 - d. No glass breakage, permanent damage to fasteners, hardware parts, support arms or activating mechanisms or any other damage which would cause window to be inoperative will be allowed.
 - e. Maximum permanent deformation of any main frame, sash or ventilator member: 0.4% of its span.
 - f. After performing Uniform Load Structural Test, increase loads 1-1/2 times and perform safety test.
 - g. Design unit to withstand following design pressures acting normal to plane of wall, per location and required building codes.
5. Condensation resistance test:
- a. Perform on "test unit," except size may be 3 x 4 feet, minimum.
 - Test in accordance with AAMA 1503.
 - c. CRF [Condensation Resistance Factor] 50, minimum.
- Structural thermal barrier tension test:
- a. Test urethane filled sections of aluminum.
 - Mechanically secure interior and exterior faces of 12 inches section in horizontal position.
 - c. Apply heat tape to exterior face to control surface temperature at 180 degrees F 5 minutes before loading, as indicated [] a thermocouple wire operated [] an automatic controller.
 - d. Apply direct tension [pull] using a Universal testing machine set in 12,000 pound load range.
 - e. Test results: No loss of bond at 4000 pound IN/IN/MIN.
7. Structural thermal barrier shear test:
- a. Test urethane filled sections of aluminum.
 - Mechanically secure interior face of 12 inches section in vertical position.

- c. Apply heat tape to exterior face to control surface temperature at 180 degrees F 5 minutes before loading, as indicated by a thermocouple wire operated by an automatic controller.
 - d. Apply load to exterior face by a bearing plate resting on top of exterior face, using Universal Testing machine set in 12,000 pound load range at a strain rate of 0.050 inches/IN/MIN.
 - e. Test results: No loss of bond at 5500 pound loading.
8. Structural thermal carrier combined torsion and shear test:
- a. Test urethane filled sections of aluminum.
 - b. Secure interior face of 12 inches section in horizontal position.
 - c. Apply heat tape to exterior face to control surface temperature at 180 degrees F 5 minutes before loading, as indicated by a thermocouple wire operated by an automatic controller.
 - d. Apply load to bearing plate centered on portion of glazing pocket to exterior side of thermal carrier, using a Universal Testing machine set in the 12,000 pound load range.
 - e. Test results: No loss of bond at 3900 pound load applied at strain rate of 0.05 inches/IN/MIN.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Set units plumb, level, and true to line.
- C. Anchor secure in place.
- D. Separate metal surfaces from sources of corrosion or electrochemical action.
 1. See Section 09901.
- E. Set sill and base members in a bed of sealant.
- F. Provide joint fillers or gaskets for weathertight construction.
- G. Seal all joints within and at perimeter of system.
- H. Provide sealant color to match finish of system at exposed locations.
- I. Provide sealants compatible with aluminum system and recommended for use with this type of installation.
 1. See Section 07900 for sealants.

3.02 FIELD QUALITY CONTROL

- A. Installation supervised or inspected by manufacturer's authorized representative.

END OF SECTION

SECTION 08710

FINISH HARDWARE

PART 1 - GENERAL

1.01 THE REQUIREMENT

- A. The Contractor shall furnish and install items known commercially as finish or door hardware that are required for swing, sliding, and folding doors, except special types of unique hardware specified in the same sections as the doors and door frames on which they are to be installed.
- B. This Section includes the following:
 - 1. Hinges.
 - 2. Key control systems.
 - 3. Lock cylinders and keys.
 - 4. Lock and latch sets.
 - 5. Bolts.
 - 6. Exit devices.
 - 7. Closers.
 - 8. Overhead holders.
 - 9. Miscellaneous door control devices.
 - 10. Door trim units.
 - 11. Protection plates.
 - 12. Weatherstripping for exterior doors.
 - 13. Astragals or meeting seals on pairs of doors.
 - 14. Thresholds.

1.02 SUBMITTALS

- A. General: Submit the following in accordance with Section 01300 entitled "Submittals":
 - 1. Product data including manufacturer's technical product data for each item of door hardware, installation instructions, maintenance of operating parts and finish, and other information necessary to show compliance with requirements.
 - 2. Final hardware schedule coordinated with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of door hardware.

- a. Final Hardware Schedule Content: Based on hardware indicated, organize schedule into "hardware sets" indicating complete designations of every item required for each door or opening. Include the following information:
 - 1. Type, style, function, size, and finish of each hardware item.
 - 2. Name and manufacturer of each item.
 - 3. Fastenings and other pertinent information.
 - 4. Location of each hardware set cross referenced to indications on Drawings, both on floor plans and in door and frame schedule.
 - 5. Explanation of all abbreviations, symbols, and codes contained in schedule.
 - 6. Door and frame sizes and materials.
 - 7. Keying information.
 - b. Submittal Sequence: Submit final schedule at earliest possible date, particularly where acceptance of hardware schedule must precede fabrication of other work that is critical in the Project construction schedule. Include with schedule the product data, samples, shop drawings of other work affected by door hardware, and other information essential to the coordinated review of schedule.
 - c. Keying Schedule: Submit separate detailed schedule indicating clearly how the City's final instructions on keying of locks has been fulfilled.
- 3. If requested by architect, submit samples of each type of exposed hardware unit in finish indicated and tagged with full description for coordination with schedule. Submit samples prior to submission of final hardware schedule.
 - a. Samples will be returned to the supplier. Units that are acceptable and remain undamaged through submittal, review, and field comparison process may, after final check of operation, be incorporated in the Work, within limitations of keying coordination requirements.
 - 4. Templates for doors, frames, and other work specified to be factory prepared for the installation of door hardware. Check shop drawings of other work to confirm that adequate provisions are made for locating and installing door hardware to comply with indicated requirements.

1.03 QUALITY ASSURANCE

- A. Single Source Responsibility: Obtain each type of hardware (latch and lock sets, hinges, closers, etc.) from a single manufacturer. All door locks shall be keyed to a keying schedule developed by the City and manufacturer.
- B. Supplier Qualifications: A recognized architectural door hardware supplier, with warehousing facilities in the Project's vicinity, that has a record of successful in-service performance for supplying door hardware similar in quantity, type, and quality to that indicated for this Project and that employs an experienced architectural hardware

consultant [AHC] who is available to City, Architect, and Contractor, at reasonable times during the course of the Work, for consultation.

1. Require supplier to meet with City to finalize key requirements and to obtain final instructions in writing.
 2. Supplier shall be an authorized factory distributor of all specified products.
- C. Fire-Rated Openings: Provide door hardware for fire-rated openings that complies with NFPA Standard No. 80 and requirements of authorities having jurisdiction. Provide only items of door hardware that are listed and are identical to products tested by UL, Warnock Hersey, FM, or other testing and inspecting organization acceptable to authorities having jurisdiction for use on types and sizes of doors indicated in compliance with requirements of fire-rated door and door frame labels.

1.04 PRODUCT HANDLING

- A. Tag each item or package separately with identification related to final hardware schedule, and include basic installation instructions with each item or package.
- B. Packaging of door hardware is responsibility of supplier. As material is received from hardware supplier from various manufacturers, sort and repackage in containers clearly marked with appropriate hardware set number to match set numbers of approved hardware schedule. Two or more identical sets may be packed in same container.
- C. Inventory door hardware jointly with representatives of hardware supplier and hardware installer until each is satisfied that count is correct.
- D. Deliver individually packaged door hardware items promptly to place of installation (shop or Project site).
- E. Provide secure lock-up for door hardware delivered to the Project, but not yet installed. Control handling and installation of hardware items that are not immediately replaceable so that completion of the Work will not be delayed by hardware losses both before and after installation.

1.05 MAINTENANCE

- A. Maintenance Tools and Instructions: Furnish a complete set of specialized tools and maintenance instructions as needed for City's continued adjustment, maintenance, and removal and replacement of door hardware.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products of one of the following:
 1. Butts and Hinges:
 - a. Hager Hinge Co.

- McKinney Products Co.
- c. Stanley Hardware, Div. Stanley Works.
- 2. Cylinders and Locks:
 - a. Sargent Manufacturing Company
 - Schlage Lock, Div. Ingersoll-Rand Door Hardware Group.
- 3. Exit/Panic Devices:
 - a. Sargent Manufacturing Company
 - Von Duprin, Div. Ingersoll-Rand Door Hardware Group.
- 4. Overhead Closers:
 - a. LCN, Div. Ingersoll-Rand Door Hardware Group.
 - Sargent Manufacturing Company
- 5. Bolts:
 - a. H.B. Ives, A Harrow Company
 - Quality Hardware Mfg. Co., Inc.
 - c. Rockwood Mfg. Co.
 - Door Trim Units:
 - a. H.B. Ives, A Harrow Company
 - Quality Hardware Mfg. Co., Inc.
 - c. Rockwood Mfg. Co.
- 7. Kick Plates:
 - a. Rockwood Mfg. Co.
 - H.B. Ives, A Harrow Company
 - c. Quality Hardware Mfg Co., Inc.
- 8. Key Control System:
 - a. Key Control Systems, Inc.
 - Telkee Inc.
- 9. Thresholds, Door Stripping and Seals, Automatic Drop Seals, Astragals:
 - a. National Guard Products, Inc.
 - Pemko Manufacturing Co., Inc.

c. Reese Enterprises, Inc.

2.02 SCHEDULED HARDWARE

- A. Requirements for design, grade, function, finish, size, and other distinctive qualities of each type of finish hardware are indicated in the "Hardware Schedule" at the end of this Section. Products are identified using hardware designation numbers of the following:
1. Manufacturer's Product Designations: The product designation and name of one manufacturer are listed for each hardware type required for the purpose of establishing minimum requirements. Provide either the product designated or, where more than one manufacturer is specified under the Article "Manufacturers" in Part 2 for each hardware type, the comparable product of one of the other manufacturers that complies with requirements.
 2. ANSI/BHMA designations used elsewhere in this Section or in schedules to describe hardware items or to define quality or function are derived from the following standards. Provide products complying with these standards and requirements specified elsewhere in this Section.
 - a. Butts and Hinges: ANSI/BHMA A15.1.
 - b. Bored and Preassembled Locks and Latches: ANSI/BHMA A15.2.
 - c. Exit Devices: ANSI/BHMA A15.3.
 - d. Door Controls - Closers: ANSI/BHMA A15.4.
 - e. Auxiliary Locks and Associated Products: ANSI/BHMA A15.5.
 - f. Architectural Door Trim: ANSI/BHMA A15.6.
 - g. Template Hinge Dimensions: ANSI/BHMA A15.7.
 - h. Door Controls - Overhead Holders: ANSI/BHMA A15.8.
 - i. Interconnected Locks and Latches: ANSI/BHMA A15.12.
 - j. Mortise Locks and Latches: ANSI/BHMA A15.13.
 - k. Closer Holder Release Devices: ANSI/BHMA A15.15.
 - l. Auxiliary Hardware: ANSI/BHMA A15.16.
 - m. Materials and Finishes: ANSI/BHMA A15.18.

2.03 MATERIALS AND FABRICATION

- A. Manufacturer's Name Plate: Do not use manufacturers' products that have manufacturer's name or trade name displayed in a visible location (omit removable nameplates except in conjunction with required fire-rated labels and as otherwise acceptable to Architect.
- B. Manufacturer's identification will be permitted on rim of lock cylinders only.

- C. Base Metals: Produce hardware units of basic metal and forming method indicated using manufacturer's standard metal alloy, composition, temper, and hardness, but in no case of lesser commercial recognized quality than specified for applicable hardware units for finish designations indicated.
- D. Fasteners: Provide hardware manufactured to conform to published templates, generally prepared for machine screw installation. Do not provide hardware that has been prepared for self-tapping sheet metal screws, except as specifically indicated.
- E. Furnish screws for installation with each hardware item. Provide Phillips flat-head screws except as otherwise indicated. Finish exposed screws to match hardware finish or, if exposed in surfaces of other work, to match finish of this other work as closely as possible including "prepared for paint" surfaces to receive painted finish.
- F. Provide concealed fasteners for hardware units that are exposed when door is closed except to the extent no standard units of type specified are available with concealed fasteners. Do not use thru-bolts for installation where bolt head or nut on opposite face is exposed in other work unless their use is the only means of reinforcing the work adequately to fasten the hardware securely. Where thru-bolts are used as a means of reinforcing the work, provide sleeves for each thru-bolt or use hex screw fasteners.

2.04 HINGES, BUTTS, AND PIVOTS

- A. Templates: Except for hinges and pivots to be installed entirely into wood doors and frames, provide only template-produced units.
- B. Screws: Provide Phillips flat-head screws complying with the following requirements:
 - 1. For metal doors and frames install machine screws into drilled and tapped holes.
 - 2. Finish screw heads to match surface of hinges or pivots.
- C. Hinge Pins: Except as otherwise indicated, provide hinge pins as follows:
 - 1. Out-Swing Exterior Doors: Nonremovable pins.
 - 2. Interior Doors: Nonrising pins.
 - 3. Tips: Flat button and matching plug, finished to match leaves, except where hospital tip HT is indicated.
- D. Number of Hinges: Provide number of hinges indicated but not less than 3 hinges per door leaf for doors 90 inches or less in height and one additional hinge for each 30 inches of additional height.
 - 1. Fire-Rated Doors: Not less than 3 hinges per door leaf for doors 8 inches or less in height with same rule for additional hinges.

2.05 LOCK CYLINDERS AND KEYS

- A. Review the keying system with the City and provide the type required master, grandmaster or great-grandmaster either new or integrated with City's existing system.

- B. Equip locks with manufacturer's special 6-pin tumblers cylinder with construction masterkey feature that permits voiding of construction keys without cylinder removal.
- C. Metals: Construct lock cylinder parts from brass or bronze, stainless steel, or nickel silver.
- D. Comply with City's instructions for masterkeying and, except as otherwise indicated, provide individual change key for each lock that is not designated to be keyed alike with a group of related locks.
- E. Key Material: Provide keys of nickel silver only.
- F. Key Quantity: Furnish 2 change keys for each lock, 5 master keys for each master system, and 5 grand master keys for each grandmaster system.

1. Deliver keys to City.

2.0 KEY CONTROL SYSTEM

- A. Provide a key control system including envelopes, labels, tags with self-locking key clips, receipt forms, 3-way visible card index, temporary markers, permanent markers, and standard metal cabinet, all as recommended by system manufacturer, with capacity for 150 percent of the number of locks required for the Project.

1. Provide hinged-panel type cabinet for wall mounting.

2.07 LOCKS, LATCHES, AND BOLTS

- A. Strikes: Provide manufacturer's standard wrought box strike for each latch or lock bolt, with curved lip extended to protect frame, finished to match hardware set, unless otherwise indicated.
 1. Provide flat lip strikes for locks with 3-piece, antifriction latch bolts as recommended by manufacturer.
 2. Provide recess type top strikes for bolts locking into frame heads, unless otherwise indicated.
 3. Provide roller type strikes where recommended by manufacturer of the latch and lock units.
- B. Lock Throw: Provide 5/8-inch minimum throw of latch on pairs of doors. Comply with UL requirements for throw of bolts and latch bolts on rated fire openings.
 1. Provide 1/2-inch minimum throw of latch for other bored and preassembled types of locks and 3/4-inch minimum throw of latch for mortise locks. Provide 1-inch minimum throw for all dead bolts.
- C. Flush Bolt Heads: Minimum of 1/2-inch-diameter rods of brass, bronze, or stainless steel with minimum 12-inch-long rod for doors up to 7'0" in height. Provide longer rods as necessary for doors exceeding 7'0" in height.

2.08 CLOSERS AND DOOR CONTROL DEVICES

- A. All closers shall be constructed with rack and pinion with compression springs. The Closing speed, latching speed and backcheck shall be controlled by key-operated valves. The delay action feature shall be a separate key-operated valve. The closer body shall be manufactured of high performance cast aluminum silicon alloy. All door closers shall be suitable for standard, top arm, track, corner bracket and parallel arm applications when provided with proper brackets and arms. The closer should be adjustable to meet the range of sizes required for opening and closing forces.
- B. Access-Free Manual Closers: Where manual closers are indicated for doors required to be accessible to the physically handicapped, provide adjustable units complying with ANSI A117.1 provisions for door opening force and delayed action closing.

2.09 DOOR TRIM UNITS

- A. Fasteners: Provide manufacturer's standard exposed fasteners for door trim units consisting of either machine screws or self-tapping screws.

2.10 WEATHERSTRIPPING AND SEALS

- A. General: Provide continuous weatherstripping on exterior doors and smoke, light, or sound seals on interior doors where indicated or scheduled. Provide noncorrosive fasteners for exterior applications and elsewhere as indicated.

2.11 THRESHOLDS

- A. General: Except as otherwise indicated, provide standard metal threshold unit of type, size, and profile as shown or scheduled.

2.12 HARDWARE FINISHES

- A. The designations used in schedules and elsewhere to indicate hardware finishes are the industry-recognized standard commercial finishes.
 - 1. Stainless steel, US32D unless otherwise noted.
 - 2. Closers shall have a USP finish unless otherwise noted.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Mount hardware units at heights indicated in following applicable publications, except as specifically indicated or required to comply with governing regulations:
 - 1. "Recommended Locations for Builders Hardware for Standard Steel Doors and Frames" by the Door and Hardware Institute.
- B. Install each hardware item in compliance with the manufacturer's instructions and recommendations. Where cutting and fitting is required to install hardware onto or into surfaces that are later to be painted or finished in another way, coordinate removal, storage, and reinstallation or application of surface protection with finishing work

specified in the Division 9 Sections. Do not install surface-mounted items until finishes have been completed on the substrates involved.

- C. Set units level, plumb, and true to line and location. Adjust and reinforce the attachment substrate as necessary for proper installation and operation.
- D. Drill and countersink units that are not factory-prepared for anchorage fasteners. Space fasteners and anchors in accordance with industry standards.
- E. Set thresholds for exterior doors in full bed of butyl-rubber or polysulfone mastic sealant.
- F. Weatherstripping and Seals: Comply with manufacturer's instructions and recommendations to the extent installation requirements are not otherwise indicated.

3.02 ADJUSTING, CLEANING, AND DEMONSTRATING

- A. Adjust and check each operating item of hardware and each door to ensure proper operation or function of every unit. Replace units that cannot be adjusted to operate freely and smoothly or as intended for the application made.
 - 1. Where door hardware is installed more than one month prior to acceptance or occupancy of a space or area, return to the installation during the week prior to acceptance or occupancy and make final check and adjustment of all hardware items in such space or area. Clean operating items as necessary to restore proper function and finish of hardware and doors. Adjust door control devices to compensate for final operation of heating and ventilating equipment.
- B. Clean adjacent surfaces soiled by hardware installation.
- C. Instruct City's personnel in the proper adjustment and maintenance of door hardware and hardware finishes.
- D. Six-Month Adjustment: Approximately six months after the date of Substantial Completion, the Installer, accompanied by representatives of the manufacturers of latchsets and locksets and of door control devices, and of other major hardware suppliers, shall return to the Project to perform the following work:
 - 1. Examine and re-adjust each item of door hardware as necessary to restore function of doors and hardware to comply with specified requirements.
 - 2. Consult with and instruct City's personnel in recommended additions to the maintenance procedures.

3.03 HARDWARE SCHEDULE

- A. General: Provide hardware for each door to comply with requirements of this Section, hardware set numbers indicated in the door schedule on the Drawings, and in the following schedule of hardware sets.

Hardware Set No. 1 – Single Leaf Exit Door

3 EA ¹	Hinge	McKinney	T4A338	4.5 x 4.5 NRP	32 D
1 EA	Exit Device	Sargent	HC8813ET		32 D

PROJECT NO. 11843 PROGRESSO VILLAGE STORM WATER IMPROVEMENTS

1 EA	Closer	Dorma	P40 STA TB	AL
1 EA	Threshold	Pemko	2005AS	AL
1 EA	Cam Seal	Pemko	S88D	AL
1 EA	Lock	Sargent	8215 LN	32 D

¹Use 4 Nos. for doors greater than 7'-0" high

Hardware Set No. 2 – Double Leaf Exit Door

EA ¹	Hinge	McKinney	T4A338	4.5 x 4.5 NRP	32 D
1 EA	Exit Device	Sargent	HC8813 ET		32 D
1 EA	Lock	Sargent	8205 LN		32 D
2 EA	Stops	Rockwood	40		20 D
1 EA	Threshold	Pemko	2005 AS		AL
1 EA	Cam Seal	Pemko	303 AS		AL
2 EA	Kickplate	Qualit	48		SS
1 EA	Surface Bolts	Ives	30-12		F2C

¹Use 8 Nos. for doors greater than 7'-0" high

END OF SECTION

SECTION 08800
GLASS AND GLAZING

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Glass and glazing.
2. Fire resistance rated glass.

B. Related Specification Sections include but are not necessarily limited to:

1. Section 07900 - Joint Sealants.
2. Section 08120 - Aluminum Doors and Frames.
3. Section 08525 – Aluminum Windows.

1.02 QUALITY ASSURANCE

A. Referenced Standards:

1. American National Standards Institute (ANSI)
 - a. Z97.1, Glazing Materials Used in Buildings - Safety Performance Specifications and Methods of Test.
2. ASTM International (ASTM)
 - a. C84, Standard Specification for Dense Elastomeric Compression Seal Gaskets, Setting Blocks, and Spacers.
 - b. C103, Standard Specification for Flat Glass.
 - c. C1048, Standard Specification for Heat-Strengthened and Fully Tempered Flat Glass.
 - d. C137, Standard Specification for Polymeric and Vacuum Deposition Coatings on Flat Glass.
 - e. E119, Standard Test Methods for Fire Tests of Building Construction and Materials.
 - f. E2190, Standard Specification for Insulating Glass Unit Performance and Evaluation.
3. Code of Federal Regulations (CFR)

- a. Title 16 - Commercial Practices, Chapter ii - Consumer Product Safety Commission (CPSC) Subchapter B - Consumer Product Safety Act Regulations:
 - 16 CFR 1201, Safety Standard for Architectural Glazing Materials.
- 4. Glass Association of North America (GANA)
 - a. Glazing Manual.
- 5. Insulating Glass Certification Council (IGCC)
 - Insulating Glass Manufacturers Alliance (IGMA)
 - a. TM-3000, North American Glazing Guidelines for Sealed Insulating Glass Units for Commercial and Residential Use.
- 7. National Fire Protection Association (NFPA)
 - a. 80, Standard for Fire Doors and Other Opening Protectives.
 - 251, Standard Methods of Tests of Fire Resistance of Building Construction and Materials.
 - 252, Standard Methods of Fire Tests of Door Assemblies.
 - 257, Standard on Fire Test for Window and Glass Block Assemblies.
- 8. Underwriters Laboratories, Inc. (UL)
 - a. 9, Standard for Fire Tests of Window Assemblies.
 - 10B, Standard for Fire Tests of Door Assemblies.
 - 203, Standard for Fire Tests of Building Construction and Materials.

1.03 DEFINITIONS

- A. Installer or Applicator:
 - 1. Installer or applicator is the person actually installing or applying the product in the field at the Project site.
 - 2. Installer and applicator are synonymous.
- B. Safety Glazing: Glazing meeting the requirements of the building code and CPSC 16 CFR 1201.
- C. Other terms as identified in CPSC 16 CFR 1201.

1.04 SUBMITTALS

- A. Shop Drawings:
 - 1. Product technical data including:

- a. Acknowledgement that products submitted meet requirements of standards referenced.
 - Manufacturer's installation instructions.
 - c. Certification that glass has been tested and approved for use in fire resistance rated doors or walls.
 - 1 □ Copies of all test criteria.
2. Certification that insulating glass units meet requirements of IGCC and are certified □□ IGCC to ASTM E2190.
- B. Samples:
1. Two, 12 □ 12 inches sample of each type, color, and thickness specified.
 - a. Samples are not required for clear monolithic glass.
- C. Informational Submittals:
1. Warrant □

1.05 WARRANT □

- A. Provide manufacturer's written 10 year warrant □ to cover deterioration of glass, glass units, coatings and ceramic frit.
1. Insulating glass units shall be warranted against failure of hermetic seal resulting in fogging or film formation on the interior glass surfaces.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
1. Glass:
 - a. Guardian Glass □□ Guardian Industries.
 - Insulite Glass Co., Inc.
 - c. NSG/Pilkington.
 - d. Oldcastle Building Envelope.
 - e. Vitro Architectural Glass.
 - f. Viracon.
 2. Gaskets, glazing compounds, setting blocks, spacers, sealant, sealant tape, etc., as recommended □□ glass manufacturer, glass unit fabricator.

- a. Provide materials as required per NFPA for use in fire-rated units.

2.02 MATERIALS

A. General:

1. ASTM C1033
 - a. Clear glass: Type I, Class 1, Quality 3.
 - b. Tinted glass: Type I, Class 2, Quality 3.
2. Thickness: 1/4 inches, unless noted otherwise.

B. Heat Strengthened and Fully Tempered Glass: ASTM C1048.

1. General use: Kind HS.
2. Safety glazing: Kind FT.
 - a. Meet requirements of ANSI Z97.1 and CSPC 16 CFR 1201.
3. Condition:
 - a. Clear or tinted vision glass: Condition A.
 - b. Spandrel Glass (ceramic coated) Condition B.
 - c. Coated vision glass: Condition C.
 1. ASTM C1373, Kind CV or CO.

2.03 MANUFACTURED UNITS

A. Laminated Safety Glass:

1. ASTM C1172, Type II.
 - a. Meet requirements of ANSI Z97.1 and CSPC 16 CFR 1201.
2. Interlayer: Clear plastic manufactured specifically for use in laminated glass.
 - a. Polyvinyl Butyl (PVB) 0.080 inches thick.
 - b. Enhanced Polyvinyl Butyl (EPVB) 0.100 inches thick.
 1. Viracon "StormGuard".

2.04 ACCESSORIES

A. Glazing Compounds:

1. Non-sag, non-stain type.
2. Pigmented to match frame units not requiring painting.
3. Compatible with adjacent surfaces.

4. One- or two-part polyurethane or silicone sealant for use in setting glass.
 - a. Provide glazing compounds which will not be affected by chemicals stored in rooms where glazing compounds are used.
- B. Sealant Tape: Butyl rubber sealant tape or ribbon having a continuous neoprene shim.
- C. Gaskets:
 1. Flexible polyvinyl chloride or neoprene.
 - a. ASTM C844.
 - Provide gaskets which will not be affected by chemicals stored in rooms where gaskets are used.
 2. Extruded of profile and hardness required to receive glass and provide a watertight installation.
 3. Provide gaskets in accordance with NFPA in fire resistance rated glazing.
- D. Setting Blocks and Spacers:
 1. Neoprene or EPDM, compatible with sealants used.
 - a. ASTM C844.
- E. Compressible Filler Stock: Closed cell polyethylene or polyethylene backed polyurethane foam.
- F. Shims, Clips, Screws and Other Miscellaneous Items: As required in condition.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install in accordance with recommendations of manufacturer, GANA Glazing Manual and IGMA TM-3000.
- B. Install setting blocks in adhesive or sealant.
- C. Install spacers inside and out, of proper size and spacing, for all glass sizes larger than 50 united inches, except where gaskets are used for glazing.
- D. Provide 1/8 inches minimum girth of spacers on glass.
- E. Spacer thickness to equal sealant width.
- F. Prevent sealant extrusion from glazing channels of insulating glass which is more than 1/2 inches thick, colored, heat absorbing, coated or laminated glass sizes larger than 75 united inches and other glass more than 9/32 inches thick or larger than 125 united inches.
 1. Leave void at heel or install filler at sills and head.

2. Do not leave void or install filler at sill.
- G. Miter cut and bond gasket ends together at corners.
- H. Immediately after installation, attach crossed streamers to framing held away from glass.
- I. Use polysulfide-based glazing sealants in window assembly and as perimeter sealant around frames in areas which may be exposed to chlorine gas or chlorine liquid splash or spillage.
 1. See Specification Section 07900 for sealants.
- Install fire resistance rated glass in accordance with manufacturer's recommendations and in accordance with applicable fire testing criteria.

3.02 FIELD QUALITY CONTROL

- A. Do not install glass with edge damage.
- B. Do not apply anything to surfaces of glass.
- C. Remove and replace damaged glass.

3.03 CLEANING

- A. Maintain glass reasonably clean during construction, so that it will not be damaged by corrosive action and will not contribute to deterioration of other materials.
- B. Wash and polish glass on both faces not more than seven days prior to acceptance of work in each area.
 1. Comply with glass manufacturer's recommendations.

3.04 SCHEDULES

- A. General:
 1. Provide safety glazing for all applications where required by the building code and CPSC 16 CFR 1201.
 2. Provide heat strengthened glazing for all general use applications where safety glazing is not required.
- B. Glass Type 1: Insulating Low-E Laminated Glass Units.
 1. Exterior lite: 1/4 inches with Viracon VE-2M on #2 surface.
 - a. Color: Gray
 2. 1/2 inches dehydrated air space.
 3. Interior lite: Laminated Glass.
 - a. Exterior ply: 1/4 inches clear.

- Interlayer: See MANUFACTURED UNITS Article in PART 2.
- c. Interior panel 1/4 inches clear.

4. Performance Requirements:

a. Transmittance:

- 1□ Visible light: □□33□□□□ .
- 2□ Solar energy □ □15□□□□ .
- 3□ UV: □□□ 1□□□□ .

□ Reflectance:

- 1□ Exterior: □□□□□□□□ .
- 2□ Interior: □□□9□□□□ .
- 3□ Solar: □□□12□□□ .

c. U-Value

- 1□ Winter: □.29□□□□□
- 2□ Summer: □□.2□□□□□

d. Shading Coefficient: □□.27□□□□

e. Relative Heat Gain: □□58□□□□

f. Solar Heat Gain Coefficient (SHGC) □□.24□□□□

C. Glass Type 2: Insulating Low-E Laminated Glass Units with opaque film.

- 1. Exterior lite: 1/4 inches with Viracon VE-2M on □2 surface.
 - a. Color: □□Gra□□□□□
- 2. 1/2 inches dehydrated air space.
- 3. Interior lite: Laminated Glass.
 - a. Exterior panel 1/4 inches clear.
 - Interlayer: See MANUFACTURED UNITS Article in PART 2.
 - c. Interior panel 1/4 inches clear with opaque film on □□ surface.
- 4. Performance Requirements:
 - a. Transmittance:
 - 1□ Visible light: □□33□□□□ .
 - 2□ Solar energy □ □15□□□□ .

3 UV: 000 10000 .

Reflectance:

1 Exterior: 0000000 .

2 Interior: 0009000 .

3 Solar: 00012000 .

c. U-Value

1 Winter: 0.290000

2 Summer: 0.200000

d. Shading Coefficient: 0.270000

e. Relative Heat Gain: 0.580000

f. Solar Heat Gain Coefficient (SHGC) 0.240000

END OF SECTION

SECTION 09220

SENERG® PLATINUM CI STUCCO ULTRA SYSTEM

Specification for 2 and 3 coat impact-resistant continuous insulated CI premium cement plaster stucco system featuring a rain screen design with enhanced water management

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Refer to all project drawings and other sections of this specification to determine the type and extent of work therein affecting the work of this section, whether such work is specifically mentioned herein.
- B. Platinum CI Stucco Wall System: Composite insulated stucco wall system consisting of air/water-resistive carrier, drainage mat, rigid insulation, plaster base, stucco base, base coat optional, reinforcing mesh optional, primer optional and finish coat.
- C. Senerg® products are listed in this specification to establish a standard of quality. Any substitutions to this specification shall be submitted to and receive approval from the Architect at least 10 days before bidding. Proof of equality shall be borne by the submitter.
- D. The system type shall be Senerg® Platinum CI Stucco Ultra wall system as manufactured by Master Builders Solutions, Shakopee, MN.

1.02 REFERENCES

- A. ASTM C150 Standard Specification for Portland Cement
- B. ASTM C927 Standard Specification for Application of Portland Cement-Based Plaster
- C. ASTM C1063 Standard Specification for Installation of Lathing and Furring to Receive Interior and Exterior Portland Cement-Based Plaster
- D. ASTM C847 Standard Specification for Metal Lath
- E. ASTM C933 Standard Specification for Welded Wire Lath
- F. ASTM C1032 Standard Specification for Woven Wire Plaster Base
- G. ASTM C1704 Standard Test Methods for Non-Metallic Plaster Bases (Lath Used with Portland Cement Based Plaster in Vertical Applications)
- H. ASTM C1787 Standard Specification for Installation of Non-Metallic Plaster Bases (Lath Used with Portland Cement Based Plaster in Vertical Applications)
- I. ASTM C1788 Standard Specification for Installation of Non-Metallic Plaster Bases (Lath Used with Portland Cement Based Plaster in Vertical Applications)
- J. ASTM D227 Standard Specification for Asphalt-Saturated Organic Felt Used in Roofing and Waterproofing

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- K. ASTM D1784 Standard Specification for Rigid Polyvinyl Chloride (PVC) Compounds and Chlorinated Polyvinyl Chloride (PVC) Compounds
- L. ICC-ES AC11 Cementitious Exterior Wall Coatings
- M. CCRR 0230 Intertek Code Compliance Research Report for STUCCOBASE™/STUCCOBASE™ PREMI
- N. CCRR 0249 Intertek Code Compliance Research Report PERMALATH 1000
- O. ESR-343 ICC Evaluation Service, LLC, ES Report™ NEOPOR Rigid Insulation Board
- P. ESR-298 ICC Evaluation Service, Inc., ES Report™ SENERSHIELD-R/RS

1.03 SUBMITTALS

- A. Submit under provisions of Division 01
- B. Product Data: Provide data on Senerg Platinum CI Stucco Ultra wall system materials, product characteristics, performance criteria, limitations and durability.
- C. Code Compliance: Provide manufacturer's applicable code compliance report.
- D. Samples: Submit two 4 inch size samples of Senerg Platinum CI Stucco Ultra wall system illustrating Senerg Finish color and texture range.
- E. Certificate: System manufacturer's approval of applicator.
- F. Sealant: Sealant manufacturer's certificate of compliance with ASTM C920.
- G. System manufacturer's current specifications, typical details, system design guide and related product literature which indicate preparation required, storage, installation techniques, painting requirements and finishing techniques.

1.04 QUALITY ASSURANCE

- A. Manufacturer: More than 10 years in the cement plaster stucco industry, with more than 1000 completed cement plaster stucco projects.
- B. Applicator: Approved Master Builders Solutions in performing work of this section.
- C. Regulator Requirements: Conform to applicable code requirements for cement plaster stucco.
- D. Field Samples
 - 1. Provide under provisions of Division 01
 - 2. Construct one field sample panel for each color and texture, 3 ft in size of system materials illustrating method of attachment, Senerg Finish color and texture.
 - 3. Prepare each sample panel using the same tools and techniques to be used for the actual application.
 - 4. Locate sample panel where directed.

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5. Accepted sample panel may remain as part of the work.

- Field samples shall be comprised of all wall assembly components including substrate, air/water-resistive barrier, drainage mat, rigid insulation, plaster base, stucco base, base coat if specified, reinforcing mesh if specified, primer if specified, finish coat and typical sealant/flashing conditions.

E. Testing

1. General Air/Water-Resistive Barrier Minimum Performance:

TEST	METHOD	CRITERIA	RESULTS
Air Leakage of Air Barrier Assemblies	ASTM E2357	0.2 l/s.m ² @ 75 Pa 0.04 cfm/ft ² @ 1.57 psf	0.0007 l/s.m ² @ 0.0001 cfm/ft ² @ 75 Pa 1.57 psf positive / post conditioning 0.0014 l/s.m ² @ 0.0003 cfm/ft ² @ 75 Pa 1.57 psf negative / post conditioning
Air Permeance of Building Materials	ASTM E2178	0.02 l/s.m ² @ 75 Pa 0.004 cfm/ft ² @ 1.57 psf	0.0049 l/s.m ² @ 75 Pa 0.00098 cfm/ft ² @ 1.57 psf
Rate of Air Leakage	ASTM E283		0.0185 l/s.m ² @ 75 Pa @ 0.0037 cfm/ft ² @ 1.57 psf
Water Vapor Transmission	ASTM E9	Report value	Senershield-R - 18 Perms @grains/Hr. in Hg. ft ² @ 10 mils wet film thickness Senershield-RS - 18 Perms @grains/Hr. in Hg. ft ² @ 12 mils wet film thickness Senershield-R/RS - 14 Perms @grains/Hr. in Hg. ft ² @ 20 mils wet film thickness Senershield-VB - 0.09 Perms @grains/Hr. in Hg. ft ² @ 2 mils wet film thickness
Pull-Off Strength of Coatings	ASTM D4541	Min. 110 kPa @ 15.9 psi or substrate failure	Pass - Tested over exterior gypsum sheathing, ASTM C1177 glass-mat sheathing, cement board, OSB, plywood and galvanized flashing
Nail Sealant Applied without Sheathing Fabric	ASTM D1970	No water penetration at galvanized roofing nail penetration under 127 mm (5") head of water after 3 days at 4° C @ 40°F	Pass
Surface Burning	ASTM E84	Flame Spread @ 25 Smoke Development @ 450	Meets Class A: Flame spread @ 15 Smoke developed @ 95

2. Air/Water-Resistive Barrier ICC-ES AC-212:

TEST	METHOD	CRITERIA	RESULTS
Sequential Testing: 1. Structural 2. Racking 3. Restrained Environmental Conditioning 4. Water Penetration	1. ASTM E 1233 Procedure A 2. ASTM E 72 3. ICC-ES AC-212 4. ASTM E 331	No cracking at joints or interface of flashing No water penetration after 15 min @ 137 Pa @ 2.8 psf	Pass - Tested over OSB and gypsum sheathing No water penetration after 90 min @ 299 Pa @ 24 psf
Sequential Testing: 1. UV Light Exposure 2. Accelerated Aging 3. Hydrostatic Pressure Test	1. ICC-ES AC-212 2. ICC-ES AC-212 3. AATCC 127-1985	No cracking or bond failure to substrate No water penetration after 21.7 in @ 550 mm @ water for 5 hours	Pass
Freeze-Thaw	ASTM E 2485 Method B	No sign of deleterious effects after 10 cycles	Pass - Tested over exterior gypsum sheathing, ASTM C1177 glass-mat sheathing, cement board, OSB, plywood
Water Resistance	ASTM D2247	No deleterious effects after 14 day exposure	Pass - Tested over exterior gypsum sheathing, ASTM C1177 glass-mat sheathing, cement board, OSB, plywood
Tensile Bond	ASTM C 297	Minimum 103 kPa @ 15 psi	Pass - Tested over exterior gypsum sheathing, ASTM C1177 glass-mat sheathing, cement board, OSB, plywood, CMU, PVC and galvanized flashing
Tensile Bond after	ASTM C 297	Minimum 103 kPa @ 15 psi avg @ no	Pass

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freeze-thaw		failure after 10 cycles freeze-thaw	
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3. Air/Water-Resistance Barrier ICC-ES AC 148:

TEST	METHOD	CRITERIA	RESULTS
Sequential Testing: 1. UV Light Exposure 2. Accelerated Aging 3. Hydrostatic Pressure Test	1. ICC-ES AC 148 2. ICC-ES AC 148 3. AATCC 127-1985	No cracking or bond failure to substrate No water penetration after 21.7 in (550 mm) water for 5 hours	Pass
Peel Adhesion	ASTM D 3330 Method F	After UV Exposure After Accelerated Aging After Elevated Temperature Exposure After Water Immersion	Pass - tested over ASTM C1177 glass-mat sheathing, OSB, plywood, PVC and uncoated aluminum
Nail Sealant after Thermal Cycling	ASTM D 1970 Modified AAMA 711	No water penetration at galvanized roofing nail penetration under 1.2" (31 mm) head of water after 24 hours at 40°F (4°C)	Pass
Tensile Strength after UV Exposure	ASTM D 5034, AAMA 711	Minimum 0.5 N/mm (2.9 lb/in)	Pass
Cold Temperature Flexibility	ASTM D 1970, AAMA 711	No cracking after bending around a 1" (25 mm) mandrel after 2 hour exposure to 0°F (-18°C)	Pass
Resistance to Peeling	AAMA 711	No signs of distress or failure after 24 hours of exposure at room temperature, 122°F (50°C), 149°F (65°C), 170°F (80°C)	Pass
Drainage Efficiency	ASTM E2273	90% Minimum	Pass
Transverse Wind-load	ASTM E330	3 5/8" 16 GA steel studs 16" o.c., 1/2" gypsum sheathing, 1 layer ASTM D2265 felt, rigid insulation board, Lath, 1/2" stucco base	Average ultimate loads1: -10.8 kPa (22 PSF) 11.8 kPa (22 PSF) Positive failure could not be reached. All failures in framing
Transverse Wind-load	ASTM E330	2" x 4" wood studs 16" o.c., 7/16" OSB, 1 layer 30-minute grade D paper, rigid insulation board, Lath, 1/2" Stucco Base	Average ultimate loads1: -10.4 kPa (218 PSF) 10.9 kPa (228 PSF) All failures in framing
Surface Burning Characteristics	ASTM E84	Flame spread (25) Smoke developed (450)	Pass
Behavior of materials in a vertical tube furnace at 750°C	ASTM E136	Weight loss of the specimen cannot exceed 50%	Pass
Freeze Thaw	ICC-ES AC11	No deleterious effects after 10 cycles	Pass

4. Platinum CI Stucco Ultra System and Component Performance:

TEST	METHOD	CRITERIA	RESULTS
Drainage Efficiency	ASTM E2273	90% minimum	Flat foam / Drainage Mat / Senerg Air/Water-Resistive Barrier exceeds 90% minimum
Surface Burning	ASTM E84	Flame Spread (25) Smoke Development (450)	Meets Class A: Flame spread (15) Smoke developed (95)
Behavior of materials in a vertical tube furnace at 750°C	ASTM E136		StuccoBase specimens all met the weight loss criteria for passing the tests
Freeze-thaw resistance	Per ICC-ES acceptance criteria - AC11	10 freeze-thaw cycles with no visible evidence of deterioration when examined under 5x magnification	Pass

5. ASTM E330 Wind-Load

NFPA 285 and NFPA 288 Compliant Assemblies:

WALL COMPONENTS	MATERIALS
Base wall system – Use either 1, 2 or 3	1. Concrete wall

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	2. Concrete Masonry wall
Cavity Insulation – Use either 1 or 2	1. None 2. Any noncombustible insulation (faced or unfaced)
Air/water-resistive barrier applied to exterior	Senerg SENERSHIELD-R/RS/VB or DRAINAGEMAT
Exterior insulation – Use either 1, 2, 3, 4 or 5	1. Extruded Polystyrene Foam (EPS) – C578 Type II or Type IV of the Class A per ASTM E84 – maximum thickness – See Note 1 2.
Lath	1. PERMALATH 1000 glass fiber lath 2. Metal lath – either 2.5 lbf/d ² or 3.4 lbf/d ² 3. Wire lath – either 1-1/2 inch, 20-gauge or 1-inch, 17-gauge
Stucco	Stucco Base – Master Builders Solutions - minimum 1/2-inch thick
Finish Coat	Senerg Wall Systems Finish

NOTE – The potential heat of the foam plastic insulation at the maximum installed thickness must not exceed 4999 Btu/ft² as determined in accordance with NFPA 259.

1.05 DELIVERY, STORAGE AND HANDLING - SENERG/MASTER BUILDERS SOLUTIONS MATERIAL

- A. Deliver, store and handle products under provisions of Section 0100.
- B. Deliver materials in original unopened packages with manufacturer’s labels intact.
- C. Protect materials during transportation and installation to avoid physical damage.
- D. Store materials in cool, dry place protected from exposure to moisture and freezing. Store at no less than 40°F/4°C (50°F/10°C for AURORA STONE, AURORA TC-100, ALUMINA finish)
- E. Store MAFLASH at a minimum of 40°F. In cold weather, keep containers at room temperature for at least 24 hours before using.
- F. Store rigid insulation boards flat, in original packaging and protected from direct sunlight and extreme heat.
- G. Store Reinforcing Mesh, SHEATHING FABRIC and WS FLASH flexible flashing in cool, dry place.

1.0 PROJECT/SITE CONDITIONS

- A. Do not apply Master Builders Solutions materials in ambient temperatures below 40°F/4°C (50°F/10°C for AURORA STONE, AURORA TC-100, ALUMINA finish). Provide proper/vented, supplemental heat during installation and drying period when temperatures less than 40°F/4°C (50°F/10°C for AURORA STONE, AURORA TC-100, ALUMINA finish) prevail.
- B. Do not apply to frozen surfaces.
- C. Maintain ambient temperature at or above 40°F/4°C (50°F/10°C for AURORA STONE, AURORA TC-100, ALUMINA finish) during and at least 24 hours after Senerg Platinum CI Stucco Ultra wall system installation and until dry.

1.07 SEQUENCING AND SCHEDULING

- A. Coordinate and schedule installation of Senerg[®] Platinum CI Stucco Ultra wall system with related work of other sections.
- B. Coordinate and schedule installation of trim, flashing, and joint sealers to prevent water infiltration behind the system.

1.08 WARRANT

- A. Provide Master Builders Solutions – Senerg[®] standard warrant for Senerg[®] Platinum CI Stucco Ultra wall system installations under provisions of Division 01 Warrant term varies with system component's configuration, reference Senerg[®] Warrant Schedule technical bulletin for specific information.
- B. Comply with Master Builders Solutions notification procedures to assure qualification for warrant.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. All components of the senerg[®] platinum ci stucco ultra wall system shall be obtained from the system manufacturer or through an authorized distributor.

2.02 MATERIALS

- A. Air/Water-Resistive Barrier Components:
 - 1. Air/Water-Resistive Barrier:
 - a. SENERSHIELD-R: A one-component fluid-applied vapor permeable air/water-resistive barrier.
 - 2. Rough Opening and Joint Treatment:
 - a. MAFLASH: A one-component elastomeric material for use as a flexible flashing membrane.
 - 3. Transitional Membrane / Expansion Joint Flashing
 - a. WS FLASH: 30-mil thick, self-sealing, self-healing composite membrane of polyester fabric and rubberized asphalt. Compatible with Senerg[®] fluid-applied air/water-resistive barriers.
 - b. FLASHING PRIMER: A water-based primer for use prior to application of WS FLASH on all acceptable surfaces.
- B. Drainage Mat Master Builders Solutions: Three-dimensional drainage core consisting of fused, entangled filaments.
- C. Insulation Board: Required, Select One
 - 1. Extruded polystyrene ASTM C578, Type IV.

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- a. Flame spread less than 25, smoke developed less than 450 per ASTM E84, UL 723.
- b. Flexural: 50 psi, compressive: 25 psi, minimum thermal resistance 5/inch at 75°F 24°C 4.55/inch at 40°F 4°C
- c. Minimum density 1.55 lb./ft³ 25 kg/m³
- d. Minimum thickness as indicated on drawings minimum 19 mm 3/4"
- e. Air-dried 7 days, or equivalent, prior to installation.
- f. Edges: square within 1/32" per ft. 0.8 mm per m
- g. Thickness: tolerance of +/- 1/16" 1.6 mm
- h. Maximum Size: 2' x 8' (61 cm x 2.44 m x 10 cm).
- i. Length and width: tolerance of +/- 1/16" 1.6 mm

D. Lath/Plaster Base:

- 1. Expanded Metal Lath: The lath shall comply with ASTM C847. Furring and self-furring requirements shall be as set forth for wire lath. Minimum weight is 2.5 lbs./sq² 1.3 kg/m² Refer to ASTM C 1003 for additional information.

E. Fastening for Rigid Insulation Board and Lath/Plaster Base:

- 1. Masonry: Minimum 3/16" 4.7mm diameter corrosion resistant masonry Wind-lock type MT fastener with Wind-lock ULP 302 washer, Lath Plates or equal with 3/4" 19 mm minimum penetration into masonry

F. Stucco Base Coat:

- 1. STUCCOBASE PREMIUM Master Builders Solutions: Factor blended stucco mixture of Portland cement, reinforcing fibers, sand, and proprietary ingredients.

G. Plaster Sand:

- 1. Must be clean and free from deleterious amounts of loam, clay, silt, soluble salts and organic matter. Sampling and testing must comply with ASTM C897. Plaster sand must be graded within the following limits: Percent retained by weight.

Retained on #2 Percent

U.S. Standard Sieve	Minimum	Maximum
No. 4		0
No. 8	0	10
No. 16	10	40
No. 30	30	55
No. 50	70	90
No. 100	95	100

H. Water: Clean and potable without foreign matter.

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- I. SENERG Adhesive/Base Coat: Required for Trim Shapes and Reinforcing Mesh
1. ALPHA Base Coat: A 100% acrylic base coat, field-mixed with Type I or Type II Portland cement. It has a cream texture that is easily spread.
 2. ALPHA DR Base Coat: A dry-mix polymer adhesive and base coat containing Portland cement, and requires only water for mixing.
- Portland cement Required if ALPHA BASE is Selected Conform to ASTM C150, Type I, II, or I/II, green or white, fresh and free of lumps.
- K. DIAMONDSHIELD Stucco Reinforcing Mesh Master Builders Solutions: A balanced, open-grid triangular glass fiber mesh that distributes stress across three directions for superior crack resistance properties on new or retrofit stucco applications.
- L. STUCCO PRIME Master Builders Solutions: A 100% acrylic-based primer that help alleviate shadowing and reduces chances of efflorescence with standard finishes color to closely match the selected SENERG Finish Color.
- M. SENERG Finish Coat:
1. SENERLASTIC Finish: 100% acrylic based, textured elastomeric finish that provides excellent
 2. flexibility, weatherability, and maximum resistance to mildew growth, air cured, compatible with base coat SENERG finish color will be selected Architect/owner from full color range finish texture to be selected Architect/owner from sample of either:
 - a. FINE: Utilizes uniform sized aggregates for a uniform, fine texture. OR
 - TEXTURE: Can achieve a wide variety of free-formed, textured appearances, including stipple and skip-trowel

2.03 ACCESSORIES

- A. Trim: Casing head, corner head, expansion joint and weep screed accessories shall meet the requirements of ASTM C1063. Accessories shall be vinyl, meeting ASTM D1784 galvanized, meeting ASTM A525 and ASTM A526 or zinc, meeting ASTM B69. Vinyl or zinc accessories are recommended where high humid or salt-laden service conditions exist. Refer to SENERG's Stucco Wall Systems Lath and Trim Accessories technical bulletin for additional information.
1. C-I Weep Track Clark Dietrich or AMICO: For returning insulated stucco into doors windows, etc.
 2. Foundation weep screed: Beveled edge designed to terminate finish system and drain internal moisture.
 3. Casing head: Square edge style.
 4. Corner head: Small radius nose style.
 5. Control joints: W-shaped accordion profile style.

- Expansion Joints: Pair of casing leads spaced for application of sealant lead.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Verify project site conditions under provisions of division 01.
- B. Walls:
 - 1. Substrates:
 - a. When applying SENERGY Air/Water-Resistive Barriers to concrete/unit masonry, verify concrete/unit masonry is free of dust, dirt, grease, oils, laitance, efflorescence, biological residue, existing paint or coatings, curing compounds, form release agents, or any other contaminants which might affect the bond. Masonry walls should be properly cured to full load bearing capacity, laid true, and with joints tooled. Properly prepared concrete will have an open texture similar to fine grit sandpaper.
 - Examine surfaces to receive system and verify that substrate and adjacent materials are dry, clean, and sound. Verify substrate surface is flat, free of fins or planar irregularities greater than 1/4" in 10' or 3 mm in 3 m.
 - 2. Flashings:
 - a. All flashings are others and must be installed in accordance with specific manufacturer's requirements. Where appropriate, end-dams must be provided.
 - Openings must be flashed prior to window/door, HVAC, etc. installation. Refer to *Secondary Moisture Protection Barrier Guidelines for Senergy Stucco Wall System* technical bulletin or *Air/Water-Resistive/Vapor Barrier Application Guidelines* technical bulletin for further guidance.
 - c. Windows and openings shall be flashed per design and building code requirements.
 - d. Individual windows that are ganged to make multiple units require continuous head flashing and/or the joints between the units must be fully sealed.
 - 3. Roof: Verify that all roof flashings have been installed in accordance with the guidelines set by the Asphalt Roofing Manufacturers Association (ARMA).
 - 4. Kick-out Flashing: Kick-out flashing must be installed where required. The kick-out flashing must be leak-proof and angled (min 100°) to allow for proper drainage and water diversion. Refer to SENERGY Platinum CI Stucco Ultra wall system typical details.
- C. Do not proceed until all unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Protect all surrounding areas and surfaces from damage and staining during application of SENERG® Platinum CI Stucco Ultra wall system.
- B. Protect finished work at end of each day to prevent water penetration.

3.03 MIXING

General: no additives are permitted unless specified in product mixing instructions. Close containers when not in use. Prepare in a container that is clean and free of foreign substances. Do not use a container which has contained or been cleaned with a petroleum-based product. Clean tools and equipment with water immediately after use. Dried material can only be removed mechanically.

A. Air/Water-Resistive Barriers:

1. SENERSHIELD-R/RS/VB: Mix with a clean, rust-free paddle and drill until thoroughly blended. Do not add water.
2. Cold Temperature Additive: LT ADDITIVE: Pour the entire contents of one 1 quart bottle of LT ADDITIVE into one 1 full pail of SENERSHIELD-R, SENERSHIELD-RS or SENERSHIELD-VB. Mix with a clean, rust-free paddle and drill until fully blended.

B. Stucco Base Coat:

1. STUCCOBASE: Use mixer which is clean and free of foreign substances. Add 5-8 gallons (18.9-22.7 liters) of clean potable water to mixer per one bag of STUCCOBASE. Add one bag of STUCCOBASE and one half 100-120 lbs. (45.4-54.4 kg) of the required plaster sand (ASTM C144 or ASTM C897) Mix for 3-4 minutes at normal mixing speed while adding the remainder 100-120 lbs. (45.4-54.4 kg) of the plaster sand. Allow material to set for 2-4 minutes and then re-mix adding water to achieve desired consistency. Desired consistency varies with type of application (trowel or gun), substrate (paper-backed lath or block) and whether the stucco is applied to a wall or a ceiling. Note: Continuous mixing may cause excessive air entrainment.
2. STUCCOBASE PREMIER: Use mixer which is clean and free of foreign substances. Add 2-2.5 gallons (7.6-9.5 liters) of clean potable water to mixer. Slowly add one bag of STUCCOBASE PREMIER. Mix for one minute at normal mixing speed. Allow material to set for 2-4 minutes with mixing blades at rest. Then re-mix adding water to achieve desired consistency. Desired consistency varies with type of application (trowel or gun), substrate (paper-backed lath or block) and whether the stucco is applied to a wall or a ceiling. Note: Continuous mixing may cause excessive air entrainment.

C. Senerg® Base Coat:

1. ALPHA Base Coat: Mix base coat with a clean, rust-free paddle and drill until thoroughly blended, before adding Portland cement. Mix one part (by weight) Portland cement with one part base coat. Add Portland cement in small increments,

mixing until thoroughly blended after each additional increment. Clean, potable water may be added to adjust workability.

2. ALPHA DR Base Coat: Mix and prepare each bag in a 19-liter (5-gallon) pail. Fill the container with approximately 5.5 liters (1.5-gallons) of clean, potable water. Add ALPHA DR Base Coat in small increments, mixing after each additional increment. Mix ALPHA DR Base Coat and water with a clean, rust-free paddle and drill until thoroughly blended. Additional ALPHA DR Base Coat or water may be added to adjust workability.
- D. STUCCO PRIME and TINTED PRIMER: Mix the factory-prepared material with a clean, rust-free paddle and drill until thoroughly blended. A small amount of clean, potable water may be added to adjust workability. Do not overwater.
- E. Senergo Finishes - SENERFLEX, SENERLASIC, SENERLASTIC PLUS, SENERFLEX TERSUS, CHROMA, and ENCAUSTO VERONA Finish: Mix the factory-prepared material with a clean, rust-free paddle and drill until thoroughly blended. A small amount of clean, potable water may be added to adjust workability. Do not overwater, 10 oz maximum.
- F. Special Finish - AURORA TC-100, AURORA STONE, and ALUMINA Finish: Gently mix the contents of the pail for 1 minute using a low RPM 1/2" drill equipped with a mixing paddle such as a Demand Twister or a Wind-lock B-MEW, B-M1 or B-M9.

3.04 APPLICATION

- A. Accessories:
- B. Attach Window/Door Drip Edge level and per manufacturer's instructions.
- C. Air/Water-Resistive Barrier:
1. Substrate shall be dry, clean, sound, and free of releasing agents, paint, or other residue or coatings. Verify substrate is flat, free of fins or planar irregularities greater than 1/4" in 10' or 4 mm in 3 m.
 2. Unsatisfactory conditions shall be corrected before application of the Senergo air/water-resistive barriers.
 3. Apply the MAFLASH in accordance with MAFLASH product Bulletin.
 4. Installed materials shall be checked before continuing system application.
 5. Installed materials shall be checked before continuing system application.
- D. DRAINAGE MAT:
1. Apply DRAINAGE MAT horizontal or vertical over Senergo Air/Water-Resistive Barrier ensuring it is free of wrinkles.
 2. Cut all vertical and horizontal edge and Secure DRAINAGE MAT to substrate with sufficient building staples or galvanized nails to remain in place prior to application of insulation board.

E. Insulation Board:

1. Vertical Surfaces: Begin at base of wall with firm temporary support
 2. Apply horizontal in running bond pattern.
 3. Precut insulation board to fit openings and projections and install as a single piece around corners of openings. Stagger vertical joints and corners. Stagger insulation board and sheathing joints.
 4. Cut all joints and ensure an overall flush surface.
 5. With appropriate fastening system, temporarily secure insulation board with minimum two fasteners per board.
- Rasp flush any irregularities that would interfere with proper application of lath.

F. Trim: Refer to Senergo Stucco Wall Systems Lath and Trim Accessories technical Bulletin.

G. Lath: Install in accordance with all local code requirements, applicable standards and application procedures.

1. Expanded Metal Lath

- a. The metal lath shall be applied with minimum 1/2" (13 mm) side laps and 1" (25 mm) end laps.
- When end laps occur between supports, lace or wire ties the ends of the sheets with 0.0475" (1.2 mm) galvanized annealed steel wire.
- c. Refer to ASTM C1063 for additional fastening information.

H. Stucco Base Coat:

1. Senergo Platinum CI Stucco Ultra wall system application 3/8"–1/2" thickness (9.5-12.7mm)
 - a. Following surface preparation and installation of the lath and accessories apply selected Master Builders Solutions stucco base mixture to the approved substrate by hand troweling or machine spraying to a thickness of 3/8" to 1/2" (9.5-12.7mm) completely embedding the lath.
 - Use rod and darby to level the applied base coat without exposing the lath.
 - c. After initial set begins and surface has sufficiently hardened, use sponge or hard rubber float as required to fill voids, holes or imperfections, leaving the surface ready to receive Senergo Finish.
 - d. At subcontractor's option, the double back method of application, whereby the first and second coats are applied and cured as one system, may be used. If this system is used, the second coat should be applied as soon as the first coat is rigid.

- e. Damp cure for at least 48 hours □□lightl□and evenl□fogging the surface with water at least twice a da□. Direct sunlight, hot temperatures, low humidit□and wind□conditions ma□make additional fogging necessar□.
 - f. Allow stucco □base to cure a minimum of □ da□s prior to application of EPS □board shapes, Senerg□□base coat, STUCCOPRIME or Senerg□Finish application.
2. Senerg□Platinum CI Stucco Ultra wall s□stem application 3/4”–7/8” thickness (19-22mm□
- a. Nominal plaster □base coat thickness:
 - 1□ First coat “scratch”: 3/8” (9.5mm□
 - 2□ Second coat “brown”: 3/8” (9.5mm□
 - Appl□first coat to completel□em□ed lath. Cross rake to provide ke□for second □rown coat. Coat must □e uniform in thickness. Ensure the first coat is properl□ “scratched” and sufficiently rigid to resist cracking prior to application and leveling of the second or “brown” coat.
 - c. Dampen scratch coat, appl□second □rown coat to provide the re□uired total thickness. Trowel stucco □base into trim to seat trim. The lath shall □e full□ em□bedded in the coating and shall □e completel□covered. Coat must □e uniform in thickness. Rod off to desired thickness, leveled with screeds, to provide a true, flat plane. Follow this □□wood floating or dar□□ing the surface.
 - d. After the surface has sufficientl□hardened, use sponge or hard ru□□er float as re□uired to fill voids, holes or imperfections, leaving the surface read□to receive Senerg□Finish.
 - e. Damp cure for at least 48 hours □□lightl□and evenl□fogging the surface with water at least twice a da□. Direct sunlight, hot temperatures, low humidit□and wind ma□make additional fogging necessar□.
 - f. Allow stucco □base to cure a minimum of □ da□s prior to application of EPS □board shapes, Senerg□Base Coat, STUCCOPRIME or Senerg□Finish application.
- I. Senerg□Adhesive/Base Coat:
- 1. Appl□a skim coat of Senerg□Base Coat, approximatel□1/16” □.□mm□thick to properly cured “brown coat” of stucco □base.
 - 2. Allow to dr□hard □normall□8 to 10 hours□
 - DIAMONDSHIELD Reinforcing Mesh:
 - 1. Base coat shall □e applied to achieve reinforcing mesh em□edment with no reinforcing mesh color visi□e.
 - 2. Install DIAMONDSHIELD over properl□cured Senerg□Platinum CI Stucco Ultra System “brown coat” of stucco □base.

3. Apply mixed Senerg Base Coat to entire surface of "brown coat" with a stainless-steel trowel to embed the reinforcing mesh.
4. Immediately place DIAMONDSHIELD Reinforcing Mesh against wet base coat and embed the reinforcing mesh into the base coat by troweling from the center to the edges.
5. Lap reinforcing mesh 2 1/2" (64 mm) minimum at edges.
 - Ensure reinforcing mesh is continuous at corners, void of wrinkles and embedded in base coat so that no reinforcing mesh color is visible.
7. If required, apply a second layer of base coat to achieve total nominal base coat/reinforcing mesh thickness of 1/16" (1.6 mm)
8. Allow base coat with embedded reinforcing mesh to dry hard normally 8 to 10 hours

K. STUCCO PRIME and TINTED PRIMER:

1. Apply Primer to the base coat/reinforcing mesh with a sprayer, 3/8" (10 mm) nap roller, or good quality latex paint brush at a rate of approximately 150- 250 ft² per gallon (3.3-4.1m² per liter)
2. Primer shall be dry to the touch before proceeding to the Senerg Finish coat application.

L. Senerg Finish Coat: SENERFLEX, SENERLASTIC, SENERLASTIC PLUS, SENERFLEX TERSUS and CHROMA.

1. Apply Senerg Finish directly to the base coat with a clean, stainless steel trowel.
2. Apply and level Senerg Finish during the same operation to minimum obtainable thickness consistent with uniform coverage.
3. Maintain a wet edge on Senerg Finish by applying and troweling continually over the wall surface.
4. Work Senerg finish to corners, joints or other natural breaks and do not allow material to set up within an uninterrupted wall area.
5. Float Senerg Finish to achieve final texture.

3.05 CLEANING

- A. Clean work under provisions of Division 01
- B. Clean adjacent surfaces and remove excess material, droppings, and debris.

3.0 PROTECTION

- A. Protect Stucco Base from rain, snow and frost for 48-72 hours following application.

PROJECT NO. 11843 PROGRESSO VILLAGE STORM WATER IMPROVEMENTS

- B. Protect Senergo base coat, air/water-resistive barriers, primer and finish from rain and temperatures below 40°F (4°C) for 24 hours or until dry
- C. Protect installed construction under provisions of Division 01

END OF SECTION

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SECTION 09240

SENTR® STUCCO WITH MASTERSEAL® 581 WALL SYSTEM

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Refer to all project drawings and other sections of this specification to determine the type and extent of work therein affecting the work of this section, whether or not such work is specifically mentioned herein.
- B. System Description: Composite wall system consisting MasterSeal® 581 waterproofing, STUCCOBASE™/ STUCCOBASE™ PREMI® Master Builders Solutions, STUCCOPRIME (optional) and Senerg® Finish Coat.
- C. Senerg® products are listed in this specification to establish a standard of quality. Any substitutions to this specification shall be submitted to and receive approval from the Architect at least 10 days before bidding. Proof of equality shall be borne by the submitter.
- D. The system type shall be Sentr® Stucco with MasterSeal 581 Wall System as manufactured by Master Builders Solutions, Shakopee, MN.

1.02 RELATED SECTIONS

- A. Section 04220 Concrete Block Masonry
- B. Section 07190 Vapor Barriers
- C. Section 08000 Openings

1.03 REFERENCES

- A. ASTM C150 Standard Specification for Portland Cement
- B. ASTM C927 Standard Specification for Application of Portland Cement-Based Plaster
- C. ASTM D1784 Standard Specification for Rigid Polyvinyl Chloride (PVC) Compounds and Chlorinated Polyvinyl Chloride (PVC) Compounds
- D. ICC-ES AC11 Cementitious Exterior Wall Coatings
- E. CCRR 0230 Intertek Code Compliance Research Report STUCCOBASE/ STUCCOBASE PREMI®

1.04 SUBMITTALS

- A. Submit under provisions of Section 01300
- B. Product Data: Provide data on Sentr® Stucco with MasterSeal 581 Wall System materials, product characteristics, performance criteria, limitations and durability.

- C. Code Compliance: Provide manufacturer’s applicable code compliance report.
- D. Samples: Submit two inch size samples of Sentr Stucco with MasterSeal 581 Wall System illustrating Finish Coat color and texture range.
- E. Certificate: System manufacturer’s approval of applicator.
- F. Sealant: Sealant manufacturer’s certificate of compliance with ASTM C1382.
- G. System manufacturer’s current specifications, typical details, system design guide and related product literature which indicate preparation required, storage, installation techniques, pointing requirements and finishing techniques.

1.05 QUALITY ASSURANCE

- A. Manufacturer: More than 10 years in the cement plaster stucco industry with more than 1000 completed cement plaster stucco projects.
- B. Applicator: Approved Master Builders Solutions in performing work of this section.
- C. Regulator Requirements: Conform to applicable code requirements for cement plaster stucco.
- D. Field Samples
 - 1. Construct one field sample panel for each color and texture, 2 feet in size of system materials illustrating method of attachment, surface finish color and texture.
 - 2. Prepare each sample panel using the same tools and techniques to be used for the actual application.
 - 3. Locate sample panel where directed.
 - 4. Accepted sample panel may not remain as part of the work.
 - 5. Field samples shall be comprised of all wall assembly components including substrate, MASTERSEAL 581, plaster trim accessories, STUCCOBASE™/STUCCOBASE™ PREMI Master Builders Solutions, STUCCOPRIME (if specified), Senerg Finish Coat and typical sealant/flashing conditions.

E. Testing:

1. Sentr Stucco with MasterSeal 581 Wall System and Component Performance:

TEST	METHOD	CRITERIA	RESULTS
Freeze-thaw Resistance	Per ICC-ES acceptance criteria AC-11	No sign of deleterious effects after 10 cycles	STUCCOBASE passed with no visible evidence of deterioration when examined under 5x magnification
Water Vapor Transmission	ASTM E91 -Wet Cup	Report Value	STUCCOBASE 20.4 perms
Compressive Strength	ASTM C109	Report Value	22.4 MPa (3245 psi) average for STUCCOBASE
Flexural Strength	ASTM C348	Report Value	4.57 MPa (663 psi) average for STUCCOBASE
Surface Burning	ASTM E84	Report Value	25 Flame Spread 450 Smoke Developed Includes StuccoBase, and Senerg Finishes

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Non-Combustible	ASTM E136	No flaming, excess temperature rise or weight loss when exposed to 750°C (1382°F)	Pass StuccoBase
Fire Resistance Rated Assemblies	ASTM E119	No transmission of heat greater than 250°F above ambient; no passage of flame or hot gasses; no passage of water from hose stream test for load-bearing walls – able to withstand load under test conditions	Does not affect rating of concrete or masonry wall

2. MASTERSEAL 581:

PROPERTY	RESULTS	TEST METHOD
Initial Set, min at 70 °F (21 °C) 50% rh	10	La Method
Final Set, at 70 °F (21 °C) 50% rh	90	La Method
Density (cured) lbs/ft ³ (kg/m ³)	129 (2,080)	La Method
Positive resistance to hydrostatic pressure, hrs, at 200 psi (1.4 MPa) 4' head ft, air cured at 70 °F (21 °C) 50% rh	752 No leakage, no softening	CRD C 48, modified
Negative resistance to hydrostatic pressure, hrs, at 200 psi (1.4 MPa) 4' head ft, air cured at 70 °F (21 °C) 50% rh	4 Limit Dampness	CRD C 48, modified
Water absorption, %, boiling water submersion at 24 hours	3%	ASTM C 67 Section 7.3
Compressive strength, psi (MPa) 7 days 28 days	4,200 (29) 10,030 (42)	ASTM C 109
Flexural strength, psi (MPa) 7 days 28 days	3 (2.5) 1,027 (7)	ASTM C 348
Tensile strength, psi (MPa) 7 days 28 days	250 (2) 440 (3)	ASTM C 190
Artificial weathering, hrs. Fenon Arc Carbon Arc	5,000 No failure 500 No failure	ASTM G 2 ASTM G 23
Adhesion strength, psi (MPa)	418 (2.9)	Test tensile bond
Artificial weathering, 500 hours	No cracking, loss of adhesion, checking, or other defect	Atlas Type DMC weatherometer
Freeze/thaw resistance, 200 cycles	No change	ASTM C 666 Procedure B

PROJECT NO. 11843 PROGRESSO VILLAGE STORM WATER IMPROVEMENTS

Salt spray resistance, 300 hours	No defect	ASTM B 117
Carbon Dioxide (CO ₂) in mm	1/16 in. Equivalent to 3/4" 19 mm new concrete	La Method Diffusion
Permeance, perms	12 0.10 98 8 103 resistance	ASTM E 9 Water-vapor transmission Swedish standard SS-02-15-82
Wind-driven rain, hrs	8 excellent	Fed. Spec. TT-P-0035 Para 4.4.7
Coefficient of thermal expansion, in/in/°F mm/mm/°C at 28 days	99 10-5 10-7	ASTM C 531
Impact strength Gardener impact tester	No chipping	Fed. Spec. TT-P-0035 Cement paints para. 3.4.8
Hardness, Barcol Coleman Impressor Requirement min 30, max 0 7 days 14 days 21 days	35 47 52	Fed. Spec. TT-P-0035 para 4.4.9
Abrasion resistance, 3,000 L sand	Passed	Fed. Spec. TT-P-141B
Standard Reflectance Graco MasterSeal 581 White MasterSeal 581	4.2 88.1	ASTM D 2244 using Hunterlab D-25 meter
Fungus resistance, at 21 days	No growth meets all requirements	Fed. Spec. TT-P-29B
Surface turning characteristics Flame Spread Smoke developed	0 5	ASTM E 84
Fire Propagation Flame spread	Index 1.5 Class 1	BS47 Part 1981 BS47 Part 7:1971

1.01 DELIVERY, STORAGE AND HANDLING

- A. Deliver, store and handle products under provisions of Section 0100.
- B. Deliver Master Builders Solutions materials in original unopened packages with manufacturer's labels intact.
- C. Protect Master Builders Solutions materials during transportation and installation to avoid physical damage.
- D. Store Master Builders Solutions materials in cool, dry place protected from freezing. Store at no less than 40°F/4°C 50°F/10°C AURORA STONE, AURORA TC-100 and ALUMINA finish.
- E. Store insulation boards flat and protected from direct sunlight and extreme heat.
- F. Store Reinforcing Mesh before flashing in cool, dry place.

1.02 PROJECT/SITE CONDITIONS

- A. Do not apply Master Builders Solutions material in ambient temperatures below 40°F/4°C 50°F/10°C for AURORA STONE, AURORA TC-100 and ALUMINA Finish. Provide proper vented, supplemental heat during installation and drying period when temperatures less than 40°F/4°C 50°F/10°C for AURORA STONE, AURORA TC-100 and ALUMINA Finish prevail.
- B. Do not apply materials to frozen surfaces.

- C. Maintain ambient temperature at or above 40°F/4°C (50°F/10°C for AURORA STONE, AURORA TC- 100 and ALUMINA Finish) during and at least 24 hours after Sentr Stucco Ultra Wall System installation and until dry.

1.03 SEQUENCING AND SCHEDULING

- A. Coordinate and schedule installation of Sentr Stucco with MasterSeal 581 Wall System with related work of other sections.
- B. Coordinate and schedule installation of trim, flashing, and joint sealers to prevent water infiltration behind the system.

1.04 WARRANTY

- A. Provide Master Builders Solutions – Senerg standard material warranty for Sentr Stucco with MasterSeal 581 Wall System installations under provisions of Section 01740. Warranty term varies with system component's configuration, reference Senerg Warranty Schedule technical Bulletin for specific information.
- B. Comply with Master Builders Solutions notification procedures to assure qualification for warranty.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. All components of the Sentr Stucco with MasterSeal 581 Wall System shall be obtained from the system manufacturer or through an authorized distributor.

2.02 MATERIALS

- A. MASTERSEAL 581 Waterproof Barrier: Portland cement-based coating for concrete and masonry that resists both air infiltration and positive as well as and negative hydrostatic pressure. Polymer-modified with MASTEREMACO A 100, MasterSeal 581 creates a low maintenance and highly durable waterproof barrier.
- B. MASTEREMACO A 100: An acrylic-polymer emulsion which enhances the adhesion, physical properties and durability of MASTERSEAL 581.
- C. Stucco Base Coat: ~~Required~~, Select One
 - 1. STUCCOBASE 100 Master Builders Solutions: Factory-blended stucco mixture of Portland cement, reinforcing fibers, and proprietary ingredients.
- D. Water: Clean and potable without foreign matter.
- E. Adhesives/Base Coats:
 - 1. ALPHA Base Coat: A 100 acrylic base coat, field-mixed with Type I or Type II Portland cement. It has a cream texture that is easily spread.
 - 2. STUCCO SURFACE LEVELER 100 Master Builders Solutions: A polymer-modified dry-mix leveling and embedment coat for use with Senerg Stucco Systems and other Portland Cement Based Stucco

- F. Portland Cement: Conform to ASTM C150, Type I, II, or I/II, green or white, fresh and free of lumps.
- G. SRT MESH [Master Builders Solutions] a woven fiberglass mesh with mechanical strength and dimensional stability for superior crack resistance properties on new or retrofit stucco applications.
- H. STUCCOPRIME Prime [Master Builders Solutions: A 100 acrylic-based primer] color to closely match the selected Senergy Finish Color.

2.03 ACCESSORIES

- A. Trim: Casing lead, corner lead, expansion joint and weep screed accessories shall meet the requirements of ASTM C1063. Accessories shall be: vinyl, meeting ASTM D1784 galvanized, meeting ASTM A525 and ASTM A526 or zinc, meeting ASTM B69. Vinyl or zinc accessories are recommended where high humidity or salt-laden service conditions exist. Refer to Senergy's Stucco Wall Systems Lath and Trim Accessories Bulletin for additional information.
 1. Foundation weep screed: Beveled edge designed to terminate finish system and drain internal moisture.
 2. Casing lead: Square edge style.
 3. Corner lead: Small radius nose style.
 4. Control joints: W-shaped accordion profile style.
 5. Expansion joints: Two piece type slip-joint design or pair of casing leads spaced for application of sealant lead

PART 3 - EXECUTION

3.01 EXAMINATION

A. Walls

1. Substrates
 - a. Acceptable substrates are poured concrete and unit masonry
 - b. Verify concrete/unit masonry is free of dust, dirt, grease, oils, laitance, efflorescence, biological residue, existing paint or coatings, curing compounds, form release agents, or any other contaminants which might affect the bond of MASTERSEAL 581. Properly prepared concrete will have an open texture similar to fine grit sandpaper. Masonry walls should be properly cured to full load bearing capacity, laid true, and with joints tooled.
 - c. Examine surfaces to receive system and verify that substrate and adjacent materials are dry, clean, and sound. Verify substrate surface is flat, free of fins or planar irregularities greater than 1/4" in 1000 mm in 3 m
2. Flashings:

- a. All flashings are others and must be installed per project design detailing. Where appropriate, end-dams must be provided.
3. Roof: Verify that all roof flashings have been installed in accordance with the guidelines set by the Asphalt Roofing Manufacturers Association (ARMA)
- B. Kick-out Flashing: Must be installed where required. The kick-out flashing must be leak-proof and angled (min 100°) to allow for proper drainage and water diversion. Do not proceed until all unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Protect all surrounding areas and surfaces from damage and staining during application of Sentr Stucco with MasterSeal 581 Wall System.
- B. Protect finished work at end of each day to prevent water penetration.

3.03 MIXING

General: No additives are permitted unless specified in product mixing instructions. Close containers when not in use. Prepare in a container that is clean and free of foreign substances. Do not use a container which has contained or been cleaned with a petroleum-based product. Clean tools and equipment with water immediately after use. Dried material can only be removed mechanically.

- A. MASTERSEAL 581 and MASTEREMACO A 100: Mix MASTERSEAL 581 with a mixing liquid consisting of a blend of MASTEREMACO A 100 diluted with water. Maximum dilution ratio is one part MASTEREMACO A 100 to four parts water. Approximately four quarts of mixing liquid is needed per 50 lbs. of MASTERSEAL 581 powder. For best results, mechanically mix MASTERSEAL 581 with a slow-speed drill and mixing paddle. Gradually add the powder to the mixing liquid while drill is running.
- B. Stucco Base Coat:
 1. STUCCOBASE PREMI: Use mixer which is clean and free of foreign substances. Add 2-2.5 gallons (7.6-9.5 liters) of clean potable water to mixer. Slowly add one bag of STUCCOBASE PREMI. Mix for one minute at normal mixing speed. Allow material to set for 2-4 minutes with mixing blades at rest. Then re-mix, adding water to achieve desired consistency. Desired consistency varies with type of application (trowel or gun) substrate and whether the stucco is applied to a wall or a ceiling.
- C. Adhesives/Leveler Base Coats:
 1. ALPHA Base Coat: Mix base coat with a clean, rust-free paddle and drill until thoroughly blended, before adding Portland cement. Mix one-part by weight Portland cement with one-part base coat. Add Portland cement in small increments, mixing until thoroughly blended after each additional increment. Clean, potable water may be added to adjust workability.
 2. STUCCO SURFACE LEVELER: Mix and prepare each bag in a 5-gallon (19-liter) pail. Fill the container with approximately 1.3-gallons (5 liters) of clean, potable water. Add leveler in small increments, mixing after each additional increment. Mix leveler and water with a clean, rust-free paddle and drill until thoroughly blended.

Additional 0.3 gallons of water for a maximum of 1.0 gallons (3.8 liters) may be added to adjust workability. Retemper before use if needed. Let stand for 5 to 10 minutes, then remix for 1 minute.

- D. Primer: Thoroughly mix the factory-prepared STUCCOPRIME with a paddle and drill to a uniform consistency. A small amount of clean, potable water may be added to adjust workability.
- E. SENERGY Finish Coat:
 - 1. SENERFLEX, MAELASTIC, SENERFLEX TERSUS, CHROMA and ENCAUSTO VERONA Finish: Mix the factory-prepared material with a clean, rust-free paddle and drill until thoroughly blended. A small amount of clean, potable water may be added to adjust workability. Do not overwater.

3.04 APPLICATION

- A. MASTERSEAL 581 Waterproof Barrier: Dampen concrete or unit masonry with SSD mist prior to MASTERSEAL 581 application. Apply with a stiff bristle brush using a two coat application. Brush apply first coat vertically and second coat horizontally, as this will allow the MASTERSEAL 581 to act as a scratch coat for the stucco. Allow 24 hours between coats. The total thickness of the 2 coats should not exceed 1/8". Allow second coat of MASTERSEAL 581 to cure 24 hours prior to STUCCOBASE application. Install according to the manufacturer's specifications and all applicable building code requirements. The waterproof barrier shall be free of any damage such as holes or cracks and must be applied to all surfaces to receive the SENERGY Stucco with MasterSeal 581 Wall System. Wrap the water resistive barrier into rough openings (doors, windows, etc.). Coordinate work with other trades to assure proper sequencing, detailing and installation of materials.
- B. Trim Junction: When two pieces of trim meet: Set intersection of trim in a minimum 4" (100 mm) bed of acceptable trim sealant. Allow 1/8"-3/16" (3-5 mm) gap between the abutting trim pieces. Do not overlap trim. Attach the trim in accordance with manufacturer's specifications, true expansion joints must be fastened to the structural substrate.
 - 1. When two or more pieces of trim intersect: The vertical trim piece shall be continuous with all horizontal pieces. Miter all corners at intersections of trim, set intersection of trim in a minimum 4" (100 mm) bed of acceptable trim sealant. Allow 1/8"-3/16" (3-5 mm) gap between the intersecting trim pieces. Do not overlap the trim. Attach the trim in accordance with manufacturers' specifications.
NOTE TO SPECIFIER: It is the sole responsibility of the project design team, including the architect, engineer, etc., to ultimately determine specific expansion and control joint placement, width and design.
- C. STUCCOBASE/STUCCOBASE PREMIUM Base Coat: Apply the STUCCOBASE/STUCCOBASE PREMIUM mixture to the cured MASTERSEAL 581 by hand troweling to a thickness of 3/8" to 1/2". Use rod and darby to level the applied stucco base coat. After initial set begins and surface has sufficiently hardened, use sponge or hard rubber float as required to fill voids, holes or imperfections, leaving the surface ready to receive SENERGY finish coat. At subcontractor's option, the double

Back method of application, where two coats scratch and brown are applied and cured as one system, may be used. If this system is used, the second coat brown should be applied as soon as the first coat is rigid and able to support the second coat. For either application method, damp cure for at least 48 hours light and even fogging the surface with water at least twice a day. Direct sunlight, hot temperatures, low humidity and wind conditions may make additional fogging necessary. Allow STUCCOBASE/STUCCOBASE PRIMER to cure a minimum of 3 days prior to application of EPS insulation board shapes, Senerg base coat and reinforcing mesh, STUCCOPRIME or Senerg finish coat.
NOTE: MASTERSEAL 581 and STUCCOBASE application should not exceed a total of 5/8".

- D. STUCCOPRIME Primer: Apply to STUCCOBASE or "brown" coat with a sprayer, 3/8" nap roller or good-quality latex paint brush at a rate of approximately 150-250ft² per gallon (3.0-1.0m² per liter). STUCCOPRIME shall be dry to the touch before proceeding with the Senerg finish coat application.
- E. Adhesive/Base Coat:
1. As a base coat: apply a skim coat of Senerg base coat, approximately 1/16" (1.6mm) thick to properly cured "brown coat" of stucco base coat.
 2. As an adhesive: Apply mixed base coat to entire surface of insulation board using a stainless-steel trowel with 1/2"x1/2" (13mm x 13mm) notches spaced 1/2" (13mm) apart or 3/8"x3/8" (10mm x 10mm) notches spaced 3/8" (10 mm) apart.
- F. SRT Mesh: Apply mixed selected Base/Level Coat to entire surface of stucco with a stainless-steel trowel. Immediately place mesh against wet Senerg Base/Level Coat and embed mesh into the Base/Level Coat by troweling from center to the edges. Lap SRT MESH 2 1/2" (64mm) minimum at edges. Ensure mesh is continuous, void of wrinkles and embedded in Base Coat so that no mesh is visible. If required, apply a second layer of Base Coat to achieve total nominal Base Coat / SRT MESH thickness of 1/16" (1.6mm). Allow Base Coat with embedded mesh to dry hard (normally 8 to 10 hours) prior to finish coat application.
- G. Senerg Finish Coat: SENERFLEX, MAFLASTIC, SENERFLEX TERSUS and CHROMA Finish
1. Apply Senerg Finish directly to the base coat with a clean, stainless steel trowel.
 2. Apply and level Senerg Finish during the same operation to minimum obtainable thickness consistent with uniform coverage.
 3. Maintain a wet edge on Senerg Finish by applying and troweling continually over the wall surface.
 4. Work Senerg finish to corners, joints or other natural breaks and do not allow material to set up within an uninterrupted wall area.
 5. Float Senerg Finish to achieve final texture.
- H. ALIMINA Finish:

1. Apply TINTED PRIMER from Master Builders Solutions to substrate in accordance with current product Bulletin. Primer shall be of corresponding color for selected ALUMINA Finish color. Allow Primer to dry to the touch before proceeding Finish application.
 2. Apply a tight coat of finish with a clean, stainless-steel trowel.
 3. Maintain a wet edge on finish during applying and leveling continually over the wall surface.
 4. Work finish to corners, joints or other natural breaks and do not allow material to set up within an uninterrupted wall area. Allow first coat to set until surface is completely dry prior to applying a second coat of finish.
 5. Use a stainless-steel trowel and apply the second coat of finish. Achieve final texture using circular motions.
- Total thickness of finish must be between 1/16" (1.6 mm) and 1/8" (3.2 mm)

3.05 CLEANING

- A. Clean adjacent surfaces and remove excess material, droppings, and debris.

3.06 PROTECTION

- A. Protect base coat from rain, snow and frost for 48–72 hours following application.
- B. Protect installed construction.

END OF SECTION

SECTION 09900

PAINTING

PART 1 - GENERAL

1.01 THE REQUIREMENT

- A. The Contractor shall furnish all labor, tools, materials, supervision and equipment necessary to do all the work specified herein and as required for a complete installation, including surface preparation, priming and painting of Contractor furnished equipment, materials, and structures.
- B. Section includes:
 - 1. Paint Materials
 - 2. Shop Painting
 - 3. Field Painting
 - a. Surface Preparation
 - b. Piping and Equipment Identification
 - c. Schedule of Colors
 - d. Work in Confined Spaces
 - e. OSHA Safety Colors

1.02 GENERAL INFORMATION AND DESCRIPTION

- A. The term "paint," as used herein, includes emulsions, enamels, paints, stains, varnishes, sealers, cement filler, cement epoxy fillers and other coatings, whether used as prime, intermediate, or finish coats.
- B. All paint for concrete and metal surfaces shall be especially adapted for use in and around water and wastewater treatment facilities and shall be applied in conformance with the manufacturer's published specifications.
- C. All paint for final coats shall be fume resistant, compounded with pigments suitable for exposure to sewage gases, especially to hydrogen sulfide and to carbon dioxide. Pigments shall be materials which do not tend to darken, discolor, or fade due to the action of sewage gases. If a paint manufacturer proposes use of paint which is not designated "fume resistant" in its literature, it shall furnish full information concerning the pigments used in this paint.
- D. Provide primers and intermediate coats produced by same manufacturer as finish coat. Use only thinners approved by paint manufacturer, and only within manufacturer's recommended limits.

- E. Coatings used in conjunction with potable water supply systems shall have U.S. Environmental Protection Agency (EPA) and FDA approval for use with potable water and shall not impart a taste or odor to the water.
- F. All building, facilities, structures, and appurtenances, as indicated on the Drawings and as specified herein, shall be painted with not less than one shop coat and two field coats, or one prime coat and two finish coats of the appropriate paint. Items to be painted include, but are not limited to, exterior and interior concrete, structural steel, miscellaneous metals, steel and aluminum doors and frames, concrete block, ductwork, sluice gates, operators, pipe fittings, valves, mechanical equipment, motors, conduit, and all other work which is obviously required to be painted unless otherwise specified.
- G. Baked on enamel finishes and items with standard shop finishes such as graphic panels, electrical equipment, toilet partitions, lockers, instrumentation, etc., shall not be field painted unless the finish is damaged during shipment or installation. Aluminum, stainless steel, fiberglass and bronze work shall not be painted unless color coding and marking is required or otherwise specified. A list of surfaces not to be coated is included in Article 1.09 of this Section.
- H. Ensure compatibility of total paint system for each substrate. Test shop primed equipment delivered to the site for compatibility with final paint system. Provide an acceptable carrier coat or totally remove shop applied paint system when incompatible with system specified, and repaint with specified paint system.
- I. The Contractor shall obtain all permits, licenses and inspections and shall comply with all laws, codes, ordinances, rules and regulations promulgated by authorities having jurisdiction which may bear on the work. This compliance will include Federal Public Law 91-59 more commonly known as the "Occupational Safety and Health Act of 1970".

1.03 REFERENCE SPECIFICATION, CODES AND STANDARDS

- A. Without limiting the generality of these specifications the Work shall conform to the applicable requirements of the following documents:
 - 1. SSPC - The Society for Protective Coatings Standards
 - a. SSPC-Vis 1 Pictorial Surface Preparation Standards for Painting Steel Structures
 - b. SSPC-SP2 Hand Tool Cleaning
 - c. SSPC-SP3 Power Tool Cleaning
 - d. SSPC-SP5 NACE No. White Metal Blast Cleaning
 - e. SSPC-SP8 NACE No. Commercial Blast Cleaning
 - f. SSPC-SP10 NACE No. Near-White Metal Blast
 - g. SSPC-SP13 NACE No. Surface Preparation of Concrete
 - 2. NACE - National Association of Corrosion Engineers

3. ASTM D1737 - Test Method for Elongation of Attached Organic Coatings with Cylindrical Mandrel Apparatus
4. ASTM B117 - Method of Salt Spray Fog Testing
5. ASTM D4060 - Test Method for Abrasion Resistance of Organic Coating on the Taber Abraser
6. ASTM D3359 - Method for Measuring Adhesion on Tape Test

1.04 MANUFACTURERS

- A. All painting materials shall be as manufactured by Tnemec, Carcoline, Sherwin Williams, or equal.

1.05 SUBMITTALS

- A. The Contractor shall submit paint manufacturer's data sheets, application instructions, and samples of each finish and color to the Engineer for review, before any work is started in accordance with Section 01300 entitled, "Submittals."
- B. Submitted samples of each finish and color shall be prepared in a step-down format so that the area of each sample indicates the appearance of the various coats. For example, where a three-coat system is specified, the sample shall be divided into three areas indicating one coat only, two coats and all three coats. The Engineer will provide written authorization constituting a standard, as to color and finish only, for each coating system.
- C. The Contractor shall prepare a complete schedule of surfaces to be coated and shall identify the surface preparation and paint system proposed for use. The Paint Schedule shall be in conformance with Article 3.03 of this Section. The schedule shall contain the name of the paint manufacturer, and the name, address and telephone number of the manufacturer's representative that will inspect the Work. The schedule shall be submitted to the Engineer for review as soon as possible following the Notice to Proceed so that the schedule may be used to identify colors and to specify shop painting systems on order for fabricated equipment.
- D. Name and detailed qualifications of the protective coating applicator or subcontractor. Qualifications shall include, but not be limited to, five (5) project references which show that the painting applicator or subcontractor has previous successful experience with the specified or comparable coating systems, a list of installations that are currently in service and documentation that applicator or subcontractor is currently a qualified applicator of the proposed coatings from the manufacturer. Include the name, address and telephone number of the owner of each installation for which the coating applicator provided the coating.

1.06 SERVICES OF MANUFACTURER'S REPRESENTATIVE

- A. The Contractor shall purchase paint from an acceptable manufacturer. The manufacturer shall assign a representative to inspect the application of his product both in the shop and field. The Contractor, through the manufacturer's representative, shall submit his report to the Engineer at the completion of his Work identifying the

products used and verifying that said products were properly applied and that the paint systems were proper for the exposure and service.

- B. Services shall also include, but not be limited to, inspecting prior coatings of paint, determination of best means of surface preparation, inspection of complete work, and re-inspection of painted work to be performed six months after the work is completed.

1.07 MANUFACTURER'S INSTRUCTIONS

- A. The manufacturer's published instructions for use as a guide in specifying and applying the manufacturer's proposed paint shall be submitted to the Engineer. Paint shall not be delivered to the work before acceptance of the manufacturer's instructions is given by the Engineer.
- B. A manufacturer's paint will not be considered for use unless that manufacturer's published instructions meets the following requirements:
 - 1. The instructions must have been written and published by the manufacturer for the purpose and with the intent of giving complete instruction for the use and application of the proposed paint in the locality and for the conditions for which the paint is specified or shown to be applied under this Contract.
 - 2. All limitations, precautions, and requirements that may adversely affect the paint that may cause unsatisfactory results after the painting application or that may cause the paint not to serve the purpose for which it was intended—that is, to protect the covered material from corrosion, shall be clearly and completely stated in the instructions. These limitations and requirements shall, if the best, include, but not be limited to the following:
 - a. Methods of application
 - b. Number of coats
 - c. Thickness of each coat
 - d. Total thickness
 - e. Drying time of each coat, including primer
 - f. Primer required to be used
 - g. Primers not permitted
 - h. Use of a primer
 - i. Thinner and use of thinner
 - j. Temperature and relative humidity limitations during application and after application
 - k. Time allowed between coats
 - l. Protection from sun
 - m. Physical properties of paint including solids content and ingredient analysis

- n. Surface preparation
 - o. Touch up requirements and limitations
- C. Concrete surfaces specified by the paint manufacturer to be acid etched shall be etched in accordance with the manufacturer's instructions. The surface shall then be thoroughly scrubbed with clean water, rinsed, and allowed to dry. The surface shall be tested with a moisture meter to determine when dry before coating. The surface shall also be tested for pH to determine the acid has been properly neutralized.

1.08 QUALITY ASSURANCE

- A. The Contractor shall give the Engineer a minimum of three days advance notice of the start of any field surface preparation work or coating application work.
- B. All such Work shall be performed only in the presence of the Engineer, unless the Engineer has specifically allowed the performance of such Work in his absence.
- C. Review by the Engineer, or the waiver of review of any particular portion of the Work, shall not relieve the Contractor of his responsibility to perform the Work in accordance with these Specifications.
- D. The Contractor shall provide references of the coating applicator or subcontractor per article 1.05, D.

1.09 SAFETY AND HEALTH REQUIREMENTS

- A. In accordance with requirements of OSHA Safety and Health Standards for Construction (29CFR192) and the applicable requirements of regulatory agencies having jurisdiction, as well as manufacturer's printed instructions, appropriate technical bulletins, manuals, and material safety data sheets, the Contractor shall provide and require use of personnel protective and safety equipment for persons working in or about the project site.
- B. Respirators shall be worn by persons engaged or assisting in spray painting. The Contractor shall provide ventilating equipment and all necessary safety equipment for the protection of the workmen and the work.
- C. All paint shall comply with all requirements of the Air Pollution Regulation Acts concerning the application and formulation of paints and coatings for an area in which the paints are applied. Specifically, paints shall be reformulated as required to meet the local, State and Federal requirements.

1.10 SURFACES NOT TO BE COATED

- A. The following items shall not be coated unless otherwise noted:
 - 1. Encased piping or conduit.
 - 2. Stainless steel work.
 - 3. Clear PVC secondary containment piping.
 - 4. Galvanized checkered plate.

5. Aluminum handrails, walkways, windows, louvers, grating and checkered plate.
6. Flexible couplings, lubricated bearing surfaces and insulation.
7. Packing glands and other adjustable parts of mechanical equipment.
8. Finish hardware.
9. Steel encased in concrete or masonry.
10. Plastic switch plates and receptacle plates.
11. Signs and nameplates.
12. Any code-required labels, such as Underwriters' Laboratories and Factory Mutual, or any equipment identification, performance rating, name or nomenclature plates.
13. Any moving parts of operating units, mechanical and electrical parts, such as valve and damper operators, linkages, sensing devices, motor and fan shafts, unless otherwise indicated.

1.11 QUALITY WORKMANSHIP

- A. The Contractor shall be responsible for the cleanliness of his painting operations and shall use covers and masking tape to protect work whenever such covering is necessary or if so requested by the City. Any unwanted paint shall be carefully removed without damage to any finished paint or surface. If damage occurs, the entire surface, adjacent to and including the damaged area, shall be repainted without visible lapmarks and without additional cost to the City.
- B. Painting found defective shall be scraped or sandblasted off and repainted as the City may direct. Before final acceptance of the work, damaged surfaces of paint shall be cleaned and repainted as directed by the City.

1.12 ADDITIONAL PAINT

- A. At the end of the project, the Contractor shall turn over to the City a one gallon can of single component material or small kit of multi component material – minimum of one gallon of each type and color of paint, primer, thinner or other coating used in the field painting. The material shall be delivered in unopened, labeled cans as it comes from the factory. The manufacturer's literature describing the materials and giving directions for their use shall be furnished in three bound copies. A type-written inventor's list shall be furnished at the time of delivery.

1.13 SHIPPING, HANDLING AND STORAGE

- A. All painting materials shall be brought to the job site in the original sealed labeled containers of the paint manufacturer and shall be subject to review by the Engineer. Where thinning is necessary, only the product of the manufacturer furnishing the paint shall be used. All such thinning shall be done strictly in accordance with the manufacturer's instructions, and with the full knowledge of the Engineer.

- B. Materials and their storage shall be in full compliance with the requirements of pertinent codes and fire regulations. Receptacles shall be placed outside buildings for paint gates and containers. Paint waste shall not be disposed of in plumbing fixtures, process drains or other plant systems or process units.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Table 09900-1 depicts the coatings referenced in Article 3.03 of this Section entitled, "Paint Schedule".

**TABLE 09900-1
PRODUCT LISTING**

Ref. No.	Description	Manufacturer's Reference		
		Tnemec	Carboline	Sherwin-Williams
101	Waterborne Polyamine Epoxy	151-1051 ElastoGrip FC	Sanitile 120	Loxon Conditioner
102	Water Based Block Filler	1254 EpoxyBlock WB	Sanitile 100	Corond 300
103	Modified Polyamidoamine Epoxy	135 – Color	Caroguard 890 – Color	Macropoxy 4
104	Polyamidoamine Epoxy Primer	N9 – 1211	Caroguard 890 – 0500	Macropoxy 4
105	Polyamidoamine Epoxy	N9 – Color	Caroguard 890 – Color	Macropoxy 4
107	Waterborne Acrylic Epoxy	113-Color	Sanitile 255 – Color	Hi-Bild WB Catalyzed Epoxy
110	Aliphatic Acrylic Polyurethane	1095 – Color	Carothane 133HB – Color	Acrolon Ultra
111	Modified Waterborne Acrylate	15 - Envirocrete Smooth Texture	Flexide Elastomer	Loxon OP
114	Acrylic Concrete Primer	1 Tneme-Cr	Sanitile 120	Loxon Conditioner
115	Aromatic Urethane / Epoxy Zinc Rich	90-97 Tneme-Zinc	Carozinc 859	Corothane I Galvapac
116	Water repellent	118 Chempro Deck A Pell 40	Carocrete Sealer WB	H2C SL-40
118	Epoxy Modified Cementitious Mortar	218 MortarClad	Caroguard 510 SG	Corond 300
119	Cycloaliphatic Amine Epoxy	104 H.S. Epoxy	Caroguard 893 (Non-immersion) Phenoline 385 (Immersion)	Tank Clad HS
131	Modified Polyamine	201 Epoxyprime	Caroguard 1340	Corond 100

Ref. No.	Description	Manufacturer's Reference		
		Tnemec	Carboline	Sherwin-Williams
	Epoxy Primer			
132	Fiber Reinforced Polyamine Epoxy	270 Stranlok	Sanitile 755	Cor-Cote HCR Clear with 1 oz. glass mat
133	Polyamine Novolac Epoxy	282 Tneme-Glaze	Sanitile 949	Cor-Cote HCR FF
137	Silicate Blend	29 CT Densifier	Carbocrete Sealer WB	H2C Clear Liquid Hardener & Densifier
138	Aromatic Urethane / Novolac Epoxy Primer	1 Omnithane	Phenoline 311	Corothane I Galvapak 1K
139	Modified Polyamine Epoxy / Phenalkamine Epoxy	435 Perma-Glaze	Carloguard 90	Cor-Cote SC Coating

PART 3 - EXECUTION

3.01 SURFACE PREPARATION

A. General

1. Surfaces to be painted shall be clean and dry, and free of dust, rust, scale and all foreign matter. No solvent cleaning, power or hand tool cleaning shall be permitted unless acceptable to the Engineer or specified herein.
2. Threaded portions of valve and gate stems, machined surfaces which are limited for sliding contact, surfaces which are to be assembled against gaskets, surfaces or shafting on which sprockets are to fit, or which are intended to fit into bearings, machined surfaces of bronze trim on slide gates and similar surfaces shall be masked off to protect them from the sandblasting of adjacent surfaces. Cadmium-plated or galvanized items shall not be sandblasted unless hereinafter specified, except that cadmium-plated, zinc-plated, or sherardized fasteners used in assembly of equipment to the sandblasted shall be sandblasted in the same manner as the unprotected metal. All installed equipment, mechanical drives, and adjacent painted equipment shall be protected from sandblasting. Protection shall prevent any sand or dust from entering the mechanical drive units or equipment where damage could be caused.
3. Hardware accessories, machined surfaces, plates, lighting fixtures, and similar items in place prior to cleaning and painting, and not intended to be painted, shall be protected or removed during painting operations and repositioned upon completion of painting operations.
4. Examine surfaces to be coated to determine that surfaces are suitable for specified surface preparation and painting. Report to Engineer surfaces found to be unsuitable in writing. Do not start surface preparation until unsuitable surfaces

have been corrected. Starting surface preparation precludes subsequent claim that such surfaces were unsuitable for the specified surface preparation or painting.

5. Surface preparation shall be in accordance with specifications and manufacturer's recommendations. Provide additional surface preparation, and fill coats where manufacturer recommends additional surface preparation, in addition to requirements of specification.
 - Touch-up shop or field applied coatings damaged □□ surface preparation or another activity, with the same shop or field applied coating □ even to the extent of applying an entire coat when required to correct damage prior to application of the next coating. Touch up coats are in addition to the specified applied systems, and not considered a field coat.
7. Protect motors and other equipment during blasting operation to ensure blasting material is not blown into motors or other equipment. Inspect motors and other equipment after blasting operations and certify that no damage occurred, or where damage occurred, the proper remedial action was taken
8. Sand from sandblasting shall be thoroughly removed, using a vacuum cleaner if necessary. No surface which has been sandblasted shall be painted until inspected □□ the Engineer.

B. Metal Surfaces

1. Except as otherwise provided, all preparation of metal surfaces shall be in accordance with Specifications SP-1 through SP-10 of the Society for Protective Coatings (SSPC). Where the Society for Protective Coatings Specifications are referred to in these Contract Documents, the corresponding Pictorial Surfaces Preparation Standard shall be used to define the minimum final surface conditions to be supplied. Grease and oil shall be removed and the surface prepared □□ hand tool cleaning, power tool cleaning or blast cleaning in accordance with the appropriate Specification SP-1 through SP-30.
2. Perform blast cleaning operations for metal when following conditions exist:
 - a. Moisture is not present on the surface.
 - Relative humidity is below 80% .
 - c. Ambient and surface temperatures are 5°F or greater than the dew point temperature.
 - d. Painting or drying of paint is not being performed in the area.
 - e. Equipment is in good operating condition.
 - f. Proper ventilation, illumination, and other safety procedures and equipment are being provided and followed.
3. Weld flux, weld spatter and excessive rust scale shall be removed □□ power tool cleaning as per SSPC-SP-3.

4. All ferrous metal surfaces not required to be galvanized shall be cleaned of all oil grease, dirt, rust and tight and loose mill scale by blasting in accordance with the following: SSPC SP 5 White Metal Blast Cleaning and comply with the visual standard NACE No. 1, for shop prepared and shop primed metal to be submerged or in a corrosive environment, SSPC-SP10 Near White Metal Blast Cleaning, and comply with the visual standard NACE No. 2 for field prepared metal to be submerged or in a corrosive environment, SSPC-SP11 and comply with the visual standard NACE No. 3 for metal in all other locations. Pickling, complying with SSPC SP 8, may be substituted for Near White Blast in areas as determined by the Engineer. Priming shall follow sand blasting before any evidence of corrosion occurs, before nightfall and before any moisture is on the surface.
5. Field surface preparation of small, isolated areas such as field welds, repair of scratches, abrasions or other marks to the shop prime or finish shall be cleaned by power tools in accordance with SSPC SP 3, or in difficult and otherwise inaccessible areas by hand cleaning in accordance with SSPC SP 2 and spot primed.
 - All coated surfaces shall be cleaned prior to application of successive coats. All non ferrous metals not to be coated shall be cleaned. This cleaning shall be done in accordance with SSPC SP 1, Solvent Cleaning.
7. All shop coated surfaces shall be protected from damage and corrosion before and after installation by treating damaged areas immediately upon detection. Abraded or corroded spots on shop coated surfaces shall be prepared in accordance with SSPC SP 2, Hand Tool Cleaning and then touched up with the same materials as the shop coat.
8. All shop coated surfaces which are faded, discolored, or which require more than minor touch up, in the opinion of the Engineer, shall be repainted. Cut edges of galvanized sheets, electrical conduit, and metal pipe sleeves, not to be finish painted, shall be cleaned in accordance with SSPC SP 1, Solvent Cleaning and primed with zinc dust zinc oxide metal primer.

C. Concrete Surfaces

1. Concrete surfaces are to be cured for at least 28 days prior to surface preparation, unless coatings are recommended for application over green concrete surfaces.
2. Test concrete for moisture content, pH and salts using test method recommended by the paint manufacturer. Do not begin surface preparation, or painting until moisture content is acceptable to manufacturer.
3. Non-submerged concrete and masonry surfaces to be painted shall be prepared by removing efflorescence, chalk, dust, dirt, grease, oil, form coating, tar and by roughening to remove glaze. All surfaces shall be repaired prior to commencement of the coating operation.
4. Concrete immersion surfaces that are to be coated shall be prepared in accordance to SSPC-SP13/NACE No. 3 to remove all laitance, curing compounds, hardeners, sealers, and other contaminants, and to provide a minimum surface profile. Refer to manufacturer's recommendation for specific coating being applied and adhere to ICRI Concrete Surface Preparation Profiles (CSP 1-10) when reviewing concrete

surface preparation. Areas of concrete which contain bug holes or voids shall be filled with the manufacturer's approved filler material.

D. Masonry

1. Cure for a minimum of 28 days prior to surface preparation or paint application.
2. Clean masonry surfaces free from all dust, dirt, oil, grease, loose mortar, chalk deposits, efflorescence, and other foreign materials.
3. Test masonry for moisture content. Use test method recommended by paint manufacturer. Do not begin painting until moisture content is acceptable to manufacturer.

E. Wood

1. Clean wood surfaces free of all foreign matter, with cracks and nail holes and other defects properly filled and smoothed. Remove sap and resin by scraping and wipe clean with rags dampened with mineral spirits.
2. Saturate end grain, cut wood, knots, and pitch pockets with an appropriate sealer before priming.
3. Prime and backprime wood trim before setting in place.
4. After prime coat has dried, fill nailholes, cracks, open joints, and other small holes with approved spackling putty. Lightly sand wood trim prior to applying second coat of paint.

F. Exposed Pipe, Valves and Pumps

1. Bituminous coated pipe shall not be used in exposed locations. Pipe which shall be exposed after project completion shall be primed in accordance with the requirements herein. An unbituminous coated ferrous pipe which is inadvertently installed in exposed locations shall be sandblasted to SSPC SP 5 White Metal before priming and painting.
2. After installation and prior to finish painting, all exterior, exposed flanged joints shall have the gap between adjoining flanges and gaps between the pipe wall and threaded-on flanges sealed with a single component Thiokol caulking to prevent rust stains.

G. Gypsum Drywall

1. Sand joint compound with sandpaper to provide a smooth flat surface. Avoid sanding of adjacent drywall paper.
2. Remove dust, dirt, and other contaminants.

H. PVC Pipe Surfaces

1. All pipe surfaces shall be cleaned and lightly sanded before painting.

I. Existing Painted Surfaces

1. Total removal of existing paint when: surface is to be submerged in a severe environment, paint is less than 75% intact, brittle, eroded or has underfilm rusting.
2. Surfaces which are greater than 75% intact require removal of failed paints and then spot primed. Spot priming is in addition to coats specified.
3. Remove surface contamination such as oil, grease, loose paint, mill scale, dirt, foreign matter, rust, mold, mildew, mortar, efflorescence, and sealers.
4. Clean and dull gloss surfaces prior to painting in accordance with the manufacturer's recommendations.
5. Check existing paints for compatibility with new paint system. If incompatible, total removal of existing paint system or apply a carrier coat recommended by the paint manufacturer. Remove existing paints of undetermined origin. Prepare a test patch of approximately 3 square feet over existing paint. Allow test patch to dry thoroughly and test for adhesion. If proper adhesion is not achieved remove existing paint and repaint.

3.02 SHOP PAINTING

- A. All fabricated steel work and equipment shall receive at the factory at least one shop coat of prime paint compatible with the paint system required by these Specifications. The Contractor shall coordinate all shop priming to ensure compatibility with paint system specified. Surface preparation prior to shop painting shall be as specified herein. Finish coats may be applied in the shop if acceptable to the Engineer. All shop painted items shall be properly packaged and stored until they are incorporated in the Work. Any painted surfaces that are damaged during handling, transporting, storage or installation shall be cleaned, scraped, and patched before field painting begins so that Work shall be equal to the original painting received at the shop. Equipment or steel Work that is to be assembled on the site shall likewise receive a minimum of one shop coat of paint at the factory. Surfaces of exposed members that will be inaccessible after erection shall be prepared and painted before erection.
- B. The Contractor shall specify the shop paints to be applied when ordering equipment in order to assure compatibility of shop paints with field paints. The paints and surface preparation used for shop coating shall be identified on shop drawings submitted to the Engineer for review. Shop paint shop drawings will not be reviewed until the final project paint system has been submitted by the Contractor and reviewed by the Engineer.
- C. Shop finish coats may be the standard finish as ordinarily applied by the manufacturer if it can be demonstrated to the Engineer that the paint system is equal to and compatible with the paint system specified. However, all pumps, motors and other equipment shall receive at least one field applied finish coat after installation.

3.03 PAINT SCHEDULE

- A. The Contractor shall adhere to this paint schedule, providing those paints named or equal. DFT shall mean the minimum dry film thickness per application measured in mils. Products are referenced by numbers listed in table 09900-1 in Article 2.01 of this Section entitled "Product Listing." The paint schedule identifies the minimum DFT required per coat. If the Contractor does not achieve the specified DFT range in a

single coat, he shall provide additional coats as necessary at no additional cost to the City.

B. Metal Surfaces, Atmospheric (Exterior) Exposure

1. Metal surfaces exposed to the atmosphere that do not come into contact with wastewater or corrosive atmosphere including the following types of surfaces shall be painted as described below:

- a. Pumps, motors, process equipment, machinery, etc.
- b. Above ground piping, valves and pipe supports.
- c. Miscellaneous steel shapes, angles, etc.
- d. Exposed surfaces of conduit, ductwork, etc.

Ferrous Metal

<u>Application</u>	<u>No.</u>	<u>Description</u>	<u>DFT</u>
First - 1 coat	104	Poliamidoamine Epoxy Primer	3.0 - 5.0
Second - 1 coat	105	Poliamidoamine Epoxy	2.0 - 3.0
Finish - 1 coat	110	Aliphatic Acrylic Urethane	<u>3.0 - 4.0</u>
Min. Total			10.0 Mils

Broadcast 50 mesh silica sand while still wet over entire digester cover area.

Non-Ferrous Metal

<u>Application</u>	<u>No.</u>	<u>Description</u>	<u>DFT</u>
First - 1 coat	105	Poliamidoamine Epoxy	2.0 - 3.0
Second - 1 coat	110	Aliphatic Acrylic Urethane	<u>3.0 - 4.0</u>
Min. Total			5.0 Mils

Galvanized

<u>Application</u>	<u>No.</u>	<u>Description</u>	<u>DFT</u>
Spot Repair	115	Aromatic Urethane / Epoxy Zinc-Rich Spot	2.5 - 3.5
First - 1 coat	105	Poliamidoamine Epoxy	2.0 - 3.0
Second - 1 coat	110	Aliphatic Acrylic Urethane	<u>3.0 - 4.0</u>
Min. Total			5.0 Mils

C. Metal Surfaces, Submerged Exposure

1. Metal surfaces that are submerged shall be painted as described below:

<u>Application</u>	<u>No.</u>	<u>Description</u>	<u>DFT</u>
Stripe coat	119	Cycloaliphatic Amine Epoxy	3.0 - 5.0
First - 1 coat	119	Cycloaliphatic Amine Epoxy	4.0 - 5.0

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Finish - 1 coat	119	Cycloaliphatic Amine Epoxy	<u>4.0 - 10.0</u>
		Min. Total (including stripe coat)	10.0 Mils

D. Metal Surfaces, Interior Exposure

1. Interior metal surfaces (nonsubmerged) that do not come in contact with wastewater or the corrosive atmosphere including the following types of surfaces shall be painted as follows:

- a. Pumps, motors, process equipment, machinery, etc.
- b. Piping, valves and supports.
- c. Miscellaneous steel shapes, angles, rails, etc.
- d. Exposed surfaces of conduit, ductwork, etc.

<u>Application</u>	<u>No.</u>	<u>Description</u>	<u>DFT</u>
First - 1 coat	104	Polyamidoamine Epoxy Primer	3.0 - 5.0
Finish - 1 coat	105	Polyamidoamine Epoxy	<u>4.0 - 10.0</u>
		Min. Total	9.0 Mils

E. Ductile Iron Pipe, Exterior or Interior Exposure

1. Ductile iron pipe exterior or interior exposure shall receive the following types of paint:

<u>Application</u>	<u>No.</u>	<u>Description</u>	<u>DFT</u>
First - 1 coat	105	Polyamidoamine Epoxy	10.0 - 10.0
Finish - 1 coat	110	Aliphatic Acrylic Polyurethane	<u>3.0 - 5.0</u>
		Min. Total	12.0 Mils

F. PVC Pipes, Exterior or Interior Exposure

1. PVC pipes, valves, and accessories, shall receive the following types of paint:

<u>Application</u>	<u>No.</u>	<u>Description</u>	<u>DFT</u>
First - 1 coat	105	Polyamidoamine Epoxy	2.0 - 3.0
Finish - 1 coat	110	Aliphatic Acrylic Polyurethane	<u>3.0 - 4.0</u>
		Min. Total	10.0 Mils

G. New Concrete, Masonry and Stucco, Exterior Exposure

- 1. The exterior above grade concrete, masonry and stucco surfaces of all new structures shall receive the following:
- 2. Surface preparation: Surface shall be clean and dry without efflorescence, chalk, dust, dirt, grease, oil, form coating, and tar. Allow concrete to cure for 28 days.

<u>Application</u>	<u>No.</u>	<u>Description</u>	<u>DFT</u>
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PROJECT NO. 11843 PROGRESSO VILLAGE STORM WATER IMPROVEMENTS

Block Filler [] []	102	Water Based Epo [] Block Filler	100-150 SF/Gal
Primer [] [] [] []	114	Acrylic Concrete Primer	300-400 SF/Gal
First - 1 coat	111	Modified Waterborne Acrylate	4.0 - 10.0
Finish - 1 coat	111	Modified Waterborne Acrylate	4.0 - 10.0
		Min. Total	10.0 Mils

(*) Block filler only to be used on new CMU

(**) Concrete primer for non-CMU applications

H. New Concrete and Masonry Surfaces, Interior Exposure

- Interior exposed masonry and concrete wall and ceiling surfaces, including beam and column surfaces of all new non-water retaining structures shall be painted as follows:
- Surface preparation: Surface shall be clean and dry without efflorescence, chalk, dust, dirt, grease, oil, form coating, and tar. Allow concrete to cure for 28 days.

<u>Application</u>	<u>No.</u>	<u>Description</u>	<u>DFT</u>
Block Filler [] []	102	Water Based Epo [] Block Filler	100-150 SF/Gal
Primer [] [] [] []	114	Acrylic Concrete Primer	300-400 SF/Gal
First - 1 coat	105	Poliamidoamine Epo []	4.0 - 10.0
Finish - 1 coat	105	Poliamidoamine Epo []	4.0 - 10.0
		Min. Total	10.0 Mils

*Block Filler shall only be used on new masonry.

** Concrete primer for non-CMU applications

I. Gypsum Wallboard Surfaces

- All exposed gypsum board shall be painted as follows:

<u>Application</u>	<u>No.</u>	<u>Description</u>	<u>DFT</u>
First - 1 coat	101	Waterborne Polyamine Epo []	1.0 - 2.0
Second - 1 coat	107	Waterborne Acrylic Epo []	2.0 - 3.0
Finish - 1 coat	107	Waterborne Acrylic Epo []	2.0 - 3.0
		Minimum Total	10.0 Mils

J. Concrete Floor Surfaces of Electrical Rooms

- Concrete floor surfaces of electrical rooms shall be painted as follows:

<u>Application</u>	<u>No.</u>	<u>Description</u>	<u>DFT</u>
First - 1 Coat	137	Silicate Blend	300 SF/Gal
Finish - 1 coat	137	Silicate Blend	350 SFT/Gal

3.04 PAINTING

- A. Application: All paint shall be applied by experienced painters with brushes or other applicators acceptable to the Engineer.
1. Paint shall be applied without runs, sags, thin spots, or unacceptable marks. Paints shall be applied at the rate specified by the manufacturer to achieve the minimum dry film thickness required. Additional coats of paint shall be applied, if necessary, to obtain thickness specified.
 2. Paint shall be applied with spraying equipment only on those surfaces approved by the Engineer. If the material has thickened or must be diluted for application by spray gun, each coat shall be built up to the same film thickness achieved with undiluted brushed on material. Where thinning is necessary, only the products of the particular manufacturer furnishing the paint shall be used and all such thinning shall be done in strict accordance with the manufacturer's instructions, as well as with the full knowledge of the Engineer.
 3. Surfaces not accessible to brushes or rollers may be painted by spray, duster or sheepskins and paint mitt. If any of these methods is to be used, it shall be done in strict accordance with the manufacturer's instructions, as well as with the full knowledge of the Engineer.
- B. Drying Time: A minimum of twenty-four hours drying time shall elapse between applications of any two coats of paint on a particular surface unless shorter time periods are a requirement of the manufacturer or specified herein. Longer drying times shall be required for abnormal conditions as defined by the manufacturer.
- C. Weather Restrictions: No painting whatsoever shall be accomplished in rain or excessive damp weather when the relative humidity exceeds 85 percent, or when the general air temperature cannot be maintained at 50 degrees Fahrenheit or above throughout the entire drying period. No paint shall be applied when it is expected that the relative humidity will exceed 85 percent or that the air temperature will drop below 50 degrees Fahrenheit within 18 hours after the application of the paint.
1. Dew or moisture condensation should be anticipated and if such conditions are prevalent, painting shall be delayed until midmorning to be certain the surfaces are dry. The day's painting shall be completed well in advance of the probable time of dawn when condensation will occur.
- D. Inspection of Surfaces
1. Surface preparation and every field coat of priming and finishing paint shall be inspected by the Engineer or his authorized representative before the succeeding coat is applied. The Contractor shall follow a system of tinting successive paint coats so that no two coats for a given surface are exactly the same color. Areas to receive black protective coatings shall in such cases be tick marked with white or actually gauged as to thickness when finished.
 2. Before application of the prime coat and each succeeding coat, any defects or deficiencies in the prime coat or succeeding coat shall be corrected by the Contractor before application of any subsequent coating.

3. Samples of surface preparation and of painting systems shall be furnished to the Contractor to be used as a standard throughout the job, unless omitted by the Engineer.
4. When an appreciable time has elapsed between coatings, previously coated areas shall be carefully inspected by the Engineer, and where, in his opinion, surfaces are damaged or contaminated, they shall be cleaned and recoated at the Contractor's expense. Recoating times of manufacturer's printed instructions shall be adhered to.
5. Coating thickness shall be verified by the use of a dry film thickness digital gauge. Gauge shall be Elcometer 45 or equal and shall be properly calibrated. Coating thickness on non-metal surfaces shall be verified by the use of an ultrasonic gauge. Ultrasonic gauge shall be Positector 200 or equal. Gauges shall include the entire range of coating thicknesses required in this section.
 - The Contractor shall provide free of charge to the Engineer two new digital dry film gauges and two wet film gauges to be used to inspect coating by Engineer and Contractor. One gauge may be used by Contractor and returned each day to the Engineer. Engineer will return gauges to Contractor at completion of job.
7. Coatings shall pass a holiday detector test.
8. Determination of Film Thickness: Randomly selected areas, each of at least 107.5 contiguous square feet, totaling at least 5% of the entire control area shall be tested. Within this area, at least 5 squares, each of 7.75 square inches, shall be randomly selected. Three readings shall be taken in each square, from which the mean film thickness shall be calculated. No more than 20 percent of the mean film thickness measurements shall be below the specified thickness. No single measurement shall be below 80 percent of the specified film thickness. Total dry film thickness greater than twice the specified film thickness shall not be acceptable. Areas where the measured dry film thickness exceeds twice that specified shall be completely redone unless otherwise approved by the Engineer. When measured dry film thickness is less than that specified additional coats shall be applied as required.
9. Holiday Testing: Holiday test painted ferrous metal surfaces which will be submerged in water or other liquids, or surfaces which are enclosed in a vapor space in such structures. Mark areas which contain holidays. Repair or repaint in accordance with paint manufacturer's printed instructions and retest.
 - a. Dry Film Thickness Exceeding 20 Mils: For surfaces having a total dry film thickness exceeding 20 mils: Pulse-type holiday detector such as Tinker □ Razor Model AP-W, D.E. Stearns Co. Model 14/20, shall be used. The unit shall be adjusted to operate at the voltage required to cause a spark jump across an air gap equal to twice the specified coating thickness.
 - Dry Film Thickness of 20 Mils or Less: For surfaces having a total dry film thickness of 20 mils or less: Tinker □ Razor Model M1 non-destructive type holiday detector, K-D Bird Dog, shall be used. The unit shall operate at less than 75-volts. For thicknesses between 10 and 20 mils, a non-sudsing type

wetting agent, such as Kodak Photo-Flow, shall be added to the water prior to wetting the detector sponge.

E. Special Areas

1. All surfaces which are to be installed against concrete, masonry etc., and will not be accessible for field priming and/or painting shall be back primed and painted as specified herein, before erection. Anchor bolts shall be painted before the erection of equipment and then the accessible surfaces repainted when the equipment is painted.

F. Special attention shall be given to insure that edges, corners, crevices, welds and rivets receive a film thickness equivalent to that of the adjacent painted surfaces.

G. Safety

1. Respirators shall be worn by persons engaged or assisting in spray painting. The Contractor shall provide ventilating equipment and all necessary safety equipment for the protection of the workmen and the Work.

H. Quality Workmanship

1. The Contractor shall be responsible for the cleanliness of his painting operations and shall use covers and masking tape to protect the Work whenever such covering is necessary, or if so requested by the City. An unwanted paint shall be carefully removed without damage to an finished paint or surface. If damage does occur, the entire surface, adjacent to and including the damaged area, shall be repainted without visible lap marks and without additional cost to the City.

I. Painting found defective shall be scraped or sandblasted off and repainted as the Engineer may direct. Before final acceptance of the Work, damaged surfaces of paint shall be cleaned and repainted as directed by the Engineer.

- An pipe scheduled to be painted and having received a coating of a tar or asphalt compound shall be painted with two coats of "Intertol Tar Stop", "Tnemec Tar Bar" or equal before successive coats are applied in accordance with the paint schedule.

3.05 SCHEDULE OF COLORS

A. All colors shall be as designated by the Engineer at the shop drawing review. The Contractor shall submit color samples including custom color choices as required to the Engineer as specified in Article 1.05 of this Section. The Contractor shall submit suitable samples of all colors and finishes for the surfaces to be painted, or on portable surfaces when required by the Engineer. The Engineer shall decide upon the choice of colors and other finishes when alternates exist. No variation shall be made in colors without the acceptance from the City. Color names and/or numbers shall be identified according to the appropriate color chart issued by the manufacturer of the particular product in question.

B. All above ground water main piping shall be painted white with blue longitudinal striping.

C. All underground water main piping shall have continuous 4" blue longitudinal stripe.

D. All above ground force main piping shall be painted green.

3.0 COLOR CODING AND LETTERING OF PIPING

A. The Contractor shall paint all piping, valves, equipment, exposed conduits and all appurtenances which are integral to a complete functional mechanical pipe and electrical conduit system, in accordance with Table 09900-2 entitled "Pipe Color Coding Schedule". Where colors are not designated for piping and conduit systems the color will be selected during the shop drawing review from the paint manufacturer's standard color charts.

B. In general, the pumps and equipment shall be painted the same color as the piping system to which it is connected unless otherwise directed by the Engineer. Where colors are not designated for piping and conduit systems the color will be selected during the shop drawing review from the paint manufacturer's standard color charts.

C. Lettering of Piping

1. The Contractor shall apply identification titles and arrows indicating the direction of flow of liquids to all types and sections of all new and existing plant piping. Titles shall be as directed by the Engineer. Identification titles shall be located midwidth between color coding bands where possible. Identification lettering and arrows shall be placed as directed by the Engineer, but shall generally be located each fifteen feet in pipe length and shall be properly inclined to the pipe axis to facilitate easy reading. Titles shall also appear directly adjacent to each side of an wall or slab the pipeline passes through.

D. The titles shall be painted by use of stencils and shall identify the contents by complete names at least once in each area through which it passes and thereafter be abbreviated. Stencils shall be provided for titles and abbreviations listed in Table 09900-3.

E. Title color shall be black or white as directed and shall have an overall height in inches in accordance with Table 09900-4. Letter type shall be Helvetica Medium upper case. The manufacturer's instructions shall be followed in respect to storage, surface preparation and application. For piping less than 3/4-inch diameter as identified in Table 09850-2, the Contractor shall furnish and attach corrosion resistant color tags with the required lettering.

F. Banding

1. Where bands are indicated in the Pipe Color Coding Schedule, the pipe is to be painted for its full circumference with a band of the color indicated. The bands shall be six inches wide, neatly made by masking, and spaced eight feet apart. The Contractor may substitute precut prefinished bands on piping subject to acceptance by the Engineer. Where banded pipes are running concurrently in a space, bands shall be located so that on adjacent located pipes, bands will be grouped beside each other.

3.07 OSHA SAFETY COLORS

A. Items listed in ANSI Z53.1-1971, Section 2.1 shall be painted ANSI Red. In general, these items shall include fire protection equipment and apparatus wall mounted

Breathing apparatus, danger signs and locations and stop bars, buttons or switches. In addition all hose valves and riser pipes, fire protection piping and sprinkler systems, and electrical stop switches shall be painted ANSI Red.

- B. Items listed in ANSI Z53.1-1971, Section 2.3 shall be painted ANSI yellow. Yellow shall be the basic color for designating caution and for marking physical hazards such as striking against, stumbling, falling, tripping, and "caught in between". In addition, an 8-inch wide strip on the top and bottom tread of stairways shall be coated.

3.08 WORK IN CONFINED SPACES

- A. The Contractor shall provide and maintain safe working conditions for all employees. Fresh air shall be supplied continuously to confined spaces through the combined use of existing openings, forced draft fans, or direct air supply to individual workers. Paint fumes shall be exhausted to the outside from the lowest level in the contained space.
- B. Electrical fan motors shall be explosion proof if in contact with fumes. No smoking or open fires will be permitted in, or near, confined spaces where painting is being done.

3.09 CLEANING

- A. The buildings and all other Work area shall be at all times kept free from accumulation of waste material and rubbish caused by the Work. At the completion of the painting, all tools, equipment, scaffolding, surplus materials, and all rubbish around the inside the buildings shall be removed and the Work left room clean unless otherwise specified.

**TABLE 09900-2
PIPE COLOR CODING SCHEDULE**

Equipment / Piping	Suggested Color
Stormwater	Green
Wastewater	Green
Potable Water	Blue
Emergency Shower/Eye Wash	Safety Yellow, BV57

**TABLE 09900-4
HEIGHT OF PIPING LETTERING**

<u>Diameter of Pipe or Pipe Covering</u>	<u>Height of Lettering</u>
3/4 to 1-1/4 inches	1/2 inch
1-1/2 to 2 inches	3/4 inch
2-1/2 to 4 inches	1-1/4 inches
8 to 10 inches	2-1/2 inches
Over 10 inches	3-1/2 inches

Notes:

1. Letter type shall be Helvetica Medium upper case. The manufacturer's instructions shall be followed in respect to storage, surface preparation and application.

END OF SECTION

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SECTION 10200
LOUVERS AND VENTS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Louvers and vents.

B. Related Sections include but are not necessarily limited to:

1. Division 00 - Procurement and Contracting Requirements.
2. Division 01 - General Requirements.
3. Section 07000 - Flashing and Roofing Accessories.
4. Section 07920 – Sealants and Caulking.

1.02 QUALITY ASSURANCE

A. Referenced Standards:

1. Aluminum Association [AA]
 - a. DAF 45, Designation System for Aluminum Finishes.
2. Air Movement and Control Association [AMCA]
3. ASTM International [ASTM]
 - a. B221, Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.

1.03 SUBMITTALS

A. Shop Drawings:

1. See Specification Section 01300 for requirements for the mechanics and administration of the submittal process.
2. Drawing showing location of each louver or vent, indicating size and arrangement of blank-off plates if required.
3. Product technical data including:
 - a. Acknowledgement that products submitted meet requirements of standards referenced.
 - b. Manufacturer's installation instructions.

- c. Color chart showing manufacturer's full line of colors including ebotic and special colors for color selection □□ Engineer.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
 1. Louvers:
 - a. Airlite Co.
 - Construction Specialties, Inc.
 - c. Ruskin Manufacturing.
 - d. Industrial Louvers, Inc.
 - e. American Warming.
- B. Submit request for substitution in accordance with Specification Section 01□40.

2.02 MANUFACTURED UNITS

- A. Louvers:
 1. 4 IN deep.
 2. Drainage with blades at 37-1/2 DEG.
 3. Continuous blade appearance.
 4. ASTM B221 extruded aluminum, alloy □□3T5, minimum 0.081 IN thick.
 5. Minimum free area: 8.58 S□FT for 4 □4 FT louver.
 - Maximum pressure drop: 0.10 IN of water at 700 FPM.
 7. Water penetration: 0.01 OZ/SF at 873 FPM.
 8. AMCA certified.
 9. Ruskin "ELF 375D□".
 10. Insect screen:
 - a. 18-1□ mesh aluminum.
 - Install in standard aluminum frame.
- B. Anchors, Fasteners, Reinforcing: Aluminum or stainless steel.
- C. Finish:

1. Architectural Class 1 coating per AA DAF 45.
 - a. AA-M12C22A41 clear anodized
- D. Size: Refer to Mechanical Drawings for louver size, and refer to Architectural Drawings for louver shapes.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Install anchoring and framing accessories as required.
- C. Seal around perimeter on exterior and interior.
 1. See Section 07920.
- D. Install 0.040 IN aluminum flashing at sill to match louver.
 1. See Section 0700.

END OF SECTION

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SECTION 10400
IDENTIFICATION DEVICES

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Tag, tape and stenciling systems for equipment, piping, valves, pumps, ductwork and similar items, and hazard and safety signs.

B. Related Specification Sections include but are not necessarily limited to:

1. Division 00 - Procurement and Contracting Requirements.
2. Division 01 - General Requirements.

1.02 QUALITY ASSURANCE

A. Referenced Standards:

1. American Society of Mechanical Engineers (ASME)
 - a. A13.1, Scheme for the Identification of Piping Systems.
2. The International Society of Automation (ISA)
3. National Electrical Manufacturers Association/American National Standards Institute (NEMA/ANSI)
 - a. Z535.1, Safety Color Code.
 - b. Z535.2, Environmental and Facility Safety Signs.
 - c. Z535.3, Criteria for Safety Symbols.
 - d. Z535.4, Product Safety Signs and Labels.
4. National Fire Protection Association (NFPA)
 - a. 70, National Electrical Code (NEC)
5. Occupational Safety and Health Administration (OSHA)
 - a. 29 CFR 1910.145, Specification for Accident Prevention Signs and Tags.

1.03 SUBMITTALS

A. Shop Drawings:

1. See Specification Section 01300 for requirements for the mechanics and administration of the submittal process.

2. Product technical data including:
 - a. Catalog information for all identification systems.
 - Acknowledgement that products submitted meet requirements of standards referenced.
3. Identification register, listing all items in PART 3 of this Specification Section to be identified, type of identification system to be used, lettering, location and color.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:

1. W.H. Bradco.
2. Panduit.
3. Seton.
4. National Band and Tag Co.
5. Carlton Industries, Inc.

B. Submit request for substitution in accordance with Specification Section 0140.

2.02 MANUFACTURED UNITS

A. Type A1 - Round Metal Tags:

1. Materials:
 - a. Aluminum or stainless steel.
 - Stainless steel shall be used in corrosive environments.
2. Size:
 - a. Diameter: 1-1/2 IN minimum.
 - Thickness: 0.035 IN #20 GA#minimum.
3. Fabrication:
 - a. 3/16 IN minimum mounting hole.
 - Legend: Stamped and filled with black coloring.
4. Color: Natural.

B. Type A2 - Rectangle Metal Tags:

1. Materials: Stainless steel.
 2. Size:
 - a. 3-1/2 IN \square 1-1/2 IN minimum.
 - \square Thickness: 0.03 IN \square 20 GA \square minimum.
 3. Fabrication:
 - a. 3/16 IN minimum mounting hole.
 - \square Legend: Stamped and filled with black coloring.
 4. Color: Natural.
- C. Type A3 - Metal Tape Tags:
1. Materials: Aluminum or stainless steel.
 2. Size:
 - a. Width 1/2 IN minimum.
 - \square Length as required \square text.
 3. Fabrication:
 - a. 3/16 IN minimum mounting hole.
 - \square Legend: Embossed.
 4. Color: Natural.
- D. Type B1- Square Nonmetallic Tags:
1. Materials: Fiberglass reinforced plastic.
 2. Size:
 - a. Surface: 2 \square 2 IN minimum.
 - \square Thickness: 100 mils.
 3. Fabrication:
 - a. 3/16 IN mounting hole with metal element.
 - \square Legend: Preprinted and permanently embedded and fade resistant.
 4. Color:
 - a. Background: Manufacturer standard or as specified.
 - \square Lettering: Black.
- E. Type B2 - Nonmetallic Signs:

1. Materials: Fiberglass reinforced or durable plastic.
 2. Size:
 - a. Surface: As required detail.
 - Thickness: 30 mils minimum.
 3. Fabrication:
 - a. Rounded corners.
 - Drilled holes in corners with grommets.
 - c. Legend: Preprinted, permanent/embossed and fade resistant for a 10 year minimum outdoor durability.
 4. Color:
 - a. Background: Manufacturer standard or as specified.
 - Lettering: Black.
 5. Standards for OSHA signs: NEMA/ANSI Z535.1, NEMA/ANSI Z535.2, NEMA/ANSI Z535.3, NEMA/ANSI Z535.4, OSHA 29 CFR 1910.145.
- F. Type D - Self-Adhesive Tape Tags and Signs:
1. Materials: Vinyl tape or vinyl cloth.
 2. Size:
 - a. Surface: As required detail.
 - Thickness: 5 mils minimum.
 3. Fabrication:
 - a. Indoor/Outdoor grade.
 - Weather and UV resistant inks.
 - c. Permanent adhesive.
 - d. Legend: Preprinted.
 - e. Wire markers to be self-laminating.
 4. Color: White with black lettering or as specified.
 5. Standards for OSHA signs: NEMA/ANSI Z535.1, NEMA/ANSI Z535.2, NEMA/ANSI Z535.3, NEMA/ANSI Z535.4, OSHA 29 CFR 1910.145.
- G. Type E - Heat Shrinkable Tape Tags:
1. Materials: Polyolefin.

2. Size: As required sheet.
3. Fabrication:
 - a. Legend: Preprinted.
4. Color: White background, black printing.

H. Type F - Underground Warning Tape:

1. Materials: Polyethylene.
2. Size:
 - a. 1/2 IN wide (minimum)
 - b. Thickness: 3.5 mils.
3. Fabrication:
 - a. Legend: Preprinted and permanent (imbedded).
 - b. Message continuous printed.
 - c. Tensile strength: 1750 PSI.
4. Color: As specified.

I. Underground Tracer Wire:

1. Materials:
 - a. Wire:
 1. 12 GA AWG.
 2. Solid.
 - b. Wire nuts: Waterproof type.
 - c. Split bolts: Brass.

2.03 ACCESSORIES

A. Fasteners:

1. Bead chain: Brass, aluminum or stainless steel.
2. Plastic strap: Nylon, urethane or polypropylene.
3. Screws: Self-tapping, stainless steel.
4. Adhesive, solvent activated.

2.04 MAINTENANCE MATERIALS

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

PART 3 - EXECUTION

3.01 GENERAL INSTALLATION

- A. Install identification devices at specified locations.
- B. All identification devices to be printed by mechanical process, hand printing is not acceptable.
- C. Attach tags to equipment with sufficient surface or bonded area with solvent activated adhesive applied to back of each tag.
- D. Attach tags with 1/8 IN round or flat head screws to equipment without sufficient surface or bonded area, or porous surfaces.
 - 1. Where attachment with screws should not or cannot penetrate substrate, attach with plastic strap.
- E. Single items of equipment enclosed in a housing or compartment to be tagged on outside of housing.
 - 1. Several items of equipment mounted in housing to be individually tagged inside the compartment.
- F. Tracer Wire:
 - 1. Attach to pipe at a maximum of 10 FT intervals with tape or tie-wraps.
 - 2. Continuous pass from each valve box and above grade at each structure.
 - 3. Coil enough wire at each valve box to extend wire a foot above the ground surface.
 - 4. 1,000 FT maximum spacing between valve boxes.
 - 5. If split bolts are used for splicing, wrap with electrical tape.
 - 6. If wire nuts are used for splicing, knot wire at each splice point leaving 1 IN of wire for splicing.
 - 7. Use continuous strand of wire between valve boxes where possible.
 - a. Continuous length shall be no shorter than 100 FT.

3.02 SCHEDULES

- A. Process Schedules:
 - 1. General:
 - a. Provide arrows and markers on piping.

- 1□ At 20 FT maximum centers along continuous lines.
 - 2□ At changes in direction route or obstructions.
 - 3□ At valves, risers, "T" joints, machinery or equipment.
 - 4□ Where pipes pass through floors, walls, ceilings, cladding assemblies and like obstructions provide markers on both sides.
- Position markers on both sides of pipe with arrow markers pointing in flow direction.
- 1□ If flow is in both directions use double headed arrow markers.
- c. Appl tapes and stenciling in uniform manner parallel to piping.
2. Trenches with piping:
- a. Tag type: Type F - Underground Warning Tape
 - Location: Halfway between top of piping and finished grade.
 - c. Letter height: 1-1/4 IN minimum.
 - d. Natural gas or digester gas:
 - 1□ Color: Yellow with black letters.
 - 2□ Legend:
 - a□ First line: "CAUTION CAUTION CAUTION"
 - Second line: "BURIED GAS LINE BELOW"
 - e. Potable water:
 - 1□ Color: Blue with black letters.
 - 2□ Legend:
 - a□ First line: "CAUTION CAUTION CAUTION"
 - Second line: "BURIED WATER LINE BELOW"
 - f. Storm and sanitary sewer lines:
 - 1□ Color: Green with black letters.
 - 2□ Legend:
 - a□ First line: "CAUTION CAUTION CAUTION"
 - Second line: "BURIED SEWER LINE BELOW"
 - g. Nonpotable water piping, except 3 IN and smaller irrigation pipe:

- 1 Color: Green with black letters.
- 2 Legend:
 - a First line: "CAUTION CAUTION CAUTION"
 - Second line: "BURIED NONPOTABLE WATER LINE BELOW"
- h. Chemical feed piping (e.g., chlorine solution, polymer solution, caustic solution, etc.)
 - 1 Color: yellow with black letters.
 - 2 Legend:
 - a First line: "CAUTION CAUTION CAUTION"
 - Second line: "BURIED CHEMICAL LINE BELOW"
- i. Other piping (e.g., compressed air, irrigation, refrigerant, heating water, etc.)
 - 1 Color: yellow with black letters.
 - 2 Legend:
 - a First line: "CAUTION CAUTION CAUTION"
 - Second line: "BURIED PIPE LINE BELOW"
3. Hard valves, buried, with valve box and concrete pad:
 - a. Tag type: Type A2 - Rectangle Metal Tags.
 - Fastener: 3/16 IN 7/8 IN plastic screw anchor with 1 IN 304 stainless steel pan head screw.
 - c. Legend:
 - 1 Letter height: 1/4 IN minimum.
 - 2 Valve designation as indicated on the Drawings (e.g., "V-xxx").
4. Valves and slide gates:
 - a. Tag type:
 - 1 Outdoor locations: Type B1 - Square Nonmetallic Tags.
 - 2 Indoor noncorrosive:
 - a Type A1 - Round Metal Tags.
 - Type B1 - Square Nonmetallic Tags.
 - 3 Indoor corrosive:

- a Stainless steel Type A1 - Round Metal Tags.
- Type B1 - Square Nonmetallic Tags.
- Fastener:
 - 1 Type A1: Chain of the same material.
 - 2 Type B1: Stainless steel chain.
- c. Color: Per ASME A13.1 corresponding to the piping system.
- d. Legend:
 - 1 Letter height: 1/4 IN minimum.
 - 2 Valve designation as indicated on the Drawings (e.g., "V-xxx").
- 5. Process equipment (e.g., pumps, pump motors, blowers, air compressors, bar screens, clarifier drive mechanism, etc.)
 - a. Tag type:
 - 1 Type B2 - Nonmetallic Signs.
 - 2 Type D - Self-Adhesive Tape Tags and Signs.
 - 3 Type G - Stenciling System.
 - Fastener:
 - 1 Self.
 - 2 Screws.
 - 3 Adhesive.
 - c. Legend:
 - 1 Letter height: 1/2 IN minimum.
 - 2 Equipment designation as indicated on the Drawings (e.g., "Primary Sludge Pump P-xxx").
 - Piping systems:
 - a. Tag type:
 - 1 Outdoor locations: Type G - Stenciling System.
 - 2 Indoor locations:
 - a Type D - Self-Adhesive Tape Tags and Signs.
 - Type G - Stenciling System.

- Fastener: Self.
 - c. Color: Per ASME A13.1.
 - d. Legend:
 - 1 Letter height: Manufacturers standard for the pipe diameter.
 - 2 Mark piping in accordance with ASME A13.1.
 - 3 Use piping designation as indicated on the Drawings.
 - 4 Arrow: Single arrow.
7. Process tanks over 1000 GAL and basins, e.g., chemical storage, clarifiers, trickling filters, digesters, etc
- a. Tag type:
 - 1 Type B2 - Nonmetallic Signs.
 - 2 Type G - Stenciling System.
 - Fastener:
 - 1 Screw.
 - 2 Self.
 - c. Location as directed Owner.
 - d. Legend:
 - 1 Letter height: 4 IN minimum.
 - 2 Equipment designation as indicated on the Drawings (e.g., "Clarifier CL-xxx").
8. Tanks less than 1000 GAL e.g., break tanks, chemical tanks, hydro-pneumatic tanks, air receivers, etc.
- a. Tag type:
 - 1 Type D - Self-Adhesive Tape Tags and Signs.
 - 2 Type G - Stenciling System.
 - Fastener: Self.
 - c. Legend:
 - 1 Letter height: 2 IN minimum.
 - 2 Equipment designation as indicated on the Drawings (e.g., "Polymer Storage Tank Txxx")

9. Equipment that starts automatically

a. Tag type:

- 1 Type B2 - Nonmetallic Signs.
- 2 Type D - Self-Adhesive Tape Tags and Signs.

b. Fastener:

- 1 Type B2 - Screw or adhesive.
- 2 Type D - Self.

c. Size: 5 IN - 7 IN

d. Location: Equipment name.

e. Legend:

- 1 OSHA Warning Sign.
- 2 Description of Warning: "THIS MACHINE STARTS AUTOMATICALLY".

B. Instrumentation Systems:

1. Instrumentation Equipment (e.g., flow control valves, primary elements, etc.)

a. Tag type:

1 Outdoor locations: Type B1 - Square Nonmetallic Tags.

2 Indoor noncorrosive:

- a Type A1 - Round Metal Tags.
- b Type B1 - Square Nonmetallic Tags.

3 Indoor corrosive:

- a Stainless steel Type A1 - Round Metal Tags.
- b Type B1 - Square Nonmetallic Tags.

b. Fastener:

- 1 Type A1: Chain of the same material.
- 2 Type B1: Stainless steel chain.

c. Legend:

- 1 Letter height: 1/4 IN minimum.
- 2 Equipment ISA designation as indicated on the Drawings (e.g., "FIT-xxx").

2. Enclosure for instrumentation and control equipment, (e.g., PLC control panels, etc.)
 - a. Tag type: Type C - Phenolic Name Plates.
 - Fastener: Screws.
 - c. Legend:
 - 1□ Letter height: 1/2 IN minimum.
 - 2□ Equipment name (e.g., "PLC CONTROL PANEL PCP-□□□")
3. Components inside equipment enclosure, (e.g., PLC's, control relays, contactors, and timers)
 - a. Tag type: Type D - Self-Adhesive Tape Tags.
 - Fastener: Self.
 - c. Legend:
 - 1□ Letter height: 3/16 IN minimum.
 - 2□ Description or function of component (e.g., "PLC-xxx" or "CR-□□□")
4. Through enclosure door mounted components (e.g., selector switches, controller digital displays, etc.)
 - a. Tag type: Type C - Phenolic Name Plates.
 - Fastener: Screws.
 - c. Legend:
 - 1□ Letter height: 1/4 IN minimum.
 - 2□ Component ISA tag number as indicated on the Drawings (e.g., "HS-xxx").

C. HVAC Systems:

1. General:
 - a. Provide arrows and markers on ducts.
 - 1□ At 20 FT maximum centers along continuous lines.
 - 2□ At changes in direction (route or obstructions).
 - 3□ At dampers, risers, branches, machinery or equipment.
 - 4□ Where ducts pass through floors, walls, ceilings, cladding assemblies and like obstructions provide markers on both sides.
 - Position markers on both sides of duct with arrow markers pointing in flow direction.

- 1□ If flow is in □oth directions use dou□le headed arrow markers.
- c. Appl□tapes and stenciling in uniform manner parallel to ducts.
- 2. HVAC E□uipment [e.g., unit heaters, e□haust fans, air handlers, etc.]
 - a. Tag t□pe:
 - 1□ T□pe B2 - Nonmetallic Signs.
 - 2□ T□pe C - Phenolic Name Plates.
 - Fastener: Screws.
 - c. Legend:
 - 1□ Letter height: 1 IN minimum.
 - 2□ E□uipment designation as indicated on the Drawings [e.g., "EF-□□□"]□
- 3. Ductwork:
 - a. Tag t□pe:
 - 1□ T□pe D - Self-Adhesive Tape Tags and Signs.
 - 2□ T□pe G - Stenciling S□stem.
 - Fastener: Self.
 - c. Legend:
 - 1□ Letter height: 1 IN minimum.
 - 2□ Description of ductwork, (e.g., "AIR SUPPLY").
 - 3□ Arrows: Single arrow.
- 4. Enclosure for instrumentation and control e□uipment, [e.g., fan control panels, etc.]
 - a. Tag t□pe: T□pe C - Phenolic Name Plates.
 - Fastener: Screws.
 - c. Legend:
 - 1□ Letter height: 1/2 IN minimum.
 - 2□ E□uipment designation as indicated on the Drawings [e.g., "FAN CONTROL PANEL FCP-□□□"]□
- 5. Wall mounted thermostats:
 - a. Tag t□pe: T□pe D - Self-Adhesive Tape Tags and Signs.
 - Fastener: Self.

c. Legend:

1 Letter height: 3/16 IN minimum.

2 Description of equipment controlled (e.g., "UH-000" or AHU-000")

- Components inside equipment enclosure, (e.g., controller's, control relays, contactors, and timers)

a. Tag type: Type D - Self-Adhesive Tape Tags and Signs.

□ Fastener: Self.

c. Legend:

1 Letter height: 3/16 IN minimum.

2 Description or function of component (e.g., "CR-000")

- 7. Through enclosure door mounted equipment (e.g., selector switches, controller digital displays, etc.)

a. Tag type: Type C - Phenolic Name Plates.

□ Fastener: Screws.

c. Legend:

1 Letter height: 1/4 IN minimum.

2 Component tag number as indicated on the Drawings or as defined by contractor (e.g., "HS-xxx").

D. Electrical Systems:

- 1. Trenches with ductbanks, direct-buried conduit, or direct-buried wire and cable.

a. Tag type: Type F - Underground Warning Tape.

□ Letter height: 1-1/4 IN minimum.

c. Location:

1 Where trench is 12 IN or more below finished grade: In trench 6 IN below finished grade.

2 Where trench is less than 12 IN below finished grade: In trench 3 IN below finished grade.

d. Electrical power (e.g., low and medium voltage)

1 Color: Red with black letters.

2 Legend:

a First line: "CAUTION CAUTION CAUTION".

- a First line: 3/8 IN minimum.
 - Subsequent lines: 3/16 IN minimum.
 - 2 First line: Equipment name (e.g., "PANELBOARD LP####" or "TRANSFORMER T####")
 - 3 Second line (panelboards only): System voltage and phase (e.g., "208/120V, 3PH").
 - 4 Third line:
 - a Source of power (e.g., "FED FROM MCC#### LOCATED IN ROOM ####")
 - Include the building name or number if the source is in another building.
 - 5 Fourth line: Date installed (e.g., "INSTALLED JULY 20xx").
4. Transfer switches:
- a. Tag type: Type C - Phenolic Name Plates.
 - Fastener: Screws.
 - c. Legend:
 - 1 Letter height:
 - a First line: 3/8 IN minimum.
 - Subsequent lines: 3/16 IN minimum.
 - 2 First line: Equipment name (e.g., "AUTOMATIC TRANSFER SWITCH ATS####")
 - 3 Second line: Normal source of power (e.g., "NORMAL SOURCE FED FROM MCC####")
 - 4 Third line: Emergency source of power (e.g., "EMERGENCY SOURCE FED FROM SGEN####")
 - 5 Fourth line: Date installed (e.g., "INSTALLED JULY 20xx").
5. Safety switches, separately mounted circuit breakers and motor starters, VFD's, etc.:
- a. Tag type: Type C - Phenolic Name Plates.
 - Fastener: Screws.
 - c. Legend:
 - 1 Letter height: 1/4 IN minimum.

- 2□ First line: Description of load equipment is connected to (e.g., "PUMP P□□□")
- Enclosure for instrumentation and control equipment, (e.g., lighting control panels, etc.)
 - a. Tag type: Type C - Phenolic Name Plates.
 - Fastener: Screws.
 - c. Legend:
 - 1□ Letter height: 1/2 IN minimum.
 - 2□ Equipment name (e.g., "LIGHTING CONTROL PANEL LCP□□□")
- 7. Components inside equipment enclosures (e.g., circuit breakers, fuses, control power transformers, control relays, contactors, timers, etc.)
 - a. Tag type: Type D - Self-Adhesive Tape Tags and Signs.
 - Fastener: Self.
 - c. Legend:
 - 1□ Letter height: 3/16 IN minimum.
 - 2□ Description or function of component (e.g., "M-xxx", "CR-xxx" or "TR-□□□")
- 8. Through enclosure door mounted equipment (e.g., selector switches, controller digital displays, etc.)
 - a. Tag type: Type C - Phenolic Name Plates.
 - Fastener: Screws.
 - c. Legend:
 - 1□ Letter height: 1/4 IN minimum.
 - 2□ Component tag number as indicated on the Drawings or as defined by contractor (e.g., "HS-xxx").
- 9. Conductors in control panels and in pull or junction boxes where multiple circuits exist.
 - a. Tag type: Type D - Self-Adhesive Tape Tags.
 - Fastener: Self.
 - c. Tag conductor at both ends.
 - d. Legend:
 - 1□ Letter height: 1/8 IN minimum.

- 2 Circuit number or wire number as scheduled on the Drawings or as furnished with the equipment.

10. Conductors in handholes and manholes.

- a. Tag type: Type A3 - Metal Tape Tags.

- Fastener: Nylon strap.

- c. Tag conductor at both ends.

- d. Legend:

- 1 Letter height: 1/8 IN minimum.

- 2 Circuit number or wire number as scheduled on the Drawings.

11. Grounding conductors associated with grounding electrode system in accordance with the following:

- a. Tag type: Type D - Self-Adhesive Tape Tags.

- Fastener: Self.

- c. Legend:

- 1 Letter height: 1/8 IN minimum.

- 2 Function of conductor (e.g., "MAIN BONDING JUMPER", "TO GROUND RING", "TO MAIN WATER PIPE")

12. Flash protection for switchboards, panelboards, industrial control panels and motor control centers:

- a. Tag type: Type D - Self-Adhesive Tape Signs.

- Fastener: Self.

- c. Legend: Per NFPA 70.

13. Entrances to electrical rooms:

- a. Tag type: Type B2 - Nonmetallic Signs.

- Fastener: Screw or adhesive.

- c. Size: 5 IN \times 7 IN.

- d. Location: Each door to room.

- e. Legend:

- 1 OSHA Danger Sign.

- 2 Description of Danger: "HIGH VOLTAGE, AUTHORIZED PERSONNEL ONLY".

14. Equipment where more than one voltage source is present:

a. Tag type:

1 Type B2 - Nonmetallic Signs.

b. Fastener:

1 Screw or adhesive.

2 Self.

c. Size: 1-3/4 IN 2-1/2 IN.

d. Location: Exterior face of enclosure or curical.

e. Legend:

1 OSHA Danger Sign.

2 Description of Danger: "MULTIPLE VOLTAGE SOURCES".

3.03 HAZARD AND SAFETY SIGNS

A. Provide 25 Hazard and Safety Signs:

1. Type B2.

2. Inscription as directed by Owner.

END OF SECTION

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SECTION 10444

SIGNAGE

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Room identification signs.
2. Other identification signs:
 - a. Fire and/or smoke carrier identification signs.
3. Aluminum letters.

B. Related Specification Sections include but are not necessarily limited to:

1. Division 00 - Procurement and Contracting Requirements.
2. Division 01 - General Requirements.
3. Section 10400 - Identification Devices.

1.02 QUALITY ASSURANCE

A. Referenced Standards:

1. Americans with Disabilities Act (ADA)
 - a. Accessibility Guidelines for Buildings and Facilities (ADAAG)
2. ASTM International (ASTM)
 - a. B21, Standard Specification for Aluminum-Alloy Sand Castings.
3. Building code:
 - a. International Code Council (ICC)
 1. International Building Code and associated standards, As well as Florida Building Code, 2015 Edition including all amendments, referred to herein as Building Code.

1.03 DEFINITIONS

- A. Wet and/or Corrosive Areas: For the purposes of this Specification Section, the following rooms or areas are considered wet and/or corrosive:

1.04 SUBMITTALS

- A. Shop Drawings:

1. See Specification Section 01300 for requirements for the mechanics and administration of the submittal process.
 2. Product technical data including:
 - a. Acknowledgement that products submitted meet requirements of standards referenced.
 - b. Manufacturer's installation instructions.
 - c. Color charts for Engineer's color selection.
 1. Color selection shall be made from manufacturer's complete color line including all premium and special colors.
 3. Schedule of all signs indicating text and graphics.
 4. Layout drawings of all signage showing size, letter style, text, color, finish, and installation detail.
 - a. Provide drawings for:
 1. Room, and stair identification signs.
 2. Fire and/or smoke barrier identification signs.
 3. Aluminum letters.
- B. Samples:
1. Room stair identification signs.
 2. Fire and/or smoke barrier identification signs.
 3. Aluminum letters.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
1. Room stair identification signs:
 - a. ASE - Architectural Signs and Engraving.
 - b. ASI Signage Innovations.
 - c. Best Sign Systems.
 - d. Mohawk Sign Systems.
 - e. Nelson-Harkins.

- f. Southwell Co.
 - g. Stamprite Supersine Identification Specialists.
2. Fire and/or smoke barrier identification signs:
- a. Bradco
 - b. Panduit.
 - c. Seton.
 - d. Carlton Industries.
3. Aluminum letters:
- a. A R K Ramos Manufacturing Co., Inc.
 - b. ASI Signage Innovations.
 - c. Leeds Architectural Letters.
 - d. Metal Arts.
 - e. Metallic Arts.
 - f. The Southwell Co.

B. Submit request for substitution in accordance with Specification Section 01040.

2.02 MATERIALS

A. Room and Stair Identification Signs:

1. Interior:
- a. Dry non-corrosive areas: Melamine plastic suitable for raised lettering and Braille.
 - b. Wet and/or corrosive areas: Aluminum or fiberglass suitable for raised lettering and Braille.
2. Exterior: Aluminum or fiberglass suitable for raised lettering and Braille.

B. Fire and/or Smoke Barrier Identification Signs:

1. Self-adhesive vinyl tape or vinyl cloth Stenciling system.

C. Aluminum Letters:

1. Cast aluminum ASTM B209
2. For machine cut letters, provide aluminum of appropriate alloy and hardness.

2.03 FABRICATION

A. Room Identification Signs:

1. General:

- a. Raised text, border and graphics.
 - 1 Minimum 1/32 IN height.
 - 2 Provide international graphic symbols for all toilet, locker and shower rooms or combinations thereof, and for unisex toilet rooms and stairs.
 - 3 Provide handicap symbol on all signs for rooms meeting handicap requirements.
- b. Grade 2 Braille.
- c. Finish: Eggshell.
 - 1 Color: To be selected.
- d. Text:
 - 1 Typeface: Sans Serif.
 - 2 Size: Minimum 3/4 IN high.
- e. Text as indicated in the SCHEDULES Article in PART 3 of this Specification Section.
- f. Exterior signs shall be rated for exterior use.
- g. All signs shall comply with requirements of ADA state or local authority as appropriate.

B. Fire and/or Smoke Barrier Identification Signs:

1. Self-adhesive tape tags and signs:

- a. Materials: Vinyl tape or vinyl cloth.
- b. Size:
 - 1 Surface: As required in text.
 - 2 Thickness: 5 mils minimum.
- c. Fabrication:
 - 1 Indoor/Outdoor grade.
 - 2 Weather and UV resistant inks.
 - 3 Permanent adhesive.

4 Legend: Preprinted.

5 Self-laminating.

d. Color: White with black lettering or as specified.

2. Stenciling system:

a. Materials:

1 Exterior type stenciling enamel.

2 Either brushing grade or pressurized spray can form and grade.

Size: As required.

c. Fabrication:

1 Legend: As required.

d. Color: Black or white for best contrast.

C. Hazard Communication Signage OSHA signage See Specification Section 10400.

D. Aluminum Letters:

1. General:

a. Cast aluminum, machine cut or laser cut aluminum.

Finish: Anodized.

c. Color: Clear.

d. Mounting:

1 1 IN protected.

2 Provide stainless steel mounting studs.

e. Text as indicated in the SCHEDULES Article in PART 3 of this Specification Section.

2. Letters:

a. Style: Helvetica.

Size: Upper case, 2 IN high.

c. Depth: 3/8 IN.

3. Provide true angles, crisp corners and straight edges with no burrs or pitting in the surface.

E. Site Signs:

2.04 MAINTENANCE MATERIALS

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

PART 3 - EXECUTION

3.01 INSTALLATION

A. Room Identification Signs:

1. Install signs using foam tape for interior signs and stainless steel screws (minimum of two (2) for exterior signs).
 - a. Stainless steel screws shall be painted to match sign color.
2. Mounting Locations:
 - a. Tactile characters on signs shall be located 48 IN minimum above the finished floor or ground surface, measured from the baseline of the lowest tactile character and 60 IN maximum above the finish floor or ground surface, measured from the baseline of the highest tactile character.
 - b. Where a tactile sign is provided at a door, the sign shall be located alongside the door at the latch side. Where a tactile sign is provided at double doors with one active leaf, the sign shall be located on the inactive leaf. Where a tactile sign is provided at double doors with two active leaves, the sign shall be located to the right side of the right hand door. Where there is no wall space at the latch side of a single door or at the right side of double doors, signs shall be located on the nearest adjacent wall.
 - c. Signs containing tactile characters shall be located so that a clear floor space of 18 IN minimum (18 IN minimum, centered on the tactile characters, is provided beyond the arc of an door swing between the closed position and 45 degree open position.
3. Interior and exterior signs identifying permanent rooms and spaces shall comply with ADA state or local authority as appropriate.

B. Fire and/or Smoke Barrier Identification Signs:

1. Provide marking and identification in compliance with Building Code.
2. Locate in accessible concealed floor, floor-ceiling, or attic spaces.
3. Repeat at intervals not exceeding 15 FT measured horizontally.
4. Lettering: Not less than 1/2 IN high.

C. Aluminum Letters:

1. Install letters where indicated on Drawings.
2. Mount to walls with 1 IN projection in accordance with manufacturer's instructions.

3.02 SCHEDULES

A. Room Identification Signs:

BUILDING LOCATION	MOUNTING	VERBIAGE	REMARKS
OPERATIONS BUILDING			
DOOR 11-102A	EXTERIOR	OFFICE	2
DOOR 11-102B	INTERIOR	OFFICE	3
DOOR 11-103A	EXTERIOR	MAINTENANCE	2
DOOR 11-103D	INTERIOR	MAINTENANCE	3
DOOR 11-104A	INTERIOR	LUNCH ROOM	3
DOOR 11-105A	INTERIOR	WOMEN	1, 3
DOOR 11-106A	INTERIOR	MENS LOCKER ROOM	1, 3
DOOR 11-107A	EXTERIOR	OPERATIONS	2
DOOR 11-108A	INTERIOR	INVENTOR	3
DOOR 11-108A	INTERIOR	INVENTOR	2
SLUDGE HANDLING BUILDING			
DOOR 11-109A	EXTERIOR	TRUCK LOADING	2
DOOR 11-109C	EXTERIOR	TRUCK LOADING	2
DOOR 11-109E	EXTERIOR	TRUCK LOADING	2
DOOR 11-110A	EXTERIOR	AQUILLIAR STORAGE	2
DOOR 11-111A	INTERIOR	POLYMER STORAGE	2
DOOR 11-112A	INTERIOR	STAIR	1, 3
DOOR 11-112A	INTERIOR	PUMP ROOM AUTHORIZED PERSONNEL ONLY	2
DOOR 11-112B	INTERIOR	PUMP ROOM AUTHORIZED PERSONNEL ONLY	2
DOOR 11-112B	INTERIOR	TRUCK LOADING	3
DOOR 11-112C	EXTERIOR	PUMP ROOM AUTHORIZED PERSONNEL ONLY	2
DOOR 11-113A	EXTERIOR	STAIR	2
DOOR 11-202A	INTERIOR	SLUDGE DEWATERING	2
DOOR 11-203A	INTERIOR	UNISEX RESTROOM	1, 3
DOOR 11-204A	INTERIOR	OPERATOR ROOM	2
DOOR 11-204A	INTERIOR	STAIR	1, 3
DOOR 11-204B	INTERIOR	SLUDGE THICKENING	2
DOOR 11-204B	INTERIOR	OPERATOR ROOM	3

PROJECT NO. 11843 PROGRESSO VILLAGE STORM WATER IMPROVEMENTS

BUILDING LOCATION	MOUNTING	VERBIAGE	REMARKS
DOOR 11-205A	INTERIOR	ELECTRICAL ROOM AUTHORIZED PERSONNEL ONLY	2
DOOR 11-205B	INTERIOR	ELECTRICAL ROOM AUTHORIZED PERSONNEL ONLY	3
DOOR 11-207A	EXTERIOR	SLUDGE THICKENING	2
DOOR 11-207A	INTERIOR	UTILITY ROOM	2
DOOR 11-208B	INTERIOR	STAIR	1, 3
DOOR 11-208B	INTERIOR	SLUDGE DEWATERING	2
DOOR 11-208C	INTERIOR	ROOF ACCESS AUTHORIZED PERSONNEL ONLY	3
REMARKS: 1. Provide Universal Graphic Symbol 2. Mount adjacent to pull side of door. 3. Mount adjacent to push side of door.			

B. Fire and/or Smoke Barrier Identification Signs:

1. FIRE AND/OR SMOKE BARRIER - PROTECT ALL OPENINGS

END OF SECTION

SECTION 10520
FIRE PROTECTION SPECIALTIES

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Portable fire extinguishers.

B. Related Specification Sections include but are not necessarily limited to:

1. Division 00 - Procurement and Contracting Requirements.
2. Division 01 - General Requirements.
3. Section 05500 - Metal Fabrications.

1.02 QUALITY ASSURANCE

A. Referenced Standards:

1. Americans with Disabilities Act (ADA)
 - a. 2010 ADA Standards for Accessible Design.
2. National Fire Protection Association (NFPA)
 - a. 10, Standard for Portable Fire Extinguishers.
3. Underwriters Laboratories, Inc. (UL)
 - a. 8, Water Based Agent Fire Extinguishers.
 - b. 154, Carbon Dioxide Fire Extinguishers.
 - c. 299, Dry Chemical Fire Extinguishers.
 - d. 2, Water Fire Extinguishers.
 - e. 711, Rating and Fire Testing of Fire Extinguishers.
 - f. 2129, Halocarbon Clean Agent Fire Extinguishers.

1.03 DEFINITIONS

- A. Authority Having Jurisdiction (AHJ) Building official, fire chief, fire marshal or other individual having statutory authority

1.04 SUBMITTALS

- A. Shop Drawings:

1. See Specification Section 01300 for requirements for the mechanics and administration of the submittal process.
2. Product technical data including:
 - a. Acknowledgement that products submitted meet requirements of standards referenced.
 - b. Manufacturer's installation instructions.
 - c. Ratings and classification of extinguishers.

B. Contract Closeout Information:

1. Operation and Maintenance Data:
 - a. See Specification Section 01300 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Deliver and install filled and charged extinguishers list prior to building occupancy.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
1. Fire extinguishers:
 - a. Amerex Corporation.
 - b. Ansul – Teco Fire Protection Products.
 - c. Badger Fire Protection.
 - d. United Technologies - Kidde.
 - e. Buckeye Fire Equipment.
 2. Fire extinguisher signs:
 - a. Seton.
 - b. Compliance Signs.
 - c. Safety Sign.
- B. Submit request for substitution in accordance with Specification Section 0140.

2.02 MANUFACTURED UNITS

- A. Fire Extinguisher (FEET)
 - 1. Steel bodied, all metal top head and valves.
 - 2. Multi-purpose dry chemical extinguisher with hose and nozzle.
 - 3. Provide one UL listed 10 LB. 4A-10BC extinguisher for each fire extinguisher location (FEET) indicated on Drawings.
 - 4. Finish: Red with epoxy finish coat.
- B. Wall Brackets:
 - 1. Bracket type to fit specified extinguisher.
 - 2. Furnish bracket for each extinguisher not in cabinet.
 - 3. Bracket to be finished in red or black enamel.
- C. Fire Extinguisher Signage:
 - 1. Single faced: SETON 21999.
 - 2. Double faced: SETON 22001.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install products in accordance with manufacturer's instructions and NFPA 10.
 - 1. Install units with extinguisher top not over 48 IN above floor.
 - 2. Install wall brackets to concrete or masonry substrate with self-tapping concrete anchors.
 - a. See Specification Section 05500.
- B. Fire extinguisher locations shown on Drawings are approximate locations.
 - 1. Verify all extinguisher mounting locations with the AHJ.
- C. Provide "FIRE EXTINGUISHER" sign for each extinguisher location.
 - 1. Provide single or double faced sign to provide optimum visibility for extinguisher location.

END OF SECTION

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SECTION 11005

EQUIPMENT - BASIC REQUIREMENTS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Requirements of this Specification Section apply to all equipment provided on the Project including those found in other Divisions even if not specifically referenced in individual "Equipment" Articles of those Specification Sections.

B. Related Sections include but are not necessarily limited to:

1. Division 01 - General Requirements.
2. Section 15002 – Ductile Iron Pipe.
3. Section 3300 - Cast-in-Place Concrete.
4. Section 05010 - Metal Materials.
5. Section 07920 - Sealants and Caulking.
- Section 09900 - Painting.
7. Section 10400 - Identification Devices.

1.02 QUALITY ASSURANCE

A. Referenced Standards:

1. American Bearing Manufacturers Association (ABMA)
2. American Gear Manufacturers Association (AGMA)
3. ASTM International (ASTM)
 - a. E1934, Standard Guide for Examining Electrical and Mechanical Equipment with Infrared Thermography
 - F593, Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
4. Hydraulic Institute (HI)
 - a. 9.4, Centrifugal and Vertical Pumps for Vibration Measurements and Allowable Valves.
5. International Electrotechnical Commission (IEC)
 - Institute of Electrical and Electronics Engineers, Inc. (IEEE)

7. International Organization for Standardization (ISO)
 - a. 1940, Mechanical Vibration - Balance Quality Requirements for Rotors in a Constant Rigid State - Part 1: Specification and Verification of Balance Tolerances.
 - b. 21940-11, Mechanical Vibration - Rotor Balancing - Part 11: Procedures and Tolerances for Rotors with Rigid Behavior.
 8. National Electrical Manufacturers Association (NEMA)
 - a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum)
 - b. ICS (C), Enclosures for Industrial Control and Systems.
 - c. MG 1, Motors and Generators.
 9. International Electrical Testing Association (NETA)
 - a. ATS, Acceptance Testing Specification for Electrical Power Distribution Equipment and Systems.
 10. National Fire Protection Association (NFPA)
 - a. 70, National Electrical Code (NEC)
 11. National Institute for Certification in Engineering Technologies (NICET)
 12. National Institute of Standards and Technology (NIST)
 13. Occupational Safety and Health Administration (OSHA)
 - a. 29 CFR 1910, Occupational Safety and Health Standards, referred to herein as OSHA Standards.
 14. Underwriters Laboratories, Inc. (UL)
 - a. 508, Standard for Safety Industrial Control Equipment.
 - b. 508A, Standard for Safety Industrial Control Panels.
 - c. 98A, Standard for Industrial Control Panels Relating to Hazardous (Classified) Locations.
 15. Vibration Institute.
- B. Natural frequency analysis firm:
1. An independent firm, whose sole or principal part of its business is the calculation of and analysis of natural frequencies of rotating equipment.
 2. Minimum of 10 years experience.
 3. Employs a registered professional engineer who has experience in finite element analysis, rotordynamic analysis and experimental modal analysis.

- a. Minimum five (5) years combined field testing and data analysis experience.
- Qualified Vibration Category III certification from the Vibration Institute.

C. Vibration Testing Program:

1. Testing firm:

- a. An independent firm performing, as the sole or principal part of its business for a minimum of 10 years, the inspection, testing, calibration, and adjusting of systems.
- Must have an established monitoring and testing equipment calibration program with accurate traceable in an unbroken chain, according to NIST.

2. Field personnel:

- a. Minimum of three (3) years field experience covering all phases of field vibration testing and data gathering.
- Qualified Vibration Category II certification from the Vibration Institute.

3. Analysis personnel:

- a. Minimum five (5) years combined field testing and data analysis experience.
- Qualified Vibration Category III certification from the Vibration Institute.

D. Infrared Thermograph Testing Program:

1. Testing firm:

- a. An independent firm performing, as the sole or principal part of its business for a minimum of 10 years, the inspection, testing, calibration, and adjusting of systems.
- Must have an established monitoring and testing equipment calibration program with accurate traceable in an unbroken chain, according to NIST.

2. Field personnel:

- a. Minimum of one (1) year field experience covering all phases of field thermograph testing and data gathering.
- Supervisor certified in NETA or NICET.

3. Analysis personnel:

- a. Minimum three (3) years combined field testing and data analysis experience.
- Supervisor certified in NETA or NICET.

E. Electrical Equipment and Connections Testing Program:

1. Testing firm:

- a. An independent firm performing, as the sole or principal part of its business for a minimum of 10 years, the inspection, testing, calibration, and adjusting of systems.
 - Must have an established monitoring and testing equipment calibration program with accurate traceable in an unbroken chain, according to NIST.
 2. Field personnel:
 - a. Minimum of one year field experience covering all phases of electrical equipment inspection, testing, and calibration.
 - Relatest technician having previous experience with testing and calibration of relays of the same manufacturer and type used on project and proficient in setting and testing the types of protection elements used.
 - c. Supervisor certified in NETA or NICET.
 3. Analysis personnel:
 - a. Minimum three years combined field testing and data analysis experience.
 - Supervisor certified in NETA or NICET.
- F. Miscellaneous:
1. A single manufacturer of a "product" shall be selected and utilized uniformly throughout Project even if:
 - a. More than one manufacturer is listed for a given "product" in Specifications.
 - No manufacturer is listed.
 2. Equipment, electrical assemblies, related electrical wiring, instrumentation, controls, and system components shall fully comply with specific NEC requirements related to area classification and to NEMA 250 and NEMA ICS designations shown on Electrical Power Drawings and defined in the Electrical specifications.

1.03 DEFINITIONS

- A. Product: Manufactured materials and equipment.
- B. Major Equipment Supports - Supports for Equipment:
 1. Located on or suspended from elevated slabs with supported equipment weighing 2000 LBS or greater, or
 2. Located on or suspended from roofs with supported equipment weighing 500 LBS or greater, or
 3. Located on slab-on-grade or earth with supported equipment weighing 5000 LBS or more.

C. Equipment:

1. One or more assemblies capable of performing a complete function.
2. Mechanical, electrical, instrumentation or other devices requiring an electrical, pneumatic, electronic or hydraulic connection.
3. Not limited to items specifically referenced in "Equipment" articles within individual Specifications.

D. Installer or Applicator:

1. Installer or applicator is the person actually installing or applying the product in the field at the Project site.
2. Installer and applicator are synonymous.

1.04 SUBMITTALS

A. Shop Drawings:

1. General for all equipment:
 - a. See Section 01300 for requirements for the mechanics and administration of the submittal process.
 1. Data sheets that include manufacturer's name and complete product model number.
 1. Clearly identify all optional accessories that are included.
 - c. Acknowledgement that products submitted comply with the requirements of the standards referenced.
 - d. Manufacturer's delivery, storage, handling, and installation instructions.
 - e. Equipment identification utilizing numbering system and name utilized in Drawings.
 - f. Equipment installation details:
 1. Location of anchorage.
 2. Type, size, and materials of construction of anchorage.
 3. Anchorage setting templates.
 4. Manufacturer's installation instructions.
 - g. Equipment area classification rating.
 - h. Shipping and operating weight.
 - i. Equipment physical characteristics:
 1. Dimensions both horizontal and vertical

- 2. Materials of construction and construction details.
 - Equipment factor □ primer and paint data.
 - k. Manufacturer's recommended spare parts list.
 - l. Equipment lining and coatings.
 - m. Equipment utility requirements include air, natural gas, electricity, and water.
 - n. Ladders and platforms provided with equipment:
 - 1. Certification that all components comply with OSHA requirements.
 - 2. Full details of construction/fabrication.
 - 3. Scaled plan and sections showing relationship to equipment.
- 2. Mechanical and process equipment:
 - a. Operating characteristics:
 - 1. Technical information including applicable performance curves showing specified equipment capacity, range, and efficiencies.
 - 2. Brake horsepower requirements.
 - 3. Copies of equipment data plates.
 - Piping and duct connection size, type and location.
 - c. Equipment bearing life certification.
 - d. Equipment foundation data:
 - 1. Equipment center of gravity.
 - 2. Criteria for designing vibration, special or unbalanced forces resulting from equipment operation.
- 3. Electric motor:
 - a. Motor manufacturer and model number.
 - Complete motor nameplate data.
 - c. Weight.
 - d. NEMA design type.
 - e. Enclosure type.
 - f. Frame size.
 - g. Winding insulation class and temperature rise.

- h. Starts per hour.
- i. Performance data:
 - 1□ Motor speed-torque curve superimposed over driven machine speed-torque curve during start-up acceleration and at rated terminal voltage a minimum permissible or specified terminal voltage for all motors over 500 HP.
 - 2□ Time-current plots with acceleration versus current and thermal damage curves at the operating and ambient temperatures and at rated terminal voltage and minimum permissible or specified terminal voltage for all motors over 500 HP.
 - 3□ Guaranteed minimum efficiencies at 100 PCT, 75 PCT, and 50 PCT of full load
 - 4□ Guaranteed minimum power factor at 100 PCT, 75 PCT, and 50 PCT of full load.
 - 5□ Locked rotor and full load current at rated terminal voltage and minimum permissible or specified terminal voltage.
 - Starting, full load, and breakdown torque at rated terminal voltage and minimum permissible or specified terminal voltage.
- Bearing data and lubrication system.
- k. Natural frequency calculations for:
 - 1□ Completed assembly including but not limited to the equipment base, rotating piece of equipment, and the rotating piece of equipment driver.
 - 2□ Individual piece of rotating equipment.
 - 3□ Equipment driver and connected gear reducer, if applicable.
- l. Thermal protection system including recommended alarm and trip settings for winding and bearing RTD's.
- m. Fabrication and/or layout drawings:
 - 1□ Dimensioned outlined drawing.
 - 2□ Connection diagrams including accessories (strip heaters, thermal protection, etc.)
- n. Certifications:
 - 1□ When utilized with a reduced voltage starter, certify that motor and driven equipment are compatible.
 - 2□ When utilized with a variable frequency controller, certify motor is inverter dut and the controller and motor are compatible.

- a Include minimum speed at which the motor may be operated for the driven machinery.
 - o. Electrical gear:
 - 1 Unless specified in a narrow-scope Specification Section, provide the following:
 - a Equipment ratings: Voltage, continuous current, kVa, watts, short circuit with stand, etc., as applicable.
 - 2 Control panels:
 - a Panel construction.
 - Point-to-point ladder diagrams.
 - c Scaled panel face and subpanel layout.
 - d Technical product data on panel components.
 - e Panel and subpanel dimensions and weights.
 - f Panel access openings.
 - g Nameplate schedule.
 - h Panel anchorage.
 - i Short Circuit Current Rating (SCCR) nameplate marking per NFPA 70. Include any required calculations.
4. Systems schematics and data:
- a. Provide system schematics where required in system specifications.
 - 1 Acknowledge all system components being supplied as part of the system.
 - 2 Utilize equipment, instrument and valving tag numbers defined in the Contract Documents for all components.
 - 3 Provide technical data for each system component showing compliance with the Contract Document requirements.
 - 4 For piping components, identify all utility connections, vents and drains which will be included as part of the system.
5. For factory-painted equipment, provide paint submittals in accordance with Section 09900.
- Qualifications for:
 - a. Natural frequency analysis firm and personnel.
 - Vibration testing firm and personnel.

- c. Infrared thermograph testing firm and personnel.
 - d. Electrical equipment and connections testing firm and personnel.
7. Equipment Monitoring and Testing plans, in accordance with PART 3 of this Specification Section:
- a. Natural frequency analysis and calculations.
 - b. Vibration testing.
 - c. Thermograph testing.
 - d. Electrical equipment and connection testing.

B. Factor Test Reports

1. Natural frequency bump test reports where required for rotating equipment.
 - a. Minimum characteristics of impact hammer.
 1. Frequency Range 1 kHz
 2. Range 5v output 5,000 Lbf (22,200 N)
 3. Hammer Sensitivity 9pprox 1 mV/lbf 0.23 mV/N
 4. Resonant Frequency 12 kHz
2. Motor, equipment and final assembled equipment including motor.
 - a. Determine natural frequency of assembled motor prior to shipping to OEM or field site.
 1. Individual motor fastened to an "infinitely rigid" mass at the same bolt circle as the final assembled equipment.
 - b. Determine natural frequency of the pump.
 1. Pump fastened to an "infinitely rigid" mass at the same bolt circle as the final assembled equipment.
 - c. Determine natural frequency of the pump/motor assembly.
 1. Pump/motor assembly fastened to an "infinitely rigid" mass at the same bolt circle as the final field assembled equipment.
 - d. For this use, the "infinitely rigid" mass shall be at least 10 times the weight of the equipment being tested.
3. Submit natural frequency report for approval prior to shipment.
4. Equipment performance tests.
 - a. As listed in individual equipment specifications.

C. Contract Closeout Information:

1. Operation and Maintenance Data:

- a. See Section 01430 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.

D. Informational Submittals:

1. Sample form letter for equipment field certification.
2. Certification that equipment has been installed properly, has been initially started up, has been calibrated and/or adjusted as required, and is ready for operation.
3. Certification for major equipment supports that equipment foundation design loads shown on the Drawings or specified have been compared to actual loads exhibited by equipment provided for this Project and that said design loadings are equal to or greater than the loads produced by the equipment provided.
4. Field noise testing reports if such testing is specified in narrow-scope Specification Sections.
5. Notification, at least one (1) week in advance, that motor testing will be conducted at factor
 - Certification from equipment manufacturer that all manufacturer-supplied control panels that interface in any way with other controls or panels have been submitted to and coordinated with the supplier/installer of those interfacing systems.
7. Motor test reports.
8. Certification prior to Project closeout that electrical panel drawings for manufacturer-supplied control panels truly represent panel wiring including any field-made modifications.
9. Provide three (3) bound final written reports documenting natural frequency testing, vibration monitoring and testing for specified equipment.
 - a. Include the acceptance criteria of all equipment tested.
 - Provide individual tabbed sections for information associated with each piece of tested equipment.
10. Preliminary field quality control testing format to be used as a basis for final field quality control reporting.
11. Testing and monitoring reports in accordance with PART 3 of this Specification Section.
12. Certification that driven equipment and VFD are compatible.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:

1. Motors:
 - a. Baldor.
 - General Electric.
 - c. Hyundai Heavy Industries.
 - d. Marathon Electric.
 - e. Rockwell - Reliance.
 - f. Siemens.
 - g. TECO-Westinghouse.
 - h. Toshiba U.S.
 - i. U.S. Motors, Nidec Motor Corporation.
 - WEG.
 - k.

B. Submit request for substitution in accordance with Section 0140.

2.02 MANUFACTURED UNITS

A. Electric Motors:

1. Where used in conjunction with adjustable speed AC or DC drives, provide motors that are fully compatible with the speed controllers.
2. Design for frequent starting duty equivalent to duty service required on driven equipment.
3. Design for full voltage starting.
4. Design bearing life based upon actual operating load conditions imposed on driven equipment.
5. Size for altitude of Project.
- Furnish with stainless steel nameplates which include all data required per NEC Article 430.
7. Use of manufacturer's standard motor will be permitted on integrally constructed motor driven equipment specified by model number in which a redesign of the complete unit would be required in order to provide a motor with features specified.

8. AC electric motors less than 1/3 HP:
 - a. Single phase, 60 Hz, designed for the supply voltage shown on the Drawings.
 - Permanent lubricated sealed bearings conforming to ABMA standards.
 - c. Built-in manual reset thermal protector or integral mounted manual motor starter with thermal overload element with stainless steel enclosure.

9. AC electric motors 1/3 to 1 HP:
 - a. Single or 3 PH, 60 Hz, designed for the supply voltage shown on the Drawings.
 - Permanent lubricated sealed bearings conforming to ABMA standards.
 - 1 For single phase motors, provide built-in manual reset thermal protector or integral mounted manual motor starter with thermal overload element.

10. AC electric motors 1-1/2 to 10 HP:
 - a. Single or 3 PH, 60 Hz, designed for the supply voltage shown on the Drawings.
 - Permanent lubricated sealed bearings conforming to ABMA standards.
 - c. For vertical motors provide 15 year, average-life thrust bearings conforming to ABMA standards.

11. AC electric motors greater than 10 HP:
 - a. Single or 3 PH, 60 Hz, designed for the supply voltage shown on the Drawings.
 - Oil or grease lubricated antifriction bearings conforming to ABMA standards.
 - 1 Design bearing life for 90 PCT survival rating at 50,000 HRS of operation for motors up to and including 100 HP.
 - 2 For motors greater than 100 HP, design bearing life for 90 PCT survival rating at 100,000 HRS of operation.
 - c. For vertical motors provide 15 year, average-life thrust bearings conforming to ABMA standards.
 - d. Thermal protection:
 - 1 For motors 50 HP and above controlled from a variable frequency drive and for all other motors 100 HP and above, provide integral thermal detectors with normally closed contacts that will open on overtemperature or resistance type temperature detector (RTD) complete with monitor and alarm panel having a normally closed contact that will open on overtemperature.
 - a Two 2 thermal sensing devices per phase in each phase hot-spot location.
 - Monitor and alarm panel:

1 For constant speed motors, install panel in and energize from the motor starter equipment.

2 For variable speed motors, install panel in and energize from the variable speed drive equipment.

12. Severe duty motor to have the following minimum features:

- a. All cast iron construction.
- b. Gasketed conduit box
- c. Epoxy finish for corrosion protection.
- d. Hydroscopic varnish on windings for corrosion protection.
- e. Drain plug and breather.

B. NEMA Design Squirrel Cage Induction Motors:

1. Provide motors designed and applied in compliance with NEMA and IEEE for the specific duty imposed on the driven equipment.
2. Motors to meet NEMA MG 1 NEMA Premium efficiencies.
3. Do not provide motors having a locked rotor kVA per HP exceeding the NEMA standard for the assigned NEMA code letter.
4. For use on variable frequency type adjustable speed drives, provide:
 - a. Induction motors that are in compliance with NEMA MG 1, Part 31.
 - 1 Nameplate identification meeting NEMA MG 1 Part 31 requirements.
 - c. Insulated drive end bearing on all motors.
 - d. Insulated non-drive end bearings, at a minimum, on all motors with horizontal shaft 100 HP and larger.
 - e. An insulated bearing carrier on the non-drive end for vertical shaft motors 100 HP and larger.
 - f. Shaft grounding ring on all motors:
 - 1 Factor installed, maintenance free, circumferential, bearing protection ring with conductive microfiber shaft contacting material.
 - 2 Electro Static Technology AEGIS SGR Bearing Protection Ring or approved equal.
 - g. Have the following minimum turndown ratio without the use of additional cooling, such as a blower, to provide continuous supply of cooling air over the motor.
 - 1 Variable torque: 10:1.

2. Constant torque: 1.

5. Design motor insulation in accordance with NEMA standards for Class F insulation with Class B temperature rise above a 40 DEGC ambient.

Design motors for continuous duty

7. Size motors having a 1.0 service factor so that nameplate HP is a minimum of 15 PCT greater than the maximum HP requirements of the driven equipment over its entire operating range.

a. As an alternative, furnish motors with a 1.15 service factor and size so that nameplate HP is at least equal to the maximum HP requirements of the driven equipment over its entire operating range.

8. Motor enclosure and winding insulation application:

a. The following shall apply unless modified by specific Specification Sections:

MOTOR LOCATION	MOTOR ENCLOSURE / WINDING INSULATION
Wet outdoor Areas	
Corrosive Areas	TEFC, Severe/ Chemical Duty
Class I, Division 1 Areas	Explosion Proof, Approved for Class I Division 1 Locations
Class II, Division 1 Areas	Explosion Proof, Approved for Class II Division 1 Locations
Class I or Class II, Division 2 Areas	Explosion Proof, Approved for Division 1 Locations or TEFC with maximum external frame temperature compatible with the gas or dust in the area, Encapsulated Windings

NOTE: Provide TENV motors in the smaller horsepower ratings where TEFC is not available.

9. Provide oversize conduit to complete with clamp type grounding terminals inside the conduit.

10. Balance motors to ISO G2.5 level.

a. Submit prior to shipping to OEM or field site.

C. Submersible Motors: Refer to individual narrow-scope Specification Sections for submersible motor requirements.

D. V-Belt Drive:

1. Provide each V-belt drive with sliding base or other suitable tension adjustment.

2. Provide V-belt drives with a service factor of at least 1.0 at maximum speed.

3. Provide staticproof belts.

E. Vibration Isolators:

1. Provide all equipment subject to vibration with restrained spring type vibration isolators or pads according to the manufacturer's written recommendation.

F. Space Heaters:

1. Silicone rubber strip type, 120 V rated.
2. Provided on:
 - a. All motors 10 HP and larger mounted outdoors.
 - Indoor motors in humid environments as indicated.

2.03 COMPONENTS

A. Gear Drives and Drive Components:

1. Size drive equipment capable of supporting full load including losses in speed reducers and power transmission.
2. Provide nominal input horsepower rating of each gear or speed reducer at least equal to nameplate horsepower of drive motor.
3. Design drive units for 24 HR continuous service, constructed so oil leakage around shafts is precluded.
4. Utilize gears, gear lubrication systems, gear drives, speed reducers, speed increasers and flexible couplings meeting applicable standards of AGMA.
5. Gear reducers:
 - a. Provide gear reducer totally enclosed and oil lubricated.
 - Utilize antifriction bearings throughout.
 - c. Provide worm gear reducers having a service factor of at least 1.20.
 - d. Furnish other helical, spiral level, and combination level-helical gear reducers with a service factor of at least 1.50.

2.04 ACCESSORIES

A. Guards:

1. Provide each piece of equipment having exposed moving parts with full length, easily removable guards, meeting OSHA requirements.
2. Interior applications:
 - a. Construct from expanded galvanized steel rolled to conform to shaft or coupling surface.
 - Utilize non-flattened type 16 GA galvanized steel with nominal 1/2 IN spacing.
 - c. Connect to equipment frame with hot-dip galvanized bolts and wing nuts.
3. Exterior applications:
 - a. Construct from 16 GA stainless steel or aluminum.
 - Construct to preclude entrance of rain, snow, or moisture.

- c. Roll to conform to shaft or coupling surface.
- d. Connect to equipment frame with stainless steel bolts and wing nuts.

B. Anchorage:

1. Cast-in-place anchorage:

- a. Provide ASTM F593, Type 316 stainless steel anchorage for all equipment.
 - Configuration and number of anchor bolts shall be per manufacturer's recommendations.
- c. Provide two locknuts for each bolt.

2. Drilled anchorage:

- a. Adhesive anchors per Section 03151.
 - Epoxy grout per Section 03315.
- c. Threaded rods same as cast-in-place.

C. Data Plate:

- 1. Attach a stainless steel data plate to each piece of rotating or reciprocating equipment.
- 2. Permanently stamp information on data plate including manufacturer's name, equipment operating parameters, serial number and speed.

D. Gages:

- 1. Provide at the following locations:
 - a. Inlet and outlet of all reciprocating, centrifugal and positive displacement mechanical and process equipment.
 - At locations identified on Drawings.
- 2. Utilize tapping sleeves for mounting.

E. Lifting Eye Bolts or Lugs:

- 1. Provide on all equipment 50 LBS or greater.
- 2. Provide on other equipment or products as specified in the narrow-scope Specification Sections.

F. Platforms and Ladders:

- 1. Design and fabricate in accordance with OSHA Standards.
- 2. Fabricate components from aluminum.

3. Provide platform surface: Non-skid grating, unless specified in narrow-scope Specification Sections.

2.05 FABRICATION

- A. Design, fabricate, and assemble equipment in accordance with modern engineering and shop practices.
- B. Manufacture individual parts to standard sizes and gages so that repair parts, furnished at anytime, can be installed in field.
- C. Furnish like parts of duplicate units to be interchangeable.
- D. Ensure that equipment has not been in service at anytime prior to delivery, except as required tests.
- E. Furnish equipment which requires periodic internal inspection or adjustment with access panels which will not require disassembly of guards, dismantling of piping or equipment or similar major efforts.
 1. Quick opening cut sound, secure access ports or windows shall be provided for inspection of chains, belts, or similar items.
- F. Provide common, lipped base plate mounting for equipment and equipment motor where said mounting is a manufacturer's standard option.
 1. Provide drain connection for 3/4 IN PVC tubing.
- G. Machine the mounting feet of rotating equipment.
- H. Fabricate equipment which will be subject to Corrosive Environment in such a way as to avoid back to back placement of surfaces that can not be properly prepared and painted.
 1. When such back to back fabrication can not be avoided, provide continuous welds to seal such surfaces from contact with corrosive environment.
 2. Where continuous welds are not practical, after painting seal the back to back surfaces from the environment in accordance with Section 07920.
- I. Natural frequency/critical Speed:
 1. All rotating parts accurately machined and in as near perfect rotational balance as practical.
 2. Excessive vibration is sufficient cause for equipment rejection.
 3. Ratio of all rotative speeds to natural frequency/critical speed of a unit or components: Greater than 1.2.
- J. Control Panels Engineered and Provided with the Equipment by the Manufacturer:
 1. Manufacturer's standard design for components and control logic unless specific requirements are specified in the specific equipment Specification Section.

2. NEMA or IEC rated components are acceptable, whichever is used in the manufacturer's standard engineered design, unless specific requirements are required in the specific equipment Specification Section.
3. Affix entire assembly with a UL 508A or UL 98A label "Listed Enclosed Industrial Control Panel" prior to delivery
 - a. Control panels without an affixed UL 508A or UL 98A label shall be rejected.
4. Provide equipment or control panels with Short Circuit Current Rating (SCCR) labeling as required by NFPA 70 and other applicable codes.
 - a. Determine the SCCR rating by one of the following methods:
 1. Method 1: SCCR rating meets or exceeds the available fault current of the source equipment when indicated on the Drawings.
 2. Method 2: SCCR rating meets or exceeds the source equipment's Amp Interrupting Current (AIC) rating as indicated on the Drawings.
 3. Method 3: SCCR rating meets or exceeds the calculated available short circuit current at the control panel.
 - b. The source equipment is the switchboard, panelboard, motor control center or similar equipment where the control panel circuit originates.
 - c. For Method 3, provide calculations justifying the SCCR rating. Utilize source equipment available fault current or AIC rating as indicated on the Drawings.

2.0 SHOP OR FACTORY PAINT FINISHES

A. Electrical Equipment:

1. Provide factory-applied paint coating systems for all electrical equipment components except those specified in Section 09900 to receive field painting.
 - a. Field painted equipment: See Section 09900 for factory-applied primer/field paint compatibility requirements.

B. Field paint other equipment in accordance with Section 09900.

1. See Section 09900 for factory-applied primer/field paint compatibility requirements.

2.07 SOURCE QUALITY CONTROL

A. Motor Tests:

1. Test motors in accordance with NEMA and IEEE standards.
2. Provide routine test for all motors.
3. The Owner reserves the right to select and have tested, either routine or complete, any motor included in the project.

- a. The Owner will pay all costs, including shipping and handling, for all motors successfully passing the tests.
- b. Pay all costs, including shipping and handling, for all motors failing the tests.
- c. If two consecutive motors of the same manufacturer fail testing, the Owner has the right to reject all motors from that manufacturer.

B. Balance:

1. Unless specified otherwise, for all equipment 10 HP or greater, all rotating elements in motors, pumps, blowers, and centrifugal compressors shall be fully assembled, including coupling hubs, before being statically and dynamically balanced. Balance all rotating elements to the following criteria, per ISO 21940-11:

$$U_{per} = \frac{G \times 6.015 \times W / 2}{N}$$

Where:

U_{per} = Permissible residual unbalance for each correction plane in ounce-inches (OZ-IN). See ISO 21940-11 for acceptable values.

G = ISO Balance Quality Grade Number, per ISO 21940-11

W = Rotor weight in pounds

N = Maximum continuous operating RPM

- a. Where specified, balancing reports, demonstrating compliance with this requirement, shall be submitted as product data.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install equipment as shown on Drawings and in accordance with manufacturer's directions.
- B. Utilize templates for anchorage placement for slab-mounted equipment.
- C. For equipment having drainage requirements such as seal water, provide 3/4 IN PVC or clear plastic tubing from equipment base to nearest floor or equipment drain.
 1. Route clear of major traffic areas and as approved by Engineer.
- D. DO NOT construct foundations until major equipment supports are approved.
- E. Extend all non-accessible grease fittings using stainless steel tubing to a location which allows easy access of fittings from closest operating floor level.
- F. Equipment Base:

1. Construct level in both directions.
2. Take particular care at anchor bolt locations so these areas are flat and level.

G. Machine Base:

1. Mount machine base of rotating equipment on equipment base.
 - a. Level in both directions, using a machinist level, according to machined surfaces on base.
2. Level machine base on equipment base and align couplings between driver and driven unit using stainless steel blocks and shims.
 - a. Blocks and shims milled flat and coplanar of both faces.
 - b. Maximum of 3 shims under each foot.
 - c. Size blocks and shims to provide solid support at each mounting bolt location.
 1. Provide area size of blocks and shims approximately 1-1/2 times area support surface at each mounting bolt point.
 - d. Provide blocks and shims at each mounting bolt.
 1. Furnish blocks and shims that are square shape with "U" cut out to allow blocks and shims to be centered on mounting bolts.
 - e. After all leveling and alignment has been completed and before grouting, tighten mounting bolts to proper torque value.

H. Rotating Equipment Couplings:

1. Align in the annular and parallel positions.
 - a. For equipment rotating at 1200 RPM or less, align both annular and parallel within 0.001 IN tolerance for couplings 4 IN size and smaller.
 - b. Couplings larger than 4 IN size: Increase tolerance 0.0005 IN per inches of coupling diameter, i.e., allow 4 IN coupling 0.002 IN tolerance, and allow a 10 IN coupling 0.004 IN tolerance.
 - c. For equipment rotating at speeds greater than 1200 RPM allow both annular and parallel positions within a tolerance rate of 0.00025 IN per inch coupling diameter.
2. If equipment is delivered as a mounted unit from factory, verify factory alignment on site after installation and realigned if necessary.
3. Check surfaces for runout before attempting to trim or align units.

I. Grouting:

1. After machine base has been shimmed, leveled onto equipment base, couplings aligned and mounting bolts tightened to correct torque value, place a dam or

formwork around base to contain grouting between equipment base and equipment support pad.

- a. Extend dam or formwork to cover leveling shims and blocks.
 - Do not use nuts below the machine base to level the unit.
2. Saturate top of roughened concrete surface with water before grouting.
- a. Add grout until entire space under machine base is filled to the top of the base underside.
 - Puddle grout by working a stiff wire through the grout and vent holes to work grout in place and release any entrained air in the grout or base cavity.
3. When the grout has sufficiently hardened, remove dam or formwork and finish the exposed grout surface to fine, smooth surface.
- a. Cover exposed grout surfaces with wet burlap and keep covering sufficiently wet to prevent too rapid evaporation of water from the grout.
 - When the grout has fully hardened after a minimum of seven (7) days, tighten all anchor bolts to engage equipment base to grout, shims, and equipment support pad.
 - c. Recheck driver-driven unit for proper alignment.

3.02 INSTALLATION CHECKS

- A. For all equipment specifically required in detailed specifications, secure services of experienced, competent, and authorized representative(s) of equipment manufacturer to visit site of work and inspect, check, adjust and approve equipment installation.
 1. In each case, representative(s) shall be present during placement and start-up of equipment and as often as necessary to resolve any operational issues which may arise.
- B. Secure from equipment manufacturer's representative(s) a written report certifying that equipment:
 1. Has been properly installed and lubricated.
 2. Is in accurate alignment.
 3. Is free from any undue stress imposed by connecting piping or anchor bolts.
 4. Has been operated under full load conditions and that it operated satisfactorily.
 - a. Secure and deliver a field written report to Owner immediately prior to leaving site.
- C. No separate payment shall be made for installation checks.
 1. All or any time expended during installation check does not qualify as Operation and Maintenance training or instruction time when specified.

3.03 IDENTIFICATION OF EQUIPMENT AND HAZARD WARNING SIGNS

- A. Identify equipment and install hazard warning signs in accordance with Section 10400.

3.04 FIELD PAINTING AND PROTECTIVE COATINGS

- A. For required field painting and protective coatings, comply with Section 09900, Painting.

3.05 WIRING CONNECTIONS AND TERMINATION

- A. Clean wires before installing lugs and connectors.
- B. Coat connection with oxidation eliminating compound for aluminum wire.
- C. Terminate motor circuit conductors with copper lugs bolted to motor leads.
- D. Tape stripped ends of conductors and associated connectors with electrical tape.
 - 1. Wrapping thickness shall be 150 PCT of the conductor insulation thickness.
- E. Connections to carry full ampacity of conductors without temperature rise.
- F. Terminate spare conductors with electrical tape.

3.06 FIELD QUALITY CONTROL

A. General:

- 1. Furnish equipment manufacturer's field quality control services and testing as specified in the individual equipment Specification Sections.
- 2. Execute pre-demonstration requirements in accordance with Section 01000.
- 3. Perform and report on all tests required by the equipment manufacturer's Operation and Maintenance Manual.
- 4. Provide testing of electrical equipment and connections in accordance with the Electrical specifications.
- 5. Equip testing and analysis personnel with all appropriate project related reference material required to perform tests, analyze results, and provide documentation including, but not limited to:
 - a. Contract Drawings and Specifications.
 - b. Related construction change documentation.
 - c. Approved Shop Drawings.
 - d. Approved Operation and Maintenance Manuals.
 - e. Other pertinent information as required.

B. Equipment Monitoring and Testing Plans:

1. Approved in accordance with Shop Drawing submittal schedule.
 2. Included as a minimum:
 - a. Qualifications of firm, field personnel, and analysis personnel doing the Work.
 - b. List and description of testing and analysis equipment to be utilized.
 - c. List of all equipment to be testing, including:
 1. Name and tag numbers identified in the Contract Documents.
 2. Manufacturer's serial numbers.
 3. Other pertinent manufacturer identification,
- C. Instruments Used in Equipment and Connections Quality Control Testing:
1. Minimum calibration frequency
 - a. Field analog instruments: Not more than 6 months.
 - b. Field digital instruments: Not more than 12 months.
 - c. Laboratory instruments: Not more than 12 months.
 - d. If instrument manufacturer's calibration requirements are more stringent, those requirements shall govern.
 2. Carry current calibration status and labels on all testing instruments.
 3. See individual testing programs for additional instrumentation compliance requirements.
- D. Testing and Monitoring Program Documentation:
1. Provide reports with tabbed sections for each piece of equipment tested.
 2. Include all testing results associated with each piece of equipment under that equipment's tabbed section.
 - a. Include legible copies of all forms used to record field test information.
 3. Prior to start of testing, submit one copy of preliminary report format for Engineer review and comment
 - a. Include data gathering and sample test report forms that will be utilized.
 4. In the final report, include as a minimum, the following information for all equipment tested:
 - a. Equipment identification, including:
 1. Name and tag numbers identified in the Contract Documents.
 2. Manufacturer's serial numbers.

- 3. Other pertinent manufacturer identification,
 - Date and time of each test.
 - c. Ambient conditions including temperature, humidity, and precipitation.
 - d. Visual inspection report.
 - e. Description of test and referenced standards, if any, followed while conducting tests.
 - f. Results of initial and all retesting.
 - g. Acceptance criteria.
 - h. "As found" and "as left" conditions.
 - i. Corrective action, if required, taken to meet acceptance.
 - Verification of corrective action signed by the Contractor, equipment supplier, and Owner's representative.
 - k. Instrument calibration dates of all instruments used in testing.
 - 5. Provide three bound final reports prior to Project final completion.
- E. Electrical Equipment and Connections Testing Program:
- 1. Perform testing on Electrical equipment and connections in accordance with the Electrical specification requirements.
 - 2. Testing of motors:
 - a. After installation and prior to energizing the motor, perform inspections and tests per NETA ATS 7.15 for all motors 100 HP or above.
 - Ensure motor has been lubricated.
 - c. Bump motor to check for correct rotation.
 - 3. Repair or replace equipment shown to be out of range of the acceptable tolerance until the equipment meets or exceeds applicable standards.
- F. Other Testing:
- 1. Perform tests and inspections not specifically listed but required to assure equipment is safe to energize and operate.
 - 2. Structure that supports the equipment base and that is made in the form of a cast iron or steel structure that has supporting beams, legs, and cross members that are cast, welded, or bolted shall be tested for a natural frequency of vibration after equipment is mounted.
 - a. The ratio of the natural frequency of the structure to the frequency of the disturbing force shall not be between 0.5 and 1.5.

G. Infrared Thermograph Testing Program:

1. Perform infrared thermograph testing for equipment specified in other Divisions during the Equipment Demonstration Period.
 - a. Perform on all rotating and reciprocating equipment having drivers 25 HP or greater.
 - Perform on electrical equipment and connections: See Section 1080.
2. Additional requirements for infrared thermograph monitoring and testing equipment:
 - a. Temperature range: -10 to 350 DEGC.
 - Accuracy: □2 PCT or 2 DEGC, whichever is greater.
 - c. Repeatability: □1 PCT or 1 DEGC, whichever is greater.
 - d. Temperature indication resolution: 0.1 DEGC.
 - e. Minimum focus distance: 0.3 meters.
 - f. Output in color palettes: □PEG, BMP, or other digital format compatible with Windows.
3. Perform inspection per ASTM E1934.
 - a. Operate VFD driven equipment at 100 PCT speed during thermographic inspection.
4. Acceptability of electrical connections and components based on temperature comparison between components and ambient air temperatures not greater than 10 DEGC per ASTM E1934.
5. Acceptability of motors and equipment bearings based on temperature rise not greater than 5 DegC above the equipment and/or bearing manufacturers published criteria.
 - Repair or replace equipment shown to be out of range of the acceptable tolerance until the equipment meets or exceeds acceptability standards.

H. Equipment Vibration Monitoring and Testing Program:

1. Perform vibration monitoring and testing for equipment specified in other Divisions during the Equipment Demonstration Period.
2. Provide vibration testing on all rotating and reciprocating equipment having driver 25 HP and greater or as shown in the Equipment Vibration Testing Schedule.
3. Additional requirements for vibration monitoring and testing equipment at 25 DEGC:
 - a. Requirements for analyzer.

- 1□ Frequency range: 10 Hz to 20 kHz
- 2□ Frequency Accuracy 0.02 PCT.
- 3□ Non-integrated spectral amplitude accuracy 5 PCT, 3 Hz to 5kHz.
- 4□ Single integrated spectral amplitude accuracy 5 PCT 10 Hz to 20kHz.
- 5□ Supports measurements of acceleration, velocity, displacement, envelope demodulation for bearing defect detection.
 - Capable of two-place computer balancing.
- Requirements for vibration sensor at 25 DEGC:
 - 1□ Sensitivity 5 PCT 100 mV/g.
 - 2□ Acceleration range: 50 g.
 - 3□ Amplitude nonlinearity 1 PCT.
 - 4□ Frequency response: 10 Hz to 7 kHz 3 dB
 - 5□ Permanent attach vibration test and monitoring mounting pads to mechanical equipment at location recommended □□ the equipment manufacturer or as recommended □□ the testing firm.
4. Acceptability of equipment conditions, except pumps, based on ISO 1940-1 Balance Quality Grade G2.5 criteria.
5. Acceptability of pumping equipment to be based on current ANSI/HI criteria:
 - a. ANSI/HI 11.1-2012 for Submersible Pumps in a Wet-pit or Dr-pit configuration.
 - ANSI/HI 9.1.4-2009 for all other centrifugal pumps.
- Repair or replace equipment shown to be out of range of the acceptable tolerance until the equipment meets or exceeds acceptable standards.
7. Utilize an Engineer approved testing agency to perform vibration monitoring and testing on equipment defined in the schedule at the end of this Section.
8. Permanent attach vibration test and monitoring mounting pads to the equipment at locations recommended □□ the equipment manufacturer or as recommended □□ the vibration testing agency.
9. Utilize mounting pads suitable for permanent installation and for incorporation into a predictive maintenance program.
10. For variable speed equipment provide vibration testing at 1 Hz increments of VFD speed throughout entire operating range.
11. Diagnosis to include, but is not limited to the following:
 - a. Unbalance.

- Misalignment.
 - c. Bent shaft.
 - d. Journal bearing related problems.
 - e. Rolling contact bearing problems.
 - f. Mechanical looseness.
 - g. Resonance.
 - h. Foundation flexibility
 - i. Electrically induced problems.
 - Pump problems.
 - k. Fan problems.
 - l. Coupling problems.
 - m. Drive belt problems.
 - n. Gear problems.
 - o. Centrifugal compressor problems.
 - p. Electric motor induced vibration from VFD or VFD carrier frequency
 - Natural frequency of the installed equipment.
12. Provide machinery condition diagnosis based on an acceptable machinery vibration severity guide or machinery fault guide analysis provided by the testing agency, ISO 1940 Balance Quality Grade 3 as a minimum.
13. Tolerances for pumping equipment shall be per HI published standards.
14. Repair or replace equipment shown to be out of range of the specified tolerance until the equipment meets the specified normal operation range required in the machinery fault guide analysis.
15. Document testing with written report.
- a. Report to include initial testing results, acceptance criteria, corrective action taken to meet acceptance, verification of corrective action and acceptance report and baseline.
 - Natural frequency of installed equipment utilizing an impact hammer.
 - c. Report to include graphical plots of vibration signature for each test point at a scale which illustrates all vibration levels greater than 0.025 ips RMS.

3.07 DEMONSTRATION

- A. Demonstrate equipment in accordance with Section 01000.

END OF SECTION

SECTION 11000

PUMPING EQUIPMENT - BASIC REQUIREMENTS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Pumping equipment.
2. Sump pump for valve vault.

B. Related Specification Sections include but are not necessarily limited to:

1. Division 00 - Procurement and Contracting Requirements.
2. Division 01 - General Requirements.
3. Section 09900 - Painting
4. Section 11005 - Equipment: Basic Requirements.

1.02 QUALITY ASSURANCE

A. Referenced Standards:

1. ANSI/Hydraulic Institute (ANSI/HI)
 - a. 9.3, Rotodynamic (Centrifugal and Vertical) Pumps – Guideline for Allowable Operating Region.
 - b. 9.4, Rotodynamic Pumps for Vibration Measurements and Allowable Values.
 - c. 9.5, Rotodynamic Pumps for Pump Piping.
 - d. 11.1, Rotodynamic Submersible Pump for Hydraulic Performance, Hydrostatic Pressure, Mechanical, and Electrical Acceptance Tests.
 - e. 14.1, Rotodynamic Pumps for Hydraulic Performance Acceptance Tests.

B. Coordinate all mechanical seal systems specified to ensure pump and seal compatibility.

C. Pump/motor and VFD coordination: See Specification Section 11005.

1.03 DEFINITIONS

A. The abbreviations used in this section are defined as follows:

1. AOR: Allowable Operating Range.
2. BEP: Best Efficiency Point.

3. IPS: Iron Pipe Size.
 4. NPSH3: Net Positive Suction Head for 3 PCT head loss.
 5. POR: Preferred Operating Range.
 - TDH: Total Dynamic Head.
 7. TEFC: Total Enclosed Fan Cooled.
 8. VFD: Variable Frequency Drive.
- B. Pump Service Category: Pump or pumps having identical names (not tag numbers) used for specific pumping service.

1.04 SUBMITTALS

A. Shop Drawings:

1. See Specification Section 01300 for requirements for the mechanics and administration of the submittal process.
2. See Specification Section 11005.
3. Product technical data including:
 - a. Performance data and curves with flow (gpm), head (FT), horsepower, hydraulic efficiency, rotating speed (rpm), AOR, BEP, POR, NPSH3 requirements, minimum flow submergence requirements for vertical mixed flow, axial and turbine pumps.
 - Pump accessory data.
 - c. Bearing supports, shafting details and lubrication provisions.
 - 1□ Bearing life calculations.
 - 2□ Critical speed calculations.
 - d. Solids passage information.
4. Certifications:
 - a. Certified pump performance curves as described in the SOURCE QUALITY CONTROL Article.
 - Verification of Primary and Secondary conditions in POR and AOR.
5. Test reports:
 - a. Factor hydrostatic test.

B. Contract Closeout Information:

1. Operation and Maintenance Data:

- a. See Specification Section 01430 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.

C. Informational Submittals:

1. Certifications:

- a. Provide a written statement that manufacturer's equipment has been installed properly, started up and is ready for operation by Owner's personnel.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:

1. Pumps:

- a. See Specification 1107 for submersible pumps.

□ Sump pumps:

- 1 □ Zoeller.
- 2 □ Ebara.
- 3 □ Or approved equal.

2. Mechanical seals:

- a. Chesterton.
- John Crane.
- c. Garlock.
- d. Or as noted in the individual pump Specification Sections.

3. Seal water station:

- a. Chesterton.
- John Crane.
- c. AESSEAL.

- B. Submit request for substitution in accordance with Specification Section 0140.

2.02 SUMP PUMP DESIGN

A. Sump Pumps:

1. Design Condition:

- a. Flow: 40 GPM.
 - Head: 1□FT.
 - c. Minimum motor horsepower: 0.25
2. Pump configuration: Submersible.
 3. Discharge diameter: 2 IN.
 4. Drive type: Constant speed.
 5. Motor electrical: 120 V, 1-phase.
- Operating sensor: Float switch.

B.

2.03 ACCESSORIES

A. See Specification Section 11005.

B. Each Unit:

1. Lifting eye bolts or lugs.
2. Plugged gage cock connection at suction and discharge nozzles.
3. Tapped and plugged openings for casing and bearing housing vents and drains.
4. Fittings for proper adding flushing lubricant.
5. Pressure relief fittings for grease lubrication.

C. Packing Seal:

1. Provide packing unless mechanical seal is specified in narrow-scope pump sections.
2. Minimum of five O-rings graphite impregnated synthetic packing.
3. Provide minimum 1/4 IN DIA supply tap and 1/2 IN DIA minimum drain tap.
4. Provide split Teflon or bronze water seal ring.
5. Adjustable split follower cast iron or bronze gland.

D. Mechanical Seals:

1. Provide as specified in the narrow-scope pump sections.
2. Provide stationary balanced O-ring type.
3. Provide water lubrication - cooling .
4. Materials:

- a. Metal parts except springs: 316 stainless steel.
- b. Springs: Hastelloy C.
- c. Seal faces: Unfilled carbon graphite versus silica-free Grade 99.5 ceramic.
- d. Elastomers: Viton.

E. Seal Water Station:

1. Provide one unit per pump with manual shut-off valve on all pumps with seals.
2. Features:
 - a. Pressure regulating.
 - b. Flow regulating.
 - c. Cleanable flow tubes while in service.
 - d. Hose bar connection.
 - e. Liquid filled pressure gage.
3. Materials of construction:
 - a. Flowmeter tubes: Polysulfone.
 - b. Unit body: Polypropylene.
 - c. Pressure gage: 316 stainless steel case and wetted parts.
 - d. Pressure regulating valve: 316 stainless steel.
 - e. Flow regulating valve: 316 stainless steel.
 - f. Tube fittings: 316 stainless steel.
 - g. Mounting brackets: 316 stainless steel.
4. Service:
 - a. Temperatures up to 150 DEGF.
 - b. Pressure up to 140 PSIG.
5. Connection:
 - a. Hose bar threaded to pump.
 - b. Hose bar to seal water unit.
 - c. Reinforced polyurethane hose:
 - 1. Minimum size: 3/8 IN ID.
 - 2. Minimum pressure rating:

a. At 180 DEGF: 115 PSI.

b. At 73 DEGF: 200 PSI.

3. Minimum wall thickness: 1/8 IN.

c. Mounting:

a. To pump or pipe flange with stainless steel bracket.

b. Maximum distance from non-potable water to shut-off ball valve to seal water station and seal water station to pump seal, 2 FT each direction.

2.04 FABRICATION

A. Pump Support:

1. Design base to support weight of drive, shafting and pump.
 2. Comply with HI vibration limitations.
 3. Mount horizontal pump, motor and coupling on single piece drip lip type baseplate.
 4. Mount vertical pumps on single piece pedestal baseplate.
 5. Fabricate to withstand all operating loads transmitted from the pump and drive.
- c. On vertically configured end suction centrifugal pumps when supplied with a fabricated steel mounting frame and suction elbow, the suction elbow shall be a long radius reducing elbow with greater than 50 PCT area reduction to comply with Table 9.3.2 of ANSI/HI 9.1 standard for straight pipe lengths.

2.05 SOURCE QUALITY CONTROL

- A. Verification primary design condition in POR.
- B. Verification secondary design condition in AOR.
- C. Factor hydrostatic test all pumps at 150 PCT of shut-off head for a minimum of 5 minutes.
- D. If specifically required in the individual pump specification sections, provide factor tests:
1. All units:
 - a. Conduct tests in accordance with HI.
 1. Shut-off head and design condition: Positive unilateral performance tolerance meeting Grade 1U per ANSI/HI 14.1 for Rotodynamic Pumps.
 2. Shut-off head and design conditions: Positive unilateral performance tolerances meeting Grade 1U per ANSI/HI 11.1 for Rotodynamic Sumperside Pumps.
 2. All pumps:

- a. Head (FT) versus flow (gpm) pump curves:
 1. Efficiencies along curve.
 2. Brake horsepower along each curve.
3. Results certified by a registered professional engineer.
- E. Static and dynamic balance each pump per ANSI/HI standards.
 1. If specifically required in the individual pump specification sections or in Specification Section 11005, field vibration test pumps:
 - a. To meet requirements of ANSI/HI 9.4 for Rotodynamic Pumps at any point on the pumps and motor.
 - F. To meet requirements of ANSI/HI 11.1 for Submersible Pumps.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. See Specification Section 11005.
- B. Submersible Units:
 1. Assemble connecting piping with gaskets in place and minimum of four (4) bolts per joint installed and tightened.
 - a. Test alignment by loosening flange bolts to see if there is any change in relationship of piping flange with equipment connecting flange.
 1. Realign as necessary, install flange bolts and make equipment connection.
 2. Field paint units as defined in Specification Section 09900.
 3. Provide discharge pressure gage visible from grade or operating floor.

3.02 FIELD QUALITY CONTROL

- A. Provide services of equipment manufacturer's field service representative to:
 1. Inspect equipment covered by this Specification Section.
 2. Supervise pre-start adjustments and installation checks.
 3. Conduct initial start-up of equipment and perform operational checks.

END OF SECTION

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SECTION 1107

PUMPING EQUIPMENT - SUBMERSIBLE END-SUCTION PUMPS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Submersible sewage pumps in a wet pit application for pumping of screened stormwater.

B. Related Specification Sections include but are not necessarily limited to:

1. Division 00 - Procurement and Contracting Requirements.
2. Division 01 - General Requirements.
3. Section 05531 - Grating, Floor Plates and Access Hatches.
4. Section 09900 – Painting.
5. Section 11005 - Equipment – Basic Requirements.
6. Section 11000 - Pumping Equipment: Basic Requirements.
7. Section 10000 – Basic Electrical Requirements.
8. Section 10123 - Low Voltage Wire and Cable.
9. Section 10207 - Reduced Voltage Solid State Starters – Low Voltage.
10. Section 10442 - Motor Control Equipment.
11. Section 17120 – Programmable Logic Controllers.
12. Section 17510 – Cabinets and Panels.

1.02 QUALITY ASSURANCE

A. Referenced Standards:

1. American Bearing Manufacturers Association (ABMA)
2. American National Standards Institute (ANSI)
3. ASTM International (ASTM)
 - a. A48, Standard Specification for Gray Iron Castings.
4. FM Global (FM)
5. Hydraulic Institute (HI)

- a. Standards for Centrifugal, Rotary and Reciprocating Pumps.
 1. National Electrical Manufacturers Association (NEMA)
 - a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum)
 7. National Fire Protection Agency (NFPA)
 - a. 70, National Electrical Code (NEC)
 1. Article 500, Hazardous (Classified) Locations, Classes I, II, and III, Divisions 1 and 2.
 8. Underwriters Laboratories, Inc. (UL)
 - a. 2, Flexible Cord and Fixture Wire.

1.03 SYSTEM DESCRIPTION

- A. Provide three new submersible stormwater pumps installed in the new pump station. The pumps shall be controlled to start/stop based on the water level in the wet well, as shown in the Drawings. Pump discharge diameter shall be 14-inch with 1-inch diameter discharge line to a 30-inch diameter header and stormwater main system. The normal mode of operation is to have all three pumps as duty pumps, with all pumps being operated through rotation to maintain equal run time among the three pumps. All three pumps are to have identical flows and heads, as well as interchangeable spare parts.
- B. Provide single source coordination responsibility through the pump manufacturer for the entire system including but not limited to the following:
 1. Pumps.
 2. Motors.
 3. Reduced Voltage Solid State Soft Starters.
 4. Pump accessories, including discharge elbow, rails, lifting chain, power cables,

1.04 SUBMITTALS

- A. Shop Drawings:
 1. See Specification Section 01300 for requirements for the mechanics and administration of the submittal process.
 2. Requirements in Specification Section 11005.
 3. Requirements in Specification Section 11000.
 4. Requirements in Specification Section 1207.
- B. Operation and Maintenance Manuals:
 1. See Specification Section 01430 for requirements for:

- a. The mechanics and administration of the submittal process.
- b. The content of Operation and Maintenance Manuals.

C. Project Information:

1. Executed Manufacturer's Installation Certification Form.

1.05 SHIPPING

- A. Per Section 11005.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
 1. Flt
 2. Or approved equal.

2.02 PERFORMANCE AND DESIGN REQUIREMENTS

- A. Pump service category and tag number:
 1. Shutoff Head range 72 FT to 74 FT.
 2. Design Condition for Single Pump Operating:
 - a. Flow: 9,150 GPM.
 - b. Head: 20.0 FT.
 - c. Minimum Hydraulic Efficiency 85 PCT.
 - d. Maximum NPSHR: 24 FT.
 3. Runout Condition for Single Pump Operating:
 - a. Minimum Flow: 10,000 GPM.
 - b. Maximum Head: 14.0 FT.
 4. Secondary Condition for Single Pump Operating (for Curve Definition)
 - a. Maximum Flow: 13,350 GPM.
 - b. Minimum Head: 39 FT.
 - c. Minimum Hydraulic Efficiency 83 PCT.
 5. Design Condition for Three Pumps Operating:

- a. Flow: 1,200 FT.
- Head: 44 FT.
- c. Minimum Hydraulic Efficiency 80 PCT.
- d. Maximum NPSHR: 12.3 FT.
- Secondary Condition for Three Pumps Operating (for Curve Definition)
 - a. Maximum Flow: 17,400 GPM.
 - Minimum Head: 42 FT.
 - c. Minimum Hydraulic Efficiency 81 PCT.
- 7. Minimum Discharge Diameter: 14 IN.
- 8. Pump Rotation: Clockwise rotation when viewed from the driver end.
 - a. Motor requirements:
 - 1□ Maximum Operating Speed: 885 RPM.
 - 2□ Minimum Operating Speed: 885 RPM.
 - 3□ Service factor: 1.15.
 - 4□ Minimum motor efficiency at the Design Condition: 91 PCT.
 - 5□ Minimum power factor: 79 PCT.
 - Maximum nameplate horsepower: 90.
 - Drive type: Constant speed.
 - c. Ambient conditions:
 - 1□ Stormwater maximum temperature: 100 DEGF.
 - 2□ Air maximum temperature: 110 DEGF.
 - d. Cooling type: Cooling jacket

2.03 MATERIALS

- A. Pump Service Category and/or Tag Number:
 - 1. Pump case: Cast iron, ASTM A48, Class 35.
 - 2. Motor housing: Cast iron, ASTM A48, Class 25 or Class 30.
 - 3. Impeller:
 - a. Cast iron, ASTM A48, Class 30.
 - Self-cleaning Impeller, N Type

4. Shaft: Stainless Steel, Series 300 or 400.
5. Wear Surfaces: Hardened Stainless Steel, ANSI Series 400, wear rings with the stationary ring harder than the rotating ring.
 - O-rings: Nitrile (Buna-N) or fluorocarbon (Viton)
7. Fasteners: 304 or 316 Stainless steel.
8. Lower ring seal: Tungsten-carbide (both faces) or Silicon Carbide (both faces).
9. Upper ring seal: Tungsten-carbide (both faces) or carbon and ceramic or carbon and Ni-resist.
10. Seal metal parts: Stainless steel.

B. Wet Pit Applications:

1. Guide rails: Type 316 Stainless steel.
2. Lifting chains and cables: Type 316 Stainless steel.
3. Base elbow: Cast iron, ASTM A48, Class 35.

2.04 COMPONENTS

A. General:

1. Provide pumps capable of handling unscreened stormwater.
2. Where watertight sealing is required, machine and fit mating surfaces with O-rings.
3. Provide with heavy duty lift lugs or hoisting rail designed for lifting the entire pump and motor assembly.

B. Impeller:

1. Provide non-clog solids-handling type dynamically balanced impeller in accordance with HI standards.
2. Provide impeller and volute wear rings as necessary to assure efficient sealing between volute and impeller.

C. Shaft:

1. Design pump shaft of sufficient size to transmit full driver output.
2. Use shaft which is accurately machined and constructed with sufficient materials.
3. Design shaft for a maximum deflection of 0.002 IN at the stuffing box as calculated at the design condition.

D. Mechanical Seal:

1. Seal shaft with two independent double mechanical seal running in an oil filled chamber.

2. Provide seals requiring neither routine maintenance nor adjustment, but capable of being easily inspected and replaced.
3. Hold interface in contact on its own spring system.

E. Bearings:

1. Support shaft on upper and lower permanent lubricated bearings with a minimum ABMA L-10 life of 100,000 HRS.

F. Motors:

1. Provide pump with FM, UL, or CSA listed motor approved for Class I, Division I rated area.
2. Provide induction type motor with a squirrel cage rotor, of totally submersible design without loss of watertight integrity to a depth of at least 15 FT, constructed with epoxy or polyurethane seal encapsulated windings, air-filled or dielectric oil filled, with Class H insulation rated for 180 DEGC and rated for continuous duty operation.
3. Motor shall be 3 PH, 60 cycle, 480 V.
4. Motor shall be capable of running continuously in an unsumerged condition while pumping under load without damage to motor or seal.
5. The motor horsepower provided shall be adequate so that the pump is non-overloading throughout the entire pump performance curve from shut-off through runout.
6. The motor shall be designed and assembled by the same manufacturer as the pump.
7. The motor shall be equipped with a closed loop cooling system where the cooling medium is circulated through the pump motor cooling jacket. The pumped fluid shall not be circulated through the cooling jacket. An impeller in the lower motor coolant reservoir will circulate coolant around the motor housing. The cooling system shall provide sufficient cooling for continuous operation whether the pump is submerged in the pumped media or surrounded by air in liquid or ambient temperatures of up to 40 DEGC.
8. Cooling system will provide sufficient cooling for the entire range of pump operating speeds.

G. Power and Control Cables:

1. Provide power and control cables which are listed per NEC requirements and approved for the installation types indicated on the drawings. As a minimum the cable shall be suitable for installation in conduit and for submersible applications.
2. Size cables in accordance with applicable NFPA 70 specifications.
3. Provide 80 FT power cable and control cable.

4. Provide each cable with a strain relief, cord grip, and explosion proof seal installed in accordance with NFPA 70, Article 500.
5. Minimum acceptable cable type: "SO-Water Resistant" per UL 12.

H. Temperature Monitor:

1. Furnish each phase of the motor with thermal switches embedded in the motor windings.
2. Should high temperature be sensed in the windings, the thermal switch will open, shut the pump down, and sound an alarm. Should any one of the thermal switches detect high temperature, it will automatically reset once the stator temperature returns to normal.
3. Set temperature of the temperature monitors not higher than 90 PCT of insulation temperature rating.

I. Leak Detection:

1. Provide sensors inside the terminal board and the stator chamber to detect water intrusion
2. If water is detected inside the terminal board or the stator chamber, a switch will stop the pump and sound an alarm.

J. Coatings:

1. Apply two-component organic ester or polyamidoamine epoxy system to the exterior of the pump casing and motor housing as specified in Specification Section 09900.

K. Wet Pit Applications:

1. Provide sliding guide bracket integral to pump unit which properly aligns the pump discharge with the discharge connection elbow for watertight seal during pumping.
2. Guide the entire weight of the pumping unit to the base discharge elbow guide rails.
3. The guide rails shall not support any portion of the weight of the pump.
4. Provide chains or cable of sufficient strength to lift pumps from sump.
5. Furnish guiding rail assembly and the discharge flange assembly of nonsparking components.

- J. Design pump to allow for removal without entering the wet well and without removal of bolts, nuts or other fastenings.
7. Provide pump unit connecting to discharge connection with a simple downward motion without rotation. The entire weight of the pumping unit shall wedge tight against the discharge elbow flange forming a seal without the use of bolts, gaskets, or o-rings.

8. Provide necessary sliding guide bracket and discharge connection which, when bolted to the floor of the sump and to the discharge line, will receive the pump discharge connecting flange without need of adjustment, fasteners, clamp, or similar devices.
9. No portion of the pump shall bear directly on the floor.

2.05 ACCESSORIES

- A. See Specification Section 11000 - Pumping Equipment: Basic Requirements.
- B. Controls:
 1. See Electrical and Instrument and Controls Designs for controls requirements.
- C. Access Doors and Frames for Wet Pit Applications:
 1. Doors: See Specification Section 05531.

2.06 SOURCE QUALITY CONTROL

- A. Secure from the pump manufacturer the following inspections and tests on each pump before shipment from factory:
 1. Check impeller, motor rating and electrical connections for compliance with this Specification Section.
 2. Test motor and cable insulation for moisture content or insulation defects.
 3. Prior to submergence, run pump dry to establish correct rotation and mechanical integrity.
 4. Run pump submerged for 30 minutes.
 5. After operational test #4, perform insulation test #2 again.
- B. Factory test of head (FT) versus flow (GPM) for all pumps being provided as specified in Specification Section 11000.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. See Specification Section 11000.
- B. For wet pit pumps, permanently install discharge connection elbow in wet well along with discharge piping.
- C. Seal pump cable end with a high quality protective covering, to make it impervious to moisture or water seepage prior to electrical installation.

3.02 FIELD QUALITY CONTROL

- A. See Specification Section 11000.

END OF SECTION

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SECTION 13101

LIGHTNING PROTECTION SYSTEM

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Lightning protection systems using lightning rods.

B. Scope:

1. Contractor shall provide all labor, materials, equipment, tools, services, and incidentals necessary and required to provide lightning protection systems of the type indicated.
2. Contractor shall furnish the services of individual possessing required qualifications, as indicated in this Section, to prepare the final design of the lightning protection systems required, in accordance with this Section and other Contract Documents. Such services are not delegated design.
3. Provide lightning protection systems for the following buildings and structures:
 - a. Pump Station Electrical Building.
 - b. Generator

C. Related Requirements include but are not necessarily limited to:

1. Section 1000 - Grounding and Bonding.

1.02 REFERENCES

A. Terminology In this Section and relative to lightning protection system Work, the terminology indicated below has the following meaning, regardless of whether indicated with initial capital letters:

1. Classification of Buildings in accordance with NFPA 780:
 - a. Class I: An commercial, industrial, or residential building less than 75 feet in height.

B. Reference Standards:

1. ASTM International [ASTM]
 - a. B8, Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft.
2. Lightning Protection Institute [LPI]

- a. 175, Standard for the Design - Installation - Inspection of Lightning Protection Systems.
3. National Fire Protection Association [NFPA]
 - a. 780, Standard for the Installation of Lightning Protection Systems.
4. National Electrical Manufacturers Association [NEMA]
 - a. TC 2, Electrical Polyvinyl Chloride [PVC] Tubing and Conduit.
5. Underwriters Laboratories, Inc. [UL]
 - a. 98, Standard for Safety Lightning Protection Components.
 - b. 98A, Standard for Installation Requirements for Lightning Protection Systems.
 - c. 51, Standard for Schedule 40, 80, Type EB and A Rigid PVC Conduit and Fittings.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordination – General:
 - a. Contractor shall coordinate the services of lightning protection system designer with all other elements of the Work.
 - b. Contractor has full responsibility for scheduling lightning protection system designs and all related Work.
 - c. Allow sufficient time in Progress Schedule for performance of lightning protection system services, including requests for interpretation or clarification between lightning protection system designer and Contractor and between Contractor and Engineer.
2. Coordination of Lightning Protection System Work's Connections to Other Work:
 - a. Where lightning protection system Work connects to other Work designed by Engineer, existing construction, or both, the lightning protection system Work shall be consistent with the other Work and existing construction to which lightning protection system Work connects, and adjacent construction.
 - b. Submit details, loading, anchorage, and other coordinating information necessary for the lightning protection system Work to properly interface with Work designed by Engineer.
 - c. Changes in the Work, whether designed by Engineer, designed by lightning protection system designer, or existing construction, necessary as a result of the lightning protection system are ineligible for increase in Contract Price or Contract Times, unless: 1) otherwise agreed by both Engineer and Owner, or 2) expressly indicated otherwise elsewhere in the Contract Documents for the lightning protection system Work.

- d. Changes requiring extra compensation, time, or both arising from lightning protection system design aspects needed for convenience of Contractor, Subcontractor, or Supplier, are not grounds for increase in Contract Price or Contract Times.
3. Coordination of Submittals, Fabrication, Production, and Shipment:
- a. Do not release for raw materials procurement, fabrication, production, and shipment to the Site materials, equipment, or systems designed by lightning protection system designer until the associated lightning protection system designer has completed the design and Engineer has reviewed and approved all associated Shop Drawings, product data Submittals, Samples, and such Submittals have been delivered to and accepted by Engineer.
 - b. Allow sufficient time in the Progress Schedule for required Submittals and required actions by lightning protection system designer and Engineer.

1.04 QUALITY ASSURANCE

A. Qualifications:

1. Lightning Protection System Designer:

- a. One individual, acceptable to Engineer, shall design or directly supervise preparation of the final design of all lightning protection systems required for the Work.
- b. Individual preparing, or directly supervising preparation of, final design of lightning protection systems shall possess current, valid "Designer Inspector" (DI) certification from Lightning Protection Institute (LPI) or "Lightning Protection Master Certification" (LPMC) from Underwriters Laboratories (UL).
- c. In addition, individual performing, or directly supervising preparation of, final design of lightning protection system shall be able to furnish documentation indicating possession of not less than ten years' experience personally designing or supervising the preparation of lightning protection systems similar to that required for the Work.
- d. Designer may be employee of lightning protection system Supplier or individual or entity retained by lightning protection system Supplier.
- e. Submit to Engineer copy of current certification as LPI DI or UL LPMC and record documenting experience of lightning protection system designer. Indicate designer's current employer and employment history.
- f. Upon Engineer's request, submit information for not less than five prior lightning protection systems, similar in type, scope, and extent to that required for the Work. Construction of each lightning protection system on each such project shall have been substantially complete for not less than one year at the time such documentation is submitted to Engineer. Such information shall include, for each project, the following: project name and location (city, state or province, country); project owner; designer's employer and their role in the project (prime contractor, subcontractor, or supplier); name of project's design

professional company name and location near lightning protection system was completed and general description of scope and extent of lightning protection system work.

2. Installer:

- a. Installer of lightning protection system shall be Contractor or Subcontractor.
- b. Throughout the Work, installer shall be a current, "UL Listed Lightning Protection Contractor".
- c. Installer's project manager or site superintendent shall possess a current, valid certification as "Master Installer" from LPI. Such individual shall be actively involved in managing and supervising installation of the lightning protection system Work.
- d. Installer shall furnish valid "UL Master Label" for the substantially completed lightning protection system Work.
- e. In addition, installer shall possess not less than five years' relevant experience performing lightning protection system construction and shall be able to document not less than five completed, prior projects or similar scope and complexity to the lightning protection system Work within the most-recent five-year period.
- f. Submit to Engineer documentation of installer's current status as "UL Listed Lightning Protection Contractor" and copy of required LPI "Master Installer" certification.
- g. Upon Engineer's request, submit documentation of required experience.

1.05 SUBMITTALS

A. Action Submittals: Submit the following:

1. Shop Drawings:

- a. Drawings of entire lightning protection system for each building and structure for which lightning protection system is required. Include plans, sections, schematics, and details as appropriate.
- b. Plan drawings showing type, size, and locations of all lightning protection materials and equipment. Roof penetration detail drawings.
- c. Submit schedules of materials and equipment as appropriate, indicating type, size, materials, and location of each, together with other pertinent information.
- d. "Certificate of Compliance" by lightning protection system designer, in accordance with this Section's Article, "Responsibilities of Lightning Protection System Designer".

2. Product Data:

- a. Data for all materials and equipment required in "Part 2 – Products" of this Section. Submit material and equipment manufacturers' published product data such as catalog pages, standard drawings, expected performance data, specifications, and the like.
 - Submit data sheets that include manufacturer's name and product model number. Clearly identify all optional accessories.
 - c. Certification that materials and equipment proposed submitted are in accordance with applicable standards of LPI or UL.
- B. Informational Submittals: Submit the following:
 1. Certifications and Notices:
 - a. Roofing system manufacturer written consent to installer's proposed penetrations if an through roofing system.
 2. Roofing System Manufacturer's Instructions:
 - a. When Contractor proposes mechanical fastening lightning protection system components to, or providing penetrations through, roofing, obtain and submit to Engineer the roofing system manufacturer's:
 - Written concurrence with proposed installation methods.
 - c. Written instructions for sealing penetrations into or through roofing system.
 3. Supplier's Instructions:
 - a. Manufacturer's written instructions for handling, storage, and installation for all materials and equipment furnished.
 4. Field Quality Control Results:
 - a. Submit results of field quality control activities required in this Section.
 5. Supplier's Reports:
 - a. Submit written report of each visit to the Site by manufacturer's factory-trained representative.
 - Submit written report of each visit to the Site lightning protection system designer.
 - Qualifications Statements:
 - a. Lightning protection system designer.
 - Installer.
- C. Closeout Submittals: Submit the following:
 1. Post-Installation Certifications:

- a. Installer's written certification that the substantial completed lightning protection system Work complies with the Contract Documents.
 - "UL Master Label" certificate.
2. Operation and Maintenance Data:
 - a. Manufacturer's operation and maintenance manual for each building's or structure's lightning protection system provided or modified. Comply with Section 01430 - Operation and Maintenance Data.
 - Indicate requirements for, and frequency of, periodic inspections.
3. Record Documents:
 - a. Prepare and submit drawings, including plans of roof or top of each building and structure for which lightning protection system was provided or modified, indicating as-constructed conditions. Include appropriate sections, details, and schematics.
 - Record drawings shall expressly indicate their status as "as-constructed" drawings with an appropriate revision date.

1.0 RESPONSIBILITIES OF LIGHTNING PROTECTION SYSTEM DESIGNER

- A. Responsibilities of lightning protection system designer employed on the Work include, but are not necessarily limited to, the following, unless specifically indicated otherwise in the associated elements of the Contract Documents where the lightning protection system is required:
 1. Ethical Conduct and Professionalism: Comply with Laws and Regulations, and standards and guidelines regarding codes of ethics and codes of conduct published by relevant industry organizations, including LPI and UL.
 2. Comply with Laws and Regulations and relevant design standards applicable to the subject lightning protection system Work.
 3. Performance and Design Criteria Indicated in the Contract Documents and Other Information:
 - a. Review performance and design criteria, indicated in the Contract Documents, that the lightning protection system Work must satisfy.
 - Prepare written requests for interpretations or clarifications of performance or design criteria.
 - c. Review existing information about the Site that constitutes Technical Data if any, applicable to the subject lightning protection system Work, as indicated in the Supplemental Conditions.
 4. Site Information and Investigations: With Contractor, obtain all other necessary dimensions, field information, and other information necessary for preparing lightning protection system Shop Drawings.

5. Design Services: Personnel perform and prepare, or actively exercise direct, personal, supervisor control over others performing or preparing:
 - a. Necessary design evaluations of conditions, materials, and equipment.
 - Prepare the Shop Drawings and product data Submittals, and related design documents such as calculations, for the subject lightning protection system Work.
 - c. Assist Contractor with applying for and obtaining permits and approvals not previously obtained by Owner or those for whom Owner is responsible necessary for the lightning protection system Work.
 - d. Preparing modifications of the lightning protection system design documents as necessary.
 - Certification of Compliance by Lightning protection system designer:
 - a. Through Contractor, submit to Engineer, lightning protection system designer's written certification indicating:
 - General Information: Project name and designation, Contractor name and Contract designation, Subcontractor or Supplier name (when applicable), (4) full name of lightning protection system designer's business entity under which the lightning protection system services were performed, full name and certification number of the individual responsible for the final design of the subject lightning protection system Work, specific elements of lightning protection system Work to which the certification applies, and lightning protection system designer's signature, and date of signature; apply lightning protection designer's seal when applicable.
 - c. Explicit certification that the subject lightning protection system complies with:
 - All applicable performance and design criteria indicated in the Contract Documents. Expressly indicate on certification of compliance the specific performance and design criteria used in the lightning protection system design
 - All Laws and Regulations.
 - Applicable design standards commonly applicable to such types of construction. Expressly indicate such design standards on the certification of compliance.
7. Progress and Quality of Construction of Lightning protection system Work:
 - a. Where appropriate for the subject lightning protection system Work, periodically visit the Site at appropriate intervals to observe the progress and quality of the subject lightning protection system Work.
 - Where lightning protection system designer does not visit the Site during construction, keep informed of the progress and quality of the subject lightning protection system Work via discussions with Contractor, Subcontractor, and

Suppliers, via photographic documentation, and other means acceptable to lightning protection system designer.

- c. Advise Contractor in writing when the subject lightning protection system Work is not in accordance with the lightning protection system designer's design documents approved by Engineer and related Submittals approved by lightning protection system designer.
 - d. Furnish to entity that retained lightning protection system designer copy of lightning protection system designer's written report of each visit to the Site.
8. Modifications to Design:
- a. Design appropriate modifications to the lightning protection system Work, including preparing new or revised certifications, reports, design drawings, sketches, design specifications, and calculations, as appropriate.
 - Such design documents and calculations shall be submitted to Engineer through Contractor to same extent original design documents Submittals and calculations, if any, where required by the Contract Documents for the subject lightning protection system Work.
9. Other services, as mutually agreed upon by lightning protection system designer and its client, or as required elsewhere in the Contract Documents.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
1. A/C Lightning Protection, Inc.
 2. Harger Lightning & Grounding.
 3. Hearsh Bros. Lightning Protection Co. Inc.
 4. National Lightning Protection Corporation.
 5. Preferred Lightning Protection, Inc.
 - Thompson Lightning Protection, Inc.
 7. VFC Lightning Protection.
 8. East Coast Lightning Equipment, Inc.
 9. Robbins Lightning, Inc.
 10. Or equal.

2.02 PERFORMANCE AND DESIGN CRITERIA.

- A. Provide lightning protection systems Work in accordance with NFPA 780, UL 96A, and LPI 175.
- B. Material for air terminals, main conductors and bonding conductors: Copper or aluminum.
- C. Size of air terminals, main conductors, and bonding conductors shall be in accordance with NFPA 780.

2.03 MATERIALS

- A. Unless otherwise expressly indicated in the Contract Documents, lightning protection system materials shall be compatible with materials of construction for the building or structure being protected and meet the requirements of UL 96.
- B. Provide lightning protection system with Class I or Class II materials, in accordance with NFPA 780.
- C. Ground Rods:
 - 1. 3/4-inch diameter 10 feet long.
 - 2. Copper-clad:
 - a. Uniform coating, not less than 10 mils thick, of electrolytic copper molecularly bonded to rigid steel core.
 - b. Corrosion resistant bond between copper and steel.
 - c. Hard drawn, scar-resistant surface.
- D. Material for conductor fasteners, connector fittings, bonding fittings, conductor splicers and through-wall or through-roof assemblies shall be cast bronze, brass, or copper, with bolt pressure connectors.
- E. Material for bolts, nuts, and screws shall be stainless steel.
- F. Underground conductors shall be bare, soft-drawn, stranded copper in accordance with ASTM B8.
- G. Raceways:
 - 1. Indicated as Schedules 40 "PVC-40" or Schedule 80 "PVC-80"
 - a. PVC thermoplastic, with inert modifiers to improve weatherability and heat distribution.
 - b. Rated for direct sunlight exposure.
 - c. Fire retardant and low smoke emission.
 - d. In accordance with NFPA 70 Type PVC, NEMA TC 2, UL 51.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Installation – General:

1. Design and provide lightning protection system Work in accordance with LPI 175, NFPA 780, and UL 96A.
2. Install lightning protection system in accordance with the Contract Documents and Shop Drawings approved by Engineer.
3. Roofing System and Installation of Lightning Protection System:
 - a. Adhesively fasten lightning protection system components to roof system unless otherwise shown or indicated otherwise in the Contract Documents.
 - b. Do not mechanically fasten lightning protection system components to metal roof panels or metal coping or penetrate roof membrane without written consent of both roofing system manufacturer and Engineer. Submit to Engineer written consent of roofing system manufacturer.
 - c. Seal all penetrations in accordance with roofing system manufacturer's written instructions and details. Obtain such instructions and details from roofing system manufacturer.
4. Surge protective devices to be provided, if others, as shown on the Drawings.

B. Structures and Buildings:

1. Lightning protection system shall include:
 - a. Roof-mounted and cellular antenna mounted air terminals.
 - b. Generator mounted air terminals.
 - c. Interconnecting conductors.
 1. Steel roof beams and trusses may be utilized as the main and secondary conductors.
 - d. Downleads: Provide the following types of conductor downleads:
 1. Conductors surface-mounted on the building's or structure's exterior wall. Route conductor in PVC-80 conduit for a minimum of 1'-0" below grade and 4'-0" above grade.
 - e. Ground terminations.
 - f. Bonding of other grounded systems of building or structure.
 - g. Bonding to grounding electrode system.
2. Connect downleads to the grounding electrode system ground ring.

3. Underground connections shall be via electrothermic weld.

3.02 FIELD QUALITY CONTROL

A. Field Tests and Inspections:

1. Perform fall-of-potential ground resistance test on each ground rod or ground ring.
 - a. When resistance exceeds 25 ohms for individual ground rod:
 1. Provide additional ground rod so they are 20 feet apart, interconnect with #4/0 AWG and retest.
 2. If retest exceeds 25 ohms, contact Engineer.
 - b. When resistance exceeds 25 ohms for a ground ring, contact Engineer.
2. Perform continuity test for system elements concealed within structure.
3. Perform continuity test for system elements utilized structural steel as downconductors.
4. Submit to Engineer written results of required field quality control activities encompassing building or structure name, and Project, type of test or inspection performed, results obtained, problems observed or noted during the test or inspection, and whether results obtained indicate successful completion i.e., acceptance. The Work will not be eligible for inspection for Substantial Completion until such results are submitted to and accepted by Engineer.

3.03 CLOSEOUT

A. Documentation and Nameplates.

1. Prior to requesting inspection for Substantial Completion of lightning protection system Work, provide the following for each lightning protection system provided or modified:
 - a. Nameplate, securely fastened to building or structure, indicating: "Lightning protection system provided by", followed by company name and address of lightning protection system installer. Name plate shall be resistant to corrosion and deterioration to which it may be subject at its installed location, including deterioration and fading due to exposure to sunlight.
 - b. Submit "UL Master Label" certification.
 - c. Deliver final operation and maintenance manuals for the lightning protection system.
2. Prior to requesting final payment, deliver to Engineer the following for each lightning protection system provided or modified:

As-constructed record drawings, in accordance with this Section's "Submittals" Article. Such as-constructed drawings shall be developed from Shop Drawings

approved Engineer and those of the Drawings showing the lightning protection system.

END OF SECTION

SECTION 13501

DOOR INTRUSION ALARM SWITCHES

PART 1 - GENERAL

1.01 SCOPE

- A. The Contractor shall provide, all components, system installation services, as well as all required and specified ancillary services in connection with the Door Intrusion Alarm Switch for the Progresso Village Pump Station. The System includes all materials, labor, tools, fees, charges and documentation required to furnish, install, test and place in operation a complete and operable door intrusion detection system as shown and/or specified. The system shall include door intrusion switch as shown, specified, and/or required to provide the functions indicated.
- B. The scope of the work to be performed under this Division includes but is not limited to the following:
1. The Contractor shall retain overall responsibility for the intrusion switches as specified herein.
 2. Furnish and install one (1) intrusion alarm contact and wiring for the electrical building entrance door as scheduled or shown on the Drawings, unless otherwise noted or supplied by equipment vendors. Electrical conduit and connection boxes for the intrusion alarm contact shall be furnished and installed by the electrical contractor, Division 1.
 3. Division 17 instrumentation and controls subcontractor shall terminate the door intrusion switch wiring in LCP-11843 and program PLC-11843 as described in Section 17950.
- C. It is the intent of the Contract Documents to construct a complete and working installation. Items of equipment or materials that may reasonably be assumed as necessary to accomplish this end shall be supplied whether or not they are specifically stated herein.

PART 2 - PRODUCTS

2.01 PRODUCTS

- A. Door Intrusion Alarm Switch - shall be recessed, steel magnetic type and operate on 24V dc. The switch shall be wired to discrete input in PLC-11845. Contractor shall coordinate with Division 17 controls and instrumentation subcontractor to insure compatibility with PLC input.

PART 3 - EXECUTION (NOT USED)

END OF SECTION

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SECTION 15047

HIGH PERFORMANCE POLYPROPYLENE STORM 12"- 60" PIPE

PART 1 - SCOPE

1.01 This specification describes 12- through 60-inch (300 to 1500 mm) hp storm pipe for use in gravity-flow storm drainage applications.

PART 2 - PIPE REQUIREMENTS

2.01 Hp storm pipe shall have a smooth interior and annular exterior corrugations.

- A. 12- through 60-inch (300 to 1500 mm) pipe shall meet ASTM F2881 or AASHTO M330
- B. Manning's "n" value for use in design shall be 0.012

PART 3 - JOINT PERFORMANCE

3.01 Pipe shall be joined using a bell and spigot joint meeting the requirements of ASTM F2881 or AASHTO M330. The joint shall be watertight according to the requirements of ASTM D3212. Gaskets shall meet the requirements of ASTM F477. Gasket shall be installed on 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. 12- through 60-inch (300 to 1500 mm) diameters shall have an exterior bell wrap installed on the manufacturer.

3.02 FITTINGS

- A. Fittings shall conform to ASTM F2881 or AASHTO M330. Bell and spigot connections shall utilize a welded or integral bell and valve or inline gaskets meeting the watertight joint performance requirements of ASTM D3212.

3.03 FIELD PIPE AND JOINT PERFORMANCE

- A. To assure watertightness, field performance verification may be accomplished by testing in accordance with ASTM F1417 or ASTM F2487. Appropriate safety precautions must be used when field-testing any pipe material. Contact the manufacturer for recommended leakage rates.

3.04 MATERIAL PROPERTIES

- A. Polypropylene compound for pipe and fitting production shall be impact modified copolymer meeting the material requirements of ASTM F2881, Section 5 and AASHTO M330, Section 1.

3.05 INSTALLATION

- A. Installation shall be in accordance with ASTM D2321 and ADS recommended installation guidelines, with the exception that minimum cover in traffic areas for 12- through 48-inch (300 to 1200 mm) diameters shall be one foot (0.3 m) and for 60-inch

For 1500 mm diameter the minimum cover shall be 2 ft. (0.6 m) in single run applications. Backfill for minimum cover situations shall consist of Class 1 compacted Class 2 minimum 90% SPD or Class 3 minimum 95% material. Maximum fill heights depend on embedment material and compaction level please refer to Technical Note 2.04.

Contact our local ADS representative or visit our website at www.adspipe.com for a copy of the latest installation guidelines.

B. Build America, Buy America (BABA)

1. HP Storm pipe per AASHTO, manufactured in accordance with ASTM F2881 or AASHTO M330, complies with the requirements in the Build America, Buy America (BABA) Act.

3.0 PIPE DIMENSIONS

Nominal Pipe I.D. in (mm)	12 (300)	15 (375)	18 (450)	24 (600)	30 (750)	36 (900)	42 (1050)	48 (1200)	60 (1500)
Average Pipe I.D. in (mm)	12.2 (310)	15.1 (384)	18.2 (462)	24.1 (612)	30.2 (777)	36.0 (914)	42.0 (1067)	47.9 (1217)	59.9 (1521)
Average Pipe O.D. in (mm)	14.5 (368)	17.7 (450)	21.4 (544)	28.0 (711)	35.5 (902)	41.5 (1054)	47.4 (1204)	54.1 (1374)	67.1 (1704)
Minimum Pipe Stiffness (5 Deflection in./in. (kN/m ²))	75 (517)	60 (414)	50 (380)	50 (345)	40 (317)	40 (270)	35 (241)	35 (241)	30 (207)

Minimum pipe stiffness values listed contact a representative for average values.

END OF SECTION

SECTION 15000

PIPE AND PIPE FITTINGS - BASIC REQUIREMENTS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Process piping systems.
2. Utility piping systems.
3. Plumbing piping systems.

B. Related Specification Sections include but are not necessarily limited to:

1. Section 09900 - Painting
2. Section 10400 - Identification Devices.
3. Section 02222 – Excavation and Backfill for Utilities
4. Section 15090 - Pipe Support Systems.
5. Section 15100 - Valves and Operators

1.02 QUALITY ASSURANCE

A. Referenced Standards:

1. American Association of State Highway and Transportation Officials (AASHTO)
 - a. M3, Corrugated Steel Pipe, Metallic-Coated, for Sewers and Drains
Equivalent ASTM A700
 - b. M190, Standard Specification for Bituminous Coated Corrugated Metal Culvert Pipe and Pipe Arches.
 - c. M252, Standard Specification for Corrugated Polyethylene Drainage Tubing.
 - d. M294, Interim Specification for Corrugated Polyethylene Pipe 12 to 24 Inch Diameter.
2. American Iron and Steel Institute (AISI)
3. American Society of Mechanical Engineers (ASME)
 - a. B1.3, Malleable Iron Threaded Fittings.
 - b. B1.5, Pipe Flanges and Flanged Fittings.
 - c. B1.9, Factory-Made Wrought Steel Butt-Welding Fittings.

- d. B122, Wrought Copper and Bronze Solder - Joint Pressure Fittings.
 - e. B122, Cast Copper Alloy Fittings for Flared Copper Tubes.
 - f. B319, Stainless Steel Pipe.
 - g. B40.100, Pressure Gauges and Gauge Attachments.
4. ASTM International [ASTM]
- a. A53, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
 - A74, Standard Specification for Cast Iron Soil Pipe and Fittings.
 - c. A10□, Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service.
 - d. A12□, Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
 - e. A182, Standard Specification for Forged or Rolled Alloy Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service.
 - f. A197, Standard Specification for Cupola Malleable Iron.
 - g. A234, Standard Specification for Pipe Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service.
 - h. A29, Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service.
 - i. A312, Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes.
 - A518, Standard Specification for Corrosion-Resistant High-Silicon Iron Castings.
 - k. A53□, Standard Specification for Ductile Iron Castings.
 - l. A587, Standard Specification for Electric-Resistance-Welded Low-Carbon Steel Pipe for the Chemical Industry.
 - m. A700, Standard Specification for Corrugated Steel Pipe, Metallic-Coated for Sewers and Drains.
 - n. A774, Standard Specification for As-Welded Wrought Austenitic Stainless Steel Fittings for General Corrosive Service at Low and Moderate Temperatures.
 - o. A778, Standard Specification for Welded, Unannealed Austenitic Stainless Steel Tubular Products.
 - p. B88, Standard Specification for Seamless Copper Water Tube.

- C14, Standard Specification for Concrete Sewer, Storm Drain, and Culvert Pipe.
- r. C7□, Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe.
- s. C425, Standard Specification for Compression Joints for Vitrified Clay Pipe and Fittings.
- t. C443, Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets.
- u. C5□4, Standard Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings.
- v. C700, Standard Specification for Vitrified Clay Pipe, Extra Strength, Standard Strength and Perforated.
- w. D1785, Standard Specification for Polyvinyl Chloride (PVC) Plastic Pipe, Schedules 40, 80, and 120.
 - D24□□, Standard Specification for Polyvinyl Chloride (PVC) Plastic Pipe Fittings, Schedule 40.
 - D24□7, Standard Specification for Polyvinyl Chloride (PVC) Plastic Pipe Fittings, Schedule 80.
- z. D4101, Standard Specification for Polypropylene Plastic Injection and Extrusion Materials.
- aa. F439, Standard Specification for Chlorinated Polyvinyl Chloride (CPVC) Plastic Pipe Fittings, Schedule 80.
 - F441, Standard Specification for Chlorinated Polyvinyl Chloride (CPVC) Plastic Pipe, Schedules 40 and 80.
- 5. American Water Works Association (AWWA)
 - a. B300, Standard for Hypochlorites.
 - C200, Standard for Steel Water Pipe - 4 inches and Larger.
 - c. C207, Standard for Steel Pipe Flanges for Waterworks Service - Sizes 4 inches through 144 inches.
 - d. C208, Standard for Dimensions for Fabricated Steel Water Pipe Fittings.
 - e. C□0□, Standard for Grooved and Shouldered Joints.
 - f. C□51, Standard for Disinfecting Water Mains.
 - g. C800, Standard for Underground Service Line Valves and Fittings.
- American Water Works Association/American National Standards Institute (AWWA/ANSI)

- a. C110/A21.10, Standard for Ductile-Iron and Gray-Iron Fittings.
 - C111/A21.11, Standard for Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
 - c. C115/A21.15, Standard for Flanged Ductile-Iron Pipe with Ductile-Iron or Gray-Iron Threaded Flanges.
 - d. C151/A21.51, Standard for Ductile-Iron Pipe, Centrifugally Cast, for Water.
 - e. C153/A21.53, Standard for Ductile-Iron Compact Fittings for Water Service.
7. Cast Iron Soil Pipe Institute (CISPI)
- a. 301, Standard Specification for Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications.
8. International Plumbing Code (IPC)
9. National Fire Protection Association (NFPA)
- a. 54, National Fuel Gas Code.
 - 9, Standard on Explosion Prevention Systems.
10. Underwriters Laboratories, Inc. (UL)
- B. Coordinate flange dimensions and drillings between piping, valves, and equipment.

1.03 SUBMITTALS

A. Shop Drawings:

- 1. Product technical data including:
 - a. Acknowledgement that products submitted meet requirements of standards referenced.
 - Copies of manufacturer's written directions regarding material handling, delivery, storage and installation.

B. Contract Closeout Information:

- 1. Operation and Maintenance Data:
 - a. See Specification Section 01430 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.

C. Informational Submittals:

- 1. Qualifications of labor performing disinfection analysis on water systems.
- 2. Test reports:
 - a. Copies of pressure test results on all piping systems.

- Reports defining results of dielectric testing and corrective action taken.
- c. Disinfection test report.
- d. Notification of time and date of piping pressure tests.

1.04 DELIVERY, STORAGE, AND HANDLING

- A. Protect pipe coating during handling using methods recommended by manufacturer.
 - 1. Use of wire cables, chains, hooks, metal bars or narrow skids in contact with coated pipe is not permitted.
- B. Prevent damage to pipe during transit.
 - 1. Repair abrasions, scars, and blemishes.
 - 2. If repair of satisfactory quality cannot be achieved, replace damaged material immediately.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
 - 1. Pipe saddles for gage installation
 - a. Dresser Steel 91 steel and ductile iron systems
 - Dresser Steel 194 nonmetallic systems

2.02 COMPONENTS AND ACCESSORIES

- A. Protective Coating and Lining:
 - 1. Include pipe, fittings, and appurtenances where coatings, linings, coating, tests and other items are specified.
 - 2. Field coating pipe in accordance with Specification Section 09900.
- B. Underground Warning Tape:
 - 1. See Specification Section 10400.
- C. Pressure Gages:
 - 1. See Specification Section 11005.

PART 3 - EXECUTION

3.01 EXTERIOR BURIED PIPING INSTALLATION

- A. Enter and exit through structure walls, floors, and ceilings using penetrations and seals specified in Specification Section 01800 and as shown on Drawings.
- B. When entering or leaving structures with buried mechanical joint piping, install joint within 2 feet of point where pipe enters or leaves structure.
 - 1. Install second joint not more than 12 feet nor less than 4 feet from first joint.
- C. Install expansion devices as necessary to allow expansion and contraction movement.
- D. Laying Pipe In Trench:
 - 1. Excavate and backfill trench in accordance with Specification Section 02222.
 - 2. Clean each pipe length thoroughly and inspect for compliance to specifications.
 - 3. Grade trench bottom and excavate for pipe bell and lay pipe on trench bottom.
 - 4. Install gasket or joint material according to manufacturer's directions after joints have been thoroughly cleaned and examined.
 - 5. Except for first two joints, before making final connections of joints, install two full sections of pipe with earth tamped alongside of pipe or final with bedding material placed.
 - Lay pipe in on-site weather with good trench conditions.
 - a. Never lay pipe in water except where approved Engineer.
 - 7. Seal open end of line with watertight plug if pipe laying stopped.
 - 8. Remove water in trench before removal of plug.
- E. Lining Up Push-On Joint Piping:
 - 1. Lay piping on route lines shown on Drawings.
 - 2. Deflect from straight alignments or grades for vertical or horizontal curves or offsets.
 - 3. Observe maximum deflection values stated in manufacturer's written literature.
 - 4. Provide special bends when specified or where required alignment exceeds allowable deflections stipulated.
 - 5. Install shorter lengths of pipe in such length and number that angular deflection of an joint, as represented by specified maximum deflection, is not exceeded.
- F. Anchorage and Blocking:

1. Provide reaction blocking, anchors, joint harnesses, or other acceptable means for preventing movement of piping caused by forces in or on buried piping tees, wyes, branches, plugs, or ends.
2. Place concrete blocking so that it extends from fitting into solid undisturbed earth wall.
 - a. Concrete blocks shall not cover pipe joints.
3. Provide bearing area of concrete in accordance with drawing detail.

G. Install underground hazard warning tape per Specification Section 10400.

H. Install insulating components where dissimilar metals are joined together.

3.02 EXPOSED EXTERIOR PIPING INSTALLATION

A. Install piping in vertical and horizontal alignment as shown on Drawings.

B. Enter and exit through structure walls, floor and ceilings using penetrations and seals specified in Specification Section 01800 and as shown on the Drawings.

C. Install vertical piping runs plumb and horizontal piping runs parallel with structure walls.

D. Pipe Support:

1. Use methods of piping support as shown on Drawings and as required in Specification Section 15090.

E. Section 15090. Locate and size sleeves and castings required for piping system.

1. Arrange for chases, recesses, inserts or anchors at proper elevation and location.

F. Unions:

1. Install in position which will permit valve or equipment to be removed without dismantling adjacent piping.
2. Mechanical type couplings may serve as unions.
3. Additional flange unions are not required at flanged connections.

G. Install expansion devices as necessary to allow expansion/contraction movement.

H. Provide full face gaskets on all systems.

I. Anchorage and Blocking:

1. Block, anchor, or harness exposed piping subjected to forces in which joints are installed to prevent separation of joints and transmission of stress into equipment or structural components not designed to resist those stresses.

J. Equipment Pipe Connections:

1. Equipment - General:

- a. Exercise care in bolting flanged joints so that there is no restraint on the opposite end of pipe or fitting which would prevent uniform gasket pressure at connection or would cause unnecessary stresses to be transmitted to equipment flanges.
 - Where push-on joints are used in conjunction with flanged joints, final positioning of push-on joints shall not be made until flange joints have been tightened without strain.
 - c. Tighten flange bolts at uniform rate which will result in uniform gasket compression over entire area of joint.
 - 1□ Provide tightening torque in accordance with manufacturer's recommendations.
 - d. Support and match flange faces to uniform contact over their entire face area prior to installation of an bolt between the piping flange and equipment connecting flange.
 - e. Permit piping connected to equipment to freely move in directions parallel to longitudinal centerline when and while bolts in connection flange are tightened.
 - f. Align, level, and wedge equipment into place during fitting and alignment of connecting piping.
 - g. Grout equipment into place prior to final bolting of piping but not before initial fitting and alignment.
 - h. To provide maximum flexibility and ease of alignment, assemble connecting piping with gaskets in place and minimum of four bolts per joint installed and tightened.
 - 1□ Test alignment by loosening flange bolts to see if there is an change in relationship of piping flange with equipment connecting flange.
 - 2□ Realign as necessary, install flange bolts and make equipment connection.
 - i. Provide utility connections to equipment shown on Drawings, scheduled or specified.
2. Plumbing and HVAC equipment:
- a. Make piping connections to plumbing and HVAC equipment, including but not limited to installation of fittings, strainers, pressure reducing valves, flow control valves and relief valves provided with or as integral part of equipment.
 - Furnish and install sinks, fittings, strainers, pressure reducing valves, flow control valves, pressure relief valves, and shock absorbers which are not specified to be provided with or as integral part of equipment.
 - c. For each water supply piping connection to equipment, furnish and install union and gate or angle valve.
 - 1□ Provide wheel handle stop valve at each lavatory sink water supply

2. Minimum size: 1/2 inches.

d. Furnish and install "P" trap for each waste piping connection to equipment if waste is connected directly to building sewer system.

1. Size trap as required by IPC.

e. Stop piping for equipment, sinks, lavatories, supply and drain fittings, knee stops, "P" traps, miscellaneous traps and miscellaneous pass through wall or floor and cap and protect until such time when later installation is performed.

K. Provide insulating components where dissimilar metals are joined together.

L. Instrument Connections:

1. See drawing details.

3.03 CONNECTIONS WITH EXISTING PIPING

A. Where connection between new work and existing work is made, use suitable and proper fittings to suit conditions encountered.

B. Perform connections with existing piping at time and under conditions which will least interfere with service to customers affected by such operation.

C. Undertake connections in fashion which will disturb system as little as possible.

D. Provide suitable equipment and facilities to dewater, drain, and dispose of liquid removed without damage to adjacent property.

E. Where connections to existing systems necessitate employment of past installation methods not currently part of trade practice, utilize necessary special piping components.

F. Where connection involves potable water systems, provide disinfection methods as prescribed in this Specification Section.

G. Once tie-in to each existing system is initiated, continue work continuously until tie-in is made and tested.

3.04 PRESSURE GAGES

A. Provide at locations shown on the Drawings and specified.

B. See Specification Section 11005.

3.05 FIELD QUALITY CONTROL

A. Pipe Testing - General:

1. Test piping systems as follows:

a. Test exposed, non-insulated piping systems upon completion of system.

- Test exposed, insulated piping systems upon completion of system cut prior to application of insulation.
 - c. Test concealed interior piping systems prior to concealment and, if system is insulated, prior to application of insulation.
 - d. Test buried piping (insulated and non-insulated) prior to backfilling and, if insulated, prior to application of insulation.
- 2. Isolate equipment which may be damaged under the specified pressure test conditions.
- 3. Perform pressure test using calibrated pressure gages and calibrated volumetric measuring equipment to determine leakage rates.
 - a. Select each gage so that the specified test pressure falls within the upper half of the gage's range.
- Notify the Engineer 24 hours prior to each test.
- 4. Complete assembly and test new piping systems prior to connection to existing pipe systems.
- 5. Acknowledge satisfactory performance of tests and inspections in writing to Engineer prior to final acceptance.
- Bear the cost of all testing and inspecting, locating and remedying of leaks and any necessary retesting and re-examination.

B. Pressure Testing:

1. All valves, hydrants, pipe and fittings shall be hydrostatically tested.
2. Furnish all necessary apparatus to run hydrostatic test, including necessary taps into the pipe.
3. Prior to pressure testing, expel air from the pipe.
4. Install corporation cocks at all high points in water main to allow air to be expelled.
5. Provide temporary restraints for expansion joints for additional pressure load under test.
- After pipe has been laid and backfilled, slowly fill each valved section of pipe with water and apply a test pressure of 110 PSI.
7. After air has been expelled, close corporation cocks and apply test pressure.
8. The duration of each hydrostatic test to be a minimum of 2 HRS.
9. Measure leakage from water main while test pressure is applied.
10. Leakage is defined as the quantity of water that must be supplied into the pipe to maintain the specified leakage test pressure within 5 PSI of the initial 110 PSI test pressure.

11. Allowable leakage rates:

- a. Hazardous gas systems, all exposed piping systems, all pressure piping systems and all buried, insulated piping systems which are hydrostatically pressure tested shall have zero leakage goal at the specified test pressure throughout the duration of the test.
- b. Hydrostatic exfiltration and infiltration for sanitary and stormwater sewers where groundwater level is below the top of pipe
 - 1. Leakage rate: 200 GAL per inch diameter per mile of pipe per day at average head on test section of 3 feet.
 - 2. Average head is defined from groundwater elevation to average pipe crown.
 - 3. Acceptable test head leakage rate for heads greater than 3 feet: Acceptable leakage rate (gallons per inch diameter per mile per day) equals 115 times actual test head to the 1/2 power.
- c. Hydrostatic infiltration test for sanitary and stormwater sewers where groundwater level is above the top of pipe
 - 1. Allowable leakage rate: 200 GAL per inch diameter per mile of pipe per day when depth of groundwater over top of pipe is 2 to 3 feet.
 - 2. Leakage rate at heads greater than 3 feet: Allowable leakage rate (gallons per inch diameter per mile of pipe per day) equals 82 times actual head to the 1/2 power.
- d. Large diameter (above 48 inches) gravity plant piping systems shall have a maximum exfiltration of 25 GPD per inch-mile.
- e. For low pressure (less than 25 psiG) air testing, the acceptable time for loss of 1 psiG of air pressure shall be:

PIPE SIZE (IN DIA)	TIME, MINUTES/100 feet
4	0.3
6	0.7
8	1.2
10	1.5
12	1.8
15	2.1
18	2.4
21	3.0
24	3.6
27	4.2
30	4.8
33	5.4

PIPE SIZE (IN DIA)	TIME, MINUTES/100 feet
36	6.0
42	7.3
48	7.6

12. Soil, waste, drain and vent systems:

1. Test at completion of installation of each stack or section of piping by filling system with water and checking joints and fittings for leaks.
2. Eliminate leaks before proceeding with work or concealing piping.
3. Minimum test heights shall be 10 feet above highest stack inlet.

13. Larger diameter (above 36 inches) gravity plant piping:

1. Plug downstream end of segment to be tested.
 - a. Provide bracing as required.
2. Fill segment and upstream structure to normal operating level as per hydraulic profile.
3. Allow 24 hours for absorption losses.
 - a. Refill to original level.
4. Provide reservoir to maintain constant head over duration of test.
5. Record reservoir water volume at beginning and end of test.

14. Air testing methodology

a. General:

1. Assure air is ambient temperature.

b. Low pressure air testing:

1. Place plugs in line and inflate to manufacturer's designated seal pressure.
2. Check plugs for proper sealing.
3. Introduce low pressure air into sealed line segment until air pressure reaches 4 psiG greater than ground water or allowable limits of ASTM F1417.
 - a. Use test gage conforming to ASME B40.100 with 0 to 15 psi scale and accuracy of 1% of full range.
4. Allow 2 minutes for air pressure to stabilize.

5. After stabilization period 3.5 psiG minimum pressure in pipe discontinue air supply to line segment.

Record pressure at beginning and end of test.

C. Dielectric Testing Methods and Criteria:

1. Provide electrical check between metallic non-ferrous pipe or appurtenances and ferrous elements of construction to assure discontinuity has been maintained.
2. Wherever electrical contact is demonstrated in such test, locate the point or points of continuity and correct the condition.

3.0 CLEANING, DISINFECTION AND PURGING

A. Cleaning:

1. Clean interior of piping systems thoroughly before installing.
2. Maintain pipe in clean condition during installation.
3. Before painting piping, thoroughly clean and wipe paint contact surfaces and then properly dress and make paint.
 - a. Pig high pressure air piping before connecting to valves or instruments.
4. At completion of work and prior to Final Acceptance, thoroughly clean work installed under these Specifications.
 - a. Clean equipment, fixtures, pipe, valves, and fittings of grease, metal cuttings, and sludge which may have accumulated in operation of system, from testing, or from other causes.
 - b. Repair any stoppage or discoloration or other damage to parts of building, its finish, or furnishings, due to failure to properly clean piping system, without cost to Owner.
5. Purge all neat liquid polymer tubing or piping between the neat polymer storage tank or tote and the polymer ending units with mineral oil to remove residual water prior to introducing neat polymer. Following purging, drain as much of the mineral oil out of the system as possible. Dispose of purged fluids and waste mineral oil in accordance with local environmental regulations.

B. Disinfection of Potable Water Systems:

1. After favorable performance of pressure test and prior to Final Acceptance, thoroughly flush entire potable water piping system including supply source and any appurtenant devices and perform disinfection as prescribed.
2. Perform work, including preventative measures during construction, in full compliance with AWWA C51.
3. Perform disinfection using sodium hypochlorite complying with AWWA B300.

4. Flush each segment of system to provide flushing velocity of not less than 2.5 feet per second.
5. Drain flushing water to sanitary sewer.
 - a. Do not drain flushing water to receiving stream.
- Use continuous feed method of application.
 - a. Tag system during disinfection procedure to prevent use.
7. After required contact period, flush system to remove traces of heavily chlorinated water.
8. Do not allow flow into a waterway without neutralizing disinfectant residual.
9. After final flushing and before placing water in service, obtain an independent laboratory approved by the Owner to collect samples and test for bacteriological quality.
 - a. Repeat entire disinfection procedures until satisfactory results are obtained.
10. Secure and deliver to Owner, satisfactory bacteriological reports on samples taken from system.
 - a. Ensure sampling and testing procedures are in full compliance to AWWA C51, local water purveyor and applicable requirements of State of Florida.

3.07 LOCATION OF BURIED OBSTACLES

- A. Furnish exact location and description of buried utilities encountered and thrust block placement.
- B. Reference items to definitive reference point locations such as found property corners, entrances to buildings, existing structure lines, fire hydrants and related fixed structures.
- C. Include such information as location, elevation, coverage, supports and additional pertinent information.
- D. Incorporate information on "As-Recorded" Drawings.

END OF SECTION

SECTION 15002
DUCTILE IRON PIPE AND FITTINGS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Process piping systems.
2. Utility piping systems.
3. Plumbing piping systems.

B. Related Specification Sections include but are not necessarily limited to:

1. Section 09900 - Painting
2. Section 10400 - Identification Devices.
3. Section 02222 – Excavation and Backfill for Utilities
4. Section 15000 – Pipe and Pipe Fittings – Basic Requirements
5. Section 15090 - Pipe Support Systems.
- Section 15100 - Valves and Operators

1.02 SUBMITTALS

A. Quality Control Submittals:

1. Manufacturer's Certificate of Compliance, in accordance with the Contract Documents, stating that inspections and specified tests have been made and that results thereon comply with requirements of Article Source Quality Control.
2. Field Hydrostatic Testing Plan: Submit at least 15 days prior to testing and at minimum, include the following:
 - a. Testing dates.
 - Piping systems and sections to be tested.
 - c. Method of isolation.
 - d. Method of conveying water from source to system being tested.
 - e. Calculation of maximum allowable leakage for piping sections to be tested.

3. Certifications of Calibration: Approved testing laboratory certificate if pressure gauge for hydrostatic test has been previously used. If pressure gauge is new, no certificate is required.
4. Test documentation form and results.

B. Shop Drawings—see Section 15000.

PART 2 - MATERIALS

2.01 MATERIALS

A. Pipe:

1. General:

- a. Centrifugally cast, grade 42-10 iron, minimum 350 psi working pressure for pipes 12 inches and less, minimum 250 psi working pressure for pipes 14 inches and greater.
 - Meet requirements of AWWA C151, C110, C153, and C111.
 - c. Lined and coated as specified.
2. Pressure rating of pipe to be specified according to the particular requirements of the Project.
3. Pipe wall thickness of threaded pipe for a flanged pipe end shall be minimum special thickness Class 53 from 4-inch to 54-inch and/or minimum pressure Class 350 for 10-inch to 44-inch diameter pipe in accordance with AWWA C115.
4. Grooved end pipe, for all pipe diameters, shall be minimum Special Class 53.
5. Pipe shall be new and recently manufactured. Refurbished pipe shall not be provided.

B. Joints:

1. Push-On Joint: Rated at minimum working pressure equal to pipe material design.
2. Restrained Joint:
 - a. Manufactured proprietary joint that mechanically restrains pipe to adjoining pipe.
 - Manufacturers and Products or equal:
 - 1 □ U.S. Pipe—TR Flex, Restrained Tension, and Field-Lok.
 - 2 □ American Cast Iron Pipe—Flex-Ring, Lok-Ring, and Fast-Grip.
 - 3 □ One Bolt fittings as manufactured by One Bolt, Inc., for restrained fittings 12 inches in diameter and less.

- c. Use of restraining gaskets for planned joint restraint is restricted to pipes 12 inches in diameter or less.
3. Mechanical Wedge Action Type Joint: Use only in areas where adjoining to fixed points where lagging length is determined in field. Prior to purchase and installation, type and application of this joint shall be approved by Engineer. Use of mechanical joint restraint or field-restraining type gaskets in excess of 12 inches shall not be allowed, unless an unexpected field condition requires cutting the pipe and installation of a field applied restraint. Use of set screws to provide restraint of any kind is not permitted.
- a. Manufacturers and Products or Equal:
 - 1. Meg-a-lug, as manufactured by EBBA Iron.
 - 2. Stargrip, as manufactured by Star Pipe Products.
 - 3. Grip-ring, as manufactured by Romac.
4. Flanged Joint: Threaded 250 psi working pressure ductile iron flanges conforming to AWWA C115 for Class 125 flanges.
5. Grooved Joint:
- a. Rigid and/or Flexible type radius cut grooved, conforming to AWWA C900, depending on the particular application.
 - 1. As manufactured by Victaulic Company of America.
- C. Fittings:
- 1. Ductile Iron, Push-On, Flanged or Restrained Joint: In accordance with AWWA C110 or C153 250 psi minimum working pressure for 4- to 24-inch fittings and 250 psi minimum working pressure for 24- to 48-inch fittings and AWWA C111.
 - 2. Mechanical Joint Fittings: In accordance with AWWA C111.
 - 3. Grooved End Fittings:
 - a. Radius cut grooved, rigid and/or flexible type conforming to AWWA C110 and/or AWWA C153 as above.
 - 1. Manufacturers or Equal:
 - 1. Victaulic Company of America.
 - 2. Gustin-Bacon.
 - 4. Fittings shall be new and recently manufactured. Refurbished fittings will not be accepted.
- D. Welded Outlet: Only weld to pipe in manufacturer's shop – may be used in lieu of a tee where economical and where subject to manufacturer's limitations.

E. Lining:

1. Pipe and fittings for clean water applications shall be cement lined and asphaltic seal coated in accordance with AWWA C104.
2. Pipe and fittings for wastewater applications shall be lined with 40-mils Protecto 401 ceramic epoxy, or equivalent.

F. Coating:

1. Buried Pipe: Asphaltic coating, 1 mil thick, in accordance with AWWA C151, C115, C110, and C153.
2. Exposed Pipe: Prime coat of 105 Polyamidoamine Epoxy, 10 - 10.0 DFT. Finish coat 110 Aliphatic Acrylic Polyurethane, 3.0 - 5.0 DFT.

G. Polyethylene Encasement:

1. All buried ductile iron pipe and fittings shall be encased, unless otherwise indicated.
2. Virgin polyethylene raw material conforming to requirements of ASTM D497
3. Elongation: 800 percent, minimum in machine and transverse direction (ASTM D882)
4. Tensile Strength: 3,000 psi, minimum.
5. Dielectric Strength: 800V/mil-thickness, minimum.
6. Propagation Tear Resistance: 2,550 gf, minimum in machine and transverse direction (ASTM 1922)
7. Tube form, conforming to AWWA C105.
8. Film shall have minimum in thickness of 0.008 in (8 mil)

H. Bolting:

1. Bolts for flanged connections shall be carbon steel, ASTM A307, Grade A hex bolts and ASTM A563, Grade A hex head nuts.
2. Bolts for grooved end connections shall be manufacturer's standard.

I. Gaskets:

1. Gaskets for flat faced 150 and 250 psi working pressure flanges shall be 1/8-inch thick, red rubber (SBR) hardness 80 (Shore A), rated to 200 degrees F, conforming to ANSI B1.21, AWWA C207, and ASTM D1330, Grades 1 and 2.
2. Gaskets for grooved end joints shall be Halogenated Butyl, conforming to ASTM D2000 and AWWA C200.
3. Tor-seal or equal gaskets shall be used for exposed, flanged joints.

J. Pressure Test Gauges:

1. Heavy-duty industrial quality gauges.

2. Oil-filled.

2.02 SOURCE QUALITY CONTROL

- A. Factor Tests: In accordance with AWWA C104, C105, C110, C111, C115, C150, C151, C153, or C200, as required in the particular Project application.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Inspect pipe and fittings to ensure no cracked, broken, or otherwise defective materials are being used.

3.02 INSTALLATION

- A. In accordance with AWWA C205, ASTM D2321, and AWWA Manual 23 and the Contract Documents.

B. Field Welding:

1. Use of field welded outlets will not be allowed. Welding for outlets shall be performed only in pipe manufacturer's shop.
2. Field installed outlets may be installed with saddle approved by Engineer. Opening in pipe shall be machined cut and not with cutting torch.
3. Field welding of bars for restrained joint systems will not be allowed. All welding shall be performed in pipe manufacturer's shop.

C. Polyethylene Encasement:

1. Encase pipe, fittings, and valves where specified in accordance with AWWA C105, Method A.
 2. Cut polyethylene tube approximately 2 feet longer than pipe length.
 3. Slip tube around pipe, centering to provide 1-foot overlap on each adjacent section.
 4. Pull encasement to take out slack and wrap snug around pipe.
 5. Secure overlap in place and fold at quarter points of pipe length.
- Wrap and tape encasement snug around fittings and valves.

3.03 TESTING AND INSPECTION

- A. See Section 15000 Pipe and Pipe Fittings – Basic Requirements and Section 15001 Pipeline Disinfection.

- END OF SECTION -

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SECTION 15090
PIPE SUPPORT SYSTEMS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Pipe support and anchor systems.
2. Design of Pipe Support Systems as specified.

B. Related Specification Sections include but are not necessarily limited to:

1. Division 00 - Procurement and Contracting Requirements.
2. Division 01 - General Requirements.
3. Section 01810 – Wind and Seismic Design Criteria
4. Section 03151 - Anchorage to Concrete.
5. Section 05035 – Galvanizing.
6. Section 09901 - High Performance Industrial Coatings.
7. Section 15183 - Pipe, Duct and Equipment Insulation.

1.02 QUALITY ASSURANCE

A. Referenced Standards:

1. American Society of Mechanical Engineers (ASME)
 - a. B31.1, Power Piping.
 6. B31.3, Process Piping.
2. ANVIL International (ANVIL)
3. ASTM International (ASTM)
 - a. A36, Standard Specification for Carbon Structural Steel.
 6. A276, Standard Specification for Stainless Steel Bars and Shapes.
 - c. A575, Standard Specification for Steel Bars, Carbon, Merchant Quality, M-Grades.
 - d. A577, Standard Specification for Steel Bars, Carbon, Hot-Wrought, Special Quality

- e. A917, Standard Specification for Steel Sheet, Coated by the Electrolytic Process for Applications Requiring Designation of the Coating Mass on Each Surface [General Requirements]
 - f. A918, Standard Specification for Steel Sheet, Zinc-Nickel Alloy-Coated by the Electrolytic Process for Applications Requiring Designation of the Coating Mass on Each Surface.
 - g. B33, Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel.
4. American Welding Society [AWS]
- a. D1.1, Structural Welding Code - Steel.
5. Manufacturers Standardization Society of the Valve and Fittings Industry Inc. [MSS]
- a. SP-58, Pipe Hangers and Supports - Materials, Design and Manufacture.
 - SP-59, Pipe Hangers and Supports - Selection and Application.
- B. Responsibility
- 1. Support systems for piping greater than 12 IN DIA, or with internal pressure over 100 PSI, or piping with product temperatures over 200 DEGF, are shown on the Drawings and are not to be designed by Contractor unless indicated in Contract Documents.
 - 2. Design complete support systems for piping 12 IN and smaller where supports are not shown on the Drawings.
 - 3. Provide all labor, materials, equipment and incidentals as shown, specified and required to design, furnish and install the system of hangers, supports, guidance, anchorage and appurtenances.
 - 4. General piping support details may be indicated on the Drawings in certain locations for pipe 12 IN DIA and smaller.
 - 5. Incorporate those details with requirements of this Specification Section to provide the piping support system.
- C. Each type of pipe hanger or support shall be the product of one manufacturer.
- D. Qualifications:
- 1. Pipe support designer:
 - a. Licensed Professional Engineer registered in the state the project is located in.
 - Minimum of 5 years experience designing pipe supports for projects of similar size and complexity.

1.03 SUBMITTALS

A. Shop Drawings:

1. See Specification Section 01300 for requirements for the mechanics and administration of the submittal process.
2. Product technical data including:
 - a. Acknowledgement that products submitted meet requirements of standards referenced.
 - b. Manufacturer's installation instructions.
 - c. Itemized list of wall sleeves, anchors, support devices and all other items related to pipe support system.
 - d. Scaled drawings showing location, installation, material, loads and forces, and deflection of all hangers and supports.
 - e. Analyze each pipe system for all loads and forces on hangers and supports and their reaction forces to the structure to which they are fastened.
 - f. Where Contract Documents indicate contractor is to design pipe support systems, submit detail design calculations and scaled drawings signed by Pipe support designer..
3. Certifications.
 - a. Pipe support designer qualifications

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Subject to compliance with the Contract Documents, the manufacturers listed in the applicable Articles below are acceptable.
- B. Submit request for substitution in accordance with Specification Section 0140.

2.02 MANUFACTURED UNITS

A. General:

1. Galvanized components:
 - a. Electro-galvanized components:
 1. Bar, forged or cast fabrications: ASTM B33, SC4.
 2. Rolled sheet fabrications: ASTM A917 and ASTM A918, 50N50NU.
 - b. Hot-dipped galvanized components: See Specification Section 05035.

2. Dissimilar metals protection:

- a. Galvanized-to-galvanized and galvanized-to-aluminum: No protection required.
- All other galvanized-to-dissimilar metal connections: Neoprene or nion pads, shims, grommets, etc.

B. Hanger Rods:

1. Material:

- a. ASTM A3□
- ASTM A575, Grade M1020.
- c. ASTM A57□, Grade 1020.
- d. Minimum allowable tensile stress of 12,000 PSI at □50 DEGF per MSS SP-58.

2. Continuous□ threaded.

3. Electro-galvanized or cadmium plated after threads are cut.

4. Load limit:

NOMINAL ROD DIAMETER	MAXIMUM SAFE LOAD, LBS□
3/8 IN DIA □min□	□10
1/2 IN DIA	1,130
5/8 IN DIA	1,810
3/4 IN DIA	2,710
7/8 IN DIA	3,770
1 IN DIA	4,9□0

C. Hangers:

- 1. Hangers for use directl□ on copper pipe: Copper or cadmium plated.
- 2. Hangers for use other than directl□ on copper pipe: Cadmium plated or galvanized.
- 3. Hanger t□pe schedule:

APPLICATION	PIPE SIZE	HANGER T□PE
All e□cept noted	4 IN and less	ANVIL Figure 108 with Figure 114
All e□cept noted	Over 4 IN	ANVIL Figure 590
Steam, condensate and hot water	All	ANVIL Figure 181, Figure 82
Service in chemical storage areas and as indicated on drawings for corrosion resistance	All	CorPro CP - Hanger or e□ual

D. Concrete Inserts for Hanger Rods:

1. Continuous slots: Unistrut □P1000.
2. Individual inserts: ANVIL Figure 281.
3. See Specification Section 03151, mechanical anchors.

E. Beam Clamps for Hanger Rods:

1. Heavy duty
2. ANVIL Figure 134.

F. Trapeze Hangers for Suspended Piping:

1. General:
 - a. Material: Steel.
 - Galvanized.
 - c. Angles, channels, or other structural shapes.
 - d. Curved roller surfaces at support point corresponding with type of hanger required.
2. In chemical storage and feed areas and as indicated on the drawings:
 - a. Materials: FRP.
 - Unistrut fiberglass channel or equal.

G. Vertical Pipe Supports:

1. At base of riser.
2. Lateral movement:
 - a. Clamps or brackets:
 - 1 □ ANVIL Figure 134.

H. Expanding Pipe Supports:

1. Spring hanger type.
2. MSS SP-58.

I. Pipe Support Saddle:

1. For pipe located 3 FT or less from floor elevation, except as otherwise indicated on Drawings.
2. ANVIL Figure 204.

□ Pipe Support Risers:

1. Schedule 40 pipe.
2. Galvanized.
3. Size: As recommended □□saddle manufacturer.

K. Pipe Support Base Plate:

1. 4 IN larger than support.
2. Collar 3/16 IN thickness, circular in shape, and sleeve type connection to pipe.
3. Collar fitted over outside of support pipe and extended 2 IN from floor plate.
4. Collar welded to floor plate.
5. Edges ground smooth.

- Assembled hot-dipped galvanized after fabrication.

L. Pipe Covering Protection Saddle:

1. For insulated pipe at point of support.
2. ANVIL Figure 107, Type B.

M. Wall Brackets:

1. For pipe located near walls and 8 FT or more above floor elevation or as otherwise indicated on the Drawings.
2. ANVIL Figure 199.

N. Pipe Anchors:

1. For locations shown on the Drawings.
2. 1/4 IN steel plate construction.
3. Hot-dipped galvanized after fabrication.
4. Designed to prevent movement of pipe at point of attachment.

O. Pipe Guides:

1. For locations on both sides on each expansion joint or loop.
2. To ensure proper alignment of expanding or contracting pipe.
3. ANVIL Figure 250.

2.03 DESIGN REQUIREMENTS

- A. Supports capable of supporting the pipe for all service and testing conditions.

1. Provide 5 to 1 safety factor.
- B. Allow free expansion and contraction of the piping to prevent excessive stress resulting from service and testing conditions or from weight transferred from the piping or attached equipment.
- C. Design supports and hangers to allow for proper pitch of pipes.
- D. For chemical and waste piping, design, materials of construction and installation of pipe hangers, supports, guides, restraints, and anchors:
 1. ASME B31.3.
 2. MSS SP-58 and MSS SP-59.
 3. Except where modified by this Specification.
- E. For steam and hot and cold water piping, design, materials of construction and installation of pipe hangers, supports, guides, restraints, and anchors:
 1. ASME B31.1.
 2. MSS SP-58 and MSS SP-59.
- F. Check all physical clearances between piping, support system and structure.
 1. Provide for vertical adjustment after erection.
- G. Support vertical pipe runs in pipe chases at base of riser.
 1. Support pipes for lateral movement with clamps or brackets.
- H. Place hangers are to be installed on outside of pipe insulation.
 1. Use a pipe covering protection saddle for insulated pipe at support point.
 2. Insulated piping 1-1/2 IN and less:
 - a. Provide a 9 IN length of high density perlite or high density calcium silicate at saddle.
 - See Specification Section 15183.
 3. Insulated piping over 1-1/2 IN: Provide a 12 IN length of high density perlite or high density calcium silicate at saddle.
- I. Provide 20 GA galvanized steel pipe saddle for fiberglass and plastic support points to ensure minimum contact width of 4 IN.
 - Pipe Support Spacing:
 1. General:
 - a. Factor loads by specific weight of liquid conveyed if specific weight is greater than water.

- Locate pipe supports at maximum spacing scheduled unless indicated otherwise on the Drawings.
- c. Provide at least one □ support for each length of pipe at each change of direction and at each valve.

2. Steel, stainless steel, cast-iron pipe support schedule:

PIPE SIZES - IN	MAXIMUM SPAN - FT
1-1/2 and less	5
2 thru 4	10
5 thru 8	15
10 and greater	20

3. Copper pipe support schedule:

PIPE SIZES - IN	MAXIMUM SPAN - FT
2-1/2 and less	5
3 thru □	10
8 and greater	15

4. PVC pipe support schedule:

PIPE SIZES - IN	MAXIMUM SPAN - FT
1-1/4 and less	3
1-1/2 thru 3	4
4 and greater	5

□ Maximum fluid temperature of 120 DEGF.

5. Support each length and every fitting:

a. Bell and spigot piping:

1 □ At least one □ hanger.

2 □ Applied at □ ell.

□ Mechanical coupling □ oints:

1 □ Place hanger within 2 FT of each side of fittings to keep pipes in alignment.

□ Space supports for soil and waste pipe and other piping systems not included above every 5 FT.

7. Provide continuous support for non tu□ing.

8. For PVC, FRP and copper piping:

- a. Provide Unistrut Unicushion wrap of pipe at each support.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Provide piping systems exhibiting pulsation, vibration, swaying, or impact with suitable constraints to correct the condition.
 1. Included in this requirement are movements from:
 - a. Trap discharge.
 - b. Water hammer.
 - c. Similar internal forces.
- B. Weld Supports:
 1. AWS D1.1.
 2. Weld anchors to pipe in accordance with ASME B31.3.
- C. Locate piping and pipe supports as to not interfere with open accesses, walkways, platforms, and with maintenance or disassembly of equipment.
- D. Inspect hangers for:
 1. Design offset.
 2. Adequacy of clearance for piping and supports in the hot and cold positions.
 3. Guides to permit movement without binding.
 4. Adequacy of anchors.
- E. Inspect hangers after erection of piping systems and prior to pipe testing and flushing.
- F. Anchorage to Concrete- reference Section 03151.
- G. Install individual or continuous slot concrete inserts for use with hangers for piping and equipment.
 1. Install concrete inserts as concrete forms are installed.
- H. Welding:
 1. Welding rods: ASTM and AWS standards.
 2. Integral attachments:
 - a. Include welded-on ears, shoes, plates and angle clips.
 - b. Ensure material for integral attachments is of good weldable quality.

3. Preheating, welding and post heat treating: ASME B31.3, Chapter V.
- I. Field Painting:
 1. Comply with Specification Section 09900 Painting.

END OF SECTION

SECTION 15100
VALVES AND OPERATORS

PART 1 - GENERAL

1.01 SUBMITTALS

- A. Shop Drawings:
1. Product data sheets for make and model.
 2. Complete catalog information, descriptive literature, Specifications, and identification of materials of construction.

PART 2 - PRODUCTS

2.01 GENERAL

- A. Valve to include operator, actuator, handwheel, chain wheel, extension stem, floor stand, worm and gear operator, operating nut, chain, wrench, and accessories as appropriate and as shown on the Drawings for a complete operation.
- B. Valve to be suitable for intended service. Renewable parts not to be of a lower quality than specified.
- C. Valve same size as adjoining pipe.
- D. Valve ends to suit adjacent piping.
- E. Size operator to operate valve for the full range of pressures and velocities.
- F. Valve to open by turning counterclockwise.
- G. Factor in mount operator, actuator, and accessories.

2.02 MATERIALS

- A. Brass and bronze valve components and accessories that have surfaces in contact with water to be alloys containing less than 1 percent zinc and 2 percent aluminum.
- B. Approved Alloys Are of the Following ASTM Designations:
1. B1, B2, B98 (Alloy UNS No. C5100, C5500, or C1100), B139 (Alloy UNS No. C51000), B584 (Alloy UNS No. C90300 or C94700), B14, B194, and B127.
 2. Stainless steel Alloy 18-8 may be substituted for bronze.

2.03 FACTOR FINISHING

- A. Epoxy Lining and Coating: In accordance with manufacturer's instructions for on-site soil and groundwater conditions and Section 1502 Ductile Iron Pipe and Fittings.

B. Exposed Valves:

1. In accordance with manufacturer's instructions for onsite soil and groundwater conditions.
2. Safety isolation valves and lockout valves with handles, handwheels, or chain wheels "safety yellow."
- 3.

2.04 TAPPING SLEEVES – DUCTILE IRON

- A. Ductile iron tapping sleeves are preferred for force main and water main taps.
- B. Tapping sleeves shall meet ASTM A53 Grade 5-45-12.
- C. Side flange seals shall be O-ring type with round, oval, or rectangular cross section.
- D. Contractor shall inspect and/or verify diameter of the pipe to be tapped and order the correct sleeve.
- E. Sleeves shall be coated in accordance with the provisions of this Specification.
- F. Tapping sleeve and tapping valve shall be of the same or compatible manufacturer to assure proper fit of the aligning ring on the valve and the recess on the sleeve. No post factor modifications to either the sleeve or valve will be permitted.
- G. Tapping sleeve shall be American Flow Control Series 1004 or 2800, Mueller H-15, US Pipe T-9 or Clow F-5205.
- H. Tapping machine and cutter shall provide the full-size of the tapped connection.
- I. The coupon shall be removed from the pipe shall be given to the PCM.

2.05 TAPPING SLEEVES - STEEL

- A. Steel tapping sleeves are acceptable for use where ductile iron sleeves are not practical and as approved by the Engineer.
- B. Tapping sleeve composed of two halves of heavy welded steel, bolting together on the pipe and sealing against a concave Buna-N wedge gasket around the nozzle opening. Both halves of the sleeve are fabricated to accurately conform to the outside diameter of the ductile iron host pipe and to provide reinforcement without the use of shims or pads.
- C. The sleeve half opposite the nozzle shall be solid and shall not consist of straps or U-bolts. Sleeve and nozzle shall be fabricated from ASTM 285, Grade C, carbon steel. Branch leg flange shall conform to AWWA, Class D, Schedule C-207, 150-pound drilling to match tapping valve. The flange face shall be recessed to accommodate the tapping valve in accordance with MSS-SP10. All steel shall meet the requirements of ASTM A36, as a minimum. All weldments shall be traced and stress relieved.
- D. The ferrous metal parts of the fitting shall receive a factory applied fusion-bonded, epoxy coating, 12-mil minimum dry film thickness in accordance with AWWA C213.

- E. Minimum wall thickness of the sleeve shall be 0.375 inch.
- F. Tapping sleeve shall be pressure rated to 150 psi, minimum.
- G. Tapping sleeve shall be, Dresser Steel 30, CM Series 412 or equal.
- H. Tapping machine and cutter shall provide the full-size of the tapped connection.
- I. The coupon removed from the pipe shall be given to the PCM.

2.0 SERVICE SADDLES

- A. Service saddles shall be ductile iron with double stainless steel straps conforming to AWWA C-111/A.21.11-00.

2.07 OPERATORS

A. Manual Operator:

1. General:

- a. Operator force not to exceed 40 pounds under an operating condition, including initial breakaway. Gear reduction operator when force exceeds 40 pounds.
- b. Operator self-locking type or equipped with self-locking device.
- c. Position indicator on quarter-turn valves.
- d. Worm and gear operators one-piece design worm-gears of gear bronze material. Worm hardened alloy steel with thread ground and polished. Traveling nut type operators threaded steel reach rods with internal threaded bronze or ductile iron nut.

2. Exposed Operator:

- a. Galvanized and painted handwheels.
- b. Lever operators allowed on quarter-turn valves 8 inches and smaller.
- c. Cranks on gear type operators.
- d. Valve handles to take a padlock, and wheels a chain and padlock.

3. Buried Operator:

- a. Buried service operators on valves larger than 2-1/2 inches shall have a 2-inch AWWA operating nut. Buried operators on valves 2 inches and smaller shall have cross handle for operation. Enclose moving parts of valve and operator in housing to prevent contact with the soil.
- b. Design buried service operators for quarter-turn valves to withstand 450 foot-pounds of input torque at the FULL OPEN or FULL CLOSED positions, grease packed and gasketed to withstand a submersion in water to 10 psi.

- c. Buried valves shall have extension stems, bonnets, and valve boxes.

2.08 ACCESSORIES

- A. Cast Iron Valve Box: Designed for traffic loads, sliding type, with minimum of 24-inch ID shaft.
 - 1. Box: Cast iron with minimum depth of 9 inches.
 - 2. Lid: Cast iron, minimum depth 3 inches, marked SEWER or WATER, as appropriate.
 - 3. Extensions: Hot-dipped galvanized Schedule 40 steel pipe as shown on the Drawings.

2.09 CORPORATION STOPS

- A. Corporation stops shall be manufactured of brass alloy in accordance with ASTM Specification B 22 unless shown otherwise on the drawings. These corporation stops shall be of the ball valve type.
- B. Inlet thread shall be AWWA taper thread in all sizes in accordance with AWWA Standard C800. Outlet connections shall have a compression type fitting. Corporation Stops shall be FB-1000 and FB-1000 as manufactured by Ford Meter Box Company or equal.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Flange Ends:
 - 1. Flanged valve bolt holes shall straddle vertical centerline of pipe.
 - 2. Clean flanged faces, insert gasket and bolts, and tighten nuts progressively and uniformly.
- B. Screwed Ends:
 - 1. Clean threads by wire brushing or swabbing.
 - 2. Apply joint compound.
- C. Locate valve to provide accessibility for control and maintenance.
- D. Extension Stem for Operator: Where the depth of the valve is such that its centerline is more than 3 feet below grade, furnish an operating extension stem with 2-inch operating nut to bring the operating nut to a point 6 inches below the surface of the ground and/or box cover.
- E. Torque Tube: Where operator for quarter-turn valve is located on floor stand, furnish extension stem torque tube of a type properly sized for maximum torque capacity of the valve.

3.02 TESTS AND INSPECTION

- A. Valve make either tested while testing pipelines, or as a separate step.
- B. Test that valves open and close smoothly with operating pressure on one side and atmospheric pressure on the other, in both directions for two-way valve and applications.
- C. Inspect air and vacuum valves as pipe is being filled to verify venting and seating is fully functional.
- D. Count and record number of turns to open and close valve account for any discrepancies with manufacturer's data.
- E. Set, verify, and record set pressures for all relief and regulating valves.
- F. Test hydrostatic relief valve seating and record leakage. Adjust and retest to maximum leakage of 0.1 gpm per foot of seat perimeter.

END OF SECTION

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SECTION 15101

GATE VALVES

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Gate valves.

B. Related Specification Sections include but are not necessarily limited to:

1. Section 15100 - Valves and Operators

1.02 QUALITY ASSURANCE

A. Referenced Standards:

1. ASTM International (ASTM)

- a. A12, Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.

2. American Water Works Association (AWWA)

- a. C500, Standard for Metal-Seated Gate Valves for Water Supply Service.
- b. C504, Standard for Rubber-Seated Butterfly Valves.
- c. C550, Standard for Protective Epoxy Interior Coatings for Valves and Hydrants.

3. Manufacturers Standardization Society of the Valve and Fittings Industry Inc. (MSS)

- a. SP-9, Spot Facing for Bronze, Iron and Steel Flanges.
- b. SP-70, Cast Iron Gate Valves, Flanged and Threaded Ends.
- c. SP-80, Bronze Gate, Globe, Angle and Check Valves.

1.03 DEFINITIONS

A. OS&O: Outside Screw and Oke.

B. NRS: Non-rising Stem.

C. RS: Rising Stem.

1.04 SUBMITTALS

A. Shop Drawings:

1. See Specification Section 15100.
- B. Contract Closeout Information:
 1. Operation and Maintenance Data:
 - a. See Specification Section 01430 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Subject to compliance with the Contract Documents, the manufacturers listed in the applicable Articles below are acceptable.

2.02 VALVES: WATER (HOT, COLD, HEATING, COOLING, SERVICE, PROCESS, POTABLE, NON-POTABLE, AND WASTEWATER)

- A. Double Disc Gate Valve, 3 to 12 inches (Water Application)
 1. Comply with AWWA C500.
 2. Materials:
 - a. Seating surfaces, stems, stem nut: Bronze.
 - b. Body disc: Cast iron.
 3. Design requirements:
 - a. 200 psi working pressure.
 - b. Buried: NRS, O-ring stem seal, 2 inches operation nut.
 - c. Exposed: NRS, O-ring stem seal, handwheel.
 4. Manufacturers:
 - a. American Flow Control.
 - b. Clow.
 - c. MCH.
 - d. Mueller.
- B. Resilient Wedge Gate Valves, 2 to 48 inches (Water, Wastewater Application)
 1. Comply with AWWA C509 and/or AWWA C515.
 2. Materials:
 - a. Stem and stem nut: Bronze.

- 1 Wetted bronze parts in low zinc bronze.
 - 2 Aluminum bronze components: Heat treated per AWWA C504.
 - Bod□ gate: Ductile iron.
 - c. Resilient wedge: Full□encapsulated rubber wedge. Eth□ene Prop□ene Diene Monomer □EPDM□
3. Design requirements:
- a. Minimum 150PSIG working pressure.
 - Buried: NRS, O-ring stem seal, 2 inches square operating nut.
 - c. Exposed: NRS, O-ring, stem seal, handwheel.
 - d. Counter clockwise open rotation.
 - e. Fusion bonded epoxy coating interior and exterior except stainless steel and bearing surfaces.
 - 1 Comply with AWWA C550.
 - 2 Wetted bronze parts in low zinc bronze.
 - 3 Aluminum bronze components: Heat treated per AWWA C504.
4. Manufacturers:
- a. Clow.
 - Mueller.
 - c. American Flow Control.
 - d. M □ H.
- C. Double Disc Gate Valves, 14 to 48 inches □Water, Wastewater Application□
- 1. Comply with AWWA C500.
 - 2. Materials:
 - a. Seating surfaces, stem, stem nut: Bronze.
 - Bod□ discs: Cast iron.
 - 3. Design requirements:
 - a. 150 psi working pressure.
 - NRS O-ring stem seal.
 - c. Provide gear actuator, 20 inches and larger valves.

- d. Provide roller tracks and scrapers for horizontal valves size 12 inches and larger.
 - e. Provide 12pass valve sized per AWWA C500.
4. Manufacturers:
- a. Clow.
 - Mueller.
 - c. American Flow Control.
 - d. M □ H.
5. Materials:
- a. Bod□ construction:
 - 1□ 2 to 4 inches: Cast stainless steel.
 - 2□ □ to 24 inches: Cast iron □od□ with stainless steel lining.
 - Wetted parts: Stainless steel T□pe 31□
 - c. Packing: Fla□, 150 degrees F ma□
 - d. Stem: Stainless steel, dou□le pitch thread.
 - e. Resilient seat material □2 to 3□ inches□ Butadiene.
- Design re□uirements:
- a. Working pressure □WOG non-shock□
 - 1□ 2 to 24 inches: 150 psi.
 - 2□ 30 to 3□ inches: 125 psi.
 - 3□ Actuator: Geared actuator for valves 20 inches and larger.
7. Manufacturers:
- a. DeZurik, Series L.
 - Fa□ri-Valve.

2.03 ACCESSORIES

- A. Refer to Drawings and valve schedule for t□pe of actuators.
 - 1. Furnish actuator integral with valve.
- B. Refer to Specification Section 15100 for actuator re□uirements.

2.04 FABRICATION

A. General:

1. Provide valves with clear waterways the full diameter of the valve.

B. Spot valves in accordance with MSS SP-9.

PART 3 - EXECUTION

3.01 INSTALLATION

A. See Specification Section 15100.

B. Where larger buried valves utilize smaller bypass valves, provide a second valve box installed over the bypass valve operating nut.

C. Do not install gate valves inverted or with the stems sloped more than 45 degrees from the upright unless the valve was ordered and manufactured specifically for this orientation.

END OF SECTION

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SECTION 15102

PLUG VALVES

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Plug valves.

B. Related Specification Sections include but are not necessarily limited to:

1. Division 00 - Procurement and Contracting Requirements.
2. Division 01 - General Requirements.
3. Section 15100 - Valves and Operators.

1.02 QUALITY ASSURANCE

A. Referenced Standards:

1. American Society of Mechanical Engineers [ASME]
 - a. B1.1, Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125 and 250.
2. ASTM International [ASTM]
 - a. A12, Standard Specification for Gray Iron Castings for Valves, Flanges and Pipe Fittings.
 - b. A53, Standard Specification for Ductile Iron Castings.
 - c. D2240, Standard Test Method for Rubber Property-Durometer Hardness.
3. American Water Works Association [AWWA]
 - a. C517 Resilient-Seated Cast-Iron Eccentric Plug Valves

1.03 SUBMITTALS

A. Shop Drawings:

1. See Specification Section 01300 for requirements for the mechanics and administration of the submittal process.
2. See Specification Section 15100.

B. Contract Closeout Information:

1. Operation and Maintenance Data:

- a. See Specification Section 01430 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.
2. See Specification Section 15100.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Subject to compliance with the Contract Documents, the manufacturers listed under the specific valve types are acceptable.
- B. Submit request for substitution in accordance with Specification Section 0140.

2.02 NON-LUBRICATED ECCENTRIC PLUG VALVES

- A. Acceptable Manufacturers:
 1. DeZurik.
 2. Or approved equal.
- B. Materials:
 1. Body: Cast-iron ASTM A124, Class B.
 2. Plug: One or two-piece construction ductile iron, ASTM A534 5-45-12 or cast iron, ASTM A124 Class B.
 3. Plug facing: Grease and/or petroleum-resistant resilient Neoprene or Buna-N compound, 70 Shore A durometer hardness per ASTM D2240.
 4. Shaft bearing bushings: Permanent lubricated TFE or Delrin sleeve type stainless steel or bronze.
 5. Valve seats: Welded-in overlay of 90 PCT nickel, minimum 1/8 IN thick.
 - Stem seal: per AWWA C517, Section 4.4.7.

2.03 ACCESSORIES

- A. Refer to Drawings and valve schedule for type of actuator.
 1. Furnish actuator integral with valve.
- B. Refer to Specification Section 15100 for actuator requirements.

2.04 DESIGN REQUIREMENTS

- A. Non-Lubricated Eccentric Plug Valves (Wastewater, Sludge)
 1. Port area:
 - a. Valves 4 IN through 20 IN: Equal to or exceed 80 PCT of full pipe area.

- Valves greater than 20 IN: 100 PCT equivalent full pipe area.
- 2. Valve Fitted with Fitted with bolted onnet.
- 3. End connections: See Specification Section 15100.
- 4. Stem seal: Adjustable and replaceable without disassembling valve or onnet.
- 5. Designed for seating drip tight in an flow direction.
- Rating:
 - a. 1/2 through 12 IN, 175 PSI working pressure.
 - 14 through 30 IN, 150 PSI working pressure.
 - c. Three-way valves, 125 PSI working pressure.
- 7. Actuator:
 - a. Actuator gearing in enclosure suitable for running in oil with seals on shaft to prevent entry of dirt or water.
 - Positive identification on actuator indicating valve position.
 - c. Adjustable stop to set closing torque.

B. Non-Lubricated Eccentric Plug Valve-HVAC

- 1. Port area: Valves 1/2 IN through 2-1/2 IN: Equal to or exceed 100 PCT of full pipe area.
- 2. Valve Fitted with threaded onnet or bolted onnet.
- 3. End connections:
 - a. Flanges: In full accordance with ASME B1.1, Class 125 including facing, drilling and thickness.
 - Threaded connection: In full compliance with NPT.
- 4. Stem seal: Self-adjusting U-cups or multiple O-ring seals.
- 5. Shut-off: Designed for setting drip-tight at the full rated pressure.

2.05 FABRICATION

- A. See Specification Section 15100.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. See Specification Section 15100.

- B. Install valve with actuator above pipe or plug centerline.

END OF SECTION

SECTION 15104

BALL VALVES

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Ball valves.

B. Related Specification Sections include but are not necessarily limited to:

1. Division 00 - Procurement and Contracting Requirements.
2. Division 01 - General Requirements.
3. Section 15100 - Valves and Operators.

1.02 QUALITY ASSURANCE

A. Referenced Standards:

1. ASTM International [ASTM]
 - a. A48, Standard Specification for Gray Iron Castings.
 - b. A128, Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
 - c. A276, Standard Specification for Stainless Steel Bars and Shapes.
 - d. A351, Standard Specification for Castings, Austenitic, for Pressure-Containing Parts.
 - e. D1784, Standard Specification for Rigid Polyvinyl Chloride [PVC] Compounds and Chlorinated Polyvinyl Chloride [CPVC] Compounds.
2. American Water Works Association [AWWA]
 - a. C507, Standard for Ball Valves, 1/2 IN through 48 IN.
3. Manufacturers Standardization Society of the Valve and Fittings Industry Inc. [MSS]
 - a. SP-110, Ball Valves [Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends.

1.03 DEFINITIONS

- A. PVDF: Polyvinylidene fluoride.
- B. PTFE: Polytetrafluoroethylene.

C. RPTFE: Reinforced PolyTetraFluoroEthylene.

1.04 SUBMITTALS

A. Shop Drawings:

1. See Specification Section 01300 for requirements for the mechanics and administration of the submittal process.
2. See Specification Section 15100.
3. Test results for AWWA valves.

B. Contract Closeout Information:

1. Operation and Maintenance Data:
 - a. See Specification Section 01430 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Subject to compliance with the Contract Documents, the manufacturers listed in the applicable Articles below are acceptable.
- B. Submit request for substitution in accordance with Specification Section 1300.

2.02 METALLIC BALL VALVES 1/4 TO 3 IN DIA

- A. Comply with MSS SP-110.
- B. Acceptable Manufacturers:
 1. Apollo.
 2. Jamesbur.
 3. Watts.
 4. Stockham.
 5. Nioco.
- C. Materials [All Stainless Steel]
 1. Body: Three-part stainless steel, ASTM A351 CF8M.
 2. Ball: Stainless steel ASTM A27.
 3. Seats: RPTFE.
- D. Design Requirements:

1. Rated for a minimum of:
 - a. 500 PSI CWP.
 - b. 150 PSI of saturated steam.
 - c. 29 IN vacuum.
2. Two-position lockable handle.
3. Stem with blowout-proof design.
4. Balancing stop for all applications.
5. Bodies with mounting pad for applications requiring actuators.

2.03 PLASTIC BALL VALVES: 1/2 IN TO 4 IN DIA

A. Acceptable Manufacturers:

1. Chemtrol/NIBCO.
2. Spears.
3. ASAHI/America.

B. Materials:

1. Body, stem, ball, handle, end connectors:
 - a. PVC ASTM D1784-12454B.
2. Ball Seat: Teflon.
3. O-rings: Viton.

C. Design Requirements:

1. Rated at 150 PSI at 75 DEGF.
2. Double or "true union" design.
3. Blocks both directions, upstream and downstream.
4. Union nut capable of compensating for seat wear.
5. Body with mounting pad for actuators where required.
 - Capable of being disconnected at downstream end under full line pressure.

2.04 AWWA C507 BALL VALVES: 1/2 IN TO 48 IN DIA PRATT & BLISS WILLAMETTE WOOD

A. Compliant with AWWA C507.

B. Acceptable Manufacturers:

1. Willamette.

2. Pratt.

C. Materials:

1. Body:

- a. Cast iron ASTM A128, Class B (P)
- Cast iron ASTM A48, Class 35 (W)

2. Ball:

- a. Cast iron ASTM A48, Class 40 (P)
- Cast iron ASTM A48, Class 35 (W)

3. Shaft:

- a. Stainless steel 18-8 Type 304 (P)
- Forged steel, chrome plated at seal tensile yield 82,000 PSI (W)

4. Bearings, sleeve type, non-metallic:

- a. Teflon lined (P)
- Sleeve type, bronze (W)

5. Ball seat: Stainless steel Type 304 (P and W)

□ Body seat:

- a. Buna-N (P)
- Monel (W)

D. Design Requirements:

1. Design pressure: 250 PSI.
2. Flanges: Class 250
3. Ball shall provide one direction seal or closure.
4. Provide pipe tap for body drain and air vent and legs or base for support.
5. Ball and body seats: Field adjustable and replaceable.

2.05 ACCESSORIES

A. Refer to Drawings and valve schedule for type of actuators.

1. Furnish actuator integral with valve.

B. Refer to Specification Section 15100 for actuator requirements.

2.0 SOURCE QUALITY CONTROL

- A. Shop test AWWA C507 ball valves in accordance with AWWA C507.
- B. Furnish record of test.
- C. Product Testing: MSS SP-110.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. See Specification Section 15100.

3.02 FIELD QUALITY CONTROL

- A. For AWWA C507 ball valves, employ and pay for services of equipment manufacturer's field service representative to:
 - 1. Inspect equipment covered in this Specification Section.
 - 2. Supervise adjustments and installation checks.
 - 3. Provide test equipment, tools, and instruments necessary to accomplish equipment testing.
 - 4. Conduct startup of equipment and perform operational checks.
 - 5. Provide Owner with a written statement that manufacturer's equipment has been installed properly, has been started up, and is ready for operation in Owner's personnel.

END OF SECTION

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SECTION 1510

CHECK VALVES

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Check valves.

B. Related Specification Sections include but are not necessarily limited to:

1. Division 00 - Procurement and Contracting Requirements.
2. Division 01 - General Requirements.
3. Section 15100 - Valves and Operators.

1.02 QUALITY ASSURANCE

A. Referenced Standards:

1. American Society of Mechanical Engineers (ASME)
 - a. B1.1, Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250.
2. American Water Works Association (AWWA)
 - a. C508, Standard for Swing-Check Valves for Waterworks Service, 2 IN through 24 IN NPS.
3. Manufacturers Standardization Society of the Valve and Fittings Industry Inc. (MSS)
 - a. SP-71, Cast Iron Swing Check Valves, Flanged and Threaded Ends.
 - b. SP-80, Bronze Gate, Globe, Angle and Check Valves.

1.03 DEFINITIONS

- A. PVDF: Polyvinylidene fluoride.

1.04 SUBMITTALS

A. Shop Drawings:

1. See Specification Section 01300 for requirements for the mechanics and administration of the submittal process.
2. See Specification Section 15100.

B. Contract Closeout Information:

1. Operation and Maintenance Data:

- a. See Specification Section 01430 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Subject to compliance with the Contract Documents, manufacturers listed under the valve with types are acceptable.
- B. Submit request for substitution in accordance with Specification Section 1300.

2.02 CHECK VALVES: 2.5 IN AND SMALLER

- A. Class 125 Bronze Swing Check Valves [Fuel Oil, Compressed Air, Water, Wastewater]

- 1. Comply with MSS SP-80.
- 2. Acceptable manufacturers:
 - a. Nicco T413-□.
 - Stockham B-319□.
- 3. Materials:
 - a. Body, bonnet, disc: Bronze.
- 4. Design requirements:
 - a. 125 PSI steam to 40□DEGF, 200 PSI WOG.
 - Horizontal swing, renewable disc.

- B. Class 150 Bronze Lift Check Valves [Fuel Oil, Compressed Air]

- 1. Comply with MSS SP-80.
- 2. Acceptable manufacturers:
 - a. Stockham B-322B.
 - Powell 158B.
- 3. Materials:
 - a. Body, cap, disc holder: Bronze.
 - Disc: Buna-N.
- 4. Design requirements:

a. 150 PSI to 150 DEGF, 300 PSI WOG.

Lift check, union cap.

C. Class 200 Bronze Swing Check Valves Steam 125 to 200 PSI

1. Compliant with MSS SP-80.

2. Acceptable manufacturers:

a. Nicco T473B.

Stockham B345.

3. Materials:

a. Body, bonnet, disc: Bronze.

4. Design requirements:

a. 200 PSI steam to 550 DEGF, 400 PSI WOG.

Horizontal swing, -pattern.

c. Renewable disc.

2.03 SWING CHECK VALVES: 3 IN TO 24 IN

A. Swing Check Valves Water, Wastewater, Sludge

1. Compliant with AWWA C508.

2. Acceptable manufacturers:

a. Clow.

American Darling.

c. Golden Anderson.

3. Materials:

a. Body and cover: Cast iron.

Seat ring, hinge: Bronze.

c. Disc:

1 3 to 4 IN: Bronze.

2 6 to 24 IN: Cast iron with bronze face.

3 6 to 24 IN: Cast iron with rubber face.

d. Hinge shaft: Stainless steel.

e. Bearings, connecting hardware: Bronze.

4. Design requirements:

- a. 175 PSI working pressure 3 to 12 IN
- b. 150 PSI working pressure 14 to 24 IN
- c. Furnish with outside weight and lever or lever and spring.

2.04 RUBBER FLAPPER SWING CHECK VALVES: 2 IN TO 24 IN

A. ASME B1.1, Class 125 175 PSI

B. Acceptable Manufacturer:

- 1. APCO Series 100.

C. Materials:

- 1. Body and cover: Cast iron.
- 2. Flapper: Buna-N, steel reinforced.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. See Specification Section 15100.
- B. Install in accordance with manufacturer's instructions.

END OF SECTION

SECTION 15114
MISCELLANEOUS VALVES

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Air release and vacuum relief valves.

B. Related Specification Sections include but are not necessarily limited to:

1. Division 00 - Procurement and Contracting Requirements.
2. Division 01 - General Requirements.
3. Section 11005 – Equipment - Basic Requirements.
4. Section 15100 – Valves and Operators.

1.02 QUALITY ASSURANCE

A. Referenced Standards:

1. American Society of Mechanical Engineers [ASME]
 - a. B1.1, Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250.
2. American Water Works Association [AWWA]
 - a. C512, Standard for Air-Release, Air-Vacuum, and Combination Air Valves for Waterworks Service.
 - b. C550, Standard for Protective Interior Coatings for Valves and Hydrants.
3. Canadian Standards Association [CSA]
4. National Electrical Manufacturers Association [NEMA]
 - a. 250, Enclosures for Electrical Equipment [1000 Volts Maximum]

1.03 SUBMITTALS

A. Shop Drawings:

1. See Specification Section 01300 for requirements for the mechanics and administration of the submittal process.
2. See Specification Section 15100.

B. Contract Closeout Information:

1. Operation and Maintenance Data:

- a. See Specification Section 01430 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Subject to compliance with the Contract Documents, the manufacturers listed in the applicable Articles below are acceptable.
- B. Submit request for substitution in accordance with Specification Section 01300.

2.02 AIR RELEASE AND VACUUM RELIEF VALVES

- A. General: Conform to AWWA C512.
- B. Stormwater:

1. Air Release and Vacuum Valve:

- a. Acceptable manufacturers:
 - 1 Vent-O-Mat RG Air Release and Vacuum Break Anti-shock air valve.
- b. Materials:
 - 1 Top and lower flange: 304 stainless steel.
 - 2 Barrel: 304 stainless steel.
 - 3 Floats: High density polyethylene.
 - 4 Float seats and seals: Nitrile or EPDM.
 - 5 Nozzle seat: Natural rubber.
 - 6 All wetted internal metal parts: 304 stainless steel.
 - 7 Flange studs: 304L stainless steel.

2. Design requirements:

- a. Size: **4 1/2 IN**.
- b. Working pressure: 90 PSI.
- c. Release 3,800 cfm at 145 PSIG.
- d. Air vacuum capacity 7,800 scfm at 5 PSI differential from atmospheric.
- e. Provide control for slow release of air through valve to prevent valve slamming shut from excessive air or water velocity through the valve.

- f. End connection:
 - 1. 2 IN and smaller: Threaded or flanged.
 - 2. 3 IN and larger: Flanged.
- g. Provide isolation valve, plug valve type as shown.

2.03 ACCESSORIES

- A. Furnish all accessories required to provide a complete operable valve.

2.04 FABRICATION

- A. Completely shop assemble unit including all interconnecting piping, speed control valves, control isolation valves and electrical components.
- B. Provide internal epoxy coating suitable for potable water for all iron body valves in accordance with AWWA C550.

2.05 SOURCE QUALITY CONTROL

- A. Shop hydrostatically test to piping system test pressure.

2.06 MAINTENANCE MATERIALS

- A. Provide one set of all special tools or wrenches required for operation or maintenance for each type valve.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. General: See Specification Section 11005 and Specification Section 15100.
- B. Air Release, Vacuum Relief, and Pressure Relief Valves:
 - 1. Pipe exhaust to a suitable disposal point.
 - 2. Where exhausted to a trapped floor drain, terminate exhaust line 1/2 IN minimum above floor.

3.02 FIELD QUALITY CONTROL

- A. Clean, inspect, and operate valve to ensure all parts are operable and valve seats properly.
- B. Check and adjust valves and accessories in accordance with manufacturer's instructions and place into operation.

END OF SECTION

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SECTION 1505

HVAC: EQUIPMENT

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Heating, ventilating, and cooling equipment.

B. Related Specification Sections include but are not necessarily limited to:

1. Division 01 - General Requirements.
2. Section 11005 - Equipment: Basic Requirements.
3. Section 15890 - HVAC: Ductwork.

1.02 QUALITY ASSURANCE

A. Referenced Standards:

1. Air Movement and Control Association (AMCA)
2. Air Conditioning and Refrigeration Institute (ARI)
3. American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE)
 - a. HVAC Applications Handbook, Chapter entitled "Sound and Vibration Control."
 - b. 20, Methods of Testing for Rating Remote Mechanical-Draft Air-Cooled Refrigerant Condensers.
 - c. 52.2, Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency at Particle Size.
4. Canadian Standards Association (CSA)
5. National Electrical Manufacturers Association (NEMA)
 - a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum)
6. National Fire Protection Association (NFPA)
 - a. 70, National Electrical Code (NEC)
7. National Roofing Contractors Association (NRCA)
8. Underwriters Laboratories, Inc. (UL)
 - a. 507, Standard for Electric Fans.

9. Building code:

- a. 5th Edition (2014) Florida Building Code and associated standards, including all amendments, referred to herein as Building Code.

B. Miscellaneous:

1. Gage thickness specified herein shall be manufacturer's standard gage for steel and Brown and Sharpe gage for non-ferrous metals.
2. Corrosion protection of equipment to be as specified herein.

1.03 SUBMITTALS

A. Shop Drawings:

1. See Specification Section 01300 for requirements for the mechanics and administration of the submittal process.
2. Fabrication and/or layout drawings.
3. Product technical data including:
 - a. Acknowledgement that products submitted meet requirements of standards referenced.
 - b. Manufacturer's installation instructions.
 - c. Wiring diagrams.
 - d. Control diagrams.
 - e. Manufacturer's catalog cuts and technical data.
 - f. Fan curves.
 - g. Sound data.
 - h. Vibration isolation.
 - i. Control description.
 - j. Performance data on all equipment.

B. Contract Closeout Information:

1. Operation and Maintenance Data:
 - a. See Specification Section 01430 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:

1. Cooling coils - direct expansion:
 - a. Bard
 - Enviro-tec
 - c. Friedrich.
2. Single packaged vertical air conditioner:
 - a. Bard
 - Enviro-tec
 - c. Friedrich

B. Submit request for substitution in accordance with Division 01.

2.02 GENERAL

A. All Manufactured Units:

1. Comply with Specification Section 11005.
2. Factory wired and assembled.
3. Use fasteners made of same material as unit.
4. Fabricate motor assemblies and unit housings with vibration isolation assemblies:
 - a. Type: As per Table 47, Chapter 48, ASHRAE HVAC Applications Handbook.

B. All manufactured units shall be constructed with corrosion-resistant materials or have corrosion-resistant coating.

1. Type:
 - a. Corrosion-resistant coating:
 - Phenolic-based coating:
 - 3 MIL minimum dry thickness, air-dried coating, for surfaces exposed to temperatures less than 150 DEGF.
 - 5 MIL baked-on coating for heat transfer surfaces and surfaces exposed to temperatures greater than 150 DEGF.
 - Factory applied.

5 Provide factor certification of application.

2.03 MANUFACTURED UNITS

A. Equipment Coils:

1. Cooling coils - direct expansion:

a. ARI certified.

Material:

1 Aluminum.

2 Copper with aluminum fins for use in administration units only

c. Fin spacing: Minimum 80 fins per foot.

d. Minimum standard operating limit: 250 PSI.

e. Size and capacity as scheduled.

B. Single Packaged Vertical Air Conditioner:

1. ANSI/ARI rated.

2. UL listed.

3. Materials:

a. Casing: Galvanized steel with baked Enameled finish to withstand 1,000 hour salt spray test per ASTM B117-03

Evaporator coils: See paragraph 5 in Article 2.3, Equipment Coils.

4. Fan: Direct Drive, centrifugal

5. Fan Motor: See Specification Section 11005.

Construct drain pans from corrosion resistant material with cross break and double sloping pitch to drain connection.

7. Weatherproof casing:

a. Screen for condenser coil.

Filter Access panel.

8. Compressor:

a. Digital Scroll compressor.

Phase rotation monitor.

c. Internal pressure protector.

- d. Internal spring mounts.
 - e. Built-in overload protection.
9. Condenser fans and motors:
- a. Horizontal discharge.
 - Direct drive.
 - c. Staticall^{ly} and dynamicall^{ly} balanced.
 - d. Motor:
 - 1st See Specification Section 11005.
 - 2nd Permanentl^{ubricated} bearings.
 - 3rd Built-in current and thermal overload protection.
 - 4th ECM varia^{ble} speed indoor and outdoor motor.
10. Built-in refrigerant filter dr^{yer}.
11. Built-in li^{quid} line and gas line service valves with gage ports.
12. Provide low am^{ient} run control.
- a. Unit to operate down to 0 DegF outside am^{ient}.
13. 24 V factor^{-wired} controls to include fusing and control power transformer.
14. Size and capacit^{as} scheduled on Drawings.
15. Filter: 2 in., MERV 8

PART 3 - EXECUTION

3.01 AD^{JUSTING}

- A. Install new filters on units which have ^{been} running prior to acceptance of Pro^{ject}.

END OF SECTION

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SECTION 15890
HVAC: DUCTWORK

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. HVAC ductwork and accessories.

B. Related Specification Sections include but are not necessarily limited to:

1. Division 01 - General Requirements.

1.02 QUALITY ASSURANCE

A. Referenced Standards:

1. American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE)
 - a. 52, Method of Testing Air Conditioning Devices Used in General Ventilation for Removing Particulate Matter.
2. National Fire Protection Association (NFPA)
3. Sheet Metal and Air Conditioning Contractors National Association (SMACNA)
 - a. Ducted Electric Heat Guide for Air Handling Systems.
 - b. HVAC Duct Construction Standards - Metal and Flexible.
4. Underwriters Laboratories, Inc. (UL)
 - a. 555, Standard for Safety Fire Damper and Ceiling Fire Damper.
 - b. 555S, Standard for Safety Leakage Rated Dampers for Use in Smoke Control Systems.
 - c. Building Materials Director.
5. Building code:
 - a. 5th Edition (2014) Florida Building Code and associated standards, including all amendments, referred to herein as Building Code.

B. Qualifications:

1. Fabricator: Firms regularly engaged in the manufacture of the specific product, of type, size required, whose products have been in use in similar service for not less than three (3) years.

2. Installers: Firm with at least five (5) years installation experience on products similar to that required for this Project.

1.03 DEFINITIONS

A. Installer or Applicator:

1. Installer or applicator is the person actually installing or applying the product in the field at the Project site.
2. Installer and applicator are synonymous.

1.04 SUBMITTALS

A. Shop Drawings:

1. See Specification Section 01300 for requirements for the mechanics and administration of the submittal process.
2. See Specification Section 11005.

B. Miscellaneous Submittal:

1. Documentation of qualifications for fabricators and installers.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:

1. Transverse joints fabricated aluminum:
 - a. Ductmate Industries, Inc.
2. Flexible duct connections:
 - a. Vent Fabric.
 - b. Duro Duct.
3. Grilles and registers:
 - a. Price.
 - b. Metal-air.
 - c. Titus.
4. Manual volume dampers:
 - a. Air Balance.
 - b. Ruskin.

- c. American Warming.
- 5. Duct sealers:
 - a. Durkee-Atwood
 - Unitec McGill
 - c. Benjamin Foster.
 - d. Design Polimerics.

B. Submit request for substitution in accordance with Division 01.

2.02 COMPONENTS

A. Duct and Fittings [Metallic]

- 1. Materials:
 - a. G90 galvanized steel:
 - 1 Comply with ASTM A53 and ASTM A90.
- 2. Fabrication [galvanized steel]
 - a. Minimum Sheet Metal Thickness:
 - 1 Per SMACNA for 2 IN WC pressure class.
 - Longitudinal Seams:
 - 1 Pittsburgh lock seam.
 - 2 Continuous [Welded].
 - c. Transverse Seams:
 - 1 SMACNA T-22 or T-24 companion flange.
 - 2 Factor fabricated flanged duct connection system:
 - a Ductmate 25/35.
 - Angles and Cleates: Galvanized.
 - c Snap cleats: Galvanized.
 - d Gaskets: Close cell neoprene.
 - e Bolts and screws: Stainless.
 - d. Sealing:
 - 1 Per SMACNA for Seal Class A.

B. Supports and Hangers:

1. Materials for galvanized duct
 - a. Support angles: Galvanized or stainless steel, minimum 1-1/2" x 1-1/2" x 1/4" angle.
 1. Hanger rods: Galvanized or Stainless steel.
 - c. Anchors: Stainless steel wedge type.
 2. Fabrication: Trapeze type units.
 3. Strap hangers are not allowed.
- C. Flexible Connections:
1. Materials: Hypalon, double coated close woven glass fabric.
 2. Fabrication: Withstand 4.5 IN water column, positive and negative pressure.
- D. Air Grille and Register Assembly
1. Materials:
 - a. Assembly: Extruded steel.
 1. Gaskets: Sponge rubber.
 2. Fabrication:
 - a. Supply registers: Two sets individually adjustable louvers.
 1. Exhaust and return registers: 45-degree deflection front blades.
 - c. Dampers: Key-operated opposed blade where indicated on drawings.
 - d. Screws, duct collars, and transitions as required.
 - e. Finish:
 1. Manufacturer's standard factory applied finish.
 2. Color: White.
- E. Duct sealer:
1. NFPA rating of "Non-Combustible".
 2. Flame spread rating: 25 or lower, in dry condition.
 3. Smoke developed rating: 50 or lower, in dry condition.
 4. Resistant to water and water vapors.
 5. Comply with UL 181.
 1. Pressure rupture rating: 16 IN WG, minimum.

2.03 MAINTENANCE MATERIALS

A. Extra Materials:

1. Furnish Owner with the following extra materials:
 - a. Twelve complete filter media changes for each filter unit.
 - Filter media used during construction is in addition to this requirement.

PART 3 - EXECUTION

3.01 INSTALLATION

A. See Specification Section 11005.

B. Metal Ductwork:

1. Install with longitudinal seams sealed for zero leakage.
 - a. For welded seams, submit sample for approval □□Engineer.
2. Install gaskets at each transverse joint and fasten sections together with □bolts.
 - a. Tighten for zero leakage.
3. Install supports and hangers with anchors in accordance with SMACNA HVAC Duct Construction Standards.
4. Install turning vanes in square elbows:
 - a. Unsupported vane length not to exceed 48 IN.
 - Position vanes at proper angle to meet specified pressure drop.
5. Install flexible connections at fans:
 - a. Locate as close as possible to fan.
 - Allow 1 IN of slack to prevent vibration transmission.
 - c. Install thrust restraints across connectors.

C. Air Grille and Register Assemblies:

1. Install where shown on Drawings of size and capacities scheduled on Drawings.
2. Install prime painted grilles and registers in areas where duct work is concealed.
 - a. Field paint to match adjacent surface finish.

END OF SECTION

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SECTION 15900

HVAC INSTRUMENTATION AND CONTROLS

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Complete system of electric temperature controls as described in the Specifications and shown on the Contract Drawings. Install system with competent mechanics regularly employed manufacturer of temperature controls. Equipment shall be full proportioning unless otherwise noted.
- B. All electric wiring in connection with temperature control system shall be construed to include furnishing of wire, conduit, and miscellaneous materials and labor as required for mounting and connecting electrical control devices except as specifically noted otherwise. Control Contractor shall retain responsibility for calibration and proper functioning of electric control devices furnished under this Section.
- C. Related Sections:
 - 1. Division 16 - Electrical.
- D. Shop Drawings:
 - 1. Submit complete catalog cut information, descriptive literature, Specifications, and identification of materials of construction edited to meet requirements.
 - 2. Bill of Material.

1.02 RELATED SECTIONS

- A. Related Specification Sections include but are not necessarily limited to:
 - 1. Division 00 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
 - 2. Division 01 - General Requirements.
 - 3. Section 1505 - HVAC - Equipment
 - 4. Section 15950 - Testing, Adjusting and Balancing.

1.03 SUBMITTALS

- A. Submit under provisions of Section 01300.
- B. Product Data: Include list which indicate:
 - 1. Temperature control, wiring and riser diagrams and sequence of operation for the control system.
- C. Submit manufacturer's installation instructions under provisions of Section 01300.

1.04 QUALITY ASSURANCE

- A. Temperature controls shall be guaranteed to be free of defects in material and workmanship under normal service for a period of twelve months from date of acceptance. If, within this period, any equipment proves defective, it shall be repaired and/or replaced at no additional cost to the Owner.
- B. All system components shall be supplied by one manufacturer.

PART 2 - PRODUCTS

2.01 ROOM THERMOSTAT/CONTROLLER

- A. Manufacturer provide digital thermostat/controller.

2.02 MISCELLANEOUS DEVICES

- A. Provide all necessary relays, electric switches, solenoid valves, switches, relays, transformers, etc., to make a complete and operable system.

2.03 SEQUENCE OF OPERATION

- A. Refer to manufacturer's recommendations, Control Drawings and descriptions herein before specified for equipment and sequence of operation required for proper operation of control system.

2.04 MANUFACTURER

- A. Control systems shall be equipment manufacturer.

PART 3 - EXECUTION

3.01 COMPLETION

- A. After completion of installation, automatic temperature control manufacturer shall regulate and adjust all thermostats, control valve actuators, damper actuators, and additional equipment provided under this Contract. Contractor shall place them in operating condition subject to the approval of the Engineer and shall supply any service incidental to proper performance of temperature control systems under guarantee outlined above.
- B. After completion of control system installation, control system manufacturer shall furnish four sets of operating and maintenance instructions, including complete control system "As-Built" Drawings.
- C. The Engineer shall fully instruct automatic control manufacturer in the operation and maintenance of the environmental control system prior to acceptance or beneficial occupancy of the project by the Owner.
- D. Automatic control system manufacturer shall furnish a service contract to cover system specified herein, for a period of one year after acceptance of the system by the Engineer.

END OF SECTION

SECTION 15950

TESTING, ADJUSTING, AND BALANCING

PART 1 - GENERAL

1.01 GENERAL

- A. The Contractor is required to cooperate and assist the Test and Balance Agency as described herein. The Contractor shall be responsible for delivering systems that produced the specified performance, and therefore, accept instruction from the Test and Balance Agency, as required to accomplish this end. The Contractor remains responsible for the performance of all systems for a period of one year beginning on the date after Final Acceptance of project by the Owner.
- B. Work Included:
1. Rotating balance of equipment as described herein.
 2. Air balance of A/C supply and return systems.
 3. Verification of operation of controls for all completed systems.

1.02 RELATED SECTIONS

- A. Related Specification Sections include but are not necessarily limited to:
1. Division 00 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
 2. Division 01 - General Requirements.
 3. Section 1505 - HVAC Equipment.
 4. Section 15890 - Ductwork.
 5. Section 15900 - HVAC Instrumentation and Controls.

1.03 REFERENCES

- A. AABC - National Standards for Field Measurement and Instrumentation, Total System Balance.
- B. ASHRAE - 1984 Systems Handbook: Chapter 37, Testing, Adjusting and Balancing.
- C. NEBB - Procedural Standards for Testing, Balancing and Adjusting of Environmental Systems.

1.04 QUALITY ASSURANCE

- A. Qualifications:
1. Engage services of an independent agency that regularly performs air and hydronic systems testing and balancing. Minimum qualifications for acceptance shall be

general membership standards of AABC, except that affiliation with manufacturers or engineering firms will not preclude their acceptance.

2. Testing organization shall be certified member of the AABC or shall submit adequate documentation to satisfy Engineer as to his competence. Three years minimum experience in testing and balancing work is required.
 3. Services of independent agency shall be borne by the Contractor and shall be included in the prices bid.
- B. Instrument Calibration: Calibrate all instruments required for air balance within a period of six months prior to using on this Project.
- C. Perform Test, adjust, balance when outside conditions approximate design conditions as shown for heating and cooling functions.
- D. Tests, at request of the Engineer shall be conducted in presence of the Engineer or his representative.
- E. All ductwork shall be pressure tested prior to test and balance procedures outlined in this Section.
- F. The testing and balance shall include the following basic systems and their associated and/or allied equipment:
1. Air distribution, Constant and/or Variable Volume Type.
 2. Ventilation and/or Exhaust.
 3. Filters Air.

1.05 SUBMITTALS

- A. Submit name of adjusting and balancing agency for approval within 40 days after award of Contract. Include certified individual qualifications of all personnel responsible for supervising and performing actual balancing, and name of Florida Registered Professional Engineer signing and sealing the report.
- B. Proposed test procedures along with sample report forms. Support forms shall be similar to format recommended by AABC.
- C. Balancing and performance test report. Test reports are due two weeks after completion of test and balance procedures. Five copies of the certified test results certified by a Professional Engineer Registered in the State of Florida shall be submitted to the Engineer for review. When reports are reviewed and accepted, copies will be a part of the operation and maintenance manuals.
 1. Report to include: Types, serial numbers, and dates of calibration of all instruments.

1.06 PROJECT RECORD DOCUMENTS

- A. Submit record documents under provisions of Section 01320 - Project Record Documents.

PART 2 - PRODUCTS

2.01 GENERAL

- A. Provide and direct installation of screwed, square head plugs in ductwork as required for insertion of test apparatus.
 - 1. Where plugs are provided in insulated ductwork, provide a removable plug of approved insulation material.
 - 2. Test and Balance Agency shall use the specific equipment required to perform the work specified herein. Apparatus used shall be the standard of the industry.

PART 3 - EXECUTION

3.01 GENERAL

- A. After completion of installation of air conditioning systems, and prior to acceptance, adjust and balance all air and water systems and appurtenances applicable to those systems to deliver air quantities as specified and as shown. Make final tests after all necessary system modifications are completed. Seal instrument test holes upon completion of balancing operation.
- B. Place all heating, ventilating, and air conditioning systems and equipment into full operation and continue operation of same during each working day of testing and balancing, at no additional cost to the Owner.
- C. Allot sufficient time in construction schedule for test and balance completion and assist Test and Balance Agency to coordinate its work with other trades.

3.02 CONTRACTOR'S RESPONSIBILITY

- A. Employ a test and balance agency acceptable to the Engineer and meeting all the requirements as specified herein.
- B. Furnish to test and balance agency one complete set of approved equipment submittal data and approved, up-to-date mechanical drawings or Shop Drawings.
 - 1. NOTE: Contractor is responsible for advising the test and balance agency of changes made during the construction process.
- C. Replace pulleys, belts, and dampers, as required for correct balance as requested by Test and Balance Agency, including rebalancing of rotating equipment as hereinafter specified.
- D. Provide scaffolding as required for Test and Balance Agency.
- E. Prepare air side for balancing as follows:
 - 1. Mechanically check fans, blowers, and air handling equipment and make available to operate under design conditions.
 - 2. Set splitters, volume dampers, , and vanes in their neutral positions.

3. Grilles, diffusers, etc., shall be installed, with vanes, blades in their neutral positions.
4. Mechanically check controls, whether they are electronic, electric, of pneumatic or a combination thereof, and make available to operate under design conditions. Calibrate and set all thermostats.
5. Dampers and locking devices marked in a conspicuous permanent manner to truly represent position of their respective dampers.
 - Filters installed and acceptable to test and balance agency with regard to design static drops for clean filters.
7. Contractor to change pulleys, belts and dampers, as required for correct balance as requested by air balance and testing agency.
8. Provide and install fixed diameter pulleys in place of adjustable pulleys at supply fans and at exhaust air fans after test and balance has been completed. Pulley size shall be as directed by the Test and Balance Agency. Install new belts as required and as directed by the Test and Balance Agency.

3.03 TEST AND BALANCE AGENCY RESPONSIBILITY

- A. Air Test and Balance: Balance and record data for each item of equipment simultaneously with data from all associated equipment, together with coincident outside air dry bulb and wet bulb temperatures and atmospheric conditions to permit evaluation of total system performance. Test and data shall include, but not be limited to the following:
 1. Make pitot tube traverse of main supply, exhaust and outside air ducts.
 2. Test, adjust and record air volumes and velocities for each fan.
 3. Test and record voltage and motor load amperes under working conditions. Current must not exceed full load amperes nameplate rating. Calculate indicated field measured brake horsepower. Record nameplate data.
 4. Test and record static pressures of all systems, suction and discharge.
 5. Test and adjust systems for design supply, return, outside and exhaust air, CFM.
 - During balancing and testing period all supply and exhaust fans shall have speeds adjusted and drives changed where necessary so that fan delivers design CFM at actual static pressure developed by installed system. Increasing static pressure by dampering at fan will not be permitted.
 7. Entering and leaving air dry bulb and wet bulb temperatures for air conditioning unit.
 8. Adjust all supply air ducts to proper design CFM.
 9. Test, and adjust each diffuser, grille, and register with 10 percent of design requirements. Volume adjusters may be used to balance air quantities at outlets and inlets providing final adjustments do not produce objectionable drafts or sound levels in excess of acceptable limits. Design positive and negative pressure in each area must be maintained.

10. Each grille, diffuser, and register shall be identified on test report as to location and area.
 11. Identify and list size, type, and manufacturer of diffusers, grilles, registers and all tested equipment. Manufacturer's ratings and coefficients for all equipment shall be used to make required calculations on reports. State coefficients used.
 12. Readings and tests of diffusers, grilles and registers shall include required FPM velocity and test resultant velocity, required CFM and test resultant CFM after adjustments.
 13. Automatically operated dampers shall operate as specified or indicated. Testing Agency shall check all controls for proper calibrations and provide a list of controls that require adjustment.
 14. Diffusers, grilles and registers shall be adjusted to minimize drafts in all areas.
 15. After systems have been adjusted and balanced, determine size of fixed diameter pulleys to replace the adjustable pulleys on those systems. Direct the Contractor to install the fixed diameter pulleys before proceeding with the vibration analyses of those systems.
- B. Test and Balance Agency shall be responsible for necessary labor involved with gaining to dampers, and other equipment or accessories.
- C. Final tests are required in both heating and cooling season as applicable.
- D. Balance Test of Rotating Equipment:
1. Test and Balance Agency shall perform static and dynamic balance test on rotating parts of air moving equipment after fixed diameter pulleys have been installed.
 2. Balance each fan to -0/±10 percent of design requirements. Airflow requirements reflect minimum air changes for code compliance and may not be less than scheduled value.
 3. Submit vibration analysis report of static and dynamic balance test. Report to include test equipment used, vibration amplitude and velocity charts, vibration severity chart, summary of readings and testing agency conclusions and recommendations.
 4. Tests are to be performed after air distribution systems are balanced, and to assure that rotating equipment is operating within satisfactory vibration levels. For each item of equipment, note fan RPM, motor horsepower and RPM, and fan discharge air volume CFM measure and record horizontal, vertical and axial displacements and velocities at all bearings.
 5. If the equipment is found to be performing beyond the fair region according to the general machinery vibration severity chart, the construction contractor is responsible to rebalance the equipment until the vibration is within the fair region. Test and balance agency shall retest the equipment and produce new graphs and charts as hereinbefore specified.

- E. Test and Balance agency shall be responsible for necessary labor involved with removal and installation of acoustical ceiling tiles as required permit them to gain access to dampers, and other equipment or accessories located in ceiling space.
- F. Submit test data format to Engineer for review prior to beginning of tests. Upon completion of testing and balancing submit five (5) copies of all test data to Engineer for review and acceptance. Test data submitted shall be signed and sealed by a Florida Registered Professional Engineer.
- G. Test and Balance agency shall submit a bid proposal indicating fees for balancing and vibration testing of rotating equipment separately from the fees required to test and balance the building systems as hereinbefore specified.

END OF SECTION

SECTION 10000

BASIC ELECTRICAL REQUIREMENTS

PART 1 - GENERAL

1.01 THE REQUIREMENT

- A. The Contractor shall furnish all labor, materials, tools, and equipment, and perform all work and services necessary for, or incidental, to the furnishing and installation of all electrical work as shown on the Drawings, and as specified in accordance with the provisions of the Contract Documents and completely coordinate with the work of other trades involved in the general construction. Although such work is not specifically shown or specified, all supplementary or miscellaneous items, appurtenances, and devices incidental to or necessary for a sound, secure, and complete installation shall be furnished and installed as part of this work. The Contractor shall obtain approved Shop Drawings showing wiring diagrams, connection diagrams, roughing-in and hook up details for all equipment and comply therewith. All electrical work shall be complete and left in operating condition in accordance with the intent of the Drawings and the Specifications for the electrical work.
- B. Reference Section 17000, Control and Information System Scope and General Requirements for scope of work details as they relate to the Division 17 Subcontractor.
- C. The electrical scope of work for this project primarily includes, but is not limited to, the following:
1. Furnish and install new automatic transfer switch and low voltage molded case circuit breaker distribution panelboard.
 2. Provide new 480/277V utility service.
 3. Furnish and install low voltage motor control equipment including reduced voltage motor starters.
 4. Furnish and install power panelboards, lighting panelboards, dry-type transformers, and other low voltage electrical power distribution equipment.
 5. Furnish and install all aboveground raceway systems including conduit, fittings, boxes, supports, and other pertinent components.
 6. Furnish and install all underground raceway systems including conduit, fittings, manholes, handholes and other pertinent components.
 7. Furnish and install all low voltage wire and cable resulting in a complete and operate electrical system.
 8. Furnish and install new lighting system and wiring devices.
 9. Other electrical work as specified herein and indicated on the Drawings.

- D. All material and equipment must be the product of an established, reputable, and approved manufacturer must be new and of first class construction must be designed and guaranteed to perform the service required and must bear the label of approval of the Underwriters Laboratories, Inc., where such approval is available for the product of the listed manufacturer as approved by the Engineer.
- E. When a specified or indicated item has been superseded or is no longer available, the manufacturer's latest equivalent type or model of material or equipment as approved by the Engineer shall be furnished and installed at no additional cost to the City.
- F. Where the Contractor's selection of equipment of specified manufacturers or additional approved manufacturers requires changes or additions to the system design, the Contractor shall be responsible in all respects for the modifications to all system designs, subject to approval of the Engineer. The Contractor's bid shall include all costs for all work of the Contract for all trades made necessary by such changes, additions or modifications or resulting from an approved substitution.
- G. Furnish and install all stands, racks, brackets, supports, and similar equipment required to properly serve the equipment which is furnished under this Contract, or equipment otherwise specified or indicated on the Drawings.

1.02 EQUIPMENT LOCATION

- A. The Drawings show the general locations of feeders, transformers, outlets, conduits, and circuit arrangements. Because of the small scale of the Drawings, it is not possible to indicate all the details involved. The Contractor shall carefully investigate the structural and finish conditions affecting all of his work and shall arrange such work accordingly by furnishing such fittings, junction boxes, and accessories as may be required to meet such conditions. The Contractor shall refer to the entire Drawing set to verify openings, special surfaces, and location of other equipment, or other special equipment prior to roughing-in for panels, switches, and other outlets. The Contractor shall verify all equipment dimensions to ensure that proposed equipment will fit properly in spaces indicated.
- B. Where outlets are shown near identified equipment furnished by this or other Contractors, it is the intent of the Specifications and Drawings that the outlet be located at the equipment to be served. The Contractor shall coordinate the location of these outlets to be near the final location of the equipment served whether placed correctly or incorrectly on the Drawings.

1.03 LOCAL CONDITIONS

- A. The Contractor shall examine the site and become familiar with conditions affecting the work. The Contractor shall investigate, determine, and verify locations of any overhead or buried utilities on or near the site, and shall determine such locations in conjunction with all public and/or private utility companies and with all authorities having jurisdiction. All costs, both temporary and permanent to connect all utilities, shall be included in the Bid. The Contractor shall be responsible for scheduling and coordinating with the local utility for temporary and permanent services.
- B. The Contractor is responsible for coordinating all electric utility equipment requirements and installations with the serving electric utility. The Contractor shall furnish and install

all equipment as required on the electric utility whether specifically shown on the Drawings or not. The Contractor shall furnish and install the following electrical utility equipment as a minimum:

1. Metering equipment cabinets and/or cases
 2. Conduit and wire required from metering cabinet to metering current transformers and potential transformers.
 3. Secondary service conductors.
 4. Service conductor terminations at service entrance equipment.
- C. The electric utility will furnish and install the following equipment:
1. Primary conduit, conductors and terminations.
 2. Service conductor terminations at utility transformer.
 3. The Contractor shall ensure all electric utility equipment and construction for which they are responsible is furnished and installed in accordance with the electric utility's design specifications and requirements. The Contractor is fully responsible for coordinating his scope of work with the electric utility. Any additional required electric utility construction or equipment not specified herein or shown on the Drawings shall be supplied by the Contractor at no additional cost to the City.
 4. The contact person at the serving electrical utility is:

Shannon Macquet
Associate Engineer
Florida Power and Light
Wingate Service Center – FPL
3020 NW 19th St.
Fort Lauderdale, FL 33311
954-717-2134
Shannon.Macquet@fpl.com
Utility Tracking #13158140

1.04 SUBMITTALS

- A. In accordance with the procedures and requirements set forth in the General Conditions, Section 01300 – Submittals, and the requirements of the individual specification sections, the Contractor shall obtain from the equipment manufacturer and submit the following:
1. Shop Drawings
 2. Operation and Maintenance Manuals
 3. Spare Parts List
 4. Proposed Testing Methods and Reports of Certified Shop Tests.

5. Reports of Certified Field Tests.

□ Manufacturer's Representative's Certification.

B. Submittals shall be sufficient and complete in detail to enable the Engineer to determine compliance with Contract requirements.

C. Submittals will be approved only to the extent of the information shown. Approval of an item of equipment shall not be construed to mean approval for components of that item for which the Contractor has provided no information.

1.05 APPLICABLE CODES AND REQUIREMENTS

A. Conformance

1. All work, equipment and materials furnished shall conform with the existing rules, requirements and specifications of the following:

a. Insurance Rating Organization having jurisdiction

□ The serving electrical utility company

c. The current adopted edition of the National Electrical Code (NEC)

d. The National Electric Manufacturers Association (NEMA)

e. The Institute of Electrical and Electronic Engineers (IEEE)

f. The Insulated Cable Engineers Association (ICEA)

g. The American Society of Testing Materials (ASTM)

h. The American National Standards Institute (ANSI)

i. The requirements of the Occupational Safety and Health Act (OSHA)

□ The National Electrical Contractors Association (NECA) Standard of Installation

k. National Fire Protection Association (NFPA)

l. All other applicable Federal, State and local laws and/or ordinances.

2. All material and equipment shall bear the inspection labels of Underwriters Laboratories, Inc., if the material and equipment is of the class inspected by said laboratories.

B. Nonconformance

1. Any paragraph of requirements in these Specifications, or Drawings, deviating from the rules, requirements and Specifications of the above organizations shall be invalid and their the above organizations requirements shall hold precedent thereto. The Contractor shall be held responsible for adherence to all rules, requirements and specifications as set forth above. Any additional work or material necessary for adherence will not be allowed as an extra, but shall be included in the Bid. Ignorance of any rule, requirement, or Specification shall not be allowed

as an excuse for nonconformity. Acceptance by the Engineer does not relieve the Contractor from the expense involved for the correction of any errors which may exist in the drawings submitted or in the satisfactory operation of any equipment.

C. Certification

1. Upon completion of the work, the Contractor shall obtain certificates of inspection and approval from the National Board of Fire Underwriters or similar inspection organization having jurisdiction and shall deliver same to the Engineer and the City.

1.0 PERMITS AND INSPECTIONS

- A. The Contractor shall reference the General Conditions and Section 01010, Summary of Work.

1.07 TEMPORARY LIGHTING AND POWER

- A. The Contractor shall reference the General Conditions and Section 01510, Utilities Services.

1.08 TESTS

- A. Upon completion of the installation, the Contractor shall perform tests for operation, load phase balance, overloads, and short circuits. Tests shall be made with and to the satisfaction of the City and Engineer.
- B. The Contractor shall perform all field tests and shall provide all labor, equipment, and incidentals required for testing and shall pay for electric power required for the tests. All defective material and workmanship disclosed shall be corrected by the Contractor at no cost to the City. The Contractor shall show demonstration in service that all circuits and devices are in good operating condition. Test shall be such that each item of control equipment will function not less than five (5) times.
- C. Refer to each individual specification section for detailed test requirements.
- D. The Contractor shall complete the installation and field testing of the electrical installation at least two (2) weeks prior to the start-up and testing of all other equipment. During the period between the completion of electrical installation and the start-up and testing of all other equipment, the Contractor shall make all components of the Work available as it is completed for their use in performing Preliminary and Final Field Tests.
- E. Before each test commences, the Contractor shall submit a detailed test procedure, and also provide test engineer resume, manpower and scheduling information for the approval of the Engineer. In addition, the Contractor shall furnish detailed test procedures for any of his equipment required as part of the field tests of other systems.

1.09 PROTECTIVE DEVICE SETTING AND TESTING

- A. All protective devices in the electrical equipment shall be set, adjusted, calibrated and tested in accordance with the manufacturers' recommendations, the coordination study, and best industry practice.

- B. Proper operation of all equipment associated with the device under test and its compartment shall be verified, as well as complete resistance, continuity and polarity tests of power, protective and metering circuits. Any minor adjustments, repairs and/or lubrication necessary to achieve proper operation shall be considered part of this Contract.
- C. All solid state trip devices shall be checked and tested for setting and operation using manufacturers recommended test devices and procedures.
- D. Circuit breakers and/or contactors associated with the above devices shall be tested for trip and close functions with their protective device.
- E. When completed, the Contractor shall provide a comprehensive report for all equipment tested indicating condition, readings, faults and/or deficiencies in same. Inoperative or defective equipment shall be brought immediately to the attention of the Engineer.
- F. Prior to placing any equipment in service, correct operation of all protective devices associated with this equipment shall be demonstrated by field testing under simulated load conditions.

1.10 POWER SYSTEM STUDIES

A. General

1. The Contractor shall provide short circuit studies, protective device evaluation studies, protective device coordination studies, and arc flash studies performed by a registered professional engineer in accordance with Section 1-055 – Power System Studies.

1.11 SCHEDULES AND FACILITY OPERATIONS

- A. All testing procedures and schedules must be submitted to the Engineer for review and approval one month prior to any work beginning. When testing has been scheduled, the Engineer must be notified 48 hours prior to any work.

1.12 MATERIALS HANDLING

- A. Materials arriving on the job site shall be stored in such a manner as to keep material free of rust and dirt and so as to keep material properly aligned and true to shape. Rust, dirt, or misaligned material will be rejected. Electrical conduit shall be stored to provide protection from the weather and accidental damage. Rigid non-metallic conduit shall be stored on even supports and in locations not subject to direct sun rays or excessive heat. Cables shall be sealed, stored, and handled carefully to avoid damage to the outer covering or insulation and damage from moisture and weather. Adequate protection shall be required at all times for electrical equipment and accessories until installed and accepted. Materials damaged during shipment, storage, installation, or testing shall be replaced or repaired in a manner meeting with the approval of the Engineer. If space heaters are provided in a piece of electrical equipment, they shall be connected to a power source during storage. The Contractor shall store equipment and materials in accordance with Section 01550 - Site Access and Storage.

1.13 WARRANTIES

- A. Unless otherwise specified in an individual specification section, all equipment and electrical construction materials furnished and installed under Division 1 shall be provided with a warranty in accordance with the requirements of Section 11000 - Equipment General Provisions, and the General Conditions.

PART 2 - PRODUCTS

2.01 PRODUCT REQUIREMENTS

- A. Unless otherwise indicated, the materials to be provided under this Specification shall be the products of manufacturers regularly engaged in the production of all such items and shall be the manufacturer's latest design. The products shall conform to the applicable standards of UL and NEMA, unless specified otherwise. International Electrotechnical Commission (IEC) standards are not recognized. Equipment designed, manufactured, and labeled in compliance with IEC standards is not acceptable.
- B. All items of the same type or ratings shall be identical. This shall be further understood to include products with the accessories indicated.
- C. All equipment and materials shall be new, unless indicated or specified otherwise.
- D. The Contractor shall submit proof if requested by the Engineer that the materials, appliances, equipment, or devices that are provided under this Contract meet the requirements of Underwriters Laboratories, Inc., in regard to fire and casualty hazards. The label of or listing by the Underwriters Laboratories, Inc., will be accepted as conforming to this requirement.

2.02 SUBSTITUTIONS

- A. Unless specifically noted otherwise, an reference in the Specifications or on the Drawings to an article, service, product, material, fixture, or item of equipment by name, make, or catalog number shall be interpreted as establishing the type, function, and standard of quality and shall not be construed as limiting competition. The Contractor, in such cases may, at his option use an article, device, product, material, fixture, or item of equipment which in the judgment of the Engineer, expressed in writing, is equal to that specified. There will be no pre-approvals. Engineer review shall take place during the shop drawing submittal process.

2.03 CONCRETE

- A. The Contractor shall furnish all concrete required for the installation of all electrical work. Concrete shall be Class A unless otherwise specified. Concrete and reinforcing steel shall meet the appropriate requirements of Division 3 of the Specifications.
- B. The Contractor shall provide concrete equipment pads for all free standing electrical apparatus and equipment located on new or existing floors or slabs. The Contractor shall provide all necessary anchor bolts, channel iron sills, and other materials as required. The exact location and dimensions shall be coordinated for each piece of

Equipment well in advance of the scheduled placing of these pads. Equipment pads shall be 4 inches high unless otherwise indicated on the Drawings and shall conform to standard detail for equipment pads shown on the Contract Drawings. Equipment pads shall extend 3" beyond the sides of the equipment.

- C. The Contractor shall provide concrete foundations for all free standing electrical apparatus and equipment located outdoors or where floors or slabs do not exist and/or are not or provided elsewhere under this Contract. The Contractor shall provide all necessary anchor bolts, channel iron sills, and other materials as required. The location and dimensions shall be coordinated for each piece of equipment well in advance of the scheduled placing of the foundations. Equipment foundations shall be constructed as detailed on the Drawings or if not detailed on the Drawings shall be 4 inches thick minimum reinforced with #4 bars at 12-inch centers each wall placed mid-depth. Concrete shall extend 4 inches minimum beyond the extreme of the equipment base and be placed on a compacted stone bed #57 stone or ABC 4 inches thick minimum.

2.04 RUBBER INSULATING MATTING

- A. Rubber insulating matting shall be furnished and installed on the floor and in front of each piece of electrical equipment that is located indoors and installed under this Contract. Rubber insulating matting shall not be installed outdoors. The mat shall be long enough to cover the full length of the equipment. The mat shall be 1/4 inch thick with beveled edges, canvas back, solid type with corrugations running the entire length of the mat. The matting shall meet OSHA requirements and the requirements of ASTM D-178 for Type 2, Class 2 insulating matting. Matting shall be 36 inches wide, minimum. However, matting width shall be no less than the NEC working clearance for the equipment with which it is associated.
- B. Matting shall be provided for the following equipment:
1. PLC Enclosures
 2. Switchgear Assemblies
 3. Reduced Voltage Starters
 4. Panels
 5. Automatic Transfer Switches
 6. Generator Output Circuit Breakers
 7. Generator Control Panels

PART 3 - EXECUTION

3.01 CUTTING AND PATCHING

- A. Coordination

1. The Work shall be coordinated between all trades to avoid delays and unnecessary cutting, channeling and drilling. Sleeves shall be placed in concrete for passage of conduit wherever possible.

B. Damage

1. The Contractor shall perform all chasing, channeling, drilling and patching necessary to the proper execution of his Contract. Any damage to the building, structure, or any equipment shall be repaired by qualified mechanics of the trades involved at the Contractor's expense. If, in the Engineer's judgment, the repair of damaged equipment is unsatisfactory, then the Contractor shall replace damaged equipment at his own expense.

3.02 EXCAVATION AND BACKFILLING

- A. The Contractor shall perform all excavation and backfill required for the installation of all electrical work. All excavation and backfilling shall be in complete accordance with the applicable requirements of Division 2.

3.03 CORROSION PROTECTION

- A. Wherever dissimilar metals, except conduit and conduit fittings, come into contact, the Contractor shall isolate these metals as required with neoprene washers, nine (9) mil polyethylene tape, or gaskets.

END OF SECTION

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SECTION 1055

POWER SYSTEM STUDIES

PART 1 - GENERAL

1.01 THE REQUIREMENT

- A. The Contractor shall provide Short Circuit Studies, Protective Device Coordination Studies, and Arc Flash Hazard Studies performed by a professional electrical engineer currently registered in the State of Florida.
- B. The scope of work for these studies shall include all proposed electrical equipment and distribution systems at the pump station. As-built documentation will be furnished to the City after the bid opening to facilitate completion of the studies.
- C. Prior to receiving final approval of the distribution equipment shop drawings for the equipment proposed under this Contract and/or prior to release of that equipment for manufacture, the Preliminary Study Report, as specified herein, shall be submitted and approved. Contractor shall expedite the completion of the Preliminary Study Report so that final approval of proposed equipment is not delayed.

1.02 REFERENCE CODES AND STANDARDS

- A. Institute of Electrical and Electronic Engineers (IEEE)
 - 1. Standard 141, Recommended Practice for Electrical Power Distribution for Industrial Plants
 - 2. Standard 241, Recommended Practice for Electrical Power Systems in Commercial Buildings
 - 3. Standard 242, Recommended Practice for Protection and Coordination of Industrial and Commercial Systems
 - 4. Standard 399, Recommended Practice for Industrial and Commercial Power System Analysis
 - 5. Standard 519-1992, Recommended Practices and Requirements for Harmonic Control in Electric Power Systems
 - Standard 1584-2002/2004a, IEEE Guide for Performing Arc-Flash Hazard Calculations
- B. American National Standards Institute (ANSI)
 - 1. Standard C37.90, IEEE Standard for Relays and Relay Systems Associated with Electric Power Apparatus
 - 2. Standard C37.91, Guide for Protective Relay Applications to Power Transformers
 - 3. Standard C37.95, Guide for Protective Relaying of Utility-Consumer Interconnections.

4. Standard C37.9, Guide for AC Motor Protection
 5. Standard C57.12.59, Guide for Dry-Type Transformer Through-Fault Current Duration
 6. Standard C.57.13, Standard Requirements for Instrumentation Transformers
 7. Standard C57.109, Guide for Liquid-Immersed Transformer Through Fault-Current Duration
- C. National Electrical Code (NEC)
- D. National Fire Protection Agency (NFPA)
1. NFPA 70E, Standard for Electrical Safety in the Workplace

1.03 SUBMITTALS

- A. The Contractor shall submit for review and approval, four (4) paper copies of the Preliminary Power System Studies Report, four (4) paper copies of the Pre-final Power System Studies Report, and six (6) paper copies of the Final Power System Studies Report. One (1) electronic copy of each report shall be also submitted. The electronic version of each report shall be in the PDF file format. Each section of the report shall be placed in a separate PDF file to allow fast and easy navigation between sections. Additional details regarding the report requirements are specified elsewhere herein.
- B. All Reports shall bear the signature and seal of the professional electrical engineer that performed the study.
- C. The Contractor shall also submit one (1) electronic copy of the system model and all required database files generated by the software analysis package used. Files shall be submitted with the Preliminary, Pre-final, and Final Power System Studies Reports.

1.04 QUALIFICATIONS

- A. The Power System Studies shall be performed by a professional electrical engineer registered in the State of Florida. The registered professional electrical engineer shall have a minimum of five (5) years of experience in performing power systems studies.
- B. The resume of the registered professional electrical engineer shall be submitted for approval prior to the start of work. An experience table shall also be provided detailing the power systems studies of similar scope to this Contract that have been performed by the proposed engineer over the last two (2) years. The table shall, at a minimum, list the facility owner's name, facility contact person with phone number and email address, and overall scope of work that was provided.

PART 2 - PRODUCTS

2.01 POWER SYSTEM STUDIES

A. General

1. The Contractor shall provide Short Circuit Studies, Protective Device Coordination Studies, and Arc Flash Hazard Studies for the entire electrical system. The studies

shall be performed in accordance with IEEE 399, Recommended Practice for Industrial and Commercial System Power Analysis (IEEE Brown Book).

2. The studies shall include all portions of the electrical distribution system from the serving electric utility company protective devices, the normal and standby power sources down to and including the 208 volt equipment. The studies shall include all low voltage switchgear, Reduced Voltage Solid State Starters (RVSSs) and panelboards as shown on the Drawings. System connections and those which result in maximum fault conditions shall be adequately covered in the study.
3. The studies shall be performed with the aid of SKM Systems Analysis Power Tools for Windows (PTW) software, Version 15 or newer. No other software analysis packages are acceptable.

B. Data Collection for the Studies

1. The Contractor shall collect all required utility transformer and service information for use in these studies. The serving electric utility representative contact information can be found in Section 1000, Basic Electrical Requirements.
2. One field visit to the project site to collect pertinent data from equipment and the personnel performing the studies is permitted. The visit shall span as many days as required to collect all necessary information. This visit shall occur as soon after the Contract is awarded as possible and shall be coordinated with the City. The Contractor and personnel performing these studies are responsible for collecting all required data for these studies.

C. Short Circuit Studies

1. The short circuit study shall be performed in accordance with the latest editions of IEEE Std. 399 and IEEE Std. 141.
2. The study input data shall include the serving electric utility company's short circuit contribution, resistance and reactance components of the branch impedances, the X/R ratios, base quantities selected, and other source impedances.
3. Short circuit close and latch duty values and interrupting duty values shall be calculated on the basis of assumed three-phase bolted short circuits at each bus, low voltage switchgear, low voltage motor control center, distribution panelboard, pertinent branch circuit panel and other significant locations through the system. The short circuit calculations shall include symmetrical fault currents, and X/R ratios. For each fault location, the total duty on the bus, as well as the individual contribution from each connected branch, shall be listed with its respective X/R ratio.
4. The short circuit study report shall include recommendations for equipment selection based on calculated short circuit values and all input and output data from the software model.

D. Protective Device Coordination Studies

1. A protective device coordination study shall be performed to provide the necessary calculations and logic decisions required to select or to check the selection of

power fuse ratings, protective relay characteristics and settings, ratios and characteristics of associated current transformers, and low voltage circuit breaker trip characteristics and settings.

2. The coordination study shall include all low voltage classes of equipment from the serving electric utility company service protective devices down to and including all additional circuit protective devices. The phase and ground overcurrent protection shall be included as well as settings of all other additional protective devices.
3. The time-current characteristics of the proposed protective devices shall be printed on a log-log scale. The plots shall include complete titles, representative one-line diagram and legends, significant motor starting characteristics, complete parameters of transformers, complete operating bands of low voltage circuit breaker trip curves and fuses. The coordination plots shall indicate the types of protective devices selected, proposed relay taps, time dial and instantaneous trip settings, transformer magnetizing inrush and ANSI transformer withstand parameters, cable thermal overcurrent withstand limits and significant symmetrical and asymmetrical fault currents. All restrictions of the National Electrical Code shall be adhered to and proper coordination intervals and separation of characteristic curves shall be maintained. The coordination plots for phase and ground protective devices shall be provided on a system basis. A sufficient number of separate curves shall be used to clearly indicate the coordination achieved.
4. The selection and settings of the protective devices shall be provided separately in a tabulated form listing circuit identification, IEEE device number, current transformer ratios and connections, manufacturer and type, range of adjustment and recommended settings.

E. Arc Flash Hazard Studies

1. An Arc Flash Hazard Study shall be performed in accordance with IEEE Std. 1584, NFPA 70E, and OSHA 29-CFR, Part 1910 Subpart S.
2. The Arc Flash Hazard Study Report shall include but not be limited to the following:
 - a. An executive summary outlining the electrical distribution system
 - b. A brief overview of what arc flash hazards are and how to avoid them.
 - c. Serving electric utility information received. Copies of the information received shall be included in an appendix
 - d. All assumptions made to complete the report
 - e. Definitions of key terms used in the report
 - f. Any recommendations to reduce the arc flash incident energies where they are found to exceed a hazard risk category of 2.
 - g. A PPE table that defines the Personnel Protective Equipment (PPE) classes and clothing descriptions identified in the report and labels.
 - h. Arc flash hazard warning labels as specified herein.

- i. An NFPA 70E energized work permit for each location where a warning label is provided.
 - Arc flash evaluation summary sheets as specified herein
 - k. Separate set of single line diagrams that show incident energies, hazard risk categories, and protective device settings. Only pertinent arc flash hazard data shall be displayed on these single line diagrams. Data from all other study calculations shall not be shown.
3. The following parameters shall be used in the Arc Flash Hazard Study
- a. Working distance for all equipment: 18"
 - Maximum arc duration for all equipment: 2 seconds
 - c. Incident energies, arc flash hazard boundaries, and hazard risk categories shall be calculated over a 1/2 - 15% of calculated arcing fault current. The worst case incident energies that result shall be used in the study report.
 - d. The equipment that connects to both the electric utility service and the stand-off power is in an open-transition configuration. The power sources will be incapable of paralleling with each other.
 - e. The arc flash analysis shall be performed as if the facility is being supplied by either of the electric utilities **and** as if the facility is being supplied by the stand-off generators. The worst case values from each calculation shall be used in the study report.
4. Arc Flash Warning Labels shall be produced for each location that allows access to energized parts. Labels shall be printed in color on adhesive backed labels. Labels shall be an ANSI Z535.4 compliant minimum size 4 in. x 6 in. thermal transfer type label. For incident energy values of less than 40 cal/cm², the labels shall have an orange colored header with the word "WARNING". For incident energy values equal to and above 40 cal/cm², the labels shall have a red colored header with the word "DANGER". Each label shall include the following information:
- a. Bus name
 - System operating voltage
 - c. Date of issue
 - d. Flash hazard protection boundary
 - e. Limited approach boundary
 - f. Restricted boundary
 - g. Prohibited boundary
 - h. Incident energy level

- i. Required personal protective equipment class [Hazard risk category]
5. Arc Flash Evaluation Summary Sheets shall be produced. All values shown on the Summary Sheets shall be commensurate with the values shown on the single line diagrams. Summary sheets shall list the following:
- a. Bus name
 - b. Upstream protective device name and protective device settings
 - c. Bus line-to-line voltage
 - d. Bus bolted fault
 - e. Protective device bolted fault current
 - f. Arcing fault current
 - g. Protective device trip / delay time
 - h. Breaker opening time
 - i. Solidly grounded column
 - j. Equipment type
 - k. Gap
 - l. Arc flash boundary
 - m. Working distance
 - n. Incident energy
 - o. Required personal protective equipment class [hazard risk category]

2.02 STUDY REPORTS

- A. The results of the Power Systems Studies shall be summarized in a series of reports. A total of three (3) separate reports shall be provided as follows:
- 1. Preliminary Report – The Preliminary Report shall consist of all power systems studies as specified herein, with the following exceptions:
 - a. NFPA 70E energized work permits shall not be included
 - b. Arc flash hazard warning labels shall be printed on plain paper for **format review purposes only**. Actual labels with calculated values shall not be included.
 - 2. Pre-final Report – The Pre-final Report shall incorporate all comments received from the previous report review and shall include specific equipment data from the approved shop drawings of the proposed electrical equipment. The Pre-final

Report shall consist of all power systems studies as specified herein, with the following exceptions:

- a. NFPA 70E energized work permits shall not be included
 - Sample arc flash hazard warning labels shall be printed on plain paper for **calculated value review purposes**. Actual adhesive labels shall not be included.
3. Final Report – The Final Report shall consist of all power systems studies as specified herein, including final adhesive arc flash hazard warning labels. Final report shall incorporate all installed electrical equipment, including any field changes made during construction, and all comments received from the previous report review. All 'as-left' protective device settings shall be included in the report.
- B. Reports shall be furnished in the quantities specified herein, neatly organized into properly identified 3" (minimum) 3-ring binders. Tabs shall clearly separate each section of the report. Each report shall begin with a table of contents. The following sections shall be included in the report as a minimum:
1. Executive Summary
 2. Short Circuit Study
 3. Protective Device Coordination Study
 4. Arc Flash Study
- C. All data used in the reports such as conductor sizes and lengths, motor sizes, utility contribution information, and the like shall be included in the appendices of the report.
- D. All single line diagrams and time current curves shall be provided in the reports on 11x17 paper, properly folded to fit into the report binder. Use of standard 8.5x11 paper for these purposes is not permitted. Single line diagrams shall be appropriately split up between several sheets if required to allow the drawing scale to be adjusted in order to make text and symbols legible.

PART 3 - EXECUTION

3.01 FIELD ADJUSTMENT

- A. Contractor shall adjust all relay and protective device settings according to the recommended settings table provided in the **approved** Pre-Final Report.
- B. Contractor shall make minor modifications to equipment as required to accomplish conformance with short circuit and protective device coordination studies.

3.02 ARC FLASH LABELS

- A. Contractor shall place approved adhesive arc flash labels on equipment after the Final Report is reviewed and approved.

3.03 TRAINING

- A. The Contractor shall train the City's qualified electrical personnel of the potential arc flash hazards associated with working on energized equipment [minimum of 4 hours]

END OF SECTION

SECTION 1000
GROUNDING AND BONDING

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Material and installation requirements for grounding and bonding systems.

B. Related Specification Sections include but are not necessarily limited to:

1. Section 10195 – Electrical - Identification.
2. Section 10000 - Basic Electrical Requirements.
3. Section 10123 – Low Voltage Wire and Cable.
4. Section 10111 – Conduit.
5. Section 10130 - Boxes.
- Section 10080 - Acceptance Testing.

1.02 QUALITY ASSURANCE

A. Referenced Standards:

1. ASTM International [ASTM]
 - a. B8, Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft.
2. Institute of Electrical and Electronics Engineers, Inc. [IEEE]
 - a. 837, Standard for Qualifying Permanent Connections Used in Substation Grounding.
3. National Fire Protection Association [NFPA]
 - a. 70, National Electrical Code [NEC]
4. Underwriters Laboratories, Inc. [UL]
 - a. 47, Grounding and Bonding Equipment.

B. Assure ground continuity is continuous throughout the entire Project.

1.03 SUBMITTALS

A. Shop Drawings:

1. Product technical data.
 - a. Provide submittal data for all products specified in PART 2 of this Specification Section except:
 - 1 Grounding clamps, terminals and connectors.
 - 2 Electrothermic welding system.
 - See Specification Section 1000 for additional requirements.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:

1. Ground rods and bars and grounding clamps, connectors and terminals:
 - a. ERICO or Pentair.
 - Harger Lightning or Grounding.
 - Hearns Bros. Lightning Protection Co. Inc.
 - Burndick or Hull.
 - Roosins Lightning, Inc.
 - Blackburn or Thomas or Betts.
 - Thompson Lightning Protection, Inc.
2. Electrothermic weld connections:
 - a. ERICO or Pentair - Cadweld.
 - Harger Lightning or Grounding - Ultraweld.
 - Burndick or Hull - Thermoweld.
 - FurseWELD or Thomas or Betts.

2.02 COMPONENTS

- A. Wire and Cable:
1. Bare conductors: Soft drawn stranded copper meeting ASTM B8.
 2. Insulated conductors: Color coded green, per Specification Section 10123.
- B. Conduit: As specified in Specification Section 10111.
- C. Ground Bars:

1. Solid copper:
 - a. 1/4 IN thick.
 - b. 2 or 4 IN wide.
 - c. 24 IN long minimum in main service entrance electrical rooms, 12 IN long elsewhere.
2. Predrilled grounding lug mounting holes.
3. Stainless steel or galvanized steel mounting brackets.
4. Insulated standoffs.

D. Ground Rods:

1. 3/4 IN x 10 FT.
2. Copper-clad:
 - a. 10 MIL minimum uniform coating of electrolytic copper molecularly bonded to a rigid steel core.
 - b. Corrosion resistant bond between the copper and steel.
 - c. Hard drawn for a scar-resistant surface.

E. Grounding Clamps, Connectors and Terminals:

1. Mechanical type:
 - a. Standards: UL 47.
 - b. High copper alloy content.
2. Compression type for interior locations:
 - a. Standards: UL 47.
 - b. High copper alloy content.
 - c. Non-reversible.
 - d. Terminals for connection to bus bars shall have two bolt holes.
3. Compression type suitable for direct burial in earth or concrete:
 - a. Standards: UL 47, IEEE 837.
 - b. High copper alloy content.
 - c. Non-reversible.
 - d. Factor-filled with oxide inhibiting compound.

F. Eothermic Weld Connections:

1. Copper oxide reduction aluminum process.
2. Molds properly sized for each application.

PART 3 - EXECUTION

3.01 INSTALLATION

A. General:

1. Install products in accordance with manufacturer's instructions.
2. Size grounding conductors and bonding jumpers in accordance with NFPA 70, Article 250, except where larger sizes are indicated on the Drawings.
3. Remove paint, rust, or other non-conducting material from contact surfaces before making ground connections. After connection, apply manufacturer's approved touch-up paint to protect metallic surface from corrosion.
4. Where ground conductors pass through floor slabs or building walls provide nonmetallic sleeves and install sleeve per Specification Section 01800.
 - a. Seal the sleeve interior to stop water penetration.
5. Do not splice grounding electrode conductors except at ground rods.
 - Install ground rods and grounding electrode conductors in undisturbed, firm soil.
 - a. Provide excavation required for installation of ground rods and conductors.
 - Use driving studs or other suitable means to prevent damage to threaded ends of sectional rods.
 - c. Unless otherwise specified, connect conductors to ground rods with compression type connectors or eothermic weld.
 - d. Provide sufficient slack in conductor to prevent conductor breakage during backfill or due to ground movement.
 - e. Backfill excavation completely, thorough tamping to provide good contact between backfill materials and ground rods and conductors.
7. Do not use eothermic welding if it will damage the structure the grounding conductor is being welded to.

B. Grounding Electrode System:

1. Provide a grounding electrode system in accordance with NFPA 70, Article 250 and as indicated on the Drawings.
 - a. All grounding electrode conductors terminate on a main ground bar located adjacent to the service entrance equipment.

2. Grounding electrode conductor terminations:

- a. Ground bars mounted on wall: Use a two-hole compression type conductor terminal and bolt it to the ground bar with two bolts.
- b. Ground bars in electrical equipment: Use compression type conductor terminal and bolt it to the ground bar or manufacturer's provided mechanical type termination device.
- c. Piping systems: Use mechanical type connections.
- d. Building steel, below grade and encased in concrete: Use compression type connector or electrothermic weld.
- e. Building steel, above grade: Use a two-hole compression type conductor terminal and bolt to the steel with two bolts or electrothermic weld.
- f. Ground rod: Compression type or electrothermic weld, unless otherwise specified.
- g. At all above grade terminations, the conductors shall be labeled per Specification Section 10195.

3. Ground ring grounding system:

- a. Ground ring consists of ground rods and a conductor looped around the structure.
- b. Placed at a minimum of 10 FT from the structure foundation and 2 FT-1 IN below grade.
- c. Provide a minimum of four ground rods placed at the corners of the structure and additional rods so that the maximum distance between ground rods does not exceed 50 FT.
- d. Building/Structure grounding:
 1. Bond building/structure metal support columns to the ground ring at all corners of the structure.
- e. Grounding conductor: Bare conductor, size as indicated on the Drawings.
- f. Ground rod test stations:
 1. Provided where indicated on the Drawings.
 2. Grounding conductors connected to ground rod with removable ground clamps.

C. Supplemental Grounding Electrode:

1. Provide the following grounding in addition to the equipment ground conductor supplied with the feeder conductors whether or not shown on the Drawings.
 - a. See Grounding Electrode System paragraph for conductor termination requirements.

2. Metal light poles:

- a. Connect metal pole and pole base reinforcing steel to a ground rod.
- Grounding conductor: Bare □□ AWG minimum.

3. Equipment support rack and pedestals mounted outdoors:

- a. Connect metallic structure to a ground rod.
- Grounding conductor: □□ AWG minimum.

4. Engine generator:

- a. Connect generator frame to the ground ring at two locations (opposite corners of frame)
- Grounding conductor: Bare conductor, size as indicated on the Drawings.

D. Other Bonding Requirements:

1. Lightning protection system:

- a. Connect to ground ring.
- See Specification Section 13101.

E. Transformer Separately-Derived Grounding System:

- 1. Install the System Bonding Jumper at the transformer. At the first disconnect, ensure the neutral is isolated from ground.
- 2. Structures with a single electrical room/area:
 - a. Connect grounding electrode conductor to the Grounding Electrode System main ground bar.
- 3. See Grounding Electrode System paragraph for conductor termination requirements.

F. Raceway Bonding/Grounding:

- 1. Install all metallic raceway so that it is electrically continuous.
- 2. Provide an equipment grounding conductor in all raceways with insulation identical to the phase conductors, unless otherwise indicated on the Drawings.
- 3. NFPA 70 required grounding bushings shall be of the insulating type.
- 4. Provide double locknuts at all panels.
- 5. Bond all conduits, at entrance and exit of equipment, to the equipment ground bus or lug.
- Provide bonding jumpers if conduits are installed in concentric knockouts.

7. Make all metallic raceway fittings and grounding clamps tight to ensure equipment grounding system will operate continuously at ground potential to provide low impedance current path for proper operation of overcurrent devices during possible ground fault conditions.

G. Equipment Grounding:

1. Ground all utilization equipment with an equipment grounding conductor.

H. Manhole and Handhole Grounding:

1. Provide a ground rod and ground bar, when indicated or as needed, in each manhole and handhole with exposed metal parts.
 - a. Expose a minimum of 4 IN of the rod above the floor for field connections to the rod.
2. Connect all exposed metal parts (e.g., conduits and cable racks) to the ground rod.

3.02 FIELD QUALITY CONTROL

- A. Leave grounding system uncovered until observed by Owner.
- B. Acceptance testing:
 1. See Specification Section 1-080.

END OF SECTION

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SECTION 1080
ACCEPTANCE TESTING

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Basic requirements for acceptance testing.

B. Related Specification Sections include but are not necessarily limited to:

1. Section 11005 - Equipment - Basic Requirements.
2. Section 1020 – Packaged Engine Generator Systems.

1.02 QUALITY ASSURANCE

A. Referenced Standards:

1. International Electrical Testing Association (NETA)
 - a. ATS, Standard for Acceptance Testing Specifications for Electric Power Equipment and Systems.
2. National Recognized Testing Laboratory (NRTL)
3. Telecommunications Industry Association/Electronic Industries Alliance/American National Standards Institute (TIA/EIA/ANSI)
 - a. 455-78-B, Optical Fibers - PART 1-40: Measurement Methods and Test Procedures - Attenuation.

B. Qualifications:

1. Testing firm qualifications: See Specification Section 11005.
2. Field personnel:
 - a. See Specification Section 11005.
 - b. As an alternative, supervising technician may be certified by the equipment manufacturer.
3. Analysis personnel:
 - a. See Specification Section 11005.
 - b. As an alternative, supervising technician may be certified by the equipment manufacturer.

C. Phasing Diagram:

1. Coordinate with Utility Company for phase rotations and Phase A, B and C markings.
 - a. Create a phasing diagram showing the coordinated phase rotations with generators and motors through the transformers.

1.03 SUBMITTALS

A. Shop Drawings:

1. See Specification Section 11005 for electrical equipment and connection testing plan submittal requirements.

B. Informational Submittals:

1. Prior to energizing equipment:
 - a. Coordinated phasing diagram.
 - b. Photocopies of continuity tests.
2. Within two weeks after successful completion of Demonstration Period (Commissioning Period)
 - a. Single report containing information including:
 1. Summary of Project.
 2. Information from pre-energization testing.
 3. See testing and monitoring reporting requirements in Specification Section 11005.

PART 2 - PRODUCTS

2.01 FACTOR QUALITY CONTROL

- A. Provide Electrical equipment with all factor tests required in the applicable industry standards or NRTL.
- B. Factor testing will not be accepted in lieu of field acceptance testing requirements specified in this Specification Section and Specification Section 11005.

PART 3 - EXECUTION

3.01 FIELD QUALITY CONTROL

- A. General:
 1. See Specification Section 11005.
 2. Complete electrical testing in three phases:
 - a. Pre-energization testing phase.

D. Buswork and Busduct:

1. Perform inspections and tests per NETA ATS 7.4.
2. Components: Test all components per applicable paragraphs of this Specification Section and NETA ATS.

E. Low Voltage Molded Case Circuit Breakers:

1. Perform inspections and tests per NETA ATS 7.1.1.
2. Components:
 - a. Test all components per applicable paragraphs of this Specification Section and NETA ATS.
 - b. Thermal magnetic breakers: Visual and mechanical inspection per NETA ATS only.
 - c. Solid state trip type: Visual and mechanical inspection and electrical tests per NETA ATS.
3. Record as-left settings.

F. Instrument Transformers:

1. Perform inspections and tests per NETA ATS 7.10.
2. Components: Test all components per applicable paragraphs of this Specification Section and NETA ATS.
3. Perform the following optional tests per NETA ATS:
 - a. Dielectric withstand test on potential transformers.

G. Metering:

1. Perform inspections and tests per NETA ATS 7.11.
2. Components: Test all components per applicable paragraphs of this Specification Section and NETA ATS.

H. Grounding:

1. Perform inspections and tests per NETA ATS 7.13.
2. Components: Test all components per applicable paragraphs of this Specification Section and NETA ATS.

I. Ground Fault Protection:

1. Perform inspections and tests per NETA ATS 7.14.
2. Components: Test all components per applicable paragraphs of this Specification Section and NETA ATS.

3. Perform the following optional tests per NETA ATS:
 - a. Control wiring insulation resistance.
4. Perform the following additional tests for four-wire systems:
 - a. Primary current injection into switchgear bus with test set configured to simulate transformer source and high current amper used to simulate unbalanced load and ground fault conditions.
 - Verify no tripping for unbalanced load on each feeder and each main breaker.
 - c. Verify no tripping for unbalanced load across tie breaker for dual-source schemes.
 - d. Verify tripping for ground fault on load side of feeder each feeder and on each main bus.
 - e. Verify tripping for ground fault on a single feeder and on each main bus through tie breaker for multiple-source schemes.
 - Motors:
 1. Perform inspections and tests per NETA ATS 7.15.
 2. See Specification Section 11005.
 - K. Motor Controllers:
 1. Perform inspections and tests per NETA ATS 7.1.
 2. Components: Test all components per applicable paragraphs of this Specification Section and NETA ATS.
 - L. Generators:
 1. Perform inspections and tests per NETA ATS 7.15.2.
 2. Components: Test all components per applicable paragraphs of this Specification Section and NETA ATS.
 3. Perform the following additional tests:
 - a. Load and cycle crank test per Specification Section 11020.
 - M. Control System Functional Test:
 1. Perform test upon completion of equipment acceptance tests.
 2. The test is to prove the correct interaction of all sensing, processing and action devices.
 3. Develop a test plan and parameters for the purpose of evaluating the performance of the system.
 4. Perform the following tests:

- a. Verify the correct operation of all interlock safety devices for fail-safe functions in addition to design function.
- Verify the correct operation of all sensing devices, alarms and indicating devices.

END OF SECTION

SECTION 10111

CONDUIT

PART 1 - GENERAL

1.01 THE REQUIREMENT

- A. The Contractor shall furnish and install conduits and conduit fittings to complete the installation of all electrically operated equipment as specified herein, indicated on the Drawings, and as required.
- B. Requirements for conduit clamps, support systems, and anchoring are not included in this Section. Reference Section 10190, Supporting Devices, for these requirements.
- C. Reference Section 10000, Basic Electrical Requirements.

1.02 CODES AND STANDARDS

- A. Conduits and conduit fittings shall be designed, manufactured, and/or listed to the following standards as applicable:
 - 1. American National Standards Institute (ANSI)
 - a. ANSI B1.20.1 – Pipe Threads, General Purpose
 - b. ANSI C80.1 – Electrical Rigid Steel Conduit
 - c. ANSI FB 1 – Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable
 - 2. Underwriters Laboratories (UL)
 - a. UL 1 – Standard for Flexible Metal Conduit
 - b. UL 6 – Electrical Rigid Metal Conduit-Steel
 - c. UL 6A – Electrical Rigid Metal Conduit-Aluminum, Red Brass, and Stainless Steel
 - d. UL 300 – Standard for Liquid-tight Flexible Metal Conduit
 - e. UL 47 – Grounding and Bonding Equipment
 - f. UL 514B – Conduit, Tubing, and Cable Fittings
 - g. UL 651 – Standard for Schedule 40 and 80 Conduit and Fittings
 - h. UL 1203 - Standard for Explosion-proof and Dust-ignition-proof Electrical Equipment for use in Hazardous (Classified) Locations
 - i. UL 1479 – Standard for Fire Tests of Penetration Fire Stops
 - j. UL 1000 – Liquid-tight Flexible Nonmetallic Conduit

3. National Electrical Manufacturer's Association (NEMA)
 - a. NEMA RN 1 – PVC Eternall[®] Coated Galvanized Rigid Steel Conduit
 - b. NEMA TC-2 – Electrical PVC Conduit
 - c. NEMA TC-3 – PVC Fittings for Use with Rigid PVC Conduit and Tubing
4. Others
 - a. ACI-318 – Building Code Requirements for Structural Concrete

1.03 SUBMITTALS

- A. In accordance with the procedures and requirements set forth in the General Conditions and Section 01300 – Submittals, the Contractor shall obtain from the equipment manufacturer and submit the following:
 1. Shop Drawings
- B. Each submittal shall be identified in the applicable specification section.

1.04 SHOP DRAWINGS

- A. Each submittal shall be complete in all respects, incorporating all information and data listed herein and all additional information required for evaluation of the proposed equipment's compliance with the Contract Documents.
- B. Partial, incomplete, or illegible submittals will be returned to the Contractor without review for resubmittal.
- C. Shop drawings shall include but not be limited to:
 1. Product data sheets for conduits and fittings.
 2. Conduit identification methods and materials.
 3. Evidence of training for all personnel that will install PVC coated rigid metal conduit.

1.05 DEFINITIONS

- A. Conduits are categorized in the circuit type of the wiring to be installed inside. Conduits are defined as follows:
 1. Power Conduits – Conduits that carry AC or DC power wiring from a source to a load. Conduits that carry lighting and receptacle wiring.
 2. Control Conduits – Conduits that carry AC or DC discrete control wiring between devices and/or equipment. Conduits that carry fiber optic cables between devices and/or equipment.
 3. Instrumentation Conduits – Conduits that carry AC or DC analog signal wiring between devices and/or equipment.

PART 2 - PRODUCTS

2.01 GENERAL

- A. Conduit and conduit fitting products are specified in the text that follows this article. Reference Part 3 herein for the application, uses and installation requirements of these conduits and conduit fittings.
- B. All metallic conduit fittings shall be UL 514B and UL 47 Listed and constructed in accordance with ANSI FB 1. All metallic conduit fittings for use in Class I Division I hazardous areas shall be UL 1203 Listed. All non-metallic fittings shall be UL 51 Listed and constructed in accordance with NEMA TC-3.
- C. Flexible conduit couplings for use in Class I Division I hazardous areas shall have threaded stainless steel end fittings and a flexible braided core. Flexible braid shall be constructed of stainless steel where available in the conduit trade size required for the application. Where stainless steel braid is not available, the braid shall be provided with a PVC coating. No other braid types or materials are acceptable.
- D. Where threading is specified herein for conduit fitting connections, the fittings shall be manufactured to accept conduit that is threaded to ANSI B1.20.1 requirements.
- E. Conduit expansion fittings for all conduit materials of construction shall be capable of 4 inches of movement along the axis of the conduit for trade sizes 2 inches or less. Expansion fittings shall be capable of 8 inches of movement along the axis of the conduit for trade sizes greater than 2 inches.
- F. Conduit deflection fittings for all conduit materials of construction shall be provided with a flexible neoprene outer jacket that permits up to 1/2 inch of expansion/contraction along the axis of the conduit as well as up to 1/2 inch of parallel misalignment between the conduit axes. Outer jacket shall be secured to the conduit hubs with stainless steel clamps.
- G. Conduit seals shall either be listed and labeled for 40% fill, or conduit reducing fittings and a trade size larger conduit seal shall be provided to achieve 25% or less fill within the seal. Percentage fill calculation shall be based on the conductors to be installed. Conduit seals shall be provided with breathers and/or drains where required by the NEC.
- H. Conduit insulating bushings shall be constructed of plastic and shall have internal threading.
- I. Additional conduit and conduit fitting requirements are specified in the articles that follow based on the specific conduit material of construction to be used.

2.02 RIGID GALVANIZED STEEL RIGID CONDUIT AND ASSOCIATED FITTINGS

A. Conduit

- 1. Conduit shall be hot dip galvanized on the inside and outside, and made of heavy wall high strength ductile steel. Conduit shall be manufactured in accordance with ANSI C80.1 and shall be UL 1 Listed.

2. Conduit shall be provided with factory-cut $\frac{3}{4}$ " per foot tapered threads at each end in accordance with ANSI B1.20.1. Threads shall be cut prior to galvanizing to ensure corrosion protection adequately protects the threads. Conduit shall be provided with a matching coupling on one end and a color-coded thread protector on the other.

B. Conduit Bodies for use with Rigid Galvanized Steel

1. Conduit bodies shall be constructed of an electro-galvanized malleable iron alloy which is coated with an acrylic paint finish. Conduit bodies shall have integral threaded conduit hubs.
2. Conduit bodies for Class I Division I hazardous areas shall be provided with integral threaded covers constructed of an electro-galvanized malleable iron alloy which is coated with an acrylic paint finish.
3. Conduit bodies for all other areas shall be provided with covers that are affixed in place with stainless steel screws which thread directly into the conduit body. Covers that utilize wedge nuts or any other method of attachment to the conduit body are not acceptable. Covers shall be constructed of an electro-galvanized malleable iron alloy which is coated with an acrylic paint finish. Covers shall be provided with matching gasket.

C. Conduit Couplings, Nipples, and Unions for use with Rigid Galvanized Steel

1. Couplings and nipples shall be threaded and shall be constructed of hot dipped galvanized steel. Split-type couplings that use compression to connect conduits are not acceptable.
2. Unions shall be threaded, rain-tight, and constructed of an electro-galvanized malleable iron alloy which is coated with an acrylic paint finish.

D. Conduit Expansion and Deflection Fittings for use with Rigid Galvanized Steel

1. Conduit expansion fittings and conduit deflection fittings shall be constructed of an electro-galvanized malleable iron alloy which is coated with an acrylic paint finish. Expansion and deflection fittings shall have threaded conduit connections.
2. Expansion fittings shall have an integral bonding jumper and deflection fittings shall have an external bonding jumper.

E. Conduit Seals for use with Rigid Galvanized Steel

1. Conduit seals shall be constructed of an electro-galvanized malleable iron alloy which is coated with an acrylic paint finish. Conduit seals shall have threaded conduit connections.

F. Conduit Termination Fittings for use with Rigid Galvanized Steel

1. Conduit hubs shall be constructed of stainless steel and shall have threaded connections to the conduit and enclosure. Hubs shall have a plastic insulated throat and shall be watertight when assembled to an enclosure.

2. Conduit locknuts shall be constructed of zinc plated steel. Locknuts shall have internal threading. Locknuts with integral gasket or seal are not acceptable. Locknuts shall have integral bonding screw where required for proper bonding.
3. Conduit bonding bushings shall be constructed of zinc plated malleable iron. Bonding bushings shall have a threaded conduit connection. Bonding bushing shall be provided with proper sized set screw for connecting bonding conductor and an integral plastic insulator rated for 150 degrees C located in the throat.

2.03 RIGID NONMETALLIC CONDUIT AND ASSOCIATED FITTINGS

A. Conduit

1. Conduit shall be Schedule 40 or 80 (dependent on application) polyvinyl chloride (PVC) construction, manufactured in accordance with NEMA TC-2, UL 51 Listed, and suitable for conductors with 90 degree C insulation.

B. Conduit Bodies for use with Rigid Nonmetallic Conduit

1. Conduit bodies shall be constructed of PVC. Conduit hubs shall be integral to the conduit body and shall be smooth inside to accept a glued conduit connection.
2. Conduit body shall be provided with cover that is affixed in place with stainless steel screws which thread directly into the conduit body. Covers that utilize wedge nuts or another method of attachment to the conduit body are not acceptable. Covers shall be provided with matching gasket.

C. Conduit Couplings and Unions for use with Rigid Nonmetallic Conduit

1. Conduit couplings and unions shall be constructed of PVC and shall be smooth inside to accept a glued conduit connection.

D. Conduit Expansion and Deflection Fittings for use with Rigid Nonmetallic Conduit

1. Conduit expansion fittings and conduit deflection fittings shall be constructed of PVC and shall be smooth inside to accept a glued conduit connection.

E. Conduit Termination Fittings for use with Rigid Nonmetallic Conduit

1. Conduit hubs shall be constructed of PVC and shall be smooth inside to accept a glued conduit connection. Hubs shall have external threads and an accompanying PVC locknut, and shall be watertight when assembled to an enclosure.
2. Conduit locknuts shall be constructed of zinc plated steel. Locknuts shall have internal threading. Locknuts constructed of PVC and locknuts with integral gasket or seal are not acceptable.
3. Conduit end bells shall be constructed of PVC and shall be smooth inside to accept a glued conduit connection. End bell shall have a smooth inner surface that curves outward towards the edge of the fitting.

2.04 PVC COATED RIGID GALVANIZED STEEL CONDUIT AND ASSOCIATED FITTINGS

A. General

1. Where an external coating of polyvinyl chloride (PVC) is specified for conduit and fittings, the coating shall be 40 mil minimum thickness. Where an internal coating of urethane is specified for conduit and fittings, the coating shall be 2 mil minimum thickness.
2. All conduit fittings shall have a sealing sleeve constructed of PVC which covers all connections to conduit. Sleeves shall be appropriately sized so that no conduit threads will be exposed after assembly.

B. Conduit

1. Conduit shall be hot dip galvanized on the inside and outside, and made of heavy wall high strength ductile steel. Conduit shall be manufactured in accordance with ANSI C80.1, and shall be UL Listed.
2. Conduit shall be provided with factory-cut 3/4" per foot tapered threads at each end in accordance with ANSI B1.20.1. Threads shall be cut prior to galvanizing to ensure corrosion protection adequately protects the threads. Conduit shall be provided with a matching coupling on one end and a color-coded thread protector on the other.
3. Conduit shall be coated on the exterior with a PVC jacket and coated on the interior with a layer of urethane. Conduit shall be manufactured in accordance with NEMA RN-1.

C. Conduit Bodies for use with PVC Coated Rigid Galvanized Steel Conduit

1. Conduit bodies shall be constructed of an electro-galvanized malleable iron alloy which is coated on the exterior with a PVC jacket and coated on the interior with a layer of urethane. Conduit bodies shall have integral threaded conduit hubs.
2. Conduit bodies for Class I Division I hazardous areas shall be provided with integrally threaded covers constructed of an electro-galvanized malleable iron alloy which is coated on the exterior with a PVC jacket and coated on the interior with a layer of urethane.
3. Conduit bodies for all other areas shall be constructed of an electro-galvanized malleable iron alloy which is coated on the exterior with a PVC jacket and coated on the interior with a layer of urethane. Covers shall be affixed in place with stainless steel screws which thread directly into the conduit body and have a plastic encapsulated head. Covers that utilize wedge nuts or another method of attachment to the conduit body are not acceptable. Covers shall be provided with matching gasket.

D. Conduit Couplings, Nipples, and Unions for use with PVC Coated Rigid Galvanized Steel Conduit

1. Couplings and nipples shall be threaded and shall be constructed of hot dipped galvanized steel which is coated on the exterior with a PVC jacket and coated on the interior with a layer of urethane. Split-type couplings that use compression to connect conduits are not acceptable.

2. Unions shall be threaded, rain-tight, and constructed of an electro-galvanized malleable iron alloy which is coated on the exterior with a PVC jacket and coated on the interior with a layer of urethane.
- E. Conduit Expansion and Deflection Fittings for use with PVC Coated Rigid Galvanized Steel Conduit
1. Conduit expansion fittings and conduit deflection fittings shall be constructed of an electro-galvanized malleable iron alloy which is coated on the exterior with a PVC jacket and coated on the interior with a layer of urethane. Expansion and deflection fittings shall have threaded conduit connections.
 2. Expansion fittings shall have an integral bonding jumper and deflection fittings shall have an external bonding jumper.
- F. Conduit Seals for use with PVC Coated Rigid Galvanized Steel Conduit
1. Conduit seals shall be constructed of an electro-galvanized malleable iron alloy which is coated on the exterior with a PVC jacket and coated on the interior with a layer of urethane. Conduit seals shall have threaded conduit connections.
- G. Conduit Termination Fittings for use with PVC Coated Rigid Galvanized Steel Conduit
1. Conduit hubs shall be constructed of an electro-galvanized malleable iron alloy which is coated on the exterior with a PVC jacket and coated on the interior with a layer of urethane. Hubs shall have threaded connections to the conduit and enclosure. Hubs shall have a plastic insulated throat and shall be watertight when assembled to an enclosure.
 2. Conduit bonding bushings shall be constructed of zinc plated malleable iron which is coated on the exterior with a PVC jacket and coated on the interior with a layer of urethane. Bonding bushings shall have a threaded conduit connection. Bonding bushing shall be provided with proper sized set screw for connecting bonding conductor and an integral plastic insulator rated for 150 degrees C located in the throat.

2.05 LIQUID TIGHT FLEXIBLE METAL CONDUIT (LFMC) AND ASSOCIATED FITTINGS

- A. Conduit
1. Conduit shall be manufactured using a single strip of hot dip galvanized high strength steel alloy, helically formed into a continuous interlocked flexible metal conduit. Trade size 1-1/4" and smaller conduits shall be provided with an integrally woven copper bonding strip.
 2. Conduit shall be covered with an outside PVC jacket that is UV resistant, moisture-proof, and oil-proof. Conduit shall be UL 300 Listed.
- B. Conduit Termination Fittings for use with LFMC
1. Conduit termination fittings shall be constructed of either 304 stainless steel or an electro-galvanized malleable iron alloy which is coated on the exterior with a 40 mil minimum PVC jacket and coated on the interior with a 2 mil minimum layer of

urethane. PVC coated fittings shall have a sealing sleeve constructed of PVC which covers the connection to conduit.

2. Termination fittings shall have a threaded end with matching locknut and sealing ring for termination to equipment, and shall have an integral external bonding lug where required for proper bonding. Termination fittings shall have a plastic insulated throat and shall be watertight when assembled to the conduit and equipment.

C. LIQUID TIGHT FLEXIBLE NONMETALLIC CONDUIT (LFNC) AND ASSOCIATED FITTINGS

D. Conduit

1. Conduit shall be constructed of rigid polyvinyl chloride (PVC) fabricated to provide flexibility. Conduit shall be covered with an outside PVC jacket that is UV resistant, moisture-proof, and oil-proof. Conduit shall be UL 1000 Listed.

E. Conduit Termination Fittings for use with LFNC

1. Conduit termination fittings shall be constructed PVC and shall have a threaded end with matching locknut and sealing ring for termination to equipment. Termination fittings shall be watertight when assembled to the conduit and equipment.

2.0 FLEXIBLE METAL CONDUIT (FMC) AND ASSOCIATED FITTINGS

A. Conduit

1. Conduit shall be manufactured using a single strip of hot dip galvanized high strength steel alloy, helically formed into a continuous interlocked flexible metal conduit. Conduit shall be UL 1 Listed.

B. Conduit Termination Fittings for use with FMC

1. Conduit termination fittings shall be constructed of an electro-galvanized malleable iron alloy. Fittings shall have a threaded end with matching locknut for termination to equipment, and a compression-stitch connection to the associated conduit.

2.07 ELECTRICAL METALLIC TUBING (EMT) AND ASSOCIATED FITTINGS

A. Conduit

1. Conduit shall be hot dipped galvanized on the inside and outside, and made of cold-rolled steel tubing. Conduit shall be manufactured in accordance with C80.3 and shall be UL 797 listed.

B. Conduit Bodies for use with EMT

1. Conduit bodies shall be constructed of an electro-galvanized malleable iron alloy which is coated with an acrylic paint finish. Conduit bodies shall have integral threaded conduit hubs.

2. Conduit bodies shall be provided with galvanized sheet steel covers that are affixed in place with stainless steel screws which thread directly into the conduit body. Covers that utilize wedge nuts or any other method of attachment to the conduit body are not acceptable. Covers shall be provided with matching gasket.

C. Conduit Couplings and Nipples for use with EMT

1. Couplings and nipples shall have threaded compression connectors with associated gland and shall be constructed of electro-galvanized steel. Fittings utilizing a set screw or indenter tool to secure the associated conduit to the fitting are not acceptable. Couplings and nipples shall be rain-tight and have a plastic insulated throat.

D. Conduit Expansion and Deflection Fittings for use with EMT

1. Conduit expansion fittings and conduit deflection fittings shall be constructed of an electro-galvanized malleable iron alloy which is coated with an acrylic paint finish. Expansion and deflection fittings shall have threaded conduit connections.
2. Expansion fittings shall have an integral bonding jumper and deflection fittings shall have an internal bonding jumper.

E. Conduit Termination Fittings for use with EMT

1. Conduit termination fittings shall be constructed of electro-galvanized steel and have a plastic insulated throat. Termination fittings shall have a threaded compression connector with associated gland on one end and external threads on the other end. Termination fittings utilizing a set screw or indenter tool to secure the associated conduit to the fitting are not acceptable.
2. Conduit locknuts shall be constructed of zinc plated steel. Locknuts shall have internal threading. Locknuts shall have integral bonding screw where required for proper bonding.

2.08 CONDUIT BENDS

- A. Rigid conduit bends, both factory fabricated and field fabricated, shall meet the same requirements listed in the articles above for the respective conduit type and material of construction.

- B. Conduit bend radii for standard radius bends shall be no less than as follows:

TRADE SIZE	3/4"	1"	1 1/4"	1 1/2"	2"	2 1/2"	3"	3 1/2"	4"	5"	6"
MIN. RADIUS	4 1/2"	5 3/4"	7 1/4"	8 1/4"	9 1/2"	10 1/2"	13"	15"	18"	24"	30"

Conduit bend radii for long radius bends shall be no less than as follows: TRADE SIZE	3/4"	1"	1 1/4"	1 1/2"	2"	2 1/2"	3"	3 1/2"	4"	5"	6"
MIN. RADIUS	N/A	12"	18"	24"	30"	30"	36"	36"	48"	48"	60"

2.09 MISCELLANEOUS

A. Conduit Peripheral Sealing

1. The sealing of the exterior surface of conduits to prevent water and/or air from passing around the conduit peripheral from one space to another where required shall be through the use of one of the following:
 - a. A conduit sleeve and pressure pushing sealing system. Acceptable products are FSK OZ-GEDNE, Link-Seal Crouse-Hinds, or Engineer approved equal.
 - b. A conduit sleeve that is two trade sizes larger than the conduit being sealed, with 2-hour fire rated UL 1479 Listed caulk filling the entire void between the conduit and sleeve. This method is only suitable for penetrations in non-fire rated walls and floors between spaces within buildings. This method shall not be used for the sealing of conduits leaving a building and/or structure.
2. Conduit penetrations through fire-rated walls and floors shall be made with an approved UL 1479 Listed product specifically intended for the trade size of the conduit.

B. Primer and Cement

1. Nonmetallic conduit shall be cleaned with primer and connected to fittings with the manufacturer's recommended cement that is labeled Low VOC.

C. Galvanizing Compounds

1. Galvanizing compounds for field application shall be the cold-applied type, containing no less than 93% pure zinc.

D. Conduit Interior Sealing

1. The sealing of the inside of conduits against water ingress shall be achieved through the use of one of the following:
 - a. Two-part expanding polyurethane foam sealing compound, dispensed from a single tube which mixes the two parts as it is injected into the conduit. Expanding foam shall be compatible with the conduit material of construction as well as the outer jacket of the cables in the conduit. Acceptable products are Pak 2000 ChemQue, FST American Polywater Corporation, or Hydro-seal S-00 Duraline.
 - b. Inflatable bag that provides seal around cables and around inside diameter of conduit. Provide appropriate quantity of additional fittings for applications with three or more cables in the conduit to be sealed. Acceptable products are Raflate RaChem, or Engineer approved equal. This sealing method is only applicable to conduits trade size 2" and larger.
 - c. Neoprene sealing ring provided with the required quantity and diameter of holes to accommodate the cables in each conduit. Sealing ring shall be compressed between two stainless steel pressure plates. Acceptable products are type CSB

OZ-GEDNE, or Engineer approved equal. This sealing method is only applicable to metallic conduits containing 4 or less cables.

2. The use of aerosol-based expanding foam sealants or another method of sealing against water ingress not listed above is not acceptable.

E. Pull Rope

1. Pull ropes for empty and/or spare conduits shall be woven polyester, 1/2" wide, with a minimum tensile strength of 1250 lbs.
2. Pull ropes for the Contractor's use in installing conductors shall be the size and strength required for the pull and shall be made of a non-metallic material.

PART 3 - EXECUTION

3.01 GENERAL

- A. Minimum trade size for all rigid conduits shall be 1 inch in exposed applications and 1 1/2 inch in embedded applications. Conduits installed within ductbanks shall be allowed to be increased in size to trade size 2 inch, at the Contractor's option, to accommodate the saddle size of the ductbank spacers. However, no combining of circuits shall be allowed in the larger conduits.
- B. Minimum trade size for flexible conduits where specifically allowed herein shall be 1 1/2 inch in all applications.
- C. Conduit routing and/or homeruns within structures is not shown on the Drawings. Conduits shall be installed concealed wherever practical and within the limitations specified herein. All other conduits not capable of being installed concealed shall be installed exposed.
- D. Empty and/or spare conduits shall be provided with pull ropes which have no less than 12 inches of slack at each end.
- E. Nonmetallic conduits for installations requiring less than a factor of length of conduit shall be field cut to the required length. The cut shall be made square, cleaned of debris, and primer shall be applied to each end for fusing. Conduits shall then be fused together with the conduit manufacturer's approved cement compound.
- F. Metallic conduits for installations requiring less than a factor of length of conduit shall be field cut to the required length. The cut shall be made square, be cleaned of all debris and be de-burred, then threaded. Conduit threading performed in the field shall be 1/8 inch per foot tapered threads in accordance with ANSI B1.20.1.
- G. Conduits shall be protected from moisture, corrosion, and physical damage during construction. Install dust-tight and water-tight conduit fittings on the ends of all conduits immediately after installation and do not remove until conductors are installed.
- H. Conduits shall be installed to provide no less than 12 inches clearance from pipes that have the potential to impart heat upon the conduit. Such pipes include, but are not limited to, hot water pipes, steam pipes, exhaust pipes, and lower air pipes.

Clearance shall be maintained whether conduit is installed in parallel or in crossing of pipes.

- I. Where non-metallic instrumentation conduits are installed exposed, the following clearances to other conduit types shall be maintained:
 - 1. Instrumentation conduits installed parallel to conduits with conductors energized at 480V or above shall be 18 inches.
 - 2. Instrumentation conduits installed parallel to conduits with conductors energized at 240V and below shall be 12 inches.
 - 3. Instrumentation conduits installed at right angles to conductors energized at 480V and below shall be 6 inches.
 - 4. Instrumentation conduits installed at right angles to conductors energized at voltages above 480V shall be 12 inches.
- J. Where conduit fittings do not include an integral insulated bushing, an insulated bushing shall be installed at all conduit termination points.
- K. Conduits which serve multi-section equipment shall be terminated in the section where wiring terminations will be made.
- L. Conduits shall not penetrate the floors or walls inside liquid containment areas without specific written authorization from the Engineer. Liquid containment areas are indicated on the Drawings.
- M. In no case shall conduit be supported or fastened to another pipe or installed to prevent the removal of other pipe for repairs.
- N. All field fabricated threads for rigid galvanized steel conduit shall be thoroughly coated with two coats of galvanizing compound, allowing at least two minutes to elapse between coats for proper drying.
- O. The appropriate specialized tools shall be used for the installation of PVC coated conduit and conduit fittings. No damage to the PVC coating shall occur during installation. Conduit and conduit fittings with damaged PVC coating shall be replaced at the Contractor's cost. The use of PVC coating touch-up compounds is not permitted.
- P. Conduits which emerge from within or below concrete encasement shall be PVC coated rigid galvanized steel where the conduit is not protected by an equipment enclosure that surrounds the conduit on all sides at the point where it emerges from the encasement.

3.02 CONCEALED AND EMBEDDED CONDUITS

- A. Conduits are permitted to be installed concealed and/or embedded with the following requirements:
 - 1. Conduits shall not be installed horizontally when concealed within CMU walls, only vertical installation is acceptable.

2. Conduits installed embedded within concrete floors or walls shall be located so as not to affect the designed structural strength of the floor or wall.
3. Where conduit ends emerge from concrete embedment, none of the curved portion of the end shall be visible. Only the straight portion of the end shall be visible.
4. Where multiple conduits emerge from concrete embedment or from concealment below a concrete floor, ample clear space shall be provided between conduits to allow for the appropriate and required conduit termination fittings to be installed.
5. Conduits installed embedded within concrete encasement of any kind shall be installed such that conduit couplings for parallel conduits are staggered so that they are not side by side.

B. Conduits are NOT permitted to be installed concealed and/or embedded for the following situations:

1. Conduits shall not be installed embedded within any water-bearing floors or walls. Conduits shall not be installed embedded within any liquid containment area floors or walls.
2. Conduits shall not be installed concealed within CMU walls that are adjacent to Class I and II hazardous areas (Division I and Division II).

3.03 CONDUIT USES AND APPLICATIONS

A. Rigid Conduit

1. Rigid conduit for non-hazardous areas shall be furnished and installed in the materials of construction as follows:

RIGID CONDUIT FOR NON-HAZARDOUS AREAS		
Installation Area Designation/ Scenario	Conduit Category Wiring/Circuit Type	
	Power and Control	Instrumentation
Exposed in indoor wet process areas	PVC coated rigid galvanized steel conduit	Same as Power and Control
Exposed in indoor dry process areas	Rigid galvanized steel conduit	Same as Power and Control
Exposed in indoor dry non-process areas	Rigid galvanized steel conduit	Same as Power and Control
Exposed in outdoor areas	PVC coated rigid galvanized steel conduit	Same as Power and Control
Concealed within underground direct-buried	Schedule 80 rigid non-metallic PVC conduit	PVC coated rigid galvanized steel conduit
Concealed within underground concrete encased ductbanks	Schedule 40 rigid non-metallic PVC conduit	PVC coated rigid galvanized steel conduit
Concealed within non-elevated (i.e. "slab-on-grade" construction) concrete slabs	Schedule 40 rigid non-metallic PVC conduit	Rigid galvanized steel conduit

RIGID CONDUIT FOR NON-HAZARDOUS AREAS		
Installation Area Designation/ Scenario	Conduit Category Wiring/Circuit Type	
	Power and Control	Instrumentation
Concealed within elevated concrete slabs	Rigid galvanized steel conduit	Same as Power and Control
Concealed below concrete slabs within earth or fill material	Schedule 40 rigid non-metallic PVC conduit	Rigid galvanized steel conduit
Concealed within concrete walls	Schedule 40 rigid non-metallic PVC conduit	Rigid galvanized steel conduit
Emerging from concealment within or below a concrete floor and transitioning to exposed conduit	PVC coated rigid galvanized steel conduit	Same as Power and Control

2. Rigid conduit for hazardous areas shall be furnished and installed in the materials of construction as follows:

RIGID CONDUIT FOR HAZARDOUS AREAS		
Installation Area Hazard/Scenario	Conduit Category Wiring/Circuit Type	
	Power and Control	Instrumentation
Exposed in Class I and II areas Division I and Division II	PVC coated rigid galvanized steel conduit	Same as Power and Control
Concealed within concrete slabs in Class I and II areas Division I and Division II	Rigid galvanized steel conduit	Same as Power and Control
Concealed below concrete slabs within earth or fill material in Class I and II areas Division I and Division II	Rigid galvanized steel conduit	Same as Power and Control
Concealed within concrete walls in Class I and II areas Division I and Division II	Rigid galvanized steel conduit	Same as Power and Control
Concealed below concrete slabs encased in at least two inches of concrete and buried 24 inches below top of slab in Class I Division I areas	Schedule 40 rigid non-metallic PVC conduit	Rigid galvanized steel conduit

3. The tables for the materials of construction for conduits in non-hazardous and hazardous areas are intended to exhaustively cover all possible scenarios and installation areas under this Contract. However, if a scenario or installation area is found that is not explicitly governed by these tables, it shall be assumed for bid purposes that the conduit material of construction is to be rigid galvanized steel. This discrepancy shall be brought to the attention of the Engineer in writing immediately for resolution.

B. Conduit Bends

1. All conduit bends shall be the same material of construction as the rigid conduit listed in the tables above, with the following exceptions:
 - a. All 90 degree bends or combinations of adjacent bends that form a 90 degree bend where concealed within concrete or below a concrete slab shall be rigid galvanized steel.

2. Field fabricated bends of metallic conduit shall be made with a bending machine and shall have no kinks. Field fabricated standard radius and long radius bends shall have minimum bending radii in accordance with the associated tables in Part 2 herein.
3. Field bending of non-metallic conduits is not acceptable, factory fabricated bends shall be used.
4. Long radius bends shall be furnished and installed:
 - a. As required.

C. Flexible Conduit

1. Flexible conduit shall only be installed for the limited applications specified herein. Flexible conduit shall not be installed in any other application without written authorization from the Engineer. Acceptable applications are as follows:
 - a. Connections to motors and engine-generator sets and similar vibrating equipment
 - b. Connections to solenoid valves and limit switches
 - c. Connections to lighting fixtures installed in suspended ceilings
 - d. Connections to lighting transformers
 - e. Connections to pre-fabricated equipment skids
 - f. Connections to HVAC equipment
 - g. Connections to instrument transmitters and elements
 - h. Where specifically indicated in the Standard Details
2. Flexible conduit length shall be limited to three (3) feet, maximum. Flexible conduit shall not be installed buried or embedded within any material.
3. Flexible conduit for non-hazardous areas shall be furnished and installed in the materials of construction as follows:

FLEXIBLE CONDUIT FOR NON-HAZARDOUS AREAS		
Installation Area Designation/Scenario	Conduit Category/Wiring/Circuit Type	
	Power and Control	Instrumentation
Exposed in indoor wet process areas	Liquid-tight flexible metal conduit	Same as Power and Control
Exposed in indoor dry process areas	Liquid-tight flexible metal conduit	Same as Power and Control
Exposed in indoor dry non-process areas	Flexible metal conduit	Same as Power and Control
Exposed in outdoor areas	Liquid-tight flexible metal conduit	Same as Power and Control

4. For Class I Division I hazardous areas, the NEC does not permit the installation of flexible conduit. In lieu of flexible conduit in these areas, flexible conduit couplings shall be installed as specified in Part 2 herein. Flexible conduit for all other hazardous areas shall be furnished and installed in the materials of construction as follows:

FLEXIBLE CONDUIT FOR HAZARDOUS AREAS		
Installation Area Hazard/Scenario	Conduit Category and Wiring/Circuit Type	
	Power and Control	Instrumentation
Exposed in Class I Division II areas	Liquid-tight flexible metal conduit	Same as Power and Control
Exposed in Class II Division I and Division II areas	Liquid-tight flexible metal conduit	Same as Power and Control

3.04 CONDUIT FITTING USES AND APPLICATIONS

A. General

1. Conduit fittings shall be furnished and installed in the materials of construction as indicated in Part 2, herein. Conduit fitting materials of construction are dependent on the material of construction used for the associated conduit.
2. Conduit fittings shall be provided in the trade size and configuration required to suit the application.

B. Conduit Bodies

1. Conduit bodies shall be installed where wire pulling points are desired or required, or where changes in conduit direction or breaking around beams is required.
2. Where conduit bodies larger than trade size 2 inches are intended to be used as a pull-through fitting during wire installation, oversized or elongated conduit bodies shall be used. Oversized or elongated conduit bodies shall not be required if the conduit body is intended to be used as a pull-out point during wire installation.

C. Conduit Nipples and Unions

1. Conduits with running threads shall not be used in place of 3-piece couplings or unions or close nipples. After installation of a conduit fitting of any kind, there shall be no more than 1/8 inch of exposed threads visible. Factory-fabricated all-thread nipples may be used between adjacent enclosures, however, the same restriction applies regarding the length of exposed threads that are visible.

D. Conduit Expansion and Deflection Fittings

1. Conduit expansion fittings shall be installed where required by the NEC and where indicated on the Drawings. Expansion fittings shall also be installed for exposed straight metallic conduit runs of more than 75 feet, in both indoor and outdoor

locations. Expansion fittings for runs of non-metallic conduit shall be installed in accordance with the NEC.

2. Conduit deflection fittings shall be installed where required by the NEC and where conduits are installed exposed and concealed across structural expansion joints.

E. Conduit Seals

1. Conduit seals shall be installed for conduits installed within or associated with hazardous areas and other areas as required by the NEC.

F. Conduit Termination Fittings

1. Where conduits terminate at enclosures with a NEMA 4, 4X, or 3R rating and the enclosure does not have integral conduit hubs, an appropriately sized watertight conduit hub shall be installed to maintain the integrity of the enclosure. The use of locknuts with integral gasket in lieu of watertight conduit hubs is not acceptable.
2. Where conduits terminate at enclosures that do not require conduit hubs, a two-locknut system shall be used to secure the conduit to the enclosure. One locknut shall be installed on the outside of the enclosure, and the other inside, drawn tight against the enclosure wall. The locknut on the interior of the enclosure shall be the type with integral bonding lug, or a conduit bonding bushing may be used in place of the locknut.
3. Conduits shall not be installed such that conduit fittings penetrate the top of an enclosure located outdoors, except in cases where specifically required by the serving electric utility. Conduits which serve outdoor equipment or an enclosure from above shall instead be routed into the side of the enclosure at the bottom. The conduit termination fitting shall be provided with a conduit drain to divert moisture from the raceway away from the enclosure.

3.05 MISCELLANEOUS

A. Conduit Peripheral Sealing

1. All conduit penetrations through exterior walls shall be sealed around the peripheral using the appropriate products specified in Part 2 herein to prevent air and/or water entry into the structure.
2. All conduit penetrations through interior walls and floors shall be sealed through the use of with conduit sleeves and caulk as specified in Part 2 herein. Alternatively, mortar may be used to seal around the conduit peripheral.
3. Conduit penetrations through fire-rated walls as floors shall be made with the appropriate fire rated penetration product.

B. Conduit Interior Sealing

1. All conduits including spares entering a structure below grade shall be sealed on the interior of the conduit against water ingress. Sealing shall be at an accessible location in the conduit system located within the building structure and shall be via one of the methods specified in Part 2 herein. If conduit sealing cannot be

achieved at an accessible location within the building structure, sealing shall be placed in the conduits in the nearest manhole or handhole outside the structure.

3.0 CONDUIT IDENTIFICATION

- A. Exposed conduits shall be identified at the source, load, and all intermediate components of the raceway system. Examples of intermediate components include but are not limited to junction boxes, pull boxes, and disconnect switches. Identification shall be by means of an adhesive label with the following requirements:
1. Labels shall consist of an orange background with black text. Text for the label shall be the conduit number as indicated in the conduit and wire schedules.
 2. In addition, at the source end of the conduit, a second line of text shall be included to indicate the load equipment name. This second line shall consist of the word "TO:" and the text in the 'TO' column of the conduit and wire schedule (e.g. TO: Stormwater Pump No. 1). At the load end of the conduit, a second line of text shall be included to indicate the source equipment name. This second line shall consist of the word "FROM:" and the text in the 'FROM' column of the conduit and wire schedule (e.g. FROM: SSRVS-1001). This requirement applies only to the source and load ends of the conduit, and not anywhere in between.
 3. For conduits trade sizes 3/4" through 1 1/2", the text shall be a minimum 18 point font. For conduits trade size 2" and larger, the text shall be a minimum 24 point font.
 4. Label height shall be 3/4" minimum, and length shall be as required to fit required text. The label shall be installed such that the text is parallel with the axis of the conduit. The label shall be oriented such that the text can be read without the use of any special tools or removal of equipment.
 5. Labels shall be installed after each conduit is installed and, if applicable, after painting. Labels shall be printed in the field via the use of a portable label printing system. Handwritten labels are not acceptable.
- Labels shall be made of permanent vinyl with adhesive backing. Labels made of any other material are not acceptable.
- B. Conduits that are not exposed but installed beneath free standing equipment enclosures shall be identified by means of a plastic tag with the following requirements:
1. The tag shall be made of white Tvek material, and have an orange label with black text, as described above, adhered to it. Text for the label shall be the conduit number as indicated in the conduit and wire schedules.
 2. The tag shall be affixed to the conduit by means of a non cable tie. The tag shall be of suitable dimensions to achieve a minimum text size of 18 points.
- C. Conduits for lighting and receptacle circuits shall not require identification.
- D. Any problems or conflicts with meeting the requirements above shall immediately be brought to the attention of the Engineer for a decision.

3.07 TESTING

- A. All tests shall be performed in accordance with the requirements of the General Conditions and Division 1. The following tests are required:
 - 1. All conduit installed below grade or concrete encased shall be tested to ensure continuity and the absence of obstructions by pulling through each conduit a swage followed by a mandrel 85% of the conduit inside diameter. After testing, all conduits shall be capped after installation of a suitable pulling rope.

3.08 TRAINING OF INSTALLATION PERSONNEL

- A. All Contractor personnel that install PVC coated RGS conduit shall be trained by the PVC coated RGS conduit manufacturer. Training shall include proper conduit system assembly techniques, use of tools appropriate for coated conduit systems, and field bending/cutting/threading of coated conduit. Training shall have been completed within the past 24 months prior to the Notice to Proceed on this Contract to be considered valid. Contractor personnel not trained within this timeframe shall not be allowed to install coated conduit or shall be trained/re-trained as required prior to commencement of conduit installation.

END OF SECTION

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SECTION 1118

UNDERGROUND ELECTRICAL

PART 1 - GENERAL

1.01 THE REQUIREMENT

- A. The Contractor shall furnish and install underground duct systems, electric manholes, and electric handholes as specified herein and as indicated on the Drawings. The work shall be complete and shall include excavation, concrete construction, backfilling, and all materials, items, and components required for a complete system.
- B. The provisions of this Division are applicable to all underground conduit work. All work shall be coordinated with that of the various utility companies and other Contractors. The Contractor shall adhere to all utility company requirements including the serving electric utility.
- C. Reference Section 1000, Basic Electrical Requirements; Section 1111, Conduit; Section 1000, Grounding and Bonding; the applicable sections of Division 2, Sitework; Section 03200, Concrete Reinforcement; and 03300, Cast-In-Place Concrete.

1.02 CODES AND STANDARDS

- A. Products specified herein shall be designed, manufactured, and/or listed to the following standards as applicable:
 - 1. AASHTO H20
 - 2. ANSI/SCTE 77-2010 – Specification for Underground Enclosure Integrity

1.03 SUBMITTALS

- A. In accordance with the procedures and requirements set forth in the General Conditions and Section 01300, Submittals, the Contractor shall obtain from the equipment manufacturer and submit Shop Drawings. Each submittal shall be identified in the applicable Specification Section.

1.04 SHOP DRAWINGS

- A. Each submittal shall be complete in all respects, incorporating all information and data listed herein and all additional information required for evaluation of the proposed equipment's compliance with the Contract Documents.
- B. Partial, incomplete, or illegible submittals will be returned to the Contractor without review for resubmittal.
- C. Shop drawings shall include but not be limited to, the following:
 - 1. Product data sheets.
 - 2. Outline and dimensional drawings including detailed sections of the manholes and/or handholes.

3. Materials specifications and structural calculations for the manholes sealed by a Professional Engineer in the State of Florida.

1.05 IDENTIFICATION

- A. Each manhole and handhole cover shall be lettered with the word "Electric" or "Controls" as applicable, the manhole or handhole identification number as noted on the Drawing, manufacturer's name or trademark, and such other information as the manufacturer may consider necessary, or as specified, for complete identification.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. The material covered by this Specification is intended to be standard material of proven performance as manufactured by reputable concerns. Material shall be fabricated, constructed and installed in accordance with the best practices of the trade, and shall operate satisfactorily when installed as specified herein and indicated on the Drawings.

2.02 DUCT SYSTEM

- A. Underground duct system shall consist of parallel runs of Schedule 40 PVC conduit encased in concrete envelopes, unless otherwise specified herein or indicated on the Drawings.
- B. Nonmetallic conduit joints shall be made with standard Schedule 40 PVC couplings and PVC solvent cement of the same manufacturer as the conduit. All PVC conduit shall be supplied by the same manufacturer. All joints shall be staggered, installed in accordance with the manufacturer's recommendations, and made watertight.
- C. Base and intermediate conduit spacers shall be furnished to provide a minimum of three-inch (3") separation between conduits. Conduit spacers shall be provided in the proper size as required for the conduit that they secure. For example, a 4" conduit spacer shall not be used to secure a 2" conduit. Conduit spacers shall be as manufactured by Carlon Electrical Products Company, Aeroquip Corporation, Underground Devices, Incorporated, or equal.
- D. All 90 degree conduit elbows and/or combinations of adjacent conduit elbows that form a 90 degree bend shall be rigid galvanized steel conduit.

2.03 ELECTRIC MANHOLES

- A. The concrete manholes shall be complete with metal frames and covers of size and location as specified herein and shown on the Drawings.
- B. Manhole frames and covers shall be double leaf aluminum construction. Leaf covers shall be constructed of 1/4" diamond pattern plate. Manhole frames and covers shall be reinforced for 300 lbs/sq.ft. for applications not subject to deliberate vehicular traffic Type D-AL as manufactured by The Bilco Company, or equal. Manhole, frames, and covers shall be AASHTO H20 heavy duty for applications subject to deliberate vehicular traffic Type D-AL H-20 as manufactured by The Bilco Company, or equal.

- C. All electric manholes shall be provided with heavy-duty non-metallic cable racks. Cable racks shall be rated for the application, with a minimum loading of 450 lbs per rack arm. Cable rack system shall be Heavy-Duty type as manufactured by Underground Devices, Incorporated or equal.

2.04 ELECTRIC HANDHOLES

- A. The electric handholes shall be a precast polymer concrete enclosure suitable for use as part of an underground electric raceway system. The enclosure shall meet or exceed the requirements of ANSI/SCTE 77-2010.
- B. The enclosure design and test load rating shall be Tier 15.
- C. The enclosure shall be the straight side design to allow easy adjustment of cover to grade. The cover shall be stackable for increased depth.
- D. Handhole opening size shall be as required to suit the application, 6" X 8", minimum.
- E. Extra heavy-duty covers shall be furnished and installed with Tier 15 enclosures. Covers shall be provided with cover hooks.
- F. The electric handholes shall be Style "PG" or "PC" (as required) Quazite boxes as manufactured by Huell, Pencil Plastics equivalent, Highline Products equivalent, or equal.

PART 3 - EXECUTION

3.01 GENERAL

- A. The underground duct system, manholes, and handholes shall be installed as specified herein, indicated on the Drawings, and in accordance with manufacturers' instructions.

3.02 DUCT SYSTEM

- A. All underground conduit shall be encased in concrete and shall be reinforced. Encasement and reinforcement shall be as indicated in the standard details. Concrete shall be furnished and installed in accordance with Section 03300. Reinforcing steel shall be furnished and installed in accordance with Section 03200.
- B. Concrete pours shall be complete from handhole to handhole and from manhole to manhole where practical. Partial pours in general shall not be permitted. Where a complete pour is impractical, written authorization shall be obtained from the Engineer for the partial pour.
- C. Conduit ductbank elevations at the manholes and handholes shall be based on minimum ductbank cover as indicated in the standard details, or deeper to avoid conflicts with other obstacles. Where deviation is necessary to clear unforeseen obstacles, the elevations may be changed after authorization by the Engineer.
- D. Slope all conduits continuously away from structures and buildings with a minimum slope of 3" per 100' unless otherwise indicated on the Drawings.

- E. The minimum clearance from the top of the concrete encasement and finished grade shall be as indicated in the standard details, except where otherwise accepted in writing by the Engineer or shown on the Drawings.
- F. Care shall be exercised during excavation for the duct banks to prevent digging too deep. Backfilling of low spots with earth fill will not be permitted unless thoroughly compacted and acceptable to the Engineer.
- G. The conduits in a duct bank shall be arranged as shown on the Electrical detail sheet. Where no specific duct bank arrangement is shown on the Drawings, the Contractor shall arrange conduits within each duct bank based on field conditions. Spare conduits shown going from duct banks into buildings or structures shall be stuffed up in the locations as indicated on the Drawings.
- H. A minimum of one #4 ground rod, furnished in accordance with Section 1-170, shall be driven adjacent to each manhole, handhole, or other concrete box. A No. 4/0 AWG bare copper ground cable shall be connected between this rod and the copper ground strap using a silicon bronze connector. All ground rods shall be interconnected by means of the No. 4/0 AWG bare copper ground cable located within each duct bank. The ends of these cables shall also be connected to substation and/or building ground buses where the conduits terminate.
- I. Care shall be exercised and temporary plugs shall be installed during installation to prevent the entrance of concrete, mortar, or other foreign matter into the conduit system. Conduit spacers shall be utilized to support conduit during the pouring of concrete to prevent movement and misalignment of the conduits. Conduit spacers shall be installed in accordance with manufacturer's instructions unless otherwise noted. Horizontal spacing of conduit spacers along duct bank shall be as indicated on the Standard Details.
- J. Large radius elbows shall be used for all 90 degree conduit bends in the duct system. The following shall be the minimum elbow radii:

TRADE SIZE	1"	1 1/2"	2"	2 1/2"	3"	3 1/2"	4"
MIN. RADIUS	12"	24"	24"	24"	36"	36"	48"

- K. Prior to pulling cables, the Contractor shall thoroughly clean the inside of each length of conduit by swabbing.
- L. After all cables have been installed, all spare and/or unused conduit openings shall be sealed or plugged as specified in Section 1-111. A 250 lb test pull rope shall be provided in the entire length of all spare and/or unused conduits.
- M. Where connections to existing underground conduits are indicated, excavate to the maximum depth necessary. After addressing the existing conductors, cut the conduits and remove loose concrete from the conduits before installing new concrete encased ducts. Provide a reinforced concrete collar, poured monolithically with the new duct line, to take the shear at the joint of the duct lines.
- N. Construct concrete-encased conduits connecting to underground structures to have a flared section adjacent to the manhole to provide shear strength. Construct underground structures to provide shear strength. Construct underground structures to

provide for keying the concrete encasement of the duct line into the wall of the structure. Use vibrators when this portion of the encasement is poured to ensure a seal between the encasement and the wall of the structure.

- O. Six inches above all duct banks, the Contractor shall furnish and install a two inch wide red plastic electrical hazard tape. Tapes shall be metallic detectable type and shall have a continuous message in bold black letters: "ELECTRIC LINE BURIED BELOW." Tape shall be Detectable Identoline by Brady, or equal.
- P. The Contractor shall perform all earthwork including excavation, backfill, bedding, compaction, shoring and bracing, grading and restoration of surfaces and seeded areas disturbed during the execution of the work.

3.03 ELECTRIC MANHOLES

- A. Electric manholes shall be installed to a sufficient depth to accommodate the required grading of ducts as well as maintaining a minimum distance of 14" from the bottom of the lowest duct centerline entrances to finished floor line and/or highest duct centerline entrance to the roof. All manholes shall be built on, or placed over a 6" layer of well-tamped gravel.
- B. Duct envelopes and conduit with cell ends shall enter at approximately right angles to the walls, except as may otherwise be shown on the Drawings.
- C. All concrete work and full assembled manholes shall be completely watertight and shall be furnished with sloped floors that pitch towards a drain. The outside surfaces shall be coated with an approved asphaltic waterproofing compound on all sides, bottom, and roof. Precast concrete manholes may be installed; however, all requirements of this section and other divisions of the Specifications and the details shown on the Drawings shall apply.
- D. Install pulling eye irons imbedded in walls opposite each duct entrance securely fastened to manhole reinforcing rods. All hardware shall be hot-dipped galvanized steel. Copper bars shall be provided in the walls for grounding. No. 4/0 AWG bare copper cables shall be connected to these bars and all non-current carrying metal parts shall be grounded to these copper bars.
- E. All cables shall be well supported on walls or nonmetallic cable racks. The cable racks shall be heavy-duty type for medium and low voltage power cables and light duty type for control, signal, communications and similar small conductors. All racks shall be rigidly attached to the wall and equipped with adjustable rack arms.

3.04 ELECTRIC HANDHOLES

- A. Electric handholes shall be installed to a sufficient depth to accommodate the required grading of ducts as well as maintaining a minimum distance of 9" from the bottom of the lowest duct centerline entrances to finished floor line and/or highest duct centerline entrance to roof. All handholes shall be built on, or placed over a 6" layer of well-tamped gravel.
- B. Duct envelopes and conduit with cell ends shall enter at approximately right angles to the walls, except as may otherwise be shown on the Drawings.

- C. All full assembled handholes shall be completely watertight.
- D. All individual cables and/or bundles of conductors shall be identified and "dressed" along the wall of the enclosure. Cable racks as specified herein shall be provided if any handhole dimension exceeds 24 inches.

3.05 TESTING

- A. All tests shall be performed in accordance with the requirements of the General Conditions and Division 1. The following tests are required:
 - 1. Field tests
 - a. Field tests for all completed duct systems shall consist of pulling a swage through each conduit followed by a mandrel equal in size to 85% of the conduit inside diameter.
 - b. After testing, all conduits shall be capped after installation of a suitable pull rope. All field tests shall be witnessed by the Engineer.

END OF SECTION

SECTION 10123

LOW VOLTAGE WIRE AND CABLE

PART 1 - GENERAL

1.01 THE REQUIREMENT

- A. The Contractor shall furnish, install, connect, test, and place in satisfactory operating condition, all low voltage wire and cable indicated on the Drawings and as specified herein and/or required for proper operation. The work of connecting cables to equipment and devices shall be considered a part of this Section. All appurtenances required for the installation of cable and wire systems shall be furnished and installed by the Contractor.
- B. The scope of this Section does not include internal wiring factors installed by electrical equipment manufacturers.
- C. Reference Section 10000, Basic Electrical Requirements; Section 10111, Conduit; Section 10118, Underground Electrical; and Section 10130, Boxes.

1.02 SUBMITTALS

- A. In accordance with the procedures and requirements set forth in the General Conditions and Section 01300, Submittals, the Contractor shall obtain from the wire and cable manufacturer and submit the following:
 - 1. Shop Drawings
 - 2. Reports of Field Tests
 - 3. Wiring Identification Methods
- B. Each submittal shall be identified by the applicable specification section.

1.03 SHOP DRAWINGS

- A. Each submittal shall be complete in all respects, incorporating all information and data listed herein and all additional information required for evaluation of the proposed material's compliance with the Contract Documents.
- B. Partial, incomplete, or illegible Submittals will be returned to the Contractor without review for resubmittal.
- C. Shop drawings shall include but not be limited to:
 - 1. Product data sheets.
 - 2. Cable pulling calculations if required.
 - 3. Wiring identification methods and materials.

1.04 IDENTIFICATION

- A. Each cable shall be identified as specified in Part 3, Execution, of this Specification.

1.05 CABLE PULLING CALCULATIONS

- A. The Contractor shall submit cable pulling calculations. These calculations, to be performed by a currently registered professional engineer in the State of Florida, shall define pulling tension and sidewall loading (sidewall bearing pressure values) for all installations of 600VAC, 1/0 conductors and larger greater than 200 feet in length. Calculations for straight horizontal installations of 600VAC, 1/0 conductors and larger greater than 200 feet are not required.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. The wire and cable to be furnished and installed for this project shall be the product of manufacturers who have been in the business of manufacturing wire and cable for a minimum of ten (10) years. Wire and cable shall be designed, constructed and installed in accordance with the best practices of the trade, and shall operate satisfactorily when installed as specified herein and indicated on the Drawings. Only one manufacturer for each wire and cable type shall be permitted.
- B. The wire and cable manufacturer shall be ISO 9000 registered.

2.02 POWER WIRE AND CABLE

- A. Power cable and wire shall consist of stranded, copper conductor with insulation type THHN, 90°C for dry locations and THWN, 75°C for wet locations.
- B. Conductors shall be stranded copper per ASTM-B8 and B-3, and Class B or C stranding contingent on the size unless otherwise specified. Minimum size wire shall be No. 12 AWG.
- C. Multi-conductor power cable assemblies shall be UL 1277 Listed, provided with a bonding conductor, and furnished with an overall PVC jacket.
- D. Power wire and cable shall be as manufactured by the Okonite Company, the Southwire Company, General Cable, or equal.

2.03 CONTROL CABLE

- A. 600 volt control cable shall consist of stranded, copper conductor with insulation type THHN, 90°C for dry locations and THWN, 75°C for wet locations, and 600V.
- B. Conductors shall be stranded copper per ASTM B-8 and B-3, and Class B or C stranding contingent on the size unless otherwise specified. Minimum wire size shall be No. 14 AWG.
- C. Multi-conductor control cable assemblies shall be UL 1277 Listed, provided with a bonding conductor, and furnished with an overall PVC jacket.

- D. Control cable shall be as manufactured by the Okonite Company, the Southwire Company, General Cable, or equal.

2.04 LIGHTING AND RECEPTACLE WIRE

- A. The lighting and receptacle branch circuit wire shall consist of solid, copper conductors with insulation type THHN, 90°C for dry locations and THWN, 75°C for wet locations.
- B. Conductors shall be solid copper per ASTM- B-3. Minimum size wire shall be No. 12 AWG.
- C. Lighting and receptacle wire shall be as manufactured by the Okonite Company, the Southwire Company, General Cable, or equal.

2.05 INSTRUMENTATION CABLE

- A. The instrumentation cable for analog signals shall be single, shielded, twisted pairs or triads with 100 volt insulation and shall have a 75°C minimum insulation rating.
- B. Conductors shall be tin or alloy coated if available, soft, annealed copper, stranded per ASTM-B8, Class B stranding unless otherwise specified. Minimum size wire shall be No. 14 AWG.
- C. The instrumentation cable shall be Okoseal-N Type P-OS for single pair or triad applications and Okoseal-N Type SP-OS for multiple pair or triad applications as manufactured by the Okonite Company, Belden equivalent, Southwire Company equivalent, or equal.

2.06 CONDUCTOR IDENTIFICATION

- A. Conductors shall be identified using a color coding method. Color coding for individual power, control, lighting, and receptacle conductors shall be as follows:
 - 1. 480/277V AC Power
 - Phase A - BROWN
 - Phase B - ORANGE
 - Phase C - YELLOW
 - Neutral – GREEN
 - 2. 120/208V or 120/240V AC Power
 - Phase A - BLACK
 - Phase B - RED
 - Phase C - BLUE
 - Neutral - WHITE
 - 3. DC Power
 - Positive Lead - RED
 - Negative Lead - BLACK
 - 4. DC Control
 - All wiring - BLUE