SECTION 23 05 29

HANGERS AND SUPPORTS FOR HVAC DUCTWORK, PIPING, AND EQUIPMENT

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, tools, equipment and incidentals as shown, specified and required to furnish and install hangers and supports complete with required appurtenances for HVAC ductwork, piping, and equipment.
   2. The Work shall comply with vibration, seismic, and wind control requirements in Section 40 05 96, Vibration, Seismic, and Wind Controls.

B. Coordination:
   1. Review installation procedures under this and other Sections and coordinate the installation of items that must be installed with, or before, the hangers and supports for HVAC ductwork, piping, and equipment Work.
   2. Notify other Contractors in advance of the installation of hangers and supports for HVAC ductwork, piping, and equipment to provide other contractors with sufficient time for the installation of items included in their contracts that must be installed with, or before, the hangers and supports for HVAC ductwork, piping, and equipment Work.

C. Related Sections:
   1. Section 03 60 00, Grouting.
   2. Section 05 05 33, Anchor Systems.
   3. Section 05 12 00, Structural Steel Framing.
   4. Section 40 05 96, Vibration, Seismic, and Wind Controls.

1.2 REFERENCES

A. American National Standards Institute (ANSI).
   1. ANSI B1.1 – Unified Inch Screw Threads (ASME B1.1).

B. American Society of Civil ENGINEERS (ASCE).
   1. ASCE 7 – Minimum Design Loads for Buildings and Other Structures.

C. American Society for Testing and Materials (ASTM).
   1. ASTM A36/A36M – Standard Specification for Carbon Structural Steel.
   2. ASTM A47/A47M – Standard Specification for Ferritic Malleable Iron Castings.
   3. ASTM A123/A123M – Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
   4. ASTM A153/A153M – Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.

5. ASTM A307 – Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
6. ASTM A575 – Standard Specification for Steel Bars, Carbon, Merchant Quality, M-Grades.
7. ASTM A668/A688M – Standard Specification for Steel Forgings, Carbon and Alloy, for General Industrial Use.

D. American Welding Society (AWS).
   1. AWS B2.1 – Specification for Welding Procedure and Performance Qualification.

E. Federal Specifications (FS).
   1. FS WW-H-171 – Hangers and Supports, Pipe.

F. Manufacturers Standardization Society (MSS).
   1. MSS SP 58 – Pipe Hangers and Supports-Materials, Design and Manufacture.
   2. MSS SP 69 – Pipe Hangers and Supports - Selection and Application.

G. National Fire Protection Association (NFPA).
   1. NFPA 90A – Standard for the Installation of Air-Conditioning and Ventilating Systems.

H. Sheet Metal and Air Conditioning CONTRACTORS National Association (SMACNA).
   1. HVAC Duct Construction Standards – Metal and Flexible.
   2. Seismic Restraint Manual: Guidelines for Mechanical Systems.
   3. Thermoset FRP Duct Construction Manual.

1.3 QUALITY ASSURANCE

A. Qualifications:
   1. Manufacturer:
      a. Minimum of five years of experience producing substantially similar equipment and able to show evidence of at least five installations in satisfactory operation for at least five years.
   2. Professional Engineer:
      a. Engage a registered professional engineer legally qualified to practice in New York State and experienced in providing engineering services of the kind indicated.
      b. Submit qualifications data.
      c. Responsibilities include but are not necessarily limited to:
         1) Carefully reviewing system performance and design criteria stated in the Contract Documents.
         2) Preparing written requests for clarifications or interpretations of performance or design criteria for submittal to ENGINEER by CONTRACTOR.
         3) Preparing or supervising the preparation of design calculations and related drawings, Shop Drawings, testing plan development, test-result

interpretation and a comprehensive engineering analysis verifying compliance of the system with the requirements of the Contract Documents.

4) Signing and sealing all calculations and design drawings, and Shop Drawings.
5) Certifying that:
   a) it has performed the design of the system in accordance with the performance and design criteria stated in the Contract Documents, and
   b) the said design conforms to all applicable local, state and federal codes, rules and regulations, and to the prevailing standards of practice.

3. Installer:
   a. Engage an experienced installer to perform the work of this Section who has specialized in installing hangers and supports for HVAC ductwork, piping, and equipment similar to that required for this Project and who is acceptable to manufacturer.
   b. Submit name and qualifications to ENGINEER along with the following information on a minimum of three successful projects:
      1) Names and telephone numbers of owners, architects or engineers responsible for projects.
      2) Approximate contract cost of the hangers and supports for HVAC ductwork, piping, and equipment.
      3) Amount of area installed.
4. Welding:
   a. Qualify processes and operators in accordance with AWS B2.1 as appropriate for material to be welded.
   b. Provide certification that operators employed on or to be employed for the Work have satisfactorily passed AWS qualification tests within previous 12 months. Ensure that all certifications are current.

B. Component Supply and Compatibility:
   1. Obtain all equipment included in this Section regardless of the component manufacturer from a single hangers and supports for HVAC ductwork, piping, and equipment manufacturer.
   2. Require the hangers and supports for HVAC ductwork, piping, and equipment manufacturer to review and approve or to prepare all Shop Drawings and other submittals for all components furnished under this Section.
   3. All components shall be specifically constructed for the specified service conditions and shall be integrated into the overall equipment assembly by the hangers and supports for HVAC ductwork, piping, and equipment manufacturer.

C. Regulatory Requirements:
   1. International Building Code (IBC).
   2. National Fire Protection Association (NFPA).
   3. Local and State Building Codes and Ordinances.

4. Permits: CONTRACTOR shall obtain and pay for all required permits, fees and inspections.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Shop Drawings:
      a. Drawings showing fabrication methods, assembly, accessories, and installation details.
      b. Setting drawings, templates, and directions for the installation of anchor bolts and other anchorages.
      c. Drawings showing floor supported components and installation arrangement.
   2. Product Data:
      a. Manufacturer's literature, illustrations, specifications, weight, dimensions, required clearances, materials of construction, and performance data for all equipment.
      b. Complete component list.
      c. Detailed description of each component.
      d. Catalog cut sheets for each component.
      e. Deviations from Contract Documents. Any exceptions to the Contract Documents must be clearly defined. CONTRACTOR shall be responsible for any additional expenses that may occur due to any exception made.
      f. Other technical data related to specified material and equipment as requested by ENGINEER.
   3. Delegated Design Submittals:
      a. 1/4-inch scale HVAC ductwork, piping, and equipment layouts, dimensioned to show length of runs, with all expansion joints, alignment guides, anchors and appurtenances required for proper control of HVAC ductwork, piping, and equipment forces. The drawings shall include all forces acting on the HVAC ductwork, piping, and equipment and the corresponding reactions of the compensation and anchor devices provided.
      b. All drawings, design calculations, and a letter indicating that the hanger and support systems have been properly designed shall be signed and sealed by a registered professional engineer legally qualified to practice in New York State.

B. Informational Submittals: Submit the following:
   1. Certificates:
      a. Independent certification reports.
   2. Manufacturer Instructions:
      a. Instructions and recommendations for handling, storing, protecting the equipment.
      b. Installation Data.
   3. Source Quality Control Submittals:
      a. Factory test reports.
   4. Qualifications Statements:
      a. Manufacturer, when requested by ENGINEER.

b. Professional engineer, when requested by ENGINEER.
c. Installer, when requested by ENGINEER.
d. Welding, when requested by ENGINEER.

1.5 DELIVERY, STORAGE AND HANDLING

A. Packing, Shipping, Handling and Unloading:
1. Deliver materials to the Site to ensure uninterrupted progress of the Work.
2. Deliver anchor bolts and anchorage devices, which are to be embedded in cast-in-place concrete, in ample time to prevent delay of that Work.
3. Comply with manufacturer's recommendations for rigging of equipment.

B. Storage and Protection:
1. Store materials to permit easy access for inspection and identification. Keep all material off the ground, using pallets, platforms, or other supports. Protect steel members and packaged materials from corrosion and deterioration.
2. Store all equipment in covered storage off the ground and prevent condensation and in accordance with the manufacturer's recommendations for long-term storage.

C. Acceptance at Site:
1. All boxes, crates and packages shall be inspected by CONTRACTOR upon delivery to the Site. CONTRACTOR shall notify ENGINEER, in writing, if any loss or damage exists to equipment or components. Replace lost equipment or components and repair damage to new condition, in accordance with manufacturer's instructions.

PART 2 - PRODUCTS

2.1 SYSTEM PERFORMANCE

A. Design Criteria:
1. Designs generally accepted as exemplifying good engineering practice and using stock or production parts shall be utilized wherever possible.
2. Accurate weight balance calculations shall be made to determine the required force at each hanger and support location and the weight load at each force concentration point.
3. Hangers and supports shall be capable of supporting and restraining HVAC ductwork, piping, and equipment in all conditions of operation. They shall allow free expansion and contraction, and prevent excessive stress resulting from transferred weight being induced into the HVAC ductwork, piping, and equipment.
4. Hangers and supports shall be designed so that they cannot become disengaged by movements of the supported HVAC ductwork, piping, and equipment.
5. Rod length shall be limited to a maximum length of eight linear feet.

6. HVAC ductwork, piping, and equipment that cannot be hung by rod and hanger, except where chain supports are specified to be provided with equipment, arrangement shall be floor or wall supported.
7. All structural components shall be designed based on static and dynamic loads imposed by the supported HVAC ductwork, piping, and equipment and shall include a safety factor of 2 for the yield strength. Minimum angle sizes shall be 2-inch x 2-inch x1/4-inch.
8. Load ratings, materials and installation shall be consistent with the recommendations from the latest edition of MSS SP 58, MSS SP 69, and FS WW-H-171.
9. Hanger and support design calculations for all HVAC ductwork, piping, and equipment shall be signed and sealed by a registered professional engineer legally qualified to practice in New York State.

2.2 MANUFACTURERS

A. Manufacturer: Provide product of one of the following:
   1. Erico International Corporation.
   2. Anvil International.
   3. Or equal.

2.3 DETAILS OF CONSTRUCTION

A. Materials:
   1. Hangers, supports, restraints, and appurtenances located in wet or corrosive areas shall be Type 316 stainless steel.
   2. Hangers, supports, restraints, and appurtenances located in dusty areas shall be hot dipped galvanized steel in accordance with ASTM A123/A123M and ASTM A153/A153M.
   3. Steel used for the support of uninsulated copper piping or plastic piping shall be PVC coated.

B. Components of hangers and supports shall conform to the following:
   1. Bolts: ASTM A307, Grade A, unless otherwise specified below.
   2. Forgings: ASTM A668/A688M.
   3. Malleable Iron: ASTM A47/A47M.
   4. Rods and Bars: ASTM A575.
   5. Threads: Unified Screw Threads, Class 2A and 2B, ANSI B1.1.
   6. Structural Steel: ASTM A36/A36M.

C. Hanger Attachments: The following types of attachments shall be considered acceptable:
   1. Adjustable Steel Clevis: FS WW-H-171E, Type 1.
   2. Steel Double Bolt Pipe Clamp: FS WW-H-171E, Type 3.
   3. Steel Pipe Clamp: FS WW-H-171E, Type 4.
   4. Adjustable Swivel Pipe Ring: FS WW-H-171E, Type 6.
   5. Adjustable Steel Band Hanger: FS WW-H-171E, Type 7.
   6. Riser Clamp: FS WW-H-171E, Type 8.

7. Light-Duty Clevis Hanger: FS WW-H-171E, Type 12.
8. Long Clips: FS WW-H-171E, Type 26.
9. Offset J-Hooks: FS WW-H-171E, Type 27.
10. Steel Pipe Covering Protection Saddle: FS WW-H-171E, Type 40A.
11. Insulation Protection Shield: FS WW-H-171E, Type 41.
12. Pipe Saddle Support: FS WW-H-171E, Type 37.
13. Pipe Stanchion Saddle: FS WW-H-171E, Type 38.
14. Pipe Saddle Support with Base: FS WW-H-171E, Type 36.
15. Adjustable Roller Hanger: FS WW-H-171E, Type 42.

D. Structural Attachments: The following types of attachments shall be considered acceptable:
1. Side Beam Clamp: FS WW-H-171E, Type 20.
2. Center I-Beam Clamp: FS WW-H-171E, Type 21.
3. Welded Steel Bracket: FS WW-H-171E, Types 32 and 33.
4. Side Beam Bracket: FS WW-H-171E, Type 35.

E. Hanger Rod Attachments: Use as required to complete assembly:
1. Forged Steel Clevis: FS WW-H-171E, Type 14.
2. Adjustable Turnbuckle: FS WW-H-171E, Type 15.
3. Forged Steel Welders Eye Nut: FS WW-H-171E, Type 17.

F. Concrete anchorage shall be provided in accordance with Section 05 05 33, Anchor Systems.

G. Structural steel shall be provided in accordance with Section 05 12 00, Structural Steel Framing.

H. Miscellaneous metal fabrications shall be provided in accordance with Section 05 50 13, Miscellaneous Metal Fabrications.

2.4 SOURCE QUALITY CONTROL

A. Shop Tests:
1. Equipment shall be completely manufactured and pre-assembled in accordance with Reference Standards. Perform the following tests and inspections at factory before shipment:
   a. Tested and inspected for approval as a unit by Underwriters Laboratories Inc., UL Label or equal.
   b. Factory test equipment to ensure that the entire package has been properly fabricated and assembled, that the package meets the specified performance requirements including manufacturer's data report.

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine conditions under which materials and equipment will be installed and notify ENGINEER in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions are corrected.

B. Take field measurements where required prior to installation to ensure proper fitting of Work.

3.2 INSTALLATION

A. General:
   1. Install the equipment in accordance with the Contract Documents and by manufacturer's instructions and recommendations. Obtain written interpretation from ENGINEER in the event of conflict between manufacturer's instructions and recommendations and the Contract Documents.
   2. Install in accordance with Laws and Regulations.
   3. Do not modify structures to facilitate installation of equipment, unless approved in writing by ENGINEER.
   4. Installation to conform to requirements of all local and state codes.

B. Ductwork:
   1. The construction and installation of hangers and supports for ductwork shall conform to the recommendations given in the SMACNA HVAC Duct Construction Standards.
   2. Hanger rods shall have threaded ends.
   3. All ductwork shall be supported from trapeze type hangers. No sheet metal duct hangers or straps will be allowed.
   4. A pair of rods shall be provided at each duct support point.

C. Piping:
   1. Insulated pipes with vapor barriers shall have an insulation protection shield conforming to FS WW-H-171E, Type 41 tack-welded to hanger.
   2. Insulated pipes without vapor barriers shall have a steel protection saddle conforming to FS WW-H-171E, Type 40A.
   3. All uninsulated copper piping shall be supported by plastic coated steel pipe attachments.
   4. All piping shall be braced as required, to prevent sway in any direction.
   5. All insulated piping 3-inch diameter and larger shall be supported by roller hangers conforming to FS WW-H-171E, Type 42.
   6. Additional supports shall be placed immediately adjacent to any change in direction.
   7. Supports for Vertical Piping:

a. Provide riser clamp placed under hub, fitting or coupling with approved solid bearing on steel sleeve at each floor level.
b. Where riser clamps are used with plastic piping they shall be modified so as not to exert any compressive forces on the pipe.
c. Support spacing shall not exceed code requirements.

8. Allow clearances for expansion and contraction of piping.

D. Anchorages and Base Plates:
1. Provide anchorages in new or existing concrete, as applicable, in accordance with equipment manufacturer's recommendations and the Contract Documents. Install anchors in accordance with Section 05 05 33, Anchor Systems.
2. Where used, pour concrete bases up to one inch below equipment baseplate or support leg as applicable. Base with equipment mounted shall then be accurately shimmed to grade and spaces between filled with non-shrink grout in accordance with Section 03 60 00, Grouting. After grout has reached its initial set, exposed edges shall be neatly cut back 1/2 inch.

3.3 ADJUSTING

A. Adjust all equipment for proper settings.

3.4 CLEANING

A. Thoroughly clean all equipment and accessories prior to installation.

B. Remove all dirt, rust, dust, etc. from equipment and accessories after installation.

C. Remove and dispose of all debris and waste from the Site resulting from installation.

3.5 SCHEDULES

A. Hangers and Supports for Ductwork:
1. Spacing:
a. Ductwork shall be supported at distances not exceeding the spacing specified below:
1) Metal Ductwork:
a) Maximum Spacing: 10 feet.
2) Flexible and Other Factory-Made Ductwork (such as FRP):
a) Maximum Spacing: In accordance with the manufacturer's installation instructions.
2. Hanger Rod Sizes:
a. Hanger rods shall be sized based on static and dynamic loads imposed by the supported ductwork and shall include a safety factor of 2 for the yield strength.
b. Rod load shall not exceed rod manufacturer's recommended capacity.

B. Hangers and Supports for Piping:
1. Spacing:

a. Piping shall be supported at distances not exceeding the spacing specified below or in accordance with MSS SP 69:
   1) Copper Pipe:
      a) Maximum Horizontal Spacing: 6 feet.
      b) Maximum Vertical Spacing: 10 feet.
   2) Steel Pipe:
      a) Maximum Horizontal Spacing: 12 feet.
      b) Maximum Vertical Spacing: 15 feet.

2. Hanger Rod Sizes:
   a. Hanger rods shall be sized based on static and dynamic loads imposed by the supported piping and shall include a safety factor of 2 for the yield strength.
   b. Rod load shall not exceed rod manufacturer's recommended capacity.

C. Hangers and Supports for HVAC Equipment:
   1. Provide spacing and hanger rod sizes in accordance with equipment manufacturer's installation instructions.

+ + END OF SECTION + +

SECTION 23 05 93

TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, tools, equipment and incidentals as shown, specified, and required to perform the testing, adjusting, and balancing for HVAC as specified herein.

B. Coordination:
   1. Review installation procedures under this and other Sections and coordinate the installation of items that must be installed with, or before, the testing, adjusting, and balancing for HVAC Work.
   2. Notify other contractors in advance of the testing, adjusting, and balancing for HVAC to provide other contractors with sufficient time for the installation of items included in their contracts that must be installed with, or before, the testing, adjusting, and balancing for HVAC Work.

C. Related Sections:
   1. Section 10 14 00, Signage.

1.2 REFERENCES

A. Associated Air Balance Council (AABC).
   1. AABC National Standards for Total System Balance.

B. American National Standards Institute/American Industrial Hygiene Association (ANSI/AIHA).
   1. ANSI/AIHA Z9.5 – Laboratory Ventilation.

C. American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE).
   1. ASHRAE Handbook – Fundamentals.

D. National Environmental Balancing Bureau (NEBB).
   1. NEBB Procedural Standards for Testing Adjusting Balancing of Environmental Systems.

E. Sheet Metal and Air Conditioning Contractors National Association (SMACNA).
   1. SMACNA HVAC Systems – Testing, Adjusting & Balancing Handbook.

1.3 QUALITY ASSURANCE

A. Qualifications:
   1. Balancer:
      a. Engage an experienced balancer to perform the work of this Section who has specialized in testing, adjusting, and balancing for HVAC systems similar to that required for this Project.
      b. Minimum of five years of experience in testing, adjusting, and balancing substantially similar equipment and able to show evidence of at least five installations in satisfactory operation for at least five years in the continental United States.
      c. Submit name and qualifications to ENGINEER along with the following information on a minimum of five successful projects:
         1) Names and telephone numbers of owners, architects or engineers responsible for projects.
         2) Approximate contract cost of the testing, adjusting, and balancing for HVAC Work.
         3) Amount of area tested, adjusted, and balanced.
         4) Biographical information on employee proposed to directly supervise the testing, adjusting, and balancing Work.

B. Regulatory Requirements:
   1. Associated Air Balance Council (AABC).
   2. National Electrical Code (NEC).
   3. National Environmental Balancing Bureau (NEBB).
   4. National Fire Protection Association (NFPA).
   5. Underwriters Laboratories Inc. (UL).
   6. Local and State Building Codes and Ordinances.
   7. Permits: CONTRACTOR shall obtain and pay for all required permits, fees and inspections.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Product Data:
      a. Data sheets with name of devices, manufacturer's name, model number, latest date of calibration, and correction factors for each testing, adjusting, and balancing instruments.
      b. Other technical data related to specified material and equipment as requested by ENGINEER.

B. Informational Submittals: Submit the following:
   1. Certificates:
      a. Certification by National Environmental Balancing Bureau (NEBB), Association Air Balance Council (AABC), or equal.

2. Source Quality Control Submittals:
    a. Specimen copies of report forms for ENGINEER's review and approval.
        1) Forms shall be 8-1/2 by 11-inch paper for loose-leaf binding, with blanks for certification of report and listing all required testing, adjusting, and balancing requirements and ratings.
3. Field Quality Control Submittals:
    a. Written startup and field test reports presenting results of required field testing, adjusting, and balancing.
        1) Certified reports shall be in typed format on approved forms imprinted with the company's name.
        2) Reports shall include procedure outline used to test, adjust, and balance the systems and the types of instruments used.
        3) Minimum three certified copies of testing, adjusting, and balancing reports to the ENGINEER for review.
        4) Reports must be submitted to ENGINEER and DEPARTMENT for approval prior to DEPARTMENT's acceptance for responsibility.
4. Qualifications Statements:
    a. Balancer, when requested by ENGINEER.

1.5 SITE CONDITIONS

A. Environmental Requirements:
    1. Testing, adjusting, and balancing for HVAC shall be performed when outside ambient conditions are approximate to the local ASHRAE Handbook – Fundamentals design conditions for all heating and cooling functions.

PART 2 - PRODUCTS

2.1 EQUIPMENT PERFORMANCE

A. Equipment Description:
    1. Air Balance Instruments:
        a. Provide all velometers, anemometers, pitot tubes, differential air pressure gages, manometers, hook gages, static pressure probe units, and all other instruments and accessories as required to perform all air balance tests of HVAC equipment, ducts, registers, grilles, etc.
        b. Flow-measuring hoods (manufactured, not fabricated) shall be acceptable for measurement of ceiling diffuser performance only.

    2. System Performance Measuring Instruments:
        a. Provide insertion thermometers, sling psychrometers, tachometers, revolution counters, clamp-on volt-ammeter recorders, and other instruments as required to measure all facets of the complete HVAC system performance.

B. Performance Criteria:
   1. Instrumentation shall be in accordance with NEBB, AABC, or SMACNA requirements and shall be calibrated to the accuracy standards demanded by these organizations.

2.2 IDENTIFICATION

A. All equipment and component identification shall be provided in accordance with Section 10 14 00, Signage.

PART 3 - EXECUTION

3.1 INSPECTION

A. Heating, ventilating and air conditioning equipment and components shall be completely installed and in continuous operation, as required, to accomplish the testing, adjusting and balancing Work specified.

B. Inspect all HVAC equipment and components for proper operation prior to testing, adjusting and balancing.
   1. Fan Belt Deflection: Not less than 1/4-inch or more than 1/2-inch.
   2. Finned Coils: Plate type fins shall be combed out with a fin comb for the appropriate fin spacing. Helical fins shall be straightened with blunt bladed instrument.

C. Pre-Startup Inspection:
   1. Verify proper equipment mounting and setting.
   2. Verify that control, interlock and power wiring is complete.
   3. Verify alignment of motors and drives.
   4. Verify proper piping connections and accessories.
   5. Verify that lubrication is completed.

D. First Run Observations:
   1. Verify direction of rotation.
   2. Verify setting of safety controls.
   3. Monitor heat build-up in bearings.
   4. Check motor loads against nameplate data.

E. Equipment Check:
   1. Verify proper overload heater sizes.
   2. Verify function of safety and operating controls.
   3. Verify proper operation of equipment.
   4. Report on inspection, observation and checking procedures.

F. Promptly report defects which may affect the Work to ENGINEER.

G. Should corrective measures caused by faulty installation require re-testing, adjusting and balancing, such Work shall be at no additional cost to the DEPARTMENT.

3.2 APPLICATION

A. General:
   1. Test, adjust, and balance all systems, ductwork, piping, etc. and their control systems in accordance with the AABC National Standards for Total System Balance, NEBB Procedural Standards for Testing Adjusting Balancing of Environmental Systems, SMACNA HVAC Systems - Testing, Adjusting & Balancing Handbook, or in compliance with the standard procedure manual published by the testing, adjusting, and balancing organization affiliated with CONTRACTOR. CONTRACTOR shall submit one copy of the standard procedure manual to the ENGINEER for their records.
   2. CONTRACTOR shall provide all necessary instruments, tools, ladders, etc. to complete all testing, adjusting, and balancing Work.
   3. CONTRACTOR shall assume full responsibility for safe keeping of all instruments, tools, ladders, etc. during the course of the Work.
   4. CONTRACTOR shall be solely responsible for the protection and safeguarding of the Work and shall provide every protection against accidents, injury, and damage to persons and property.
   5. CONTRACTOR shall keep dust, dirt, and debris to an absolute minimum and reinstall all removed ceiling components to their original positions at the end of each day's Work.
   6. CONTRACTOR shall be fully responsible for removal and reinstallation of ceiling system and replacement of any component damaged.
   7. CONTRACTOR shall install additional access panels at no extra cost to the DEPARTMENT, as is required to gain access to equipment concealed above ceilings, behind walls, or any other concealed space.
   8. Systems shall be tested, adjusted, and balanced with clean filters and strainers.

B. Air Systems:
   1. Preliminary:
      a. Identify and list size, type and manufacturer of all equipment to be tested, including air terminals.
   2. 2. Central Systems:
      a. Test rpm for all equipment, including adjusting of each fan, air handling unit, and air conditioning unit to design requirements within the limits of mechanical equipment provided.
      b. Test and record motor voltages and running amperes including motor nameplate data, and starter heater ratings for each unit as listed above.

c. Make pitot tube traverse of main supply, exhaust and return ducts, determine airflow at all fans and units and adjust fans and units to within five percent of design requirements.
d. Test and record system static pressure, suction and discharge.
e. Test and adjust system for design outside air, (cfm).
f. Test and adjust system for design recirculated air, (cfm).
g. Test and record heating apparatus entering air temperatures, (dry bulb).
h. Test and record cooling apparatus entering air temperatures, (dry bulb and wet bulb).
i. Test and record heating apparatus leaving air temperatures, (dry bulb).
j. Test and record cooling apparatus leaving air temperatures, (dry bulb and wet bulb).
k. Record all fan and air handling unit speeds.
l. Record air quantity delivered by each fan and air-handling unit.

3. Distribution:
   a. Sheave and belt replacement shall be provided as the first means of accomplishing the balancing Work before volume dampers are adjusted from their initial open positions.
   b. Adjust volume dampers, control dampers, splitter dampers, etc., to proper design airflow in main ducts, branch ducts, and zones.
4. Air Terminals:
   a. Identify each air terminal as to location and determine required flow reading.
   b. Test and adjust each air terminal to within tolerance of design requirements as listed below.
      1) Positive Zones:
         a) Diffusers and Supply Air Terminals: 0 percent to +10 percent.
         b) Exhaust and Return Air Terminals: 0 percent to -10 percent.
      2) Negative Zones:
         a) Diffusers and Supply Air Terminals: 0 percent to -10 percent.
         b) Exhaust and Return Air Terminals: 0 percent to +10 percent.
      3) Neutral Zones:
         a) All Air Terminals: -10 percent to +10 percent.
         b) Test procedure on air terminals shall include recording comparison of required airflow and observed airflow, adjustment of terminal, and recording of final airflow.
         c) Adjust flow patterns from air terminal units to minimize drafts to the extent that the design and equipment permits.
5. Verification:
   a. Prepare summation of readings of observed airflow for each system, compare with required airflow, and verify that duct losses are within specified allowable range.
   b. Verify design airflow at fans as described above.

c. If determined that the air system has not been properly balanced, CONTRACTOR shall rebalance and recheck all equipment and components in the presence of the ENGINEER and as accepted by the ENGINEER.

3.3 SCHEDULES

A. Test, adjust, and balance all HVAC equipment.

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SECTION 23 31 13

METAL DUCTWORK

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, tools, equipment and incidentals as shown, specified and required to furnish and install metal ductwork complete and operational with accessories.
   2. The Work shall comply with vibration, seismic, and wind control requirements in Section 40 05 96, Vibration, Seismic, and Wind Controls.

B. Coordination:
   1. Review installation procedures under this and other Sections and coordinate the installation of items that must be installed with, or before, the metal ductwork Work.
   2. Notify other Contractors in advance of the installation of metal ductwork to provide other contractors with sufficient time for the installation of items included in their contracts that must be installed with, or before, the metal ductwork Work.

C. Related Sections:
   1. Section 10 14 00, Signage.
   2. Section 23 05 29, Hangers and Supports for HVAC Ductwork, Piping, and Equipment.
   3. Section 23 05 93, Testing, Adjusting, and Balancing for HVAC.
   4. Section 40 05 96, Vibration, Seismic, and Wind Controls.

1.2 REFERENCES

A. Air Movement and Control Association International, Inc. (AMCA).
   1. AMCA Standard 500-D – Laboratory Methods of Testing Dampers for Rating.
   2. AMCA Publication 511 – Certified Ratings Program - Product Rating Manual for Air Control Devices.

B. American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE).
   1. ASHRAE Standard 52.2 – Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size.

C. American Society for Testing and Materials (ASTM).
   1. ASTM E84 – Standard Test Method for Burning Characteristics of Building Materials.

2. ASTM B209 – Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
3. ASTM A653/A653M – Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.

D. American Welding Society (AWS).
1. AWS B2.1 – Specification for Welding Procedure and Performance Qualification.

E. National Bureau of Standard's Voluntary Product Standard.
1. NBS PS 15-69 – Standard for Contact-Molded Reinforced Polyester Chemical Resistant Process Equipment.

F. National Fire Protection Association (NFPA).
1. NFPA 90A – Standard for the Installation of Air-Conditioning and Ventilating Systems.
2. NFPA 90B – Standard for the Installation of Warm Air Heating and Air-Conditioning Systems.
3. NFPA 701 – Standard Methods of Fire Tests for Flame Propagation of Textiles and Films.

G. Sheet Metal and Air Conditioning Contractors National Association (SMACNA).
1. Fire, Smoke and Radiation Damper Installation Guide for HVAC Systems.
2. HVAC Duct Construction Standards – Metal and Flexible.
3. Round Industrial Duct Construction Standards.
4. Rectangular Industrial Duct Construction Standards.

H. Underwriters Laboratories Inc. (UL).
1. UL 181 – Factory-Made Air Ducts and Air Connectors.
2. UL 181A – Closure Systems for Use With Rigid Air Ducts.
3. UL 181B – Closure Systems for Use With Flexible Air Ducts and Air Connectors.
4. UL 555 – Fire Dampers.
5. UL 555S – Smoke Dampers.
6. UL 900 – Air Filter Units.

1.3 QUALITY ASSURANCE

A. Qualifications:
1. Manufacturer:
   Minimum of five years of experience producing substantially similar equipment and able to show evidence of at least five installations in satisfactory operation for at least five years.
2. Installer:
   a. Engage an experienced installer to perform the work of this Section who has specialized in installing metal ductwork similar to that required for this Project and who is acceptable to manufacturer.

b. Submit name and qualifications to ENGINEER along with the following information on a minimum of three successful projects:
   1) Names and telephone numbers of owners, architects or engineers responsible for projects.
   2) Approximate contract cost of the metal ductwork.
   3) Amount of area installed.

3. Welding:
   a. Qualify processes and operators in accordance with AWS B2.1 as appropriate for material to be welded.
   b. Provide certification that operators employed on or to be employed for the Work have satisfactorily passed AWS qualification tests within previous 12 months. Ensure that all certifications are current.

B. Regulatory Requirements:
   1. National Electrical Code (NEC).
   2. National Fire Protection Association (NFPA).
   3. Underwriters Laboratories Inc. (UL).
   4. Local and State Building Codes and Ordinances.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Shop Drawings:
      a. Drawings showing fabrication methods, assembly, accessories, and installation details.
      b. 1/4-inch scale duct layouts, dimensioned to show length of runs, sizes, support spacing and expansion provisions.
      c. Detailed installation drawing of each individual component showing:
         1) Mounting requirements.
         2) Locations.
      d. Setting drawings, templates, and directions for the installation of anchor bolts and other anchorages.
   2. Product Data:
      a. Manufacturer's literature, illustrations, specifications, weight, wall thicknesses, design pressures, dimensions, required clearances, materials of construction, and performance data for all equipment.
      b. Complete component list.
      c. Detailed description of each component.
      d. Catalog cut sheets for each component.
      e. Deviations from Contract Documents. Any exceptions to the Contract Documents must be clearly defined. CONTRACTOR shall be responsible for any additional expenses that may occur due to any exception made.
      f. Other technical data related to specified material and equipment as requested by ENGINEER.

B. Informational Submittals: Submit the following:
   1. Certificates:

a. Certification that all stainless steel ductwork, accessories, and hardware are of the Type specified.

2. Manufacturer Instructions:
   a. Instructions and recommendations for handling, storing, protecting the equipment.
   b. Installation Data.
3. Source Quality Control Submittals:
   a. Factory test reports.
4. Field Quality Control Submittals:
   a. Written report presenting results of required field testing.
5. Supplier Reports:
   a. Submit written report of results of each visit to Site by Supplier's service personnel, including purpose and time of visit, tasks performed, and results obtained. Submit within two days of completion of visit to the Site.
6. Qualifications Statements:
   a. Manufacturer, when requested by ENGINEER.
   b. Installer, when requested by ENGINEER.
   c. Welding, when requested by ENGINEER.

C. Closeout Submittals: Submit the following:
1. Record Documentation:
   a. During progress of the Work keep an up-to-date set of the Drawings showing field and Shop Drawing modifications. Immediately upon completion of the Work, submit "pdf" of CADD drawings showing the actual in place installation of all ductwork and equipment installed under this Section at a scale satisfactory to the CITY. The drawings shall show all ductwork on plans and in sections, with all reference dimensions and elevations required for complete Record Drawings of the systems. Two paper prints shall also be furnished. The prints and electronic copies of the CADD files shall be furnished no later than 30 days after completion of the Contract and prior to final payment.

1.5 DELIVERY, STORAGE AND HANDLING

A. Packing, Shipping, Handling and Unloading:
1. Deliver materials to the Site to ensure uninterrupted progress of the Work.
2. Deliver anchor bolts and anchorage devices, which are to be embedded in cast-in-place concrete, in ample time to prevent delay of that Work.
3. Comply with manufacturer's recommendations for rigging of equipment.

B. Storage and Protection:
1. Store materials to permit easy access for inspection and identification. Keep all material off the ground, using pallets, platforms, or other supports. Protect steel members and packaged materials from corrosion and deterioration.
2. Store all equipment in covered storage off the ground and prevent condensation and in accordance with the manufacturer's recommendations for long-term storage.

C. Acceptance at Site:
   1. All boxes, crates and packages shall be inspected by CONTRACTOR upon delivery to the Site. CONTRACTOR shall notify ENGINEER, in writing, if any loss or damage exists to equipment or components. Replace lost equipment or components and repair damage to new condition, in accordance with manufacturer's instructions.

1.6 SITE CONDITIONS

A. Existing Conditions:
   1. The Contract Documents show the general arrangement and extent of the Work to be done. The exact location and arrangement of all parts shall be determined as the Work progresses. The exact location of all parts of the Work is governed by the general building plans and the actual building conditions.
   2. The Drawings are intended as an indication of the arrangement of equipment and ductwork and are as nearly correct as can be determined in advance of the actual construction of the Work. Equipment, ductwork, and appurtenances found to interfere with the construction of the building, plumbing apparatus and piping, electrical wiring or other obstructions, etc., must be changed in location to clear such obstructions.

PART 2 - PRODUCTS

2.1 SYSTEM PERFORMANCE

A. System Description:
   1. The Drawings show the general arrangement of all systems. Should local conditions necessitate rearrangement of the systems, CONTRACTOR, before proceeding with the Work, shall prepare and submit complete drawings showing all details of the proposed rearrangement for written approval.
   2. The connections shown to the various units are intended as an indication only. The actual connections at the time of installation to be made and arranged to suit the requirements of each case and adequately provide for expansion and minimize the amount of space required for the same.
   3. The Drawings do not show all offsets, fittings, accessories and details, which may be required. CONTRACTOR shall carefully examine all of the General Construction, Electrical, Mechanical, Structural and other Drawings and the respective Specifications for conditions which may affect the installation of the Work, and shall arrange the Work accordingly, furnishing all required items to meet such conditions which are not specified as work "by others," to complete the systems to the true extent of the Contract Documents.

B. Design Criteria:
   1. All sheet metal construction shall be in accordance with the construction details and installation details in the latest edition of the SMACNA HVAC Duct Construction Standards. This Standard is hereinafter referred to as HVAC DS.

2. Sheet metal construction shall conform to the following minimum pressure classification (positive and negative pressure), unless otherwise shown or specified:
    a. Ductwork serving process spaces: 3-inch W.G.

2.2 DETAILS OF MATERIALS

A. Material Type:
    1. Aluminum ductwork shall be Alloy 3003 – H-14 in accordance with ASTM B209.
        a. All accessories for aluminum ductwork shall be aluminum, unless noted otherwise.

B. Duct construction alternatives (duct gauge in relation to reinforcement spacing) selected by CONTRACTOR from HVAC DS Tables shall be identified by duct system and shall be submitted in schedule form to the ENGINEER prior to beginning installation of ductwork. CONTRACTOR shall construct ductwork to meet the requirements of the HVAC DS Tables in conjunction with the minimum duct thickness schedules in Article 3.10 below.

C. Thickness of aluminum ductwork and size and thickness of stiffeners shall be appropriately converted using the aluminum conversion tables in the HVAC DS.

D. Rectangular ductwork longitudinal seams shall be Pittsburgh Lock type with permanently elastomeric sealant applied continuously within the seam.

E. Round ductwork seams shall be spiral lock seam.

F. Duct reinforcement shall be made using external stiffener angles. Tie rods shall not be acceptable. Stiffener angles shall be constructed of the same material as the ductwork.

G. Transverse Joints:
    1. Manufacturer: Provide product of one of the following:
        a. Ductmate Industries, Inc.
        b. Elgen Manufacturing Company, Inc.
        c. Or equal.
    2. Ductwork shall be connected by a mechanical joining system, except where otherwise noted.
    3. Manufacturer's installation instructions will be followed, except where otherwise noted.
    4. SMACNA T-24 and other flange type connectors formed from the duct edge will NOT be allowed.
    5. All connectors shall meet or exceed the functional criteria outlined in the HVAC DS and shall be constructed of the same material as the ductwork.

H. Turning Vanes:
   1. Manufacturer: Provide product of one of the following:
      a. Ductmate Industries, Inc.
      b. Elgen Manufacturing Company, Inc.
      c. C.L. Ward & Family, Inc.
      d. Or equal.
   2. Material: Same material as ductwork.
   3. Ducts 24-inches or shorter:
      a. Vanes: Single thickness.
      b. Runners: Type 2.
   4. Ducts taller than 24-inches:
      a. Vanes: Double thickness.
      b. Runners: Type 1.

I. Splitter Dampers:
   1. Reference: HVAC DS.
   2. Material: Same material as ductwork.

J. Transitions and Offsets:
   1. Reference: HVAC DS.
   2. Material: Same material as ductwork.

K. Branch Take-Offs:
   1. Reference: HVAC DS.
   2. Material: Same material as ductwork.
   3. 45 degrees, NO straight taps, unless specifically shown.

L. Rectangular Square Throat Elbows:
   1. Reference: HVAC DS.
   2. Material: Same material as ductwork.
   3. Provided with turning vanes.

M. Rectangular Radius Elbows and Round Elbows:
   1. Reference: HVAC DS.
   2. Material: Same material as ductwork.
   3. Centerline Radius: R=1.5W, unless specifically shown otherwise.

N. Round Converging Flow Fittings:
   1. Converging flow fittings shall be constructed with a radius entrance to all branch taps and with no excess material projecting from the body into the branch tap entrance.
   2. Branch entrances shall be by means of factory-fabricated fittings or factory fabricated duct tap assemblies.

O. Seal Class:
   1. Class B – Ductwork constructed with a minimum pressure classification (positive and negative pressure) less than 4-inch W.G.

P. Leakage:
   1. Not to exceed five percent.

Q. Flexible duct or duct constructed of fiberglass duct board shall not be permitted, except where specifically shown or indicated.

2.3 ACCESSORIES

A. Hangers and Supports:
   1. Hangers and supports shall be provided in accordance with Section 23 05 29, Hangers and Supports for HVAC Ductwork, Piping, and Equipment.

B. Volume Dampers (for Rectangular Ductwork):
   1. Dampers for Aluminum Ductwork:
      a. Design and Performance Criteria (based on 48-inch damper width):
         1) Dampers shall be performance rated and certified in accordance with AMCA Standard 500-D and AMCA Publication 511.
         2) Maximum Design Total Static Pressure: 5.2-inch W.G.
         3) Damper Leakage: Class 1 Leakage Rated – Not more than 8 cfm per square foot at 4-inch W.G. with blade seals.
         4) Certification: Manufacturer shall submit certified test data.
      b. Product and Manufacturer: Provide one of the following:
         1) Model CD50, as manufactured by Ruskin.
         2) Model VCD-40, as manufactured by Greenheck Fan Corporation.
         3) Or equal.
      c. Details of Construction:
         1) Material: 6063-T5 aluminum.
         2) Frame: 0.125-inch thick hat channel with mounting flanges.
         3) Single Section Sizes:
            a) Minimum: 6-inch wide by 9-inch high.
            b) Maximum: 60-inch wide by 72-inch high.
         4) Blades:
            a) 6-inch wide.
            b) Opposed blades.
            c) Airfoil shape with heavy gauge 6063-T5 aluminum double skin construction.
            d) EPDM edge seals for motorized control dampers only.
         5) Linkage: Concealed in frame outside the air stream.
         6) Axles: 1/2-inch plated steel hex.
         7) Bearings: Molded synthetic.
         8) Jamb Seals: Flexible metal compressible type.
         9) Provide Type 304 stainless steel outside handle, quadrant with 2-inch standoff and approved position indicator with locking device for all volume dampers.

C. Volume Dampers (for Round Ductwork):
   1. Dampers for Aluminum Ductwork:
      a. Design and Performance Criteria (based on 48-inch damper diameter):

1) Dampers shall be performance rated and certified in accordance with AMCA Standard 500-D and AMCA Publication 511.
2) Maximum Design Total Static Pressure: 4.0-inch W.G.
3) Damper Leakage: Not more than 11.30 cfm total at 1-inch W.G. with blade seals.
4) Certification: Manufacturer shall submit certified test data.

b. Product and Manufacturer: Provide one of the following:
1) Model CDRS82, as manufactured by Ruskin.
2) Or equal.

c. Details of Construction:
1) Material: Same as ductwork.
2) Frame: Minimum 16 gauge frame with 12 gauge mounting flanges.
3) Single Section Sizes:
a) Minimum: 4-inch diameter.
b) Maximum: 48-inch diameter.
4) Blades:
a) Minimum 16 gauge double skin construction with material same as ductwork.
b) EPDM continuous edge seals with pin angle stops for motorized control dampers only.
5) Axles: Minimum 1/2-inch with material same as ductwork.
6) Bearings: Stainless steel sleeve.
7) Provide outside handle, quadrant with 2-inch standoff and approved position indicator with locking device constructed from same material as ductwork for all volume dampers.

D. Access Doors:
1. Provide access doors for all fire and smoke dampers, control dampers, and other duct mounted devices where required to be accessible.
2. Access doors for fire and smoke dampers shall not affect the integrity of fire-resistance-rated assemblies. The access openings shall not reduce the fire-resistance rating of the assembly.
3. Access doors for fire and smoke dampers shall be labeled “FIRE/SMOKE DAMPER ACCESS”, “SMOKE DAMPER ACCESS”, or “FIRE DAMPER ACCESS” with minimum 1/2-inch high letters.
4. Reference: HVAC DS.
5. Material: Same as ductwork.
6. For Rectangular Ductwork:
a. Type: Gasketed cam lock covers.
b. Unless otherwise specified rectangular access doors shall be:
1) 12 by X-2-inches for ducts X-inches and smaller less than 14-inches.
2) 24 by 12-inches for ducts between 14 and 36-inches.
3) 24 by 24-inches for ducts between 36 and 60-inches.
4) Two 24 by 24-inch doors for ducts larger than 61-inches.
7. For Round Ductwork:
a. Type: Industrial oval gasketed access door with locking hand wheels.
b. Unless otherwise specified oval access door sizes shall be:

Duct Diameter:	Nominal Opening:
8 thru 18-inches:	10 by 6-inches.
19 thru 48-inches:	16 by 12-inches.
49 thru 72-inches:	24 by 18-inches.

E. Flexible Connectors (FC):
   1. Design and Performance Criteria:
      a. Flexible connectors shall be tested in accordance with UL 181.
      b. Flexible connectors shall be listed and labeled as Class 0 or Class 1 flexible connectors.
      c. Flexible connectors shall meet NFPA 90A, NFPA 90B, NFPA 701, and local building codes.
      d. Maximum Design Total Static Pressure: 10.0-inch W.G.
      e. Temperature Range: -65 degrees F to 500 degrees F.
      f. Width: Minimum 4 inches, but shall not exceed 14 inches.
   2. Product and Manufacturer: Provide one of the following:
      a. Model Thermafab, as manufactured by Duro Dyne Corporation.
      b. Model PROflex, as manufactured by Ductmate Industries, Inc.
      c. Or equal.
   3. Details of Construction:
      a. Base Fabric: Woven fiberglass.
      b. Coating: Silicone rubber.
      c. Weight: 17 ounce per square yard.
      d. Tensile Strength: 200 lb by 250 lb.
      e. Tear Strength: 50 lb by 40 lb.
      f. Features:
         1) Excellent high temp resistance.
         2) Excellent low temp resistance.
         3) Excellent chemical resistance.
         4) Excellent low smoke emission.
         5) Excellent ozone resistance.
         6) Excellent weathering.
         7) Unaffected by mildew.
      g. Metal connectors shall be of the same material and gauge as ductwork with double-lock fold.

F. Flexible Duct:
   1. Product and Manufacturer: Provide one of the following:
      a. Model FW1, as manufactured by Hosecraft.
      b. Or equal.
   2. Details of Construction:
      a. Heavy duty 2-ply aluminized fiberglass construction.
      b. Corrosion resistant metal helix.
      c. Pressure Rating for 4-inch diameter: 4 psig
      d. Vacuum Rating for 4-inch diameter: 2.7 inches mercury
      e. Compression Ratio: 4 to 1
      f. Weight: 1.34 lbs per foot

g. Temperature Range: -20°F to 600°F
3. Provide connectors for attachment to ductwork and equipment.

G. Miscellaneous Duct Fittings:
1. Reference: HVAC DS.
2. Material: Same material as ductwork.

H. Sleeves:
1. Material: Same material as ductwork passing through opening.
2. Thickness: Minimum 24-gauge.
3. Calk airtight with fire resistant sealant between sleeve and ductwork.

I. Duct Gaskets:
1. Product and Manufacturer: Provide one of the following:
a. Model 440 Gasket Tape, as manufactured by Ductmate Industries, Inc.
b. Model 440 Butyl Gasket, as manufactured by Elgen Manufacturing Company, Inc.
c. Or equal.
2. Material: Non-hardening butyl.
3. Service Temperatures: -30 degrees F to 180 degrees F.
4. Service Life: 20 years minimum.
5. Gaskets shall have the following Fire Hazard Classifications in accordance with ASTM E84:
a. Flame Spread: 10 maximum.
b. Smoke Developed: 10 maximum.

J. Hardware and Fasteners:
1. All hardware and fasteners for aluminum and stainless steel ductwork shall be Type 316 stainless steel, unless noted otherwise.
2. All hardware and fasteners for galvanized ductwork shall be G90 hot dipped galvanized steel, unless noted otherwise.

K. Grilles and Diffusers:
1. General:
a. Aluminum grilles and diffusers not mounted in hung ceilings shall have a clear anodized finish.
b. Where registers are shown to be provided in lieu of grilles, include an integral opposed blade damper of the same construction as the grille.
2. Supply Grilles (SG):
a. Product and Manufacturer: Provide one of the following:
1) Aluminum construction:
a) Model X20, as manufactured by Anemostat.
b) Model A54, as manufactured by Tuttle & Bailey.
c) Model 300FL, as manufactured by Titus.
d) Or equal.
b. Double deflection with horizontal face bars for horizontal duct and vertical face bars for vertical duct.
c. 3/4-inch blade spacing.

d. For surface mounting as shown or indicated on Drawings.

3. Return/Exhaust Grilles (RG/EG):
   a. Product and Manufacturer: Provide one of the following:
      1) Aluminum construction:
         a) Model X30, as manufactured by Anemostat.
         b) Model A70, as manufactured by Tuttle & Bailey.
         c) Model FL, as manufactured by Titus.
         d) Or equal.
   b. Single 0- or 45-degree deflection with horizontal face bars for horizontal duct and vertical face bars for vertical duct.
   c. 3/4-inch blade spacing.
   d. For surface mounting as shown or indicated on Drawings.
4. Drum Grilles (DG):
   a. Product and Manufacturer: Provide one of the following:
      1) Aluminum construction:
         a) Model IJ, as manufactured by Anemostat.
         b) Model STRJ, as manufactured by Tuttle & Bailey.
         c) Model DL, as manufactured by Titus.
         d) Or equal.
   b. Adjustable direction and length of airstream.
   c. Single bank of adjustable vanes in a rotating barrel with full perimeter gasket locked into barrel frame.
   d. Adjustable barrel with up to 60 degrees of rotation (30 degrees up or down).
   e. Minimum 3-inch vane spacing.
   f. For surface mounting as shown or indicated on Drawings.

L. Insulation:
1. All Infrared radiant heating outside air intake ductwork shall be insulated with minimum 2 inches thick insulation.
2. All supply and return air ductwork located outside associated with DAHU-1 shall be insulated with minimum 3 inches thick insulation.
3. Type: Rigid fiberglass board with vapor barrier facing.
4. Density: Minimum six pound per cubic foot.
5. Facing: Foil-Scrim-Kraft (FSK).
6. Maximum Thermal Conductivity: 0.22 Btu in/hr-sq ft-degree F at 75 degrees F mean temperature.
7. Water Vapor Transmission: Maximum 0.05 perm.

M. Insulation Covering:
1. All indoor and outdoor ductwork insulation shall be provided with insulation covering.
2. Product and Manufacturer: Provide one of the following:
   a. VentureClad Plus as manufactured by VentureTape.
   b. Polyguard as manufactured by Alumaguard.
   c. FlexClad as manufactured by MFM Building Products.
   d. Or equal.
3. Type: Weatherproof laminate covering.

4. Material: Heavy duty multilayered laminate coated with acrylic pressure sensitive adhesive.
5. Thickness: 24 mills.
6. Tensile Strength: 188 Lbs/in
7. Puncture: 80 Lbs.
8. Emittance: 0.03
9. Water Vapor Transmittance: 0.00 Perm
10. Temperature Rating: -40 to 248 degrees F.
11. Fastening: Self-adhering adhesive.
12. Finish: Embossed Aluminum

2.4 IDENTIFICATION

A. All equipment and component identification shall be provided in accordance with Section 10 14 00, Signage.

2.5 SOURCE QUALITY CONTROL

A. Shop Tests:
   1. Equipment shall be completely manufactured and pre-assembled in accordance with Reference Standards. Perform the following tests and inspections at factory before shipment:
      a. Tested and inspected for approval as a unit by Underwriters Laboratories Inc., UL Label or equal.
      b. Factory test equipment to ensure that the entire package has been properly fabricated and assembled, that all the controls function as specified herein and that the package meets the specified performance requirements including manufacturer's data report.

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine conditions under which materials and equipment will be installed and notify ENGINEER in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions are corrected.

B. Take field measurements where required prior to installation to ensure proper fitting of Work.

3.2 PREPARATION

A. Protection of Surrounding Areas/Surfaces:
   1. Openings and penetrations shall be capped to protect the building from outside conditions.

2. Properly cap the open ends of all ductwork at the end of each day's Work or other stopping point throughout the construction. Equipment shall be tightly covered and protected against dirt, water, and chemical or mechanical damage.

3.3 INSTALLATION

A. General:
   1. Install the equipment in accordance with the Contract Documents and by manufacturer's instructions and recommendations. Obtain written interpretation from ENGINEER in the event of conflict between manufacturer's instructions and recommendations and the Contract Documents.
   2. Install in accordance with Laws and Regulations.
   3. Do not modify structures to facilitate installation of equipment, unless approved in writing by ENGINEER.
   4. Installation to conform to requirements of all local and state codes.

B. All ductwork shall conform accurately to the dimensions shown, the ducts shall be straight and smooth inside with joints neatly finished. Ductwork shall be installed so as to preclude the possibility of vibration under all operating conditions.

C. Tape and seal all joints in accordance with HVAC DS. Tape shall not be used as the primary means of sealing. Tape used in sealing metallic ductwork shall be listed and labeled in accordance with UL 181A and shall be marked "181 A-P" for pressure-sensitive tape, "181 A-M" for mastic or "181 A-H" for heat-sensitive tape. Tape used in sealing flexible ductwork and connectors shall be listed and labeled in accordance with UL 181B and shall be marked "181 B-FX" for pressure-sensitive tape or "181 B-M" for mastic.

D. Fire dampers shall be provided and installed where indicated and where required by UL and authorities having jurisdiction, and shall be approved by local building codes and in accordance with the requirements of the NFPA.

E. Install all ductwork and accessories to provide a system free from buckling, warping, bellowing, or vibration.

F. All ducts at flexible connections with fans shall be supported at free end within 12-inches of flexible connection.

G. Provisions shall be made for supporting all ductwork, dampers, and other ductwork accessories, where necessary.

3.4 ADJUSTING

A. All duct systems shall be tested, adjusted, and balanced per Section 23 05 93, Testing, Adjusting, and Balancing for HVAC.

B. Test openings shall be installed in the ductwork as directed by the testing, adjusting, and balancing subcontractor. Test openings shall be sealed by a screw cap and gasket.

3.5 CLEANING

A. Thoroughly clean all ductwork and accessories prior to installation.

B. Remove all dirt, rust, dust, etc. from ductwork and accessories after installation.

C. Remove and dispose of all debris and waste from the Site resulting from installation.

3.6 SCHEDULES

A. Minimum Duct Thicknesses:
   1. Ductwork serving process spaces: One gauge thicker than recommended in the HVAC DS for the same pressure classification, reinforcement and support spacing.

B. All ductwork shall be aluminum.

C. Ductwork materials not specified above or on the Drawings shall be constructed of aluminum, unless otherwise directed by ENGINEER.

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SECTION 23 51 23

GAS VENTS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, tools, equipment and incidentals as shown, specified and required to furnish and install gas vents complete and operational with accessories.

B. Coordination:
   1. Review installation procedures under this and other Sections and coordinate the installation of items that must be installed with, or before, the gas vents Work.
   2. Notify other contractors in advance of the installation of gas vents to provide other contractors with sufficient time for the installation of items included in their contracts that must be installed with, or before, the gas vents Work.

C. Related Sections:
   1. Section 23 05 29, Hangers and Supports for HVAC Ductwork, Piping, and Equipment.

1.2 REFERENCES

A. American National Standards Institute (ANSI).

B. Underwriters Laboratories Inc. (UL).
   1. UL 1738 – Venting Systems for Gas-Burning Appliances, Categories II, III, and IV.

1.3 QUALITY ASSURANCE

A. Qualifications:
   1. Manufacturer:
      a. Minimum of five years of experience producing substantially similar material and able to show evidence of at least five installations in satisfactory operation for at least five.
   2. Installer:
      a. Engage an experienced installer to perform the work of this Section who has specialized in installing gas vents similar to that required for this Project and who is acceptable to manufacturer.
      b. Submit name and qualifications to ENGINEER along with the following information on a minimum of three successful projects:
         1) Names and telephone numbers of owners, architects or engineers responsible for projects.
         2) Approximate contract cost of the gas vents.

3) Amount of area installed.

B. Component Supply and Compatibility:
   1. Obtain all material included in this Section regardless of the component manufacturer from a single gas vent manufacturer.
   2. Require the gas vent manufacturer to review and approve or to prepare all Shop Drawings and other submittals for all components furnished under this Section.
   3. All components shall be specifically constructed for the specified service conditions and shall be integrated into the overall assembly by the gas vent manufacturer.

C. Regulatory Requirements:
   1. National Electrical Code (NEC).
   2. National Fire Protection Association (NFPA).
   3. Underwriters Laboratories Inc. (UL).
   4. Local and State Building Codes and Ordinances.
   5. Permits: CONTRACTOR shall obtain and pay for all required permits, fees and inspections.

D. Certifications:
   1. Gas vents shall bear an approved label with all the necessary identification marks and any necessary cautions as required by a nationally recognized testing laboratory or inspection agency acceptable to the code officials.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Shop Drawings:
      a. Drawings showing fabrication methods, assembly, accessories, installation details, and diagrams.
      b. 1/4-inch scale gas vent layouts, dimensioned to show length of runs, sizes, support spacing and expansion provisions.
      c. Detailed installation drawing of each individual component showing:
         1) Mounting requirements.
         2) Locations.
      d. Setting drawings, templates, and directions for the installation of anchor bolts and other anchorages.
   2. Product Data:
      a. Manufacturer's literature, illustrations, specifications, weight, dimensions, required clearances, materials of construction, and performance data for all equipment.
      b. Complete component list.
      c. Detailed description of each component.
      d. Catalog cut sheets for each component.
      e. Sealant Specification: Furnish sealant specification for type and grade required for material furnished.

f. Deviations from Contract Documents. Any exceptions to the Contract Documents must be clearly defined. CONTRACTOR shall be responsible for any additional expenses that may occur due to any exception made.
g. Other technical data related to specified material and equipment as requested by ENGINEER.

B. Informational Submittals: Submit the following:
1. Certificates:
a. Independent certification reports:
1) UL Label or equal.
2. Manufacturer Instructions:
a. Instructions and recommendations for handling, storing, protecting the material.
b. Installation Data.
3. Source Quality Control Submittals:
a. Factory test reports.
4. Supplier Reports:
a. Submit written report of results of each visit to Site by Supplier's service personnel, including purpose and time of visit, tasks performed, and results obtained. Submit within two days of completion of visit to the Site.
5. Qualifications Statements:
a. Manufacturer, when requested by ENGINEER.
b. Installer, when requested by ENGINEER.

C. Closeout Submittals: Submit the following:
1. Record Documentation:
a. During progress of the Work keep an up-to-date set of the Drawings showing field and Shop Drawing modifications. Immediately upon completion of the Work, submit "pdf" of CADD drawings showing the actual in place installation of all gas vents installed under this Section at a scale satisfactory to the CITY. The drawings shall show all gas vents on plans and in sections, with all reference dimensions and elevations required for complete Record Drawings of the systems. Two paper prints shall also be furnished. The prints and electronic copies of the CADD files shall be furnished no later than 30 days after completion of the Contract and prior to final payment.

D. Maintenance Material Submittals: Furnish the following:
1. Spare Parts:
a. Spare parts list and recommended quantities.
2. Tools:
a. Two sets of special tools, if any, required for normal operation and maintenance.
3. Spare parts, extra stock materials, and tools shall be packed in sturdy containers with clear indelible identification markings and shall be stored in a dry, warm location until transferred to the CITY at the conclusion of the Project.

1.5 DELIVERY, STORAGE AND HANDLING

A. Packing, Shipping, Handling and Unloading:
   1. Deliver materials to the Site to ensure uninterrupted progress of the Work.
   2. Deliver anchor bolts and anchorage devices, which are to be embedded in cast-in-place concrete, in ample time to prevent delay of that Work.

B. Storage and Protection:
   1. Store materials to permit easy access for inspection and identification. Keep all material off the ground, using pallets, platforms, or other supports. Protect steel members and packaged materials from corrosion and deterioration.
   2. Store all equipment in covered storage off the ground and prevent condensation and in accordance with the manufacturer's recommendations for long-term storage.

C. Acceptance at Site:
   1. All boxes, crates and packages shall be inspected by CONTRACTOR upon delivery to the Site. CONTRACTOR shall notify ENGINEER, in writing, if any loss or damage exists to equipment or components. Replace lost equipment or components and repair damage to new condition, in accordance with manufacturer's instructions.

PART 2 - PRODUCTS

2.1 SYSTEM PERFORMANCE

A. System Description:
   1. The Drawings show the general arrangement of all systems. Should local conditions necessitate rearrangement of the systems, CONTRACTOR, before proceeding with the Work, shall prepare and submit complete drawings showing all details of the proposed rearrangement for written approval.
   2. The connections shown to the various units are intended as an indication only. The actual connections at the time of installation to be made and arranged to suit the requirements of each case and adequately provide for expansion and minimize the amount of space required for the same.
   3. The Drawings do not show all offsets, fittings, accessories and details, which may be required. CONTRACTOR shall carefully examine all of the General Construction, Electrical, Mechanical, Structural and other Drawings and the respective Specifications for conditions which may affect the installation of the Work, and shall arrange the Work accordingly, furnishing all required items to meet such conditions which are not specified as work "by others," to complete the systems to the true extent of the Contract Documents.

B. Design Criteria:
   1. Gas vents shall be tested and listed to meet UL 1738.
   2. Gas vents shall be listed for ANSI Category I, II, III, or IV appliances.

C. Performance Criteria:
   1. Gas vents shall be suitable for continuous temperatures up to 550 degrees F.
   2. Gas vents shall be listed for operating in pressure services from -2-inch W.C. up to +8-inch W.C.

2.2 MANUFACTURERS

A. Manufacturer: Provide product of one of the following:
   1. Selkirk Corporation, Heatfab Division.
   2. Metal-Fab, Inc.
   3. Or equal.

2.3 DETAILS OF MATERIALS

A. Double Wall Gas Vent:
   1. Inner vent diameter sizes: 4-in through 32-in.
   2. Minimum 1-in air space between inner wall and outer wall.
   3. Inner Wall:
      a. Thickness: Minimum 0.015-in (28 gauge).
      b. Material: Superferritic AL29-4C stainless steel.
   4. Outer Wall:
      a. Thickness: Minimum 0.024-in (24 gauge).
      b. Material: Stainless steel.

2.4 ACCESSORIES

A. Provide manufacturer's approved Room Temperature Vulcanizing (RTV) sealant for all joints without a factory adhered seal.

B. Provide the following fittings and components as required for a complete system:
   1. Adjustable length sections.
   2. Ventilated roof or wall thimbles.
   3. Elbows.
   4. Tees (square, boot, barometric, and/or air intake).
   5. Tee cover with drain fitting.
   6. Tall cone flashing and support, pitched as required.
   7. Ventilation/finish/storm collars.
   8. Increasers/reducers.
   9. Draft hoods.
   10. Flue collar adapters.
   11. Vent connectors.
   12. Horizontal/vertical in-line drain sections.
   13. Rain caps.
   14. Screened terminations.

C. Structural Supports:
   1. CONTRACTOR shall provide and install all hangers, rods, supports (vertical, horizontal, guy, and/or floor), bolts, nuts, washers, inserts, and appurtenances as required to mount all gas vents.
   2. All hangers, rods, supports, bolts, nuts, washers, inserts, and appurtenances shall conform to Section 23 05 29, Hangers and Supports for HVAC Ductwork, Piping, and Equipment.

2.5 SOURCE QUALITY CONTROL

A. Shop Tests:
   1. Material shall be completely manufactured and pre-assembled in accordance with Reference Standards. Perform the following tests and inspections at factory before shipment:
      a. Tested and inspected for approval as a unit by Underwriters Laboratories Inc., UL Label or equal.
      b. Factory test material to ensure that the entire package has been properly fabricated and assembled as specified herein and that the package meets the specified performance requirements including manufacturer's data report.

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine conditions under which materials will be installed and notify ENGINEER in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions are corrected.

B. Take field measurements where required prior to installation to ensure proper fitting of Work.

3.2 PREPARATION

A. Protection of Surrounding Areas/Surfaces:
   1. Openings and penetrations shall be capped to protect the building from outside conditions.
   2. Properly plug or cap the open ends of all gas vents at the end of each day's Work or other stopping point throughout the construction. Material shall be tightly covered and protected against dirt, water, and chemical or mechanical damage.

3.3 INSTALLATION

A. General:
   1. Install the material in accordance with the Contract Documents and by manufacturer's instructions and recommendations. Obtain written interpretation from ENGINEER in the event of conflict between manufacturer's instructions and recommendations and the Contract Documents.

2. Install in accordance with Laws and Regulations.
3. Do not modify structures to facilitate installation of material, unless approved in writing by ENGINEER.
4. Installation to conform to requirements of all local and state codes.

B. Gas vents shall be installed and terminated in accordance with the manufacturer's installation instructions.

C. All gas vent systems shall conform accurately to the dimensions shown, the gas vents shall be straight and smooth inside with joints neatly finished. Gas vent systems shall be installed so as to preclude the possibility of vibration under all operating conditions.

D. Connect and seal all joints in accordance with the manufacturer's installation instructions using overlapping joints and mechanical locking bands or tabs.

E. Install all gas vent systems and accessories to provide a system free from buckling, warping, breathing or vibration.

F. Provisions shall be made for supporting all gas vent systems.

G. Provide condensate drains per manufacturer's installation instruction recommendations.

3.4 ADJUSTING

A. Adjust all controls for proper settings.

B. While system is operable, balance all equipment to achieve design conditions.

3.5 CLEANING

A. Thoroughly clean all gas vents and accessories prior to installation.

B. Remove all dirt, rust, dust, etc. from gas vents and accessories after installation.

C. Remove and dispose of all debris and waste from the Site resulting from installation.

3.6 SCHEDULES

A. All gas vents shall be double wall gas vent.

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SECTION 23 81 26

DUCTLESS SPLIT-SYSTEM AIR-CONDITIONERS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, tools, equipment and incidentals as shown, specified, and required to furnish and install ductless split-system air-conditioners complete and operational with accessories.
   2. The Work shall comply with vibration, seismic, and wind control requirements in Section 40 05 96, Vibration, Seismic, and Wind Controls.

B. Coordination:
   1. Review installation procedures under this and other Sections and coordinate the installation of items that must be installed with, or before, the ductless split-system air-conditioners Work.
   2. Notify other contractors in advance of the installation of the ductless split-system air-conditioners to provide other contractors with sufficient time for the installation of items included in their contracts that must be installed with, or before, the ductless split-system air-conditioners Work.

C. Related Sections:
   1. Section 05 05 33, Anchor Systems.
   2. Section 10 14 00, Signage.
   3. Section 23 05 29, Hangers and Supports for HVAC Ductwork, Piping, and Equipment.
   4. Section 26 28 16.33, Disconnect Switches.
   5. Section 40 05 96, Vibration, Seismic, and Wind Controls.

1.2 REFERENCES

A. Air-Conditioning, Heating, and Refrigeration Institute (AHRI).
   1. AHRI 210/240 – Performance Rating of Unitary Air-Conditioning and Air-Source Heat Pump Equipment.

B. American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE).
   1. ASHRAE Standard 15 – Safety Standard for Refrigeration Systems.

C. American Society for Testing and Materials (ASTM).
   1. ASTM E84 – Standard Test Method for Surface Burning Characteristics of Building Materials.

2. ASTM B117 – Standard Practice for Operating Salt Spray (Fog) Apparatus.
3. ASTM B280 – Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service.

D. National Electrical Code (NEC).

E. National Electrical Manufacturers Association (NEMA).

F. Underwriters Laboratories Inc. (UL).
   1. UL 1995 – Heating and Cooling Equipment.

1.3 QUALITY ASSURANCE

A. Qualifications:

   1. Manufacturer:
      a. Minimum of five years experience producing substantially similar equipment and shall be able to show evidence of at least five installations in satisfactory operation for at least five years.
      b. Manufacturer's facility, where equipment will be manufactured and tested, shall be ISO 9001:2000 certified. Manufacturer shall include a copy of the ISO 9001:2000 certificate with the submittals.

B. Component Supply and Compatibility:
   1. Obtain all equipment included in this Section regardless of the component manufacturer from a single ductless split-system air-conditioner manufacturer.
   2. Require the ductless split-system air-conditioner manufacturer to review and approve or to prepare all Shop Drawings and other submittals for all components furnished under this Section.
   3. All components shall be specifically constructed for the specified service conditions and shall be integrated into the overall equipment assembly by the ductless split-system air-conditioner manufacturer.

C. Regulatory Requirements:
   1. National Electrical Code (NEC).
   2. National Fire Protection Association (NFPA).
   3. Underwriters Laboratories Inc. (UL).
   4. Local and State Building Codes and Ordinances.

D. Certifications:

   1. Ductless split-system air-conditioners shall bear an approved label with all the necessary identification marks, electrical data, and any necessary cautions as required by the National Electric Code.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Shop Drawings:
      a. Drawings showing fabrication methods, assembly, accessories, installation details, and wiring diagrams.
      b. Detailed drawings of each individual component's wiring diagrams.
      c. Detailed drawings of control panel layout.
      d. Detailed installation drawing of each individual component showing:
         1) Mounting requirements.
         2) Locations (panel, field, etc.).
         3) Ductwork, piping, and wiring connections, labeled and coded.
      e. Setting drawings, templates, and directions for the installation of anchor bolts and other anchorages.
   2. Product Data:
      a. Manufacturer's literature, illustrations, specifications, weight, dimensions, required clearances, materials of construction, and performance data for all equipment.
      b. Complete component list.
      c. Detailed description of each component.
      d. Catalog cut sheets for each component.
      e. Fan performance curves with operating points.
      f. Deviations from Contract Documents. Any exceptions to the Contract Documents must be clearly defined. CONTRACTOR shall be responsible for any additional expenses that may occur due to any exception made.
      g. Lubricant Specification: Furnish lubricant specification for type and grade required for equipment furnished.
      h. Other technical data related to specified material and equipment as requested by ENGINEER.

B. Informational Submittals: Submit the following:
   1. Certificates:
      a. Certification of unit painting systems in accordance with "Finishing" Article in this Section.
      b. Independent certification reports:
         1) UL Label or equal.
         2) AHRI Label.
      c. Copy of manufacturer's ISO 9001:2000 certificate.
   2. Manufacturer Instructions:
      a. Instructions and recommendations for handling, storing, protecting the equipment.
      b. Installation Data.
      c. Instructions for handling, start-up, and troubleshooting.

3. Source Quality Control Submittals:
    a. Written report presenting results of required shop testing.
    b. Factory test reports.
4. Field Quality Control Submittals:
    a. Written report presenting results of required field testing.
5. Supplier Reports:
    a. Submit written report of results of each visit to Site by Supplier's service personnel, including purpose and time of visit, tasks performed, and results obtained. Submit within two days of completion of visit to the Site.
6. Qualifications Statements:
    a. Manufacturer, when requested by ENGINEER.

C. Closeout Submittals: Submit the following:
1. Operations and Maintenance Data:
    a. Submit complete Installation, Operation and Maintenance Manuals, including, test reports, maintenance data and schedules, description of operation, and spare parts information.
    b. Furnish Operation and Maintenance Manuals in conformance with the requirements of Section 01 78 23, Operations and Maintenance Data.
2. Warranty Documentation:
    a. General warranty.
    b. Special warranties on materials and equipment.

D. CONTRACTOR Maintenance Material Submittals: Furnish the following:
1. Spare Parts:
    a. Spare parts list and recommended quantities.
    b. One set of filters for each unit.
2. Tools:
    a. Two sets of fin combs for each fin spacing required.
3. Spare parts, extra stock materials, and tools shall be packed in sturdy containers with clear indelible identification markings and shall be stored in a dry, warm location until transferred to the CITY at the conclusion of the Project.

1.5 DELIVERY, STORAGE AND HANDLING

A. Packing, Shipping, Handling and Unloading:
1. Deliver materials to the Site to ensure uninterrupted progress of the Work.
2. Deliver anchor bolts and anchorage devices, which are to be embedded in cast-in-place concrete, in ample time to prevent delay of the Work.
3. Comply with manufacturer's recommendations for rigging of equipment.

B. Storage and Protection:
   1. Store materials to permit easy access for inspection and identification. Keep all material off the ground, using pallets, platforms, or other supports. Protect steel members and packaged materials from corrosion and deterioration.
   2. Store all equipment in covered storage off the ground and prevent condensation and in accordance with the manufacturer's recommendations for long-term storage.

C. Acceptance at Site:
   1. All boxes, crates and packages shall be inspected by CONTRACTOR upon delivery to the Site. CONTRACTOR shall notify ENGINEER, in writing, if any loss or damage exists to equipment or components. Replace lost equipment or components and repair damage to new condition, in accordance with manufacturer's instructions.

1.6 WARRANTY

A. General Warranty: The special warranties specified in this Article shall not deprive DEPARTMENT or CITY of other rights or remedies DEPARTMENT or CITY may otherwise have under the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by CONTRACTOR under the Contract Documents. The obligations of CONTRACTOR under the Contract Documents shall not be limited in any way by the provisions of the specified special warranties.

B. Special Warranties on Materials and Equipment:
   1. Provide manufacturer's written warranty, running to the benefit of DEPARTMENT and CITY, agreeing to correct, or at option of CITY, remove or replace materials or equipment specified in this Section found to be defective during a period of years as listed below after the date of Substantial Completion.
      a. Compressors shall carry a minimum 6-year non-prorated warranty.
      b. All other components not listed above shall carry a minimum 5-year non-prorated warranty.

PART 2 - PRODUCTS

2.1 EQUIPMENT PERFORMANCE

A. Equipment Description:
   1. Units shall be completely factory assembled and tested, and internally piped and wired. Units shall consist of indoor air conditioners (indoor units) with filters, evaporator coils, supply fans, motors, and remotely located outdoor air-cooled condensing units (outdoor units).
   2. Units shall include all unit mounted controls, wiring, and accessories.

3. Indoor units and refrigerant pipes shall be purged with dry air before shipment from the factory.
4. Outdoor units shall be pre-charged with refrigerant for a minimum of 70 feet of refrigerant tubing.

B. Design Criteria:
1. Design conditions shall be as indicated on the Equipment Schedule.
2. Units shall conform and be certified to the latest editions of ASHRAE Standard 15 and UL 1995.

C. Performance Criteria:
1. Minimum performance data for each unit shall be as indicated on the Equipment Schedule. Provided equipment shall not exceed scheduled total power.
2. Units shall meet or exceed the Energy Efficiency Ratio (EER) shown on the Equipment Schedule when tested in accordance to the latest editions of AHRI Standard 210/240.
3. Outdoor units shall be capable of cooling operation down to 23 degree F ambient temperature without additional low ambient controls.
4. Outdoor units shall be able to operate with a maximum height difference of 100 feet between indoor and outdoor units.
5. System shall be capable of operating up to a minimum refrigerant tubing length of 100 feet between indoor and outdoor units without the need for line size changes, traps or additional oil.

2.2 DETAILS OF EQUIPMENT

A. Ceiling Cassette Air Conditioners:
1. Product and Manufacturer: Provide one of the following:
   a. Model FCQ, as manufactured by Daikin
   b. Model PLA, as manufactured by Mitsubishi Electric.
   c. Or equal.
2. Cabinet:
   a. Cabinet shall be formed from galvanized sheet metal coated with high-density foam insulation.
   b. Cabinet shall be for recessed mounting and provided with four corner mounting supports behind removable corner pockets in grille assembly allowing adjustment of mounting height from front of unit.
   c. White grille assembly shall be attached to the front of the cabinet to provide supply air vanes in four directions and a center mounted return air section. Four-way grille shall allow two, three, or four-way blow.
   d. Cabinet panel shall have provisions for a field installed filtered outside air intake.
   e. Cabinet shall have a knock-out to provide a branch air duct for conditioning a secondary space.

3. Evaporator Coil:
    a. Coil shall be of nonferrous construction with pre-coated aluminum strake fins on copper tubing. All tube joints shall be brazed with PhosCopper or silver alloy.
    b. Coil shall be pressure tested at the factory.
    c. Coil shall be furnished with a condensate pan and drain.
    d. Unit shall include a built-in, automatic condensate lift mechanism that will be able to raise condensate 33 inches above the condensate pan. The lift mechanism shall be equipped with a positive acting liquid level sensor to shut down the indoor unit if liquid level in the drain pan reached maximum level.
4. Supply Fans:
    a. Direct drive, turbo propeller fan shall be driven by a single motor.
    b. Multi-speed fan motor shall have permanently lubricated bearings.
    c. Fan shall have a selectable AUTO fan setting that will adjust the fan speed based on the difference between controller setpoint and sensed space temperature.
5. Vanes:
    a. Motorized adjustable air outlet system shall provide two-way, three-way, or four-way airflow with switches that can be set to provide optimum airflow based on ceiling height and number of outlets used.
    b. Vane angles shall be individually adjustable from the remote controller to customize the airflow pattern for the conditioned space.
    c. Vanes shall have five fixed positions and a swing feature that shall be capable of automatically swinging the vanes up and down for uniform air distribution.
    d. Vanes shall have the selectable capability to randomly cycle the vanes up and down to evenly heat the space in the heating mode.
6. Filter:
    Return air shall be filtered by means of an easily removable, washable polypropylene honeycomb filter.

B. Outdoor Units:
1. Product and Manufacturer: Provide one of the following:
    a. Model RZQ, as manufactured by Daikin.
    b. Model PUY, as manufactured by Mitsubishi Electric.
    c. Or equal.
2. Cabinet:
    a. Casing shall be fabricated of galvanized steel.
    b. Mounting feet shall be provided and shall be welded to the base of the cabinet.
    c. Removable panel sections shall allow easy access to all serviceable parts.
    d. Fan grill shall be constructed from ABS plastic.

e. Cabinet mounting and construction shall be sufficient to withstand 155 MPH wind speed conditions for use in Hurricane condition areas.

3. Condenser Fans:
   a. Direct drive fan and motor shall be configured for horizontal discharge airflow.
   b. Fan blades shall be of aerodynamic design for quiet operation and the fan motor bearings shall be permanently lubricated.
   c. Fan shall be mounted in front of the coil, pulling air across it from the rear and dispelling it through the front.
   d. Fan shall be provided with a raised guard to prevent external contact with moving parts.
4. Condenser Coil:
   a. Coil shall be of copper tubing with flat aluminum fins.
   b. Coil shall be protected with an integral metal guard.
5. Compressors:
   a. Compressor shall be hermetically sealed, variable speed, rotary or scroll type. Compressor shall be equipped with an internal thermal overload.
   b. Compressor shall be driven by inverter circuit to control compressor speed.
   c. In lieu of a crankcase heater, minimal amount of current shall be automatically and intermittently applied to the compressor motor windings to maintain sufficient heat to vaporize any refrigerant during the off cycle to prevent liquid accumulation.
   d. Compressor shall be mounted so as to avoid transmission of vibration.
6. Refrigeration System:
   a. Refrigerant flow from the condenser shall be controlled by means of an electronic linear expansion valve (LEV) metering device. The LEV shall be control by a microprocessor controlled step motor.
   b. System shall include an accumulator, high pressure safety switch, refrigerant line filter driers (strainers), Schrader type service fittings (stop valves) for liquid and suction connections, and service ports.

2.3 ACCESSORIES

A. Hangers and Supports:
   1. Hangers and supports shall be provided in accordance with Section 23 05 29, Hangers and Supports for HVAC Ductwork, Piping, and Equipment.
   2. Hangers shall be provided at each of the four corner attachment points on the cabinet and supported from the building structure.

B. Refrigerant Piping:
   1. All refrigerant lines between outdoor and indoor units shall be of annealed, refrigeration grade copper tubing, Type ACR, meeting ASTM B280 requirements.

C. Condensate Piping:
   1. Type K, hard drawn temper copper tube conforming to the requirements of ASTM B88.

D. Refrigerant and Condensate Piping Insulation:

   1. Product and Manufacturer: Provide one of the following:
      a. Model Armaflex Tube Insulation, as manufactured by Armacell.
      b. Model Insul-Tube Insulation, as manufactured by K-Flex USA.
      c. PermaTherm
      d. Or equal.
   2. Refrigerant suction and condensate piping shall be individually insulated in 1-inch twin-tube, flexible, closed-cell, CFC-free (ozone depletion potential of zero), elastomeric material.
   3. Insulation shall have a maximum Flame Spread Index of 25 and a maximum Smoke Developed Index of 50 when tested in accordance with ASTM E84.
   4. Density: Minimum three pound per cubic foot.
   5. Thermal Conductivity: Maximum 0.25 Btu-in/hr-sq ft-degree F at 75 degrees F mean temperature.
   6. Water Vapor Transmission: Maximum 0.05 perm.
   7. Provide manufacturer's approved contact adhesive for sealing seams and butt joints.

E. Refrigerant and Condensate Piping Insulation Covering:
   1. Provide insulation covering on all insulated indoor and outdoor piping.
   2. Product and Manufacturer: Provide one of the following:
      a. VentureClad Plus as manufactured by VentureTape.
      b. Polyguard as manufactured by Alumaguard.
      c. FlexClad as manufactured by MFM Building Products.
      d. Or equal.
   3. Type: Weatherproof laminate covering.
   4. Material: Heavy duty multilayered laminate coated with acrylic pressure sensitive adhesive.
   5. Thickness: 24 mills.
   6. Tensile Strength: 188 Lbs/in
   7. Puncture: 80 Lbs.
   8. Emittance: 0.03
   9. Water Vapor Transmittance: 0.00 Perm
   10. Temperature Rating: -40 to 248 degrees F.
   11. Fastening: Self-adhering adhesive.
   12. Finish: Embossed Aluminum

F. Indoor units shall be provided with a condensate mini-pump that is capable of lifting condensate 23 inches above the drain pan.

G. Outdoor units shall be provided with wind baffle and shall be capable of low ambient cooling operation down to 0°F.

2.4 FINISHING

A. Outdoor units shall be finished with an electrostatically applied, thermally fused acrylic or polyester powder coating for corrosion protection. Coating shall be capable of withstanding at least 500 hours, with no visible corrosive effects, when tested in a salt spray and fog atmosphere in accordance with ASTM B117 test procedure.

2.5 CONTROLS

A. Ductless split system shall be controlled by manufacturer provided temperature controller.

B. Unit shall be completely factory wired with the necessary controls, starters, contactors and terminal blocks for power and control wiring.

C. A color-coded circuit diagram of the approved electrical drawing shall be provided with the unit.

D. All electrical components shall bear the UL label.

E. The system shall include a 3-minute time delay mechanism, an automatic restart function when power is restored after power interruption, and a test run switch.

F. The system shall have self-diagnostics ability, including total hours of compressor run time. Diagnostics codes for indoor and outdoor units shall be displayed on the controller panel.

G. Controller:
   1. Wired, Wall Mounted:
      a. Each indoor unit shall be provided with its own independent controller.
      b. Remote controller shall be approximately 5-inch by 5-inch in size and white in color with a light-green LCD display.
      c. The control voltage from the wired controller to the indoor unit shall be 12/24 VDC.
      d. Field wiring shall run directly from the indoor unit to the wall mounted controller with no splices. Up to two wired controllers shall be able to be used to control one unit.
      e. Controller shall support a selection from multiple languages (Spanish, German, Japanese, Chinese, English, Russian, Italian, or French) for display information.
      f. Controller shall include be a built-in weekly timer with up to 8 pattern settings per day.
      g. Controller shall consist of an ON/OFF button, Increase/Decrease Set Temperature buttons, a Cool/Auto/Fan/Dry mode selector, a Timer Menu

button, a Timer ON/OFF button, Set Time buttons, a Fan Speed selector, a Ventilation button, a Test Run button, and a Check Mode button.

h. Controller shall have a built-in temperature sensor.

i. Temperature shall be displayed in either Fahrenheit (°F) or Celsius (°C), and temperature changes shall be by increments of 1 degree F (0.5 degree C).

j. Controller shall have the capability of controlling up to a maximum of 16 systems, as a group with the same mode and temperature setpoint for all, at a maximum developed control cable distance of 1,500 feet.

k. Basic functions of the controller shall include:

1) ON/OFF for run and stop operation.
2) Operation mode for switching between Cool/Dry/Auto/Fan/Heat.
3) Fan speed settings.
4) Air flow direction settings.
5) Scheduling.
6) Operating conditions and error code display.
7) Ventilation control.
8) Auto lock out function for setting or releasing of all buttons.

2.6 IDENTIFICATION

A. All equipment and component identification shall be provided in accordance with Section 10 14 00, Signage.

2.7 SOURCE QUALITY CONTROL

A. Shop Tests:

1. Equipment shall be completely manufactured and pre-assembled in accordance with Reference Standards. Perform the following tests and inspections at factory before shipment:

a. Tested and inspected for approval as a unit by Underwriters Laboratories Inc., UL Label or equal.

b. Factory test equipment to ensure that the entire package has been properly fabricated and assembled, that all the controls function as specified herein and that the package meets the specified performance requirements including manufacturer's data report.

c. Fan wheels and shafts shall be statically and dynamically balanced.

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine conditions under which materials and equipment will be installed and notify ENGINEER in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions are corrected.

B. Take field measurements where required prior to installation to ensure proper fitting of Work.

3.2 PREPARATION

A. Protection of Surrounding Areas/Surfaces:
   1. Openings and penetrations shall be capped to protect the building from outside conditions.
   2. Equipment shall be tightly covered and protected against dirt, water, and chemical or mechanical damage.

3.3 INSTALLATION

A. General:
   1. Install the equipment in accordance with the Contract Documents and by manufacturer's instructions and recommendations. Obtain written interpretation from ENGINEER in the event of conflict between manufacturer's instructions and recommendations and the Contract Documents.
   2. Install in accordance with Laws and Regulations.
   3. Do not modify structures to facilitate installation of equipment, unless approved in writing by ENGINEER.
   4. Installation to conform to requirements of all local and state codes.

B. Anchorage shall be provided in accordance with Section 40 05 96, Vibration, Seismic, and Wind Controls.

C. Concrete Pad Anchorages and Base Plates:
   1. Provide anchorages in new or existing concrete, as applicable, in accordance with equipment manufacturer's recommendations and the Contract Documents. Install anchors in accordance with Section 05 05 33, Anchor Systems.
   2. Where used, pour concrete bases up to one inch below equipment baseplate or support leg as applicable. Base with equipment mounted shall then be accurately shimmed to grade and spaces between filled with non-shrink grout

in accordance with Section 03 60 00, Grouting. After grout has reached its initial set, exposed edges shall be neatly cut back 1/2 inch.

3.4 FIELD QUALITY CONTROL

A. Field Tests:
   1. Field testing shall be provided in accordance with Section 01 79 13, System and Facility Performance Testing Procedures.
   2. After equipment installation is complete, CONTRACTOR and a qualified field service representative of unit manufacturer shall perform an operating test and a sound test of each unit and associated controls, in presence of ENGINEER. Equipment will pass the test when each unit and its controls are demonstrated to function correctly, and sound levels do not exceed maximum limits.
   3. Running Tests:
      a. Field-test each equipment together with its controls and appurtenances. Tests shall demonstrate to ENGINEER that each part and all parts together function in accordance with the Contract Documents. Provide all necessary testing equipment, labor, and appurtenances.
      b. Verify that equipment operates at design point as intended, that vibration limits are not excessive and beyond manufacturer's recommendations, and that equipment operates smoothly without excessive noise, temperature rise, or other defects, across entire range of operating curve. Verify that all controls work as intended in both manual and automatic mode. Successfully test-operate each equipment for at least 24 hours.

      If equipment does not comply with the Contract Documents and does not pass the tests, CONTRACTOR shall adjust, modify, and retest the equipment as often as necessary until tests are successfully passed.

B. Manufacturer's Services:
   1. Provide a qualified, factory-trained service person to perform the following:
      a. Instruct CONTRACTOR in installing equipment.
      b. After installation, inspect and adjust equipment, verify proper operation, and assist with field testing.
      c. Instruct operations and maintenance personnel in operation and maintenance of the equipment.
   2. Manufacturer's service person shall make visits to the Site as follows:
      a. First visit shall be for instructing CONTRACTOR in proper equipment installation, and assisting in installing equipment. Minimum number of hours on-Site: 8 hours.
      b. Second visit shall be for checking completed installation, start-up of system; and performing field testing. Minimum number of hours on-Site: 16 hours.
      c. Third visit shall be to instruct operations and maintenance personnel.

1) Furnish services of manufacturer's qualified, factory-trained specialists to instruct operations and maintenance personnel in recommended operation and maintenance of equipment.
2) Training requirements, duration of instruction, and qualifications shall be in accordance with Section 01 79 23, Instruction of Operations and Maintenance Personnel.
3) Number of hours on-Site shall be in accordance with Section 01 79 23, Instruction of Operations and Maintenance Personnel.

d. Technician shall revisit the Site as often as necessary until installation is acceptable.

3. All costs, including expenses for travel, lodging, meals and incidentals, and cost of travel time, for visits to the Site shall be included in the Contract Price.

3.5 ADJUSTING

A. Adjust all controls for proper settings.

B. While system is operable, balance all equipment to achieve design conditions.

3.6 CLEANING

A. Thoroughly clean all equipment and accessories prior to installation.

B. Remove all dirt, rust, dust, etc. from equipment and accessories after installation.

C. Remove and dispose of all debris and waste from the Site resulting from installation.

3.7 SEQUENCE OF OPERATIONS

A. AC-1, 2 and 3:
1. Each unit shall be controlled by its own individual controller to meet set point.
2. Each unit shall be available to operate and only two are needed to meet design cooling. The unit temperature set points shall be adjusted to provide equal run time.
3. Temperature Set Points:
   a. AC-1: 82°F
   b. AC-2: 78°F
   c. AC-3: 86°F (stand-by)

++ END OF SECTION ++

SECTION 23 82 39.43

ELECTRIC UNIT HEATERS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, tools, equipment and incidentals as shown, specified and required to furnish and install electric unit heaters complete and operational with accessories.

B. Coordination:
   1. Review installation procedures under this and other Sections and coordinate the installation of items that must be installed with, or before, the electric unit heaters Work.
   2. Notify other contractors in advance of the installation of electric unit heaters to provide other contractors with sufficient time for the installation of items included in their contracts that must be installed with, or before, the electric unit heaters Work.

C. Related Sections:
   1. Section 10 14 00, Signage.

1.2 REFERENCES

A. Air Movement and Control Association International, Inc. (AMCA).
   1. AMCA Standard 210 – Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating.

B. Factory Mutual (FM).

C. National Electrical Code (NEC).

D. National Electrical Manufacturers Association (NEMA).

E. Underwriters Laboratories Inc. (UL).
   1. UL 873 – Temperature-Indicating and -Regulating Equipment.

1.3 QUALITY ASSURANCE

A. Qualifications:
   1. Manufacturer:
      a. Minimum of five years of experience producing substantially similar equipment and able to show evidence of at least five installations in satisfactory operation for at least five years.

b. Manufacturer's facility, where equipment will be manufactured and tested, shall be ISO 9001:2000 certified. Manufacturer shall include a copy of the ISO 9001:2000 certificate with the submittals.

B. Component Supply and Compatibility:
1. Obtain all equipment included in this Section regardless of the component manufacturer from a single electric unit heater manufacturer.
2. Require the electric unit heater manufacturer to review and approve or to prepare all Shop Drawings and other submittals for all components furnished under this Section.
3. All components shall be specifically constructed for the specified service conditions and shall be integrated into the overall equipment assembly by the electric unit heater manufacturer.

C. Regulatory Requirements:
1. Factory Mutual (FM).
2. National Electrical Code (NEC).
3. National Fire Protection Association (NFPA).
4. Underwriters Laboratories Inc. (UL).
5. Local and State Building Codes and Ordinances.
6. Permits: CONTRACTOR shall obtain and pay for all required permits, fees and inspections.

D. Certifications:
1. Electric unit heaters shall bear an approved label with all the necessary identification marks, electrical data, and any necessary cautions as required by the National Electric Code.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:
1. Shop Drawings:
a. Drawings showing fabrication methods, assembly, accessories, installation details, and wiring diagrams.
2. Product Data:
a. Manufacturer's literature, illustrations, specifications, weight, dimensions, required clearances, materials of construction, and performance data for all equipment.
b. Complete component list.
c. Detailed description of each component.
d. Catalog cut sheets for each component.
e. Deviations from Contract Documents. Any exceptions to the Contract Documents must be clearly defined. CONTRACTOR shall be responsible for any additional expenses that may occur due to any exception made.
f. Other technical data related to specified material and equipment as requested by ENGINEER.

B. Informational Submittals: Submit the following:
   1. Certificates:
      a. Independent certification reports:
         1) UL Label or equal.
      b. Copy of manufacturer's ISO 9001:2000 certificate.
   2. Manufacturer Instructions:
      a. Instructions and recommendations for handling, storing, protecting the equipment.
      b. Installation Data.
      c. Instructions for handling, start-up, and troubleshooting.
   3. Source Quality Control Submittals:
      a. Written report presenting results of required shop testing.
      b. Factory test reports.
   4. Field Quality Control Submittals:
      a. Written report presenting results of required field testing.
   5. Supplier Reports:
      a. Submit written report of results of each visit to Site by Supplier's service personnel, including purpose and time of visit, tasks performed, and results obtained. Submit within two days of completion of visit to the Site.
   6. Qualifications Statements:
      a. Manufacturer, when requested by ENGINEER.

C. Closeout Submittals: Submit the following:
   1. Operations and Maintenance Data:
      a. Submit complete Installation, Operation and Maintenance Manuals, including, test reports, maintenance data and schedules, description of operation, and spare parts information.
      b. Furnish Operation and Maintenance Manuals in conformance with the requirements of Section 01 78 23, Operations and Maintenance Data.

D. Maintenance Material Submittals: Furnish the following:
   1. Spare Parts:
      a. Spare parts list and recommended quantities.
   2. Tools:
      a. Two sets of special tools, if any, required for normal operation and maintenance.
   3. Spare parts and tools shall be packed in sturdy containers with clear indelible identification markings and shall be stored in a dry, warm location until transferred to the CITY at the conclusion of the Project.

1.5 DELIVERY, STORAGE AND HANDLING

A. Packing, Shipping, Handling and Unloading:
   1. Deliver materials to the Site to ensure uninterrupted progress of the Work.
   2. Deliver anchor bolts and anchorage devices, which are to be embedded in cast-in-place concrete, in ample time to prevent delay of that Work.
   3. Comply with manufacturer's recommendations for rigging of equipment.

B. Storage and Protection:
   1. Store materials to permit easy access for inspection and identification. Keep all material off the ground, using pallets, platforms, or other supports. Protect steel members and packaged materials from corrosion and deterioration.
   2. Store all equipment in covered storage off the ground and prevent condensation and in accordance with the manufacturer's recommendations for long-term storage.

C. Acceptance at Site:
   1. All boxes, crates and packages shall be inspected by CONTRACTOR upon delivery to the Site. CONTRACTOR shall notify ENGINEER, in writing, if any loss or damage exists to equipment or components. Replace lost equipment or components and repair damage to new condition, in accordance with manufacturer's instructions.

PART 2 - PRODUCTS

2.1 EQUIPMENT PERFORMANCE

A. Design Criteria:
   1. Design conditions shall be as indicated on the Equipment Schedule.
   2. All electric unit heaters shall be UL Listed.

B. Performance Criteria:
   1. Minimum performance data for each unit shall be as indicated on the Equipment Schedule. Provided equipment shall not exceed scheduled total power.

2.2 DETAILS OF EQUIPMENT

A. Horizontal Unit Heaters
   1. Product and Manufacturer: Provide one of the following:
      a. Model LUH, as manufactured by Chromalox.
      b. Model Industrial Unit Heater, as manufactured by INDEECO.
      c. Or equal.
   2. Casing:
      a. Minimum 18-gauge die formed steel construction.
      b. Phosphate undercoated and finished with polyester powder coat.
      c. Provided with universal wall swivel bracket and mounting hardware.
   3. Heating Elements:
      a. Corrosion resistant steel fins brazed to tubular element.
   4. Fans:
      a. Aluminum broad blade, axial-flow type design.
      b. Attached with rubber vibration isolators.
   5. Fan Motors:
      a. Totally-enclosed-fan-cooled enclosure.
      b. Permanently lubricated bearings.
      c. Integral thermal cutout.

6. Louvers:
    a. Same material of construction as casing.
    b. Individually adjustable for downward, upward or straight air flow.
7. Controls:
    a. Sub-divided circuits with individual fuse protection for all heaters with a total current draw of 48 A or greater.
    b. Heavy duty magnetic contactors.
    c. Thermal cutout with automatic reset.
    d. Integral 120 VAC control transformer.
    e. Thermostats:
        1) Refer to Equipment Schedule for type.
        2) Integral Type (factory installed):
            a) Thermostat Setpoint Range: 40 degrees F – 90 degrees F.
            b) Adjustable knob.
        3) Remote Type (shipped loose):
            a) Refer to Article 2.3.

2.3 ACCESSORIES

A. Space Thermostats
    1. Product and Manufacturer: Provide one of the following:
        a. Model WCRT-100, as manufactured by Chromalox.
        b. Model TW255A, as manufactured by TPI Corporation.
        c. Or equal.
    2. Sealed Noryl case.
    3. Shielded nickel-plated sensing bulb attached directly to thermostat enclosure.
    4. Thermostat Setpoint Range: 40 degrees F to 100 degrees F, with 2.5-degree F differential.
    5. Adjustable setpoints through dial on face.
    6. 120 VAC, 125 VA rating.
    7. Contacts shall have proper ampere rating for intended use.
    8. NEMA 4X rated.

2.4 IDENTIFICATION

A. All equipment and component identification shall be provided in accordance with Section 10 14 00, Signage.

2.5 SOURCE QUALITY CONTROL

A. Shop Tests:
    1. Equipment shall be completely manufactured and pre-assembled in accordance with Reference Standards. Perform the following tests and inspections at factory before shipment:
        a. Tested and inspected for approval as a unit by Underwriters Laboratories Inc., UL Label or equal.
        b. Factory test equipment to ensure that the entire package has been properly fabricated and assembled, that all the controls function as specified herein

and that the package meets the specified performance requirements including manufacturer's data report.

c. Fan wheels and shafts shall be statically and dynamically balanced.

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine conditions under which materials and equipment will be installed and notify ENGINEER in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions are corrected.

B. Take field measurements where required prior to installation to ensure proper fitting of Work.

3.2 INSTALLATION

A. General:
   1. Install the equipment in accordance with the Contract Documents and by manufacturer's instructions and recommendations. Obtain written interpretation from ENGINEER in the event of conflict between manufacturer's instructions and recommendations and the Contract Documents.
   2. Install in accordance with Laws and Regulations.
   3. Do not modify structures to facilitate installation of equipment, unless approved in writing by ENGINEER.
   4. Installation to conform to requirements of all local and state codes.

3.3 FIELD QUALITY CONTROL

A. Field Tests:
   1. Field testing shall be provided in accordance with Section 01 79 13, System and Facility Performance Testing Procedures.
   2. After equipment installation is complete, CONTRACTOR and a qualified field service representative of unit manufacturer shall perform an operating test of each unit and associated controls, in presence of ENGINEER. Equipment will pass the test when each unit and its controls are demonstrated to function correctly.
   3. Running Tests:
      a. Field-test each equipment together with its controls and appurtenances. Tests shall demonstrate to ENGINEER that each part and all parts together function in accordance with the Contract Documents. Provide all necessary testing equipment, labor, and appurtenances.
      b. Verify that equipment operates at design point as intended, that vibration limits are not excessive and beyond manufacturer's recommendations, and that equipment operates smoothly without excessive noise, temperature rise, or other defects, across entire range of operating curve. Verify that all

controls work as intended. Successfully test-operate each equipment for at least 24 hours.

c. If equipment does not comply with the Contract Documents and does not pass the tests, CONTRACTOR shall adjust, modify, and retest the equipment as often as necessary until tests are successfully passed.

B. Manufacturer's Services:

1. Provide a qualified, factory-trained service person to perform the following:
   a. Instruct CONTRACTOR in installing equipment.
   b. After installation, inspect and adjust equipment, verify proper operation, and assist with field testing.
   c. Instruct operations and maintenance personnel in operation and maintenance of the equipment.
2. Manufacturer's service person shall make visits to the Site as follows:
   a. First visit shall be for instructing CONTRACTOR in proper equipment installation, and assisting in installing equipment. Minimum number of hours on-Site: 8 hours.
   b. Second visit shall be for checking completed installation, start-up of system; and performing field testing. Minimum number of hours on-Site: 16 hours.
   c. Third visit shall be to instruct operations and maintenance personnel.
      1) Furnish services of manufacturer's qualified, factory-trained specialists to instruct operations and maintenance personnel in recommended operation and maintenance of equipment.
      2) Training requirements, duration of instruction, and qualifications shall be in accordance with Section 01 79 23, Instruction of Operations and Maintenance Personnel.
      3) Number of hours on-Site shall be in accordance with Section 01 79 23, Instruction of Operations and Maintenance Personnel.
   d. Technician shall revisit the Site as often as necessary until installation is acceptable.
3. All costs, including expenses for travel, lodging, meals and incidentals, and cost of travel time, for visits to the Site shall be included in the Contract Price.

3.4 ADJUSTING

A. Adjust all controls for proper settings.

B. Position unit as shown on the Drawings and adjust outlet louvers and diffusers for maximum throw.

3.5 CLEANING

A. Thoroughly clean all equipment and accessories prior to installation.

B. Remove all dirt, rust, dust, etc. from equipment and accessories after installation.

C. Remove and dispose of all debris and waste from the Site resulting from installation.

3.6 SEQUENCE OF OPERATON

A. EUH-1 shall be controlled by its remote mounted thermostat to maintain 60°F.

+ + END OF SECTION + +

SECTION 23 83 26.01

VACUUM VENTED GAS RADIANT HEATERS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, tools, equipment and incidentals as shown, specified, and required to provide gas fired radiant heaters complete and operational with accessories.
   2. The Work shall comply with vibration, seismic, and wind control requirements in Section 40 05 96, Vibration, Seismic, and Wind Controls.

B. Coordination:
   1. Review installation procedures under this and other Sections and coordinate the installation of items that must be installed with, or before, the gas fired radiant heaters Work.
   2. Notify other Contractors in advance of the installation of the gas fired radiant heaters to provide other contractors with sufficient time for the installation of items included in their contracts that must be installed with, or before, the gas fired radiant heaters Work.

C. Related Sections:
   1. Section 10 14 00, Signage.
   2. Section 23 05 29, Hangers and Supports for HVAC Ductwork, Piping, and Equipment.
   3. Section 26 05 53, Identification For Electrical Systems.
   4. Section 23 31 13 - Metal Ductwork.
   5. Section 23 51 23 - Gas Vents
   6. Section 40 05 96, Vibration, Seismic, and Wind Controls.

1.2 REFERENCES

A. American National Standards Institute (ANSI).
   1. Z83.20 - Gas-Fired Low-Intensity Infrared Heaters.
   2. Z223.1 – NFPA 54 National Fuel Gas Code.

B. American Society for Testing and Materials (ASTM).
   1. ASTM B117 – Standard Practice for Operating Salt Spray (Fog) Apparatus.

C. Canadian National Standards Association (CSA).
   1. CSA 2.34 – Gas-Fired Low-Intensity Infrared Heaters.

D. National Fire Protection Association (NFPA)
   1. NFPA 70 - National Electrical Code.

1.3 QUALITY ASSURANCE

A. Qualifications:
   1. Manufacturer:
      a. Minimum of five years of experience producing substantially similar equipment and able to show evidence of at least five installations in satisfactory operation for at least five years in the continental United States.
      b. Equipment shall be manufactured in the United States.
   2. Installer:
      a. Engage an experienced installer to perform the work of this Section who has specialized in installing gas fired radiant heating equipment similar to that required for this Project and who is acceptable to manufacturer.
      b. Submit name and qualifications to ENGINEER along with the following information on a minimum of three successful projects:
         1) Names and telephone numbers of owners, architects or engineers responsible for projects.
         2) Approximate contract cost of the gas fired radiant heaters Work.

B. Source Limitations: Obtain each gas fired radiant heater system component from one source by a single manufacturer.

C. Regulatory Requirements:
   1. National Electrical Code (NEC).
   2. National Fire Protection Association (NFPA).
   3. Underwriters Laboratories Inc. (UL).
   4. CSA Group
   5. Local and State Building Codes and Ordinances.
   6. Permits: CONTRACTOR shall obtain and pay for all required permits, fees and inspections.

D. Certifications:
   1. Gas fired radiant heaters shall bear an approved label with all the necessary identification marks, electrical data, and any necessary cautions as required by the National Electric Code.
   2. Gas fired radiant heaters shall be constructed and certified in accordance with the latest edition of ANSI Z83.20 / CSA 2.34.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Shop Drawings:
      a. Drawings showing fabrication methods, assembly, accessories, installation details, and wiring diagrams.
      b. Minimum 1/4-inch scale layout drawings with dimensions.
      c. Detailed drawings of each individual component's wiring diagrams.
      d. Detailed drawings of control panel layout.
      e. Detailed installation drawing of each individual component showing:
         1) Mounting requirements.
         2) Locations (panel, field, etc.)
         3) Piping and wiring connections, labeled and coded.
   2. Product Data:
      a. Manufacturer's literature, illustrations, specifications, weight, dimensions, required clearances, materials of construction, and performance data for all equipment.
      b. Complete component list.
      c. Detailed description of each component.
      d. Catalog cut sheets for each component.
      e. Deviations from Contract Documents. Any exceptions to the Contract Documents must be clearly defined. CONTRACTOR shall be responsible for any additional expenses that may occur due to any exception made.
      f. Other technical data related to specified material and equipment as requested by ENGINEER.
   3. Testing Plans, Procedures, and Testing Limitations:
      a. Plan for performing required field testing.

B. Informational Submittals: Submit the following:
   1. Certificates:
      a. Independent certification reports:
         1) CSA Label or equal.
         2) UL Label or equal.
   2. Manufacturer Instructions:
      a. Instructions and recommendations for handling, storing, protecting the equipment.
      b. Installation Data.
      c. Instructions for handling, start-up, and troubleshooting.
   3. Source Quality Control Submittals:
      a. Factory test reports.
   4. Field Quality Control Submittals:
      a. Written report presenting results of required field testing.

5. Manufacturer Reports:
    a. Submit written report of results of each visit to Site by manufacturer's service personnel, including purpose and time of visit, tasks performed, and results obtained. Submit within two days of completion of visit to the Site.
6. Qualifications Statements:
    a. Manufacturer, when requested by ENGINEER.
    b. Installer, when requested by ENGINEER.

C. Closeout Submittals: Submit the following:
1. Maintenance Contracts:
    a. Service shall be provided by a factory-trained and certified equipment manufacturer's representative during the One Year Correction Period. The equipment manufacturer's representative shall maintain all equipment furnished under this Section during the first year of operation.
    b. Service provided shall include the following:
        1) On-Site Service: Service intervals shall be quarterly for a minimum of one day of eight hours each quarter. The service duration shall be increased, as necessary by the equipment manufacturer's representative, taking into consideration the equipment service requirements and equipment size. Equipment manufacturer's representative shall indicate the service duration and service scope. Prior to the visits, the equipment manufacturer's representative shall contact the CITY and inquire as to problems encountered with the equipment. Service visits shall be scheduled at times agreeable to the CITY at least one week in advance. The quarterly service shall include, but not limited to the following:
            a) Provide manufacturer's recommended maintenance.
            b) Check all controls and components, and recalibrate or adjust as necessary.
            c) Perform necessary cleaning and services that are scheduled on a quarterly basis in accordance with the approved Operations and Maintenance Manuals. Provide all expendable materials, as necessary.
            d) Review and provide recommendations concerning CITY's operations.
            e) Replace or repair defective controls and components.
            f) Inspect control panels. Test control panel's indication lights and replace defective lights.
            g) Provide a detailed field report to the CITY.
        2) Technical Support: Technical support shall be provided between the hours of 8:00 AM and 4:00 PM local standard time, Monday through Friday when requested by the CITY. Technical support shall include, but not limited to the following:

a) Telephone Technical Support.
b) On-Site Visits: If resolution of a problem is not achieved via the Telephone Technical Support, an on-site visit and field report shall be required.

2. Operations and Maintenance Data:
   a. Submit complete Installation, Operation and Maintenance Manuals, including, test reports, maintenance data and schedules, description of operation, and spare parts information.
   b. Furnish Operation and Maintenance Manuals in conformance with the requirements of Section 01 78 23, Operations and Maintenance Data.
3. Warranty Documentation:
   a. General warranty.
   b. Special warranties on materials and equipment.
4. Record Documentation:
   a. During progress of the Work keep an up-to-date set of the Drawings showing field and Shop Drawing modifications. Immediately upon completion of the Work, submit "pdf" of CADD drawings showing the actual in place installation of all equipment installed under this Section at a scale satisfactory to the CITY. The drawings shall show all equipment in plan and section, with all reference dimensions and elevations required for complete Record Drawings of the systems. Two paper prints shall also be furnished. The prints and electronic copies of the CADD files shall be furnished no later than 30 days after completion of the Contract and prior to final payment.

D. Maintenance Material Submittals: Furnish the following:
   1. Spare Parts:
      a. Parts list.
      b. One spare set of burner combustion air filters for each unit.
   2. Extra Stock Materials:
      a. Touch up paint for each unit.
   3. Tools:
      a. Two sets of special tools, if any, required for normal operation and maintenance.
   4. Spare parts, extra stock materials, and tools shall be packed in sturdy containers with clear indelible identification markings and shall be stored in a dry, warm location until transferred to the CITY at the conclusion of the Project.

1.5 DELIVERY, STORAGE AND HANDLING

A. Packing, Shipping, Handling and Unloading:
   1. Deliver materials to the Site to ensure uninterrupted progress of the Work.

2. Comply with manufacturer's recommendations for handling and unloading of equipment.

B. Storage and Protection:
   1. Store materials to permit easy access for inspection and identification. Keep all material off the ground, using pallets, platforms, or other supports. Protect steel members and packaged materials from corrosion and deterioration.
   2. Store all equipment in covered storage off the ground and prevent condensation and in accordance with the manufacturer's recommendations for long-term storage.

C. Acceptance at Site:
   1. All boxes, crates and packages shall be inspected by CONTRACTOR upon delivery to the Site. CONTRACTOR shall notify ENGINEER, in writing, if any loss or damage exists to equipment or components. Replace lost equipment or components and repair damage to new condition, in accordance with manufacturer's instructions.

1.6 WARRANTY

A. General Warranty: The special warranties specified in this Article shall not deprive DEPARTMENT or CITY of other rights or remedies DEPARTMENT or CITY may otherwise have under the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by CONTRACTOR under the Contract Documents. The obligations of CONTRACTOR under the Contract Documents shall not be limited in any way by the provisions of the specified special warranties.

B. Special Warranties on Materials and Equipment:
   1. Provide manufacturer's written warranty, running to the benefit of DEPARTMENT and CITY, agreeing to correct, or at option of CITY, remove or replace materials or equipment specified in this Section found to be defective during a period of years as listed below after the date of Substantial Completion.
      a. Three (3) year warranty on the burner system and on the tubing.
      b. Twenty five (25) year warranty on the vacuum pump housing.
      c. Three (3) year warranty of all other components, including electrical.

PART 2 - PRODUCTS

2.1 EQUIPMENT PERFORMANCE

A. Equipment Description:

1. Natural gas fired infrared radiant heater shall by of the low-intensity radiant tube type consisting of single or multiple series arranged burners. To preclude the possibility of combustion gases escaping into the building, the entire system must be under a negative pressure at all times and vacuum vented to the outside atmosphere.
2. Radiant tubes shall be provided with reflectors in various configurations for directing infrared energy. The tubes shall be capable of individual or common gas venting.

B. Design Criteria:
   1. Design conditions shall be as indicated on the Equipment Schedule.

C. Performance Criteria:
   1. Minimum performance data for each unit shall be as indicated on the Equipment Schedule.

2.2 MANUFACTURERS

A. Product and Manufacturer: Provide one of the following:
   1. CoyRayVac, as manufactured by Roberts-Gordon.
   2. AmbiRad.
   3. Detroit Radiant.
   4. Or Approved Equal.

2.3 DETAILS OF CONSTRUCTION

A. Burner Box
   1. Burner assemblies consisting of heavy duty cast iron burner heads. Pre-wired gas controls with direct spark ignition module, and combustion air filters. Provide minimum numbers of burners indicated to insure proper radiant heat distribution. Fewer burners of larger capacity shall not be accepted. Burners shall be designed for firing in tandem without adverse effects from combustion gases from upstream burners.
   2. Design firing rate of burners and clearances to combustible surfaces as measured from the tube surface shall not exceed dimensions shown in the equipment schedules on the drawings.
   3. Provide burners to totally pre-mix air and gas required for combustion.
   4. Provide burners designed to maintain constant proportion of fuel gas to filtered combustion air. Introduce both fuel gas and air at atmospheric pressure, and establish flow of both by means of negative pressure on the downstream side of the flow metering orifices. Design so that if combustion air flow is impeded for any reason, gas flow rate will decrease in constant proportion to maintain proper gas/air mixture for complete combustion.

5. Provide stainless steel flexible gas line and high-pressure gas cock assembly.
6. Burner shall be provided with hanger attachment points.

B. Burner Controls
1. Burners shall be factory wired for 120 volts AC with transformer for 24 volt direct spark ignition and supplied with a grounded 24-30 inch three wire pigtail located at rear of burner.
2. Fail-safe controls shall preclude main flow of gas if any or all of the following abnormal conditions occur:
   a. Power fails (Gas valves in burners close in safe position).
   b. Main Valve fails in open position
   c. Vacuum pump motor fails (Vacuum proving switch cuts power to burners).
3. Burners shall be equipped with a Direct Spark Ignition Module (DSI). The DSI module shall have a 15-second flame safety time per ignition trial before lockout occurs. In addition, the DSI module shall be capable of a minimum of 3 trials for ignition to provide maximum reliability.

C. Vacuum Pump
1. The system shall vent all products of combustion outdoors by means of the vacuum pump.
2. Motor: Motor requirements shall be as shown in the equipment schedules on the drawing and have thermal overload protection, high temperature sealed ball bearings, and constructed in accordance with electric motor industry standards. The motor in the vacuum pump shall be secured with rubber mounts for acoustical isolation.
3. Housing: The scroll shall be 12-gauge stamped steel construction for less than ½ horsepower motor pumps and cast iron with a minimum metal thickness of approximately 3/16 inches for ½ horsepower and larger pumps. The impeller wheel shall be pressure cast 319-alloy aluminum with a minimum metal thickness of approximately 3/32 inches.
4. Pressure Switch: As an additional safety measure, there shall be a low 24 volt interlock circuit from the pressure switch (located at the inlet to the vacuum pump) to the controller to prove pump operation.
5. High Temperature Acoustical Isolation: The vacuum pump shall be acoustically isolated from the system with a flexible connector with a constant service temperature rating of 350ºF minimum. The connection between the pump inlet and tailpipe and the pump outlet and vent pipe is made with acoustic boots and clamps supplied by the radiant heater manufacturer.
6. Vacuum pump shall be provided with hanger attachment points.

D. Reflectors
   1. Highly radiant reflective 0.024 minimum thick aluminum reflectors shall be installed over all radiant tubes.
   2. Reflector joint pieces shall be provided over radiant tube fittings such as elbows so reflector covers radiant tube continuously. In order to maximize radiant output and minimize convection losses, reflectors are to protrude past the bottom of the radiant tube.
   3. End caps shall be provide at the termination of the radiant tube and elbows to prevent convective heat from escaping.
   4. Reflector supports shall be provided to support reflectors at intervals between hangers.
   5. Provide 6-inch minimum overlap between adjacent reflectors.
   6. Provide manufactures system of reflector formed hanger assemblies and attachment points.

E. Radiant Piping - Heat Exchanger
   1. Radiant Tube shall be 4-inch 16 gauge heat treated aluminized steel tube with an emissivity factor of 0.80 or greater.
   2. Tail Pipe Tube shall be 4-inch 16 gauge heat treated aluminized steel tube with an emissivity factor of 0.80 or greater.
   3. Radiant tube shall be provided in 10-foot lengths and include 90-degree and U-Tube fittings as required to accommodate tube configurations shown on the Contract Drawings. Provide manufacturer's U-Tube support brackets where U-Tube configurations are used.
   4. Radiant tube shall be connected using the manufacturer's mechanical joining system comprised of a coupling and lock assembly.
   5. Radiant tube shall pitch down and away from the burner box a minimum 1/2-inch per 20 feet. The tail pipe shall pitch down at least 1 inch in 20 feet towards the vacuum pump.
   6. Each open end combustion chamber shall have an approved end vent and the reflector shall terminate with an end cap.
   7. A condensate collection fitting and drain pipe shall be provided immediately upstream of the vacuum pump inlet to remove condensate from the system. The condensate drain pipe shall include a check valve assembly provided by the radiant heater manufacturer. Drain piping shall be terminated in an acid neutralization tank prior to entering the building waste drainage system.
   8. Provide manufactures system of tube formed hanger assemblies and attachment points.

F. Hangers
   1. Equipment shall be attached to the building structure with minimum 3/16-inch Type 304 stainless steel chain. Chain length and attachment shall be in

accordance with manufacturer's recommendations to provide adequate movement for tube expansion. Chain shall have a minimum working load limit of 830 lbs.

2. Provide turnbuckles for adjusting radiant tube pitch and "S" hooks and screw hooks for attachment of chain hanger to radiant heaters, vacuum pumps, and structure attachments.
3. Hanger spacing shall be provided in accordance with the manufacturer but shall not exceed 10 feet.
4. Refer to Section 23 05 29, Hangers and Supports for HVAC Ductwork, Piping, and Equipment for hanger attachments to the building structure.

G. Combustion Air Vents
1. Provide outside air supply to each burner and radiant tube end vent for the support of combustion air.
2. Combustion air ductwork shall be provided in accordance with Section 23 31 13, Metal Ductwork.
3. Ductwork shall be terminated through the roof or wall as shown on the Contract Drawings with an approved termination cap incorporating a weather guard and bird screen.

H. Gas Vents
1. Provide a system of gas venting for each vacuum pump to remove products of combustion.
2. Double wall, stainless steel, positive pressure design, gas venting system shall be provided in accordance with Section 23 51 23, Gas Vents.
3. Venting shall be terminated through the roof or wall as shown on the Contract Drawings with an approved termination cap incorporating a weather guard and bird screen.

I. Condensate Drain Piping
1. Piping:
   a. Type K, hard drawn temper copper tube conforming to the requirements of ASTM B88.

2.4 ACCESSORIES

A. Side Reflectors
1. Provide side reflectors where specified on the Equipment Schedule. One side or two side reflectors shall be provided as specified for focusing radiant energy.
2. Side reflectors shall be provided with extension brackets for supporting reflectors from radiant tubes.

2.5 FINISHING

A. Burner exterior paint finish shall be capable of withstanding at least 2,500 hours, with no visible corrosive effects, when tested in a salt spray and fog atmosphere in accordance with ASTM B117 test procedure.

B. All wear surfaces shall receive a heavy application of grease or other rust-resistant coating. Maintain coating during shipping and storage until equipment is placed into operation.

2.6 CONTROLS

A. The radiant heating system shall be controlled by a system control panel provided by the radiant heater manufacturer. Single or multiple system control panels shall be provided as required to accommodate the number of radiant heater components served by each system.

B. System Control Panel: Provide radiant heating microprocessor system control panels and locate were shown on the Contract Drawings. Each panel shall be capable of managing four zones of burners, temperature control, and power. Each zone shall be capable of supporting up to four burners. The control shall also give power output to as many as two vacuum pumps provided that the load is not greater than 20 amps and single phase. The control panel shall have indicator lights showing: Line Power, Pump 1 Power, Pump 2 Power, Pressure Switch 1 Power, Pressure Switch 2 power and 4-Zones. The panel shall include a 24 VAC power supply to supply power to electronic thermostats and shall be capable of using mechanical thermostats equipped with a heat anticipator. The control panel enclosure shall be painted steel and shall include indicator lights to display when line power is available to the panel, when the vacuum pumps are energized, when the vacuum proving switches are closed and when the burner zone relays are energized. The control panel shall have separate line voltage and low voltage terminal strips for ease of wiring.

C. Space Thermostats
   1. Provide low voltage thermostats where shown on the Contract Drawings and connect to associated infrared heater.
   2. Mount thermostat 5 to 6 feet above finish floor.
   3. Product and Manufacturer: Provide one of the following:
      a. Model T631F1084, as manufactured by Honeywell.
      b. TPI Corporation.
      c. Or equal.
   4. Type: Industrial thermostat with sealed NEMA 4X housing and external mounted sensing bulb.

5. Thermostat Setpoint Range: 35 degrees F to 100 degrees F. Adjustable setpoint through dial on face.
6. Differential: 2-degree F.
7. Electrical Rating: 24 VAC @ 2 amps, 120 VAC @ 7.4 amps, 240 VAC @ 2.7
8. Output: Single pole double throw.
9. Provide 304 stainless steel mounting hardware to install unit from building structure.

D. Timers
1. A timer shall be provided at each thermostat wired in parallel with the thermostat. Timer shall be used to manually energize radiant heaters when thermostat is satisfied and additional heat is desired.
2. Mount timer next to thermostat.
3. Product and Manufacturer: Provide one of the following:
   a. Model E501T, as manufactured by Tork.
   b. Or equal.
4. Type: Industrial timer with sealed NEMA 4X housing.
5. Timer Range: 30 time durations from 10 seconds to 12 hours. Adjustable setpoint through dial on face.
6. Timer Control: Integral start/stop button initiates interval time ON and automatically turns OFF after preset time.
7. Electrical Input: 120 VAC.
8. Electrical consumption: 16 VA maximum
9. Output: Single pole double throw.
10. Provide 304 stainless steel mounting hardware to install unit from building structure.

2.7 IDENTIFICATION

A. All equipment and component identification shall be provided in accordance with Section 10 14 00, Signage.

B. All electrical wiring identification shall be provided in accordance with Section 26 05 53, Identification For Electrical Systems.

C. All electrical wiring shall be color-coded and labeled for simplified identification. Power wiring shall be coded per Contract Documents.

2.8 SOURCE QUALITY CONTROL

A. Shop Tests:
   1. Equipment shall be completely manufactured and pre-assembled in accordance with Reference Standards. Perform the following tests and inspections at factory before shipment:
      a. Tested and inspected for approval as a unit by Underwriters Laboratories Inc., UL Label or equal.
      b. Factory test equipment to ensure that the entire package has been properly fabricated and assembled, that all the controls function as specified herein and that the package meets the specified performance requirements including manufacturer's data report.
      c. Rotating equipment shall be statically and dynamically balanced.

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine conditions under which materials and equipment will be installed and notify ENGINEER in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions are corrected.

B. Take field measurements where required prior to installation to ensure proper fitting of Work.

3.2 PREPARATION

A. Protection of Surrounding Areas/Surfaces:
   1. Openings and penetrations shall be capped to protect the building from outside conditions.
   2. Equipment shall be tightly covered and protected against dirt, water, and chemical or mechanical damage.

3.3 INSTALLATION

A. General:
   1. Install the equipment in accordance with the Contract Documents and by manufacturer's instructions and recommendations. Obtain written interpretation from ENGINEER in the event of conflict between manufacturer's instructions and recommendations and the Contract Documents.
   2. Install in accordance with Laws and Regulations.

3. Do not modify structures to facilitate installation of equipment, unless approved in writing by ENGINEER.
4. Installation to conform to requirements of all local and state codes.
5. Install and connect gas piping in accordance with Z223.1.
6. Install and connect electrical wiring in accordance with NFPA 70.
7. Do not exceed clearance to combustibles outlined and printed on burner nameplate, and in manufacturer's product data. Measure clearance distance from surface of heat exchangers or as indicated by approval agency's listing.

3.4 FIELD QUALITY CONTROL

A. Field Tests:
   1. Field testing shall be provided in accordance with Section 01 79 13, System and Facility Performance Testing Procedures.
   2. After equipment installation is complete, CONTRACTOR and a qualified field service representative of unit manufacturer shall perform an operating test of each unit and associated controls, in presence of ENGINEER. Equipment will pass the test when each unit and its controls are demonstrated to function correctly.

B. Manufacturer's Services:
   1. Provide a qualified, factory-trained service person to perform the following:
      a. Instruct CONTRACTOR in installing equipment.
      b. After installation, inspect and adjust equipment, verify proper operation, and assist with field testing.
      c. Instruct CITY's operations and maintenance personnel in operation and maintenance of the equipment.
   2. Manufacturer's service person shall make visits to the Site as follows:
      a. First visit shall be for instructing CONTRACTOR in proper equipment installation, and assisting in installing equipment. Minimum number of hours on-Site: 8 hours.
      b. Second visit shall be for checking completed installation, start-up of system; and performing field testing. Minimum number of hours on-Site: 16 hours.
      c. Third visit shall be to instruct operations and maintenance personnel.
         1) Furnish services of manufacturer's qualified, factory-trained specialists to instruct operations and maintenance personnel in recommended operation and maintenance of equipment.
         2) Training requirements, duration of instruction, and qualifications shall be in accordance with Section 01 79 23, Instruction of Operations and Maintenance Personnel.
         3) Number of hours on-Site shall be in accordance with Section 01 79 23, Instruction of Operations and Maintenance Personnel.
      d. Technician shall revisit the Site as often as necessary until installation is acceptable.

3. All costs, including expenses for travel, lodging, meals and incidentals, and cost of travel time, for visits to the Site shall be included in the Contract Price.

3.5 ADJUSTING

A. Adjust all controls for proper settings.

B. Adjust burners.

3.6 CLEANING

A. Thoroughly clean all equipment and accessories prior to installation.

B. Remove all dirt, rust, dust, etc. from equipment and accessories after installation.

C. Remove and dispose of all debris and waste from the Site resulting from installation.

3.7 SEQUENCE OF OPERATIONS

A. On a demand for heat from any of the thermostats, the system control panel shall send power to the vacuum pump. The pump shall be energized.

B. Once vacuum is established, the pressure switch at the vacuum pump shall close. If vacuum is not established within 30 seconds, the vacuum pump shall go into lockout (vacuum pump LED shall flash). After one hour of lockout, the system shall re-start.

C. The system control panel shall send power to the burners on the associated zone calling for heat. The burners shall go through a 45 second purge and cycle time.

D. Once flame is established, the burners shall remain in operation until such time as either the heating is turned off by the thermostat, lockout conditions occur, or after 24 hours of continuous operation. After 24 hours of continuous operation, the system control shall shut off and re-start to verity no faults exist in the system.

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SECTION 23 84 19

DESICCANT DEHUMIDIFICATION UNITS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, tools, equipment and incidentals as shown, specified and required to furnish and install desiccant dehumidification units complete and operational with accessories.
   2. The Work shall comply with vibration and wind control requirements in Section 40 05 96, Vibration, Seismic, and Wind Controls.

B. Coordination:
   1. Review installation procedures under this and other Sections and coordinate the installation of items that must be installed with, or before, the desiccant dehumidification units Work.
   2. Notify other contractors in advance of the installation of packaged outdoor heating-only makeup-air units to provide other contractors with sufficient time for the installation of items included in their contracts that must be installed with, or before, the desiccant dehumidification units Work.

C. Related Sections:
   1. Section 10 14 00, Signage.
   2. Section 26 05 53, Identification For Electrical Systems.
   3. Section 40 05 96, Vibration, Seismic, and Wind Controls.

1.2 REFERENCES

A. Air Movement and Control Association International, Inc. (AMCA).
   1. AMCA Standard 210 – Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating.
   2. AMCA Standard 500-D – Laboratory Methods of Testing Dampers for Rating.
   3. AMCA Publication 511 – Certified Ratings Program - Product Rating Manual for Air Control Devices.

B. American Bearing Manufacturers Association (ABMA).
   1. ABMA 9 – Load Ratings and Fatigue Life for Ball Bearings.
   2. ABMA 11 – Load Ratings and Fatigue Life for Roller Bearings.

C. American National Standards Institute (ANSI).
   1. ANSI Z21.47 – Standard for Gas-Fired Central Furnaces
   2. ANSI Z83.8 – Gas Unit Heaters, Gas Packaged Heaters, Gas Utility Heaters and Gas-Fired Duct Furnaces.

D. American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE).
   1. ASHRAE Standard 52.2 – Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size.

E. American Society for Testing and Materials (ASTM).
   1. ASTM 84 - Standard Test Method for Surface Burning Characteristics of Building Materials
   2. ASTM B117 – Standard Practice for Operating Salt Spray (Fog) Apparatus.
   3. ASTM D870 – Standard Practice for Testing Water Resistance of Coatings Using Water Immersion.
   4. ASTM D1929 – Standard Test Method for Determining Ignition Temperature of Plastics.
   5. ASTM 1289 - Standard Specification for Faced Rigid Cellular Polyisocyanurate Thermal Insulation Board.
   6. ASTM D2247 – Standard Practice for Testing Water Resistance of Coatings in 100% Relative Humidity.

F. International Agency for Research on Cancer (IARC)

G. National Electrical Code (NEC).

H. National Electrical Manufacturers Association (NEMA).
   1. NEMA ICS 3.1 – Guide for the Application, Handling, Storage, Installation and Maintenance of Medium-Voltage AC Contactors, Controllers and Control Centers.

I. National Fire Protection Association (NFPA)
   1. 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems
   2. 90B - Standard for the Installation of Warm Air Heating and Air-Conditioning Systems

J. Underwriters Laboratories Inc (UL)
   1. UL 795 – Commercial-Industrial Gas Heating Equipment.
   2. UL 900 – Air Filter Units.
   3. UL 1995 – Heating and Cooling Equipment.

1.3 QUALITY ASSURANCE

A. Qualifications:
   1. Manufacturer:
      a. Minimum of five years of experience producing substantially similar equipment and able to show evidence of at least five installations in satisfactory operation for at least five years in the continental United States.
      b. Equipment shall be manufactured in the United States.

B. Component Supply and Compatibility:
   1. Obtain all equipment included in this Section regardless of the component manufacturer from a single desiccant dehumidification unit manufacturer.
   2. Require the desiccant dehumidification unit manufacturer to review and approve or to prepare all Shop Drawings and other submittals for all components furnished under this Section.
   3. All components shall be specifically constructed for the specified service conditions and shall be integrated into the overall equipment assembly by the desiccant dehumidification unit manufacturer.

C. Regulatory Requirements:
   1. National Electrical Code (NEC).
   2. National Fire Protection Association (NFPA).
   3. Underwriters Laboratories Inc. (UL).
   4. Local and State Building Codes and Ordinances.
   5. Permits: CONTRACTOR shall obtain and pay for all required permits, fees and inspections.

D. Certifications:
   1. Desiccant dehumidification units shall bear an approved label with all the necessary identification marks, electrical data, and any necessary cautions as required by the National Electric Code.
   2. The unit assembly shall carry an ETL Label and be constructed in accordance to UL 1995 and ANSI Z83.8. All features and options shall be included in the listing, including controls shipped loose.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Shop Drawings:
      a. Drawings showing fabrication methods, assembly, accessories, installation details, and wiring diagrams.
      b. Detailed drawings of each individual component's wiring diagrams.

c. Detailed installation drawing of each individual component showing:
   1) Mounting requirements including roof/equipment curbs.
   2) Locations (panel, field, etc.)
   3) Ductwork, piping, and wiring connections, labeled and coded.
d. Setting drawings, templates, and directions for the installation of roof/equipment curbs, anchor bolts, and other anchorages.

2. Product Data:
   a. Manufacturer's literature, illustrations, specifications, weight, dimensions, required clearances, shipping splits, materials of construction, and performance data for all equipment.
   b. Complete component list.
   c. Detailed description of each component.
   d. Catalog cut sheets for each component.
   e. Certified fan performance curves with operating points.
   f. Certified fan-sound power ratings with power levels in each octave band and A-weighted for unit's inlet and outlet.
   g. Certified coil-performance ratings with system operating conditions indicated.
   h. Desiccant rotor performance data with system operating conditions.
   i. Motor ratings and electrical characteristics.
   j. Material gauges and finishes.
   k. Filters and their performance characteristics.
   l. Dampers, including housings linkages, and operators.
   m. Control components.
   n. Utility requirements (ex- gas, steam, electrical, etc.)
   o. Airflow static pressure drops for each component.
   p. Method of field assembly and location and size of each field connection.
   q. Standard and custom color selection charts for finishing system.
   r. Lubricant Specification: Furnish lubricant specification for type and grade required for equipment furnished.
   s. Deviations from Contract Documents. Any exceptions to the Contract Documents must be clearly defined. CONTRACTOR shall be responsible for any additional expenses that may occur due to any exception made.
   t. Other technical data related to specified material and equipment as requested by ENGINEER.
3. Testing Plans, Procedures, and Testing Limitations:
   a. Plan for performing required shop testing.
   b. Plan for performing required field testing.

B. Informational Submittals: Submit the following:
   1. Certificates:

a. Independent certification reports:
   1) UL Label or equal.
2. Manufacturer Instructions:
   a. Instructions and recommendations for handling, storing, protecting the equipment.
   b. Installation Data.
   c. Instructions for handling, start-up, and troubleshooting.
3. Source Quality Control Submittals:
   a. Written report presenting results of required shop testing.
   b. Factory test reports.
4. Field Quality Control Submittals:
   a. Written report presenting results of required field testing.
5. Supplier Reports:
   a. Submit written report of results of each visit to Site by Supplier's service personnel, including purpose and time of visit, tasks performed, and results obtained. Submit within two days of completion of visit to the Site.
6. Qualifications Statements:
   a. Manufacturer, when requested by ENGINEER.

C. Closeout Submittals: Submit the following:
1. Maintenance Contracts:
   a. Service shall be provided by a factory-trained and certified equipment manufacturer's representative during the One Year Correction Period. The equipment manufacturer's representative shall maintain all equipment furnished under this Section during the first year of operation.
   b. Service provided shall include the following:
      1) On-Site Service: Service intervals shall be quarterly for a minimum of one day of eight hours each quarter. The service duration shall be increased, as necessary by the equipment manufacturer's representative, taking into consideration the equipment service requirements and equipment size. Equipment manufacturer's representative shall indicate the service duration and service scope. Prior to the visits, the equipment manufacturer's representative shall contact the CITY and inquire as to problems encountered with the equipment. Service visits shall be scheduled at times agreeable to the CITY at least one week in advance. The quarterly service shall include, but not limited to the following:
         a) Provide manufacturer's recommended maintenance.
         b) Check all controls and components, and recalibrate or adjust as necessary.
         c) Perform necessary cleaning and services that are scheduled on a quarterly basis in accordance with the approved Operations and

Maintenance Manuals. Provide all expendable materials, as necessary.

d) Review and provide recommendations concerning CITY'S operations.

e) Replace or repair defective controls and components.

f) Inspect control panels. Test control panel's indication lights and replace defective lights.

g) Provide a detailed field report to the CITY.

2) Technical Support: Technical support shall be provided between the hours of 8:00 AM and 4:00 PM local standard time, Monday through Friday when requested by the CITY. Technical support shall include, but not limited to the following:

a) Telephone Technical Support.

b) On-Site Visits: If resolution of a problem is not achieved via the Telephone Technical Support, an on-site visit and field report shall be required.

2. Operations and Maintenance Data:

a. Submit complete Installation, Operation and Maintenance Manuals, including, test reports, maintenance data and schedules, description of operation, and spare parts information.

b. Furnish Operation and Maintenance Manuals in conformance with the requirements of Section 01 78 23, Operations and Maintenance Data.

3. Warranty Documentation:

a. General warranty.

b. Special warranties on materials and equipment.

D. Maintenance Material Submittals: Furnish the following:

1. Spare Parts:

a. Spare parts list and recommended quantities.

b. One set of filters for each unit.

2. Tools:

a. Special tools for routine maintenance of unit.

3. Spare parts, extra stock materials, and tools shall be packed in sturdy containers with clear indelible identification markings and shall be stored in a dry, warm location until transferred to the CITY at the conclusion of the Project.

1.5 DELIVERY, STORAGE AND HANDLING

A. Packing, Shipping, Handling and Unloading:

1. Cover all openings into gear boxes with vapor inhibiting and water repellent material.

2. Deliver materials to the Site to ensure uninterrupted progress of the Work.

3. Deliver anchor bolts and anchorage devices, which are to be embedded in cast-in-place concrete, in ample time to prevent delay of that Work.
4. Comply with manufacturer's recommendations for rigging of equipment.

B. Storage and Protection:
1. Store materials to permit easy access for inspection and identification. Keep all material off the ground, using pallets, platforms, or other supports. Protect steel members and packaged materials from corrosion and deterioration.
2. Store all equipment in covered storage off the ground and prevent condensation and in accordance with the manufacturer's recommendations for long-term storage.

C. Acceptance at Site:
1. All boxes, crates and packages shall be inspected by CONTRACTOR upon delivery to the Site. CONTRACTOR shall notify ENGINEER, in writing, if any loss or damage exists to equipment or components. Replace lost equipment or components and repair damage to new condition, in accordance with manufacturer's instructions.

1.6 WARRANTY

A. General Warranty: The special warranties specified in this Article shall not deprive DEPARTMENT or CITY of other rights or remedies DEPARTMENT or CITY may otherwise have under the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by CONTRACTOR under the Contract Documents. The obligations of CONTRACTOR under the Contract Documents shall not be limited in any way by the provisions of the specified special warranties.

B. Special Warranties on Materials and Equipment:
1. Provide manufacturer's written warranty, running to the benefit of DEPARTMENT and CITY, agreeing to correct, or at option of CITY, remove or replace materials or equipment specified in this Section found to be defective during a period of years as listed below after the date of Substantial Completion.
   a. 24 months from the date of factory shipment or 18 months from the date of start-up, whichever is shorter.

PART 2 - PRODUCTS

2.1 EQUIPMENT PERFORMANCE

A. Equipment Description:

1. Units shall be completely factory assembled and tested, internally wired, and equipped for outdoor installation. Unit shall consist of insulated weatherproof cabinet with dampers, filters, fans, motors and drives, desiccant rotor, reactivation heating section, outdoor air electric heating coil, outside air intake hood, unit mounted controls, wiring, and accessories.
2. Units shall be equipped with provisions for forklift or crane lifting and be designed structurally to withstand the stresses.
3. Factory fabricate and test units of sizes, capacities, and configuration as indicated and specified. Units shall be fully assembled on support members up to practical shipping limitations. On units not shipped fully assembled, manufacturer shall tag each section to indicate location and direction of airflow to facilitate assembly at the Site.

B. Design Criteria:
1. Desiccant rotor shall be sized for full airflow capacity, without the need for bypass airstreams, unless required by specific project requirements.
2. Units shall conform and be certified to the latest edition of UL 1995.
3. Units with gas-fired heat exchangers shall conform and be certified to the latest edition of ANSI Z21.47, ANSI Z83.8, or UL 795.

C. Performance Criteria:
1. Minimum performance data for each unit shall be as indicated on the Equipment Schedule. Provided equipment shall not exceed scheduled total power.

2.2 MANUFACTURERS

A. Manufacturer: Provide product of one of the following:
1. Concepts and Design, Inc (CDI).
2. Munters Corporation.
3. Bry-Air Inc
4. Or equal.

2.3 DETAILS OF CONSTRUCTION

A. Unit Construction:
1. Unit shall be 2 inch minimum double wall construction.
2. Base frame shall be a single frame construction for supporting the casing and internal components.
3. The casing walls and roof assemblies shall be constructed as a double wall design with the exterior and interior components mechanically attached and shall make up the insulated self-supporting casing.

4. Casing wall penetrations shall be provided with a finished cover plate both on the interior and exterior of the unit casing. Additionally, any conduit passing through the unit casing shall be sealed to prevent air leakage.

B. Base Frame Construction:
   1. Unit shall be supported on formed Type 304 stainless steel channel or structural channel supports, designed and welded for low deflections. Base frame shall be designed for mounting on roof curb, concrete pad or steel frame structure to suit mounting arrangement shown on the drawings.
   2. Units shall have an electrically welded structurally formed 12 gauge Type 304 stainless steel frame. All frames to be suitably reinforced and braced to permit the loading, shipping, unloading and rigging to the installation location. All frames are suitable for general handling of the completed sections without damage or misalignment to the external and internal components.
   3. Lifting lugs sets shall be provided on the base. Lifting lug distance shall not exceed a distance of 100 inches on center.
   4. The floor assembly shall be 16 gauge and 20 gauge Type 304 stainless steel for the top and bottom of the floor deck respectively. Fiberglass insulation 4 inch minimum nominal thickness shall be used to insulate the base. Minimum 4 inch deep 12 gauge Type 304 stainless steel formed channels shall be used in the floor for support. This floor shall sustain the equipment loading and normal maintenance loading for the unit.

C. Casing Construction:
   1. Exterior and interior wall panels shall be a minimum of 16 gauge and 20 gauge respectively of Type 304 stainless steel. The panels shall be fabricated into self-framing, double standing seam type construction. The panels shall form a self-framing casing with no additional structural support required. All joints shall be caulked airtight with a Room Temperature Vulcanizing (RTV) silicone sealant.
   2. Exterior roof deck panels and interior roof liner shall be a minimum of 16 gauge Type 304 stainless steel. The roof shall have a minimum of 1 ½ inch standing seams securely fastened at intervals not exceeding 12 inches, caulked and sealed.
   3. All wall and roof assemblies shall be insulated with 2 inch thick 3.0 lb/ft^3 density rigid fiberglass that is rot-proof and non-combustible. The insulation shall have a total R-Value not less than 9 Sq Ft-°F-Hr / Btu. Fiberglass insulation shall conform to a 25 smoke and 50 flame spread per ASTM E 84 and UL 723.
   4. Insulation shall meet NFPA 90A and 90B.
   5. All joints shall be caulked airtight with a sealant that is 100% pure RTV silicone with a temperature range of -50°F to 450°F.
   6. Closures around all components shall be provided and made airtight and be of minimum 16 gauge Type 304 stainless steel.

D. Access Door Construction:
   1. Access doors in the unit housing shall be provided to permit ready access to internal components. The access doors shall be provided with an inner sheet of 20 gauge Type 304 stainless steel to protect the insulation. The exterior of the access doors shall be 16 gauge Type 304 stainless steel. The doors shall be designed to swing against the fan static pressure in all sections; outward on negative pressurize sections and inward on positive pressure sections.
   2. Access doors shall be provided on the following components and on other sections as required to provide routine maintenance: dampers, filters, dehumidification section, reactivation section, heating section, supply fans, motors and drives. Removal of screwed wall panels shall not be acceptable.
   3. Access doors shall be provided with Type 304 stainless steel hinges in welded frames.
   4. Access doors shall be provided with Type 304 stainless steel quarter-turn latching handles that are operable from both sides. Each door shall be provided with a single handle with multiple latching points. Door latches are linked on units over 68 inches tall, provided the access doors are 46 inches or taller. This also ensures complete sealing of the door. Safety latches shall be provided to limit door movement when cabinet is positively or negatively pressurized.
   5. Access doors shall be sealed with a thermoplastic vulcanizate (TPV) gasket press-fitted into the access door frame for maximum air and water seal tightness. Gaskets shall be field replaceable.
   6. Access doors shall be provided with tie back hooks, clips or mechanical door stay.
   7. Access doors shall be provided with Type 304 stainless steel rain gutters or diverters over doors.

E. Unit shall be provided with minimum 16 gauge factory fabricated Type 304 stainless filter section with filter guides or holding frames. Block-offs shall be provided as required to prevent air bypass around filters.

F. Unit shall be provided with Type 304 stainless steel drain trap connections.

2.4 DESICCANT DEHUMIDIFICATION SYSTEM

A. Desiccant Rotor:
   1. The desiccant shall be made “in-the-flute” encapsulating the fiberglass substrate.
   2. The rotor shall be both washable and non-shedding. Rotors shall be capable of withstanding cleaning by vacuum cleaner, with a water or, water and detergent wash.

3. The substrate shall be manufactured with a fiberglass matrix meeting the IARC standards for non-respirable fibers.
4. The fiberglass substrate shall provide the structural support for the desiccant. The fiberglass substrate shall be combined with desiccant to form the dehumidifier rotor. The desiccant shall be self-bonding to the fiberglass substrate and to itself through the substrate voids filling in all the voids in the substrate and shall totally encapsulate the fiberglass.
5. The desiccant dehumidification rotor shall be assembled from smooth and corrugated sheets of fiberglass substrate interleaved in a winding to form the rotor creating a large number of axial passages through which the air flows
6. Where a face and by-pass arrangement is indicated, the performance shall meet the dew point values of the mixed air downstream of the face and by-pass section.
7. Rotor surfaces shall be ground, polished smooth and coated for long seal life.
8. Rated lifetime shall not be less than (87,600) hours and shall be defined by media performance meeting >90% of original specification.
9. Rotor media shall be tested to ASTM-E84 and produce results with zero Flame Spread Index and zero Smoke Developed Index.

B. Desiccant Rotor Cassette Frame:
1. Rotor cassette frames shall be manufactured from Type 304 stainless tubular steel. All welds shall be reasonably ground and dressed for appearance. Structural welds shall be continuous and non-structural welds shall be on 4 inch centers.
2. Cassette face panels and other sheet steel components shall be manufactured from Type 304 stainless steel material.

C. Desiccant Rotor Drive System:
1. Rotor drives shall be equipped with harden carbon steel ANSI drive sprocket, nickel plated corrosion resistant drive chain and spring type automatic chain tension device.
2. For ease of maintenance and chain alignment the gear motor shall be fastened to a Type 304 stainless steel gear motor plate which is fastened onto the cassette frame with standard hardware.
3. The drive assembly shall be equipped with a rotation detection circuit which shuts down the dehumidifier and signals the operator through an indicating light on the control cabinet if the wheel is not rotating.

D. Desiccant Rotor Seals:
1. Seals are to be Viton. The extruded Viton seal shall have a Teflon coating applied over both of the wipers of the seal such that the coating is impregnated within the seal. Rotor seals are rated for lifetime use (87,600 hours). Rotor seals

shall be rated for minimum 400°F continuous temperature rating. Bulb type seals are not allowed.

2. Rulon is to be used as the complementary seal material to the Teflon seal mentioned above. Rulon tape has an operating temperature range from -100 °F to 500°F .
3. Rotor dividing seals shall contact the face of the Desiccant Rotor media to seal between the process and reactivation airstreams. Standard hardware shall fasten the dividing seals flanges to the cassette frame partitions. Pop rivets shall not be used.
4. All other areas that have a potential for air bypass shall be RTV silicone sealed. This shall eliminate and ensure that no air bypasses the rotor cassette assembly. The silicone shall have a temperature ranges of -50°F to 450°F.

E. Reactivation Direct Fired Burner:

1. The reactivation heat source shall be full-modulation direct-fired gas. The capacity of the burner shall be sufficient to provide scheduled performance.
2. The gas burner shall be suitable for burning with a modulating turn-down ratio of 20:1. The gas burner shall have stainless steel baffles and non-clogging gas orifices. The burner assembly and complete pre-piped manifold shall include main and pilot gas regulators, main motorized fuel valve, 2 main safety shut off valves, pilot solenoid valve, main and pilot gas hand valves and manually adjustable burner air flow profile plates. A butterfly type gas valve is not acceptable due to poor control characteristics.
3. Pilot gas shall be automatically lit after a seven-second pre-purge timing by a spark rod that utilizes a 6,000 volt ignition transformer. After a proven flame by the flame rod, the main burner valve(s) open.
4. The gas burner shall be rated at no more than 390 MBH per foot of burner length, in order to limit flame length, and minimize the generation of carbon monoxide.
5. The control safety circuit shall include, but not be limited to: air flow proving device, high temperature limit switch, electronic primary flame safeguard with flame rod rectification, red alarm light to indicate flame failure, microprocessor rate controller, reactivation fan motor starter interlock and seven second combustion area pre-purge. Complete assemblies shall be pre-piped, wired, and tested.
6. Single point reactivation leaving air temperature controls are not acceptable.

F. Reactivation Outlet Tunnel:

1. The outlet tunnel casing shall be double insulated wall constructed of a minimum of 16 gauge Type 304 stainless steel interior panels, exterior panels, and interior tunnel flooring. The interior tunnel flooring shall incorporate a double sloped drain pan with drain. The panels shall form a self-framing casing with no

additional structural support required. All joints shall be caulked airtight with RTV silicone sealant.

2. The outlet tunnel casing shall be insulated with 2 inch thick 3.0 lb per sq. ft. density rigid fiberglass that is rot-proof and non-combustible. The insulation shall have a total R-Value not less than 9 Sq Ft-°F-Hr / Btu. Insulation shall conform to a 25 smoke and 50 flame spread per ASTM E 84 and UL 723. Insulation shall meet NFPA 90A and 90B.
3. All joints shall be caulked airtight with RTV silicone sealant.
4. The outlet tunnel drain pan shall have a fabricated drainage connection protruding through the floor for the purpose of condensation drainage to the unit exterior.
5. Closures around all interior components shall be provided airtight. Closures shall be of the same material used in the outlet tunnel interior and shall provide solid close-off inside of the outlet tunnel walls. No air bypass or leakage around the components shall be allowed.
6. For ease of rotor shaft and bearing maintenance, an access panel of the same material used in the tunnel exterior shall be provided and mounted in the bottom corner located by the rotor axis.

G. Reactivation Fan and Motor:
1. Reactivation air fan shall be single width, single inlet, airfoil type direct drive wheel, class III, and fabricated of aluminum construction.
2. Fan inlet cone shall be of aluminum construction.
3. Motors shall be TEFC, NEMA premium efficiency.
4. Motor horsepower shall be as indicated on the schedule.
5. Fan and motor shall be dynamically balanced as an assembly.
6. Reactivation motor shall be completely isolated from the reactivation air stream by means of a shaft sealing plate.

H. Reactivation Outlet Damper
1. Outlet system balancing damper is to be fabricated of Type 304 stainless steel and consist of a single damper blade and a locking quadrant.

2.5 OUTSIDE AIR INLET HOODS

A. Outside air hoods shall be furnished with either multiple or a single hood and bird screen which shall be sized for no more than 500 fpm.

B. Hoods shall be manufactured of a minimum of 16 gauge Type 304 stainless steel with Type 304 stainless steel 1-inch x 1-inch, 0.120-wire diameter mesh bird screen.

C. Hoods shall be provided with mist eliminators.

D. Motorized inlet damper and balancing damper shall be provided.

2.6 DAMPERS

A. Design and Performance Criteria (based on 48-inch damper width):
   1. Dampers shall be performance rated and certified in accordance with AMCA Standard 500-D and AMCA Publication 511.
   2. Maximum Design Total Static Pressure: 10.0-inch W.G.
   3. Damper Leakage: Class 1 Leakage Rated – Not more than 8 cfm per square foot at 4 inch W.G.
   4. Certification: Manufacturer shall submit certified test data.

B. Details of Construction:
   1. Material: Same as unit construction.
   2. Frame: Minimum 14 gauge channel frame with mounting flanges.
   3. Blades:
      a. Opposed blades.
      b. EPDM edge seals.
      c. Double skin airfoil shape construction.
   4. Linkage: Concealed in frame outside the air stream.
   5. Axles: Minimum 3/4-inch with material same as unit construction.
   6. Bearings: Stainless steel sleeve.
   7. Jamb Seals: Stainless steel compressible type.

C. Provide damper actuators with NEMA 4X enclosure.

2.7 FILTERS

A. Throwaway pleated panel type.

B. Manufacturer: Provide product of one of the following:
   1. Camfil Farr Company.
   2. Koch Filter Corporation.
   3. American Air Filter.
   4. Flanders Corporation.
   5. Or equal.

C. Filter media shall be a cotton and synthetic fiber blend lofted to a uniform depth and formed into a uniform radial pleat.

D. A welded wire grid, spot-welded and treated for corrosion resistance shall be bonded to the downstream side of the media to maintain radial pleats and prevent media oscillation.

E. A biodegradable enclosing frame of virgin-origin Kraft board, produced under an initiative for sustainable forest management, shall provide a rigid and durable enclosure. The frame shall be bonded to the media on all sides to prevent air bypass. Integral diagonal support members on the air entering and air exiting side shall be bonded to the apex of each pleat to maintain uniform pleat spacing in varying airflows.

F. Filter efficiency shall be determined in accordance with ASHRAE Standard 52.2 with a minimum MERV 11 rating.

G. Filter shall be UL 900 Class 2 rated.

H. Initial resistance to airflow shall not exceed 0.41 inch W.G. for a 2 inch deep or 0.35 inch W.G. for a 4 inch deep filter at a velocity of 500 fpm.

I. Filters shall be held in frames equipped with gaskets. Filter frames shall be a minimum of 16 gauge Type 304 stainless steel.

2.8 OUTDOOR AIR HEATING SECTION

A. Heater shall be constructed in accordance with UL Standards for zero clearance to combustible surfaces and shall meet NEC requirements.

B. Heater frame shall be constructed from minimum 16 gauge Type 304 stainless steel. Heater frame shall be reinforced with required corner bracing, stiffening ribs, and gussets spot-welded to the frame.

C. Heating elements shall be finned tubular type with internal Grade A resistance wire consisting of 80 percent nickel and 20 percent chromium, precisely centered in an electrically isolated, Type 304 steel protective sheath and filled with granular magnesium oxide, fully compacted. Sheath shall be helically wound with Type 304 stainless steel fins.

D. Heating elements shall be furnished with mounting flanges, making them individually removable through the terminal box.

E. Heating element wiring shall terminate in a full height terminal box at one end of the heater.

F. Terminal box shall be NEMA 4X rated with Type 304 stainless steel construction and shall be provided with a hinged latching cover, multiple concentric knockouts for field wiring, and without louvers or grilles in accordance with UL 1996.

G. Terminal box shall be insulated from heating elements with minimum 1 inch thick fiberglass insulation for maximum condensation protection.

H. Three phase heater shall be furnished with balanced phases on each step.

I. All internal wiring shall be stranded copper with 105 deg C insulation and shall be terminated in insulated, crimped connectors or box lugs.

J. Terminal block shall be provided for all field wiring and shall be sized for installation of 75 deg C copper wire rated in accordance with NEC requirements.

K. Heater's safety devices shall be hard wire interlocked with the unit and at minimum include the following:
   1. Disc type and linear type automatic reset thermal cutouts as the primary over temperature protection.
   2. Disc type manual reset thermal cutout with backup contactors as the secondary over temperature protection. Heat limiters or other fusible over temperature devices are not acceptable.
   3. Air flow proving switch.
   4. Normally opened magnetic contactors.
   5. Safety fuses located in the line of power to prevent power surge damage.
   6. Built-in, snap-acting, door interlocked disconnect switch.
   7. "Low Air Flow" and "Heater On" pilot lights.

L. Heater shall be installed a minimum of 12 inches downstream from air filters.

2.9 SUPPLY FAN

A. Fan:
   1. Aluminum centrifugal backward inclined airfoil plenum, single width, single inlet, class III. Fan wheel shall be rated in accordance with AMCA Standard 210. Fan manufacturer shall be a member of AMCA.
   2. Fan motor, fan bearings, and drive assembly shall be located inside the fan plenum.
   3. Fan assembly shall be provided with vibration isolators. Isolators shall be bolted to Type 304 stainless steel channel welded to unit floor, which is welded to the structural frame of the unit. Fans shall incorporate vertical spring type isolators with leveling bolts, bridge bearing waffled pads with minimum 1-inch static deflection designed to achieve high isolation efficiency.

4. A piezometer flow measurement system shall be provided on all fans. It shall have pressure taps piped to the exterior of the unit for proper system balancing and troubleshooting.

B. Fan Drive:
1. Fan shall be belt drive or direct drive as indicated on the Equipment Schedule.
2. Belt drives shall be factory installed, tensioned and aligned using a matched set of belts, except when fan motor is shipped loose.
3. Belt drives shall be sized with a minimum 1.2 service factor of the installed motor horsepower.
4. Belt drives shall be variable pitch type and suitable for adjustment within plus or minus ten percent of specified RPM, but not to exceed the maximum RPM of the unit.
5. Fan shaft shall be selected for stable operation at least 20 percent below the first critical RPM. Fan shaft shall be ground and polished solid steel with a rust inhibiting coating.
6. Fan pillow-block bearings shall be grease-lubricated ball or roller bearings. Bearings shall be rated for a minimum L-10 life of 100,000 [200,000] hours at the fan's maximum operating speed in accordance with ABMA 9 or 11. Grease lines shall be extended to the drive side of the fan for easy access.
7. Belts shall be oil, heat, and static resistant type.

C. Fan Motor:
1. Motors shall be premium efficiency, totally enclosed fan cooled (TEFC) type.
2. Motors shall have a service factor of 1.15.
3. Motors shall be normal starting torque, normal slip, squirrel cage induction type. Where VFD's are specified, VFD driven motors shall be compatible for variable frequency drive operation and suitable to be applied in speed varying service without overheating.
4. Motors shall be of sufficient size so that there will be no overload on the motor above rated nameplate horsepower under any condition of operation imposed by the driven equipment.
5. Motors shall have Class F insulation with Class B temperature rise and be capable of carrying nameplate full load current plus service factor continuously without an injurious temperature rise in an ambient temperature of 40 degrees C.
6. Motor thrust bearings shall be adequate to carry continuous thrust loads under all conditions of operation imposed by the driven equipment.
7. Motors shall be in accordance with all current applicable standards of NEMA, IEEE, ABMA, NEC, and ANSI.
8. Locked rotor currents shall be as specified in NEMA Standards.
9. Provide lubrication of non-hygroscopic grease or oil type.

10. Provide automatic breather and drain for TEFC motor enclosures.
11. Provide integral overload protection on all single phase motors.
12. Motor starter shall be provided where VFD is not specified on the Equipment Schedule.

D. Variable Frequency Drives:
1. Motors shall be provided with a factory installed and wired variable frequency drive (VFD) where specified on the Equipment Schedule.
2. Provide enclosed variable frequency drives (VFD) suitable for operation at the current, voltage, and horsepower shown on the Equipment Schedule. VFD shall conform to the requirements of NEMA ICS 3.1.
3. Product and Manufacturer: Provide one of the following:
   a. Model E7, as manufactured by Yaskawa Electric Corporation.
   b. Or equal.
4. Ratings:
   a. VFD must operate, without fault or failure, when voltage varies plus 10 percent or minus 15 percent from rating, and frequency varies plus or minus 5 percent from rating.
   b. Displacement Power Factor: 0.98 over entire range of operating speed and load.
   c. Operating Ambient Temperature: 14 to 104 degrees F.
   d. Humidity: 0 to 95 percent non-condensing.
   e. Altitude: Up to 3,300 ft, higher altitudes achieved by derating.
   f. Minimum Efficiency: 96 percent at half speed and 98 percent at full speed.
   g. Starting Torque: 100 percent starting torque shall be available from 0.5 to 60 Hz.
   h. Overload capability: 110 percent of rated FLA (Full Load Amps) for 60 seconds; 180 percent of rated FLA, instantaneously.
   i. VFD must meet the requirements for Radio Frequency Interference (RFI) above 7 MHz as specified by FCC CFR 47, part 15, subpart J, Class A devices.
   j. VFDs must have a minimum short circuit rating of 65K amps RMS (100K amps RMS with a DC bus reactor) without additional input fusing.
5. Unit Features:
   a. VFD shall employ microprocessor based inverter logic, isolated from all power circuits.
   b. VFD shall include surface mount technology with protective coating.
   c. VFD shall employ a Pulse Width Modulated (PWM) power electronic system, consisting of:
      1) Input Section:

a) VFD input power stage shall convert three-phase AC line power into a fixed DC voltage via a solid state full wave diode rectifier, with Metal Oxide Varistor (MOV) surge protection.

2) Intermediate Section:
   a) DC bus as a supply to the VFD output Section shall maintain a fixed voltage with filtering and short circuit protection.
   b) DC bus shall be interfaced with the VFD diagnostic logic circuit, for continuous monitoring and protection of the power components.
   c) 30 HP to 150 HP @ 208 VAC, 30 HP to 150 HP @ 240 VAC, and 40 HP to 500 HP 480 VAC, VFDs shall include a DC bus reactor to minimize reflected harmonics.

3) Output Section:
   a) Insulated Gate Bipolar Transistors (IGBTs) shall convert DC bus voltage to variable frequency and voltage.
   b) The VFD shall employ PWM sine coded output technology to power the motor.

d. VFD must be selected for operation at carrier frequencies at or above 5 kHz without derating to satisfy the conditions for current, voltage, and horsepower as shown on the Equipment Schedule. Exception to this requirement is allowed only for VFDs providing 506A or more.

e. VFD shall have an adjustable carrier frequency: The carrier frequency shall have a minimum of six settings to allow adjustment in the field.

f. VFD shall have embedded Building Automation System (BAS) protocols for network communications; Johnson Metasys N2, Siemens System 600 APOGEE, and Modbus/Memobus. Provide a serial communication gateway for LonWorks or BACnet where required for communication with the BAS. These protocols shall be accessible via a RS-422/485 communication port.

g. VFD shall have a quick disconnect, removable control I/O terminal block to simplify control wiring procedures.

h. VFD shall include two independent analog inputs. One shall be 0-10 VDC. The other shall be programmable for either 0-10 VDC or 4-20 mA. Either input shall respond to a programmable bias and gain.

i. VFD shall include a minimum of seven multi-function digital input terminals, capable of being programmed to determine the function on a change of state. These terminals shall provide up to 30 functions, including, but not limited to:
   1) Remote/Local operation selection.
   2) Detection of external fault condition.
   3) Remote Reset.
   4) Multi-step speed commands.
   5) Run permissive.
   6) Floating control.

j. VFD shall include two 0-10 VDC or 4-20 mA analog output for monitoring or "speed tracking" the VFD. The analog output signal will be proportional to output frequency, output current, output power, Proportional and Integral control (PI) feedback, or DC bus voltage.
k. VFD shall provide terminals for remote input contact closure, to allow starting in the automatic mode.
l. VFD shall include at least one external fault input, which shall be programmable for a normally open or normally closed contact. These terminals can be used for connection of firestats, freezestats, high pressure limits or similar safety devices.
m. VFD shall include two form "A" contacts and one form "C" contact, capable of being programmed to determine conditions that must be met in order for them to change state. These output relay contacts shall be rated for at least 5A at 120 VAC and shall provide up to 18 functions, including, but not limited to:
    1) Speed agree detection.
    2) Low and high frequency detection.
    3) Missing frequency reference detection.
    4) Overtorque/Undertorque detection.
    5) Drive Running.
    6) Drive Faulted.
n. VFD shall include a power loss ride through of 2 seconds.
o. VFD shall have DC injection braking capability, to prevent fan "wind milling" at start or stop, adjustable, current limited.
p. VFD shall have a motor preheat function to prevent moisture accumulation in an idle motor.
q. VFD shall include diagnostic fault indication in selected language, last 10 faults storage and heatsink cooling fan operating hours.
r. VFD shall have a digital operator with program copy and storage functions to simplify set up of multiple drives. The digital operator shall be interchangeable for all drive ratings.
s. VFD shall include a front mounted, sealed keypad operator, with an English language illuminated LCD display. The operator will provide complete programming, program copying, operating, monitoring, and diagnostic capability. Keys provided shall include industry standard commands for HAND, OFF, and AUTO functions.
t. VFD plain language display shall provide readouts of output frequency in Hz, PI feedback in percent, output voltage in volts, output current in amps, output power in kilowatts, D.C. bus voltage in volts, interface terminal status, heatsink temperature and fault conditions. All displays shall be viewed in an easy-to-read illuminated LCD.

u. VFD unit shall include the following meters to estimate use of energy:
   1) Elapsed Time Meter.
   2) Kilowatt Meter.
   3) Kilowatt Hour Meter.
v. VFD shall include PI control logic, to provide closed loop setpoint control capability, from a feedback signal, eliminating the need for closed loop output signals from a building automation system. The PI controller shall have a differential feedback capability for closed loop control of fans and pumps for pressure, flow or temperature regulation in response to dual feedback signals.
w. An energy saving sleep function shall be available in both open loop (follower mode) and closed loop (PI) control, providing significant energy savings while minimizing operating hours on driven equipment. When the sleep function senses a minimal deviation of a feedback signal from setpoint, or low demand in open loop control, the system reacts by stopping the driven equipment. Upon receiving an increase in speed command signal deviation, the drive and equipment resume normal operation.
x. VFD shall include loss of input signal protection, with a selectable response strategy including speed default to a percent of the most recent speed.
y. VFD shall include electronic thermal overload protection for both the drive and motor. The electronic thermal motor overload shall be approved by UL. If the electronic thermal motor overload is not approved by UL, a separate UL approved thermal overload relay shall be provided in the VFD enclosure.
z. VFD shall include the following program functions:
   1) Critical frequency rejection capability: 3 selectable, adjustable deadbands.
   2) Auto restart capability: 0 to 10 attempts with adjustable delay between attempts.
   3) Ability to close fault contact after the completion of all fault restart attempts.
   4) Stall prevention capability.
   5) “S” curve soft start capability.
   6) Bi-directional “Speed search” capability, in order to start a rotating load.
   7) 14 preset and 1 custom volts per Hz pattern.
   8) Heatsink over temperature speed fold back capability.
   9) Terminal status indication.
   10) Program copy and storage in a removable digital operator.
   11) Current limit adjustment capability, from 30 to 200 percent of rated full load current of the VFD.
   12) Motor pre-heat capability.
   13) Input signal or serial communication loss detection and response strategy.
   14) Anti “wind-milling” function capability.

15) Automatic energy saving function.
16) Undertorque/Overtorque Detection.
17) Preset speeds.

aa. VFD shall include factory settings for all parameters, and the capability for those settings to be reset.

bb. VFD shall include user parameter initialization capability to re-establish project specific parameters.

cc. VFD shall include the capability to adjust the following functions, while the VFD is running:

1) Speed command input.
2) Acceleration adjustment from 0 to 6000 seconds.
3) Deceleration adjustment from 0 to 6000 seconds.
4) Select from 5 preset speeds.
5) Analog monitor display.
6) Removal of digital operator.

6. Enclosures:

a. All standard and optional features shall be included in a single NEMA 1, plenum rated enclosure with a UL certification label.

7. Bypass:

a. Two Contactor Manual Bypass shall be provided where specified on the Equipment Schedule. VFD and bypass components shall be mounted inside a common NEMA 1 enclosure, fully pre-wired and ready for installation as a single UL listed device.

2.10 ACCESSORIES

A. Unit shall be provided with two, unit mounted, 120 VAC ground-fault-circuit-interrupter (GFCI) type service outlets, NEMA 4X rated.

B. Unit shall include factory wired, marine duty service lights in each section.

C. Service outlets and marine duty service lights shall be powered from a separate service line. Provide NEMA 4X rated disconnect switch and a warning label to indicate that the service outlets and marine duty service lights are powered separately from the unit main power.

D. Unit shall include Photohelic gauge for visual filter pressure differential indication.

2.11 CONTROLS

A. General

1. Provide provisions for local and remote monitoring and control as specified herein.

2. Unit shall be factory wired and tested, and shall be UL certified and labeled. Prewired unit shall bear an approved label with all the necessary identification marks, electrical data, and any necessary cautions as required by the National Electrical Code. All electrical components shall bear the UL label.
3. Provide a system of motor controls, including all necessary terminal blocks, motor circuit protector, motor contactors, motor overload protection, grounding lugs, control transformers, auxiliary contactors and terminals for the connection of external control devices or relays. Control voltage shall be 120 VAC maximum.
4. Unit shall be provided with phase and brown-out protection to de-energize all motors in the unit if the phases are more than 10 percent out of balance on voltage, or the voltage is more than 10 percent under design voltage, or on phase reversal.
5. Control panel shall be of similar construction to unit conforming to UL 1995 and shall be provided with a hinged latching cover and multiple concentric knockouts for field wiring. Control panel shall be NEMA 4X rated.
6. Control panel shall be provided with heaters, automatically controlled closed loop ventilation fans or closed loop air conditioners with filtered air louvers if required to maintain temperature inside below the maximum and above the minimum operating temperature ratings of the electrical components.
7. All wiring inside the unit shall be type THHN. All electrical wiring located inside the air stream shall be installed in threaded aluminum conduit. Use of lengths of flexible conduit will be permitted when rigid conduit is not applicable. All flexible conduit shall be liquid tight, and approved by UL
8. Where unit construction is such that wiring must be disconnected for shipment, terminal blocks in an accessible enclosure shall be provided at the section points for field wiring.
9. All wiring shall be color-coded and labeled. Power wiring shall be coded per Owner standards.
10. A circuit diagram of the approved electrical drawing shall be provided with the unit. The circuit diagram shall include recommended power supply wire sizes and fuse sizes in conformance to the NEC. Typical wiring diagrams are not acceptable.
11. Unit shall be designed for single point electrical connection except where otherwise noted for service outlets and lighting. All necessary power transformers shall be factory provided and installed.

B. Factory Provided Unit Controller:
   1. General:
      a. Provide a microprocessor based direct digital controller with Operator Interface Terminal (OIT). The OIT shall provide all monitoring and

interfacing functions with the control system. OIT shall be a minimum of 5 inches by 7 inches liquid crystal display with 8 lines by 20 characters wide and backlit.

b. The controller shall include interface modules for future connectivity to a building management system using BACnet protocol. BACnet shall be available via two mediums, RS485 or using an IP address. All controller points shall be available via BACnet connection.

c. The control system shall be programed by the manufacturer with operating and safety controls needed to provide complete control of the system. Controller shall be installed in the unit control panel and factory tested.

d. Controller shall be capable of standalone operation without dependence on a building management system.

e. Controller shall include non-volatile memory to retain all programmed values, without the use of an external battery, in the event of a power failure.

f. Controller shall include an algorithm for calculating dew point temperature given air temperature and relative humidity values.

g. The control system shall come complete with all sensors required to operate the unit except where otherwise noted. At minimum provide the following sensors factory wired to the control system terminal block:
   1) Reactivation air inlet temperature
   2) Reactivation air outlet temperature
   3) Discharge air temperature and relative humidity.
   4) Return air temperature and relative humidity.
   5) Outside air temperature and relative humidity (NEMA 4X).
   6) Mixed air temperature and relative humidity.

h. A process water temperature transmitter provided under the process instrumentation and control work shall be wired under the electrical work to a terminal block on the unit controller. The temperature shall be displayed and used to control the dehumidification system.

2. The following minimum functions shall be provided and displayed at the OIT:
   a. Control
      1) Unit ON/OFF
      2) Return air dew point set point (maximum)
      3) Return air dew point to process water temperature offset
      4) Outside air supply air temperature set point
   b. Monitoring
      1) Reactivation energy rate bar graph
      2) Power on
      3) Supply air flow
      4) Process fan on
      5) Reactivation air flow

6) Reactivation fan on
7) Call for dehumidification
8) Discharge air temperature, humidity and dew point
9) Return air temperature, humidity and dew point
10) Outside air temperature, humidity and dew point
11) Mixed air temperature, humidity and dew point
12) Outside air supply temperature
13) Process water temperature (Remote input from GAC Control Panel)
14) Supply, return and outside air damper positions
15) Supply air fan VFD percent speed
16) Outside air electric heater % capacity
17) Process supply fan VFD in bypass

c. Alarms
1) Low reactivation temperature
2) Rotor rotation fault
3) Reactivation flame failure
4) Reactivation high temperature
5) Reactivation inlet temperature limit exceeded
6) Reactivation outlet temperature limit exceeded
7) Possible reactivation airflow restriction
8) Supply fan fault
9) Reactivation fan fault
10) Space high dew point temperature
11) Low outside air supply temperature
12) Electric heater fault
13) Common alarm (for remote monitoring by GAC Control Panel)
14) Smoke alarm (remote shut down signal)

C. Sequence of Operations:
1. Unit shall be indexed ON/OFF by an ON/OFF switch at the unit control panel. The unit shall normally be in the ON position to dehumidify the space. The supply air fan shall be controlled through a factory installed VFD used to soft start the motor and balance the fan. In the OFF position the unit shall be in the stand-by mode and the controller shall be powered and the sensors active.
2. When the unit is indexed to ON, the unit mounted supply air damper, return air damper, and outside air damper shall open. When the supply air and return air dampers reach their assigned positions, the supply fan shall be energized. When the unit is indexed OFF, The supply fan shall be de-energize and the dampers shall close after a predetermined time to allow the fan to come to a stop.
3. Dehumidification:

a. When the return air dew point is less than or equal to 5°F below the process water temperature, the unit shall operate in the dehumidification mode to keep the return air 5°F below the process water temperature. When the sensed dew point exceeds the setpoint by 2°F (adjustable) the controller shall energize the reactivation circuit including reactivation fan, rotor, and reactivation burner.
b. Reactivation burner ignition and flame management are controlled via a dedicated flame safeguard system and proven via flame rectification. Pre-ignition interlocks include reactivation airflow differential pressure proving switch, and manual reset high temperature limit switch.
c. Reactivation burner firing rate is controlled as follows:
    1) Desiccant reactivation inlet temperature is maintained at optimum temperature for maximum dehumidification performance irrespective of outdoor temperature or filter loading.
    2) As moisture load decreases and reactivation outlet temperature rises, the controller resets reactivation inlet temperature down as required to limit reactivation outlet temperature.
    3) In the event of a sensor failure, the controller shall deliver a fail-safe mode burner rate signal to provide limited performance as follows:
        a) With failed desiccant reactivation inlet sensor, burner output signal is set to 50%.
        b) With failed reactivation outlet sensor, desiccant reactivation inlet is maintained at 260°F.
        c) With diminished reactivation airflow (i.e. dirty filters) desiccant reactivation inlet temperature is limited in order to prevent rotor overheat.
        d) With overheat caused by an abnormal condition, a manual reset high temperature limit in desiccant reactivation inlet air stream cycles burner off.
        e) Adequate reactivation energy is proven via reactivation outlet temperature. If the reactivation outlet temperature fails to achieve or falls below 90°F over a 15 minute period a “Low Reactivation Temp” alarm shall be displayed at the OIT. Unit supply fan shall continue to run.
    4) Reactivation shutdown occurs under the following:
        a) Desiccant rotor rotation is proven via magnetic proximity switch input to the controller. If rotation is not detected within programmed time, reactivation shut-down occurs. A "Rotation Fault" alarm shall be displayed at the OIT.

b) Flame failure via flame safeguard relay causes reactivation shut-down in the event of failure to ignite or maintain pilot flame. A "Flame Failure" alarm shall be displayed at the OIT.
c) If reactivation inlet temperature exceeds 400°F a high limit fault and reactivation shut-down occurs. A "Reactivation High Temp" alarm shall be displayed at the OIT. The High Limit condition shall be reset by switching the main disconnect off and then back on.
d) If reactivation inlet temperature reaches 325°F or the reactivation outlet exceeds 200°F, the reactivation process is shut-down. A "Reactivation Inlet Temp Limit Exceeded" and/or "Reactivation Outlet Temp Limit Exceeded" alarm(s) shall be displayed at the OIT.
e) If the reactivation inlet temperature exceeds 300°F and the reactivation energy modulation is at 0%. A "Possible Reactivation Airflow Restriction" alarm will display at the controller.
f) Failure to sense supply air flow within 60 seconds of the run command or loss of supply air flow during operation results in a supply fan fault and unit shut-down. A "Supply Fan Fault" alarm shall be displayed at the OIT.
g) Failure to sense reactivation airflow within 60 seconds of the reactivation enable command or loss of reactivation air flow during operation results in a reactivation fan fault and unit shut-down. A "Reactivation Fan Fault" alarm shall be displayed at the OIT.
h) After corrective action is taken, the controller fault condition may be reset via key-stroke entry on the controller display, by cycling of the "ON/OFF" selector switch to the Off position or cycling unit power.

4. Outside Air Heating:
   a. Electric heater shall have full modulation capacity controlled by a Silicon Controlled Rectifier (SCR).
   b. The heating coil shall maintain the outdoor air supply at 55 ° F through the outdoor temperature supply air sensor.
5. Fire Alarm Shut Down:
   a. A signal from the building fire alarm control panel (FACP) shall be provided to the unit control panel under the electrical work for unit shut down under an alarm condition.

2.12 IDENTIFICATION

A. All equipment and component identification shall be provided in accordance with Section 10 14 00, Signage.

B. All electrical wiring identification shall be provided in accordance with Section 26 05 53, Identification For Electrical Systems.

C. Units shall be provided with nameplates giving the manufacturer's model and serial number, rated capacity, and all other pertinent data. Nameplates shall be stainless steel with laser etched black letters. Nameplates shall be affixed to the units with two stainless steel self-tapping screws or rivets. Industrial grade adhesive that will not peel or lose adhesion strength due to extreme temperature variations with chemical and water resistances shall also be acceptable.

D. All electrical wiring shall be color-coded and labeled for simplified identification. Power wiring shall be coded per CITY standards.

2.13 SOURCE QUALITY CONTROL

A. Shop Tests:
   1. Equipment shall be completely manufactured and pre-assembled in accordance with Reference Standards. Perform the following tests and inspections at factory before shipment:
      a. Tested and inspected for approval as a unit by Underwriters Laboratories Inc., UL Label or equal.
      b. Electric heating section shall be electrically tested at 1000 VAC if rated at 250 VAC or less and 1000 VAC plus twice the rated voltage if rated at more than 250 VAC.
      c. Factory test equipment to ensure that the entire package has been properly fabricated and assembled, that all the controls function as specified herein and that the package meets the specified performance requirements including manufacturer's data report.
      d. Fan wheels and shafts shall be statically and dynamically balanced.

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine conditions under which materials and equipment will be installed and notify ENGINEER in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions are corrected.

B. Take field measurements where required prior to installation to ensure proper fitting of Work.

3.2 PREPARATION

A. Protection of Surrounding Areas/Surfaces:
   1. Openings and penetrations shall be capped to protect the building from outside conditions.
   2. Equipment shall be tightly covered and protected against dirt, water, and chemical or mechanical damage.

3.3 INSTALLATION

A. General:
   1. Install the equipment in accordance with the Contract Documents and by manufacturer's instructions and recommendations. Obtain written interpretation from ENGINEER in the event of conflict between manufacturer's instructions and recommendations and the Contract Documents.
   2. Install in accordance with Laws and Regulations.
   3. Do not modify structures to facilitate installation of equipment, unless approved in writing by ENGINEER.
   4. Installation to conform to requirements of all local and state codes.

B. Concrete Pad Anchorages:
   1. Provide anchorages in accordance with equipment manufacturer's recommendations.
   2. Equipment shall be anchored to the equipment pad. Anchorage shall be provided in accordance with Section 40 05 96, Vibration, Seismic, and Wind Controls.

3.4 FIELD QUALITY CONTROL

A. Field Tests:
   1. Field testing shall be provided in accordance with Section 01 79 13.
   2. After equipment installation is complete, CONTRACTOR and a qualified field service representative of unit manufacturer shall perform an operating test in presence of ENGINEER. Equipment will pass the test when each unit and its controls are demonstrated to function correctly.
   3. Running Tests:
      a. Field-test each equipment together with its controls and appurtenances. Tests shall demonstrate to ENGINEER that each part and all parts together function in accordance with the Contract Documents. Provide all necessary testing equipment, labor, and appurtenances.
      b. Verify that equipment operates at design point as intended, that vibration limits are not excessive and beyond manufacturer's recommendations, and that equipment operates smoothly without excessive noise, temperature rise, or other defects, across entire range of operating curve. Verify that all

controls work as intended in both manual and automatic mode. Successfully test-operate each equipment for at least (48) hours.

c. If equipment does not comply with the Contract Documents and does not pass the tests, CONTRACTOR shall adjust, modify, and retest the equipment as often as necessary until tests are successfully passed.

B. Manufacturer's Services:

1. Provide a qualified, factory-trained service person to perform the following:
   a. Instruct CONTRACTOR in installing equipment.
   b. After installation, inspect and adjust equipment, verify proper operation, and assist with field testing.
   c. Instruct operations and maintenance personnel in operation and maintenance of the equipment.
2. Manufacturer's service person shall make visits to the Site as follows:
   a. First visit shall be for instructing CONTRACTOR in proper equipment installation, and assisting in installing equipment. Minimum number of hours on-Site: (8) hours.
   b. Second visit shall be for checking completed installation, start-up of system; and performing field testing. Minimum number of hours on-Site: (16) hours.
   c. Third visit shall be to instruct operations and maintenance personnel.
      1) Furnish services of manufacturer's qualified, factory-trained specialists to instruct operations and maintenance personnel in recommended operation and maintenance of equipment.
      2) Training requirements, duration of instruction, and qualifications shall be in accordance with Section 01 79 23, Instruction of Operations and Maintenance Personnel.
      3) Number of hours on-Site shall be in accordance with Section 01 79 23, Instruction of Operations and Maintenance Personnel.
   d. Technician shall revisit the Site as often as necessary until installation is acceptable.
3. All costs, including expenses for travel, lodging, meals and incidentals, and cost of travel time, for visits to the Site shall be included in the Contract Price.

3.5 ADJUSTING

A. Adjust all controls for proper settings.

B. While system is operable, balance all equipment to achieve design conditions.

3.6 CLEANING

A. Thoroughly clean all equipment and accessories prior to installation.

B. Remove all dirt, rust, dust, etc. from equipment and accessories after installation.

C. Remove and dispose of all debris and waste from the Site resulting from installation.

+ + END OF SECTION + +

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SECTION 26 05 05

GENERAL PROVISIONS FOR ELECTRICAL SYSTEMS

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals shown, specified, and required to complete the electrical Work, which includes:
      a. Providing conduits, inserts and other electrical items to be embedded in concrete, built into walls, partitions, ceilings, and panels provided by others.
   2. Demolition: Electrical demolition shall be in accordance with Section 02 41 00, Demolition.
   3. Utility Companies:
      a. Electric Utility Company: Perform the Work in connection with the electric service and utility metering in accordance with requirements of Central Hudson.

B. Coordination:
   1. Review installation procedures and schedules under other Specification Sections and coordinate with other trades the installation of electrical items that will be installed with or within formwork, walls, partitions, ceilings, and panels.
   2. Coordination and Intent of Electrical Drawings:
      a. Dimensions on Drawings related to equipment are based on equipment of certain manufacturers. Verify the dimensions of equipment furnished to space available at the Site and allocated to the equipment.
      b. Drawings show the principal elements of the electrical Work, and are not intended as detailed working drawings for the electrical Work. Drawings supplement and complement the Specifications and other Contract Documents relative to principal features of electrical systems.
      c. Equipment and devices provided under this Contract shall be properly connected and interconnected with other equipment and devices for successful operation of complete systems, whether or not all connections and interconnections are specifically mentioned or shown in the Contract Documents.
      d. Drawings are provided for CONTRACTOR's guidance in fulfilling the intent of the Contract Documents CONTRACTOR shall comply with Laws and Regulations, including safety and electrical codes, and provide materials, equipment, appurtenances, and specialty items necessary for complete and operable systems.
   3. Obtain from CITY record drawings required to execute the Work.
   4. Field Coordination:

a. Provide materials, equipment, and services to interface with existing circuits. Field-verify system and equipment requirements prior to modifying existing systems.
b. Coordinate the interface of equipment with CITY's personnel and field conditions.
c. Field-compare existing starter and panel control circuit terminations from record documents with existing circuits.
d. Field-trace existing circuits as required to interface the equipment provided.
e. Field-identify terminations for starters and panel controls for follow function for re-connection.

C. Related Sections:
1. Section 02 41 00, Demolition.
2. Section 03 30 00 Cast-in-Place Concrete.
3. Section 05 05 33, Anchor Systems.
4. Section 09 91 00, Painting.
5. Section 31 23 05, Excavation and Fill.
6. Section 40 60 05, Instrumentation and Control.

D. Work Included in This Contract but Specified Elsewhere:
1. Concrete for pads, manholes, ductbanks, and conduit encasement shall comply with Section 03 30 00, Cast-in-Place Concrete.
2. Anchorage systems shall comply with Section 05 05 33, Anchor Systems.
3. Shop painting and surface preparation shall comply with Section 09 91 00, Painting, unless otherwise specified in Division 26 Sections.
4. Excavation and filling associated with buried electrical Work shall comply with Section 31 23 05, Excavation and Fill.

E. Area Classifications:
1. Materials, equipment, and incidentals shall be suitable for the area classification(s) shown, specified, and required.
2. Wet Locations: Comply with NEC and NEMA requirements for wet locations. Enclosures in wet locations shall comply with NEMA 4 unless specified otherwise.
3. Corrosive Locations: Comply with NEC and NEMA requirements for corrosive locations. Enclosures in corrosive locations shall conform to NEMA 4X requirements unless specified otherwise.
4. Hazardous Locations: Comply with NEC requirements for the Class and Division designated.
5. Dusty Locations: Indoor areas not designated as hazardous, corrosive, or wet are dusty locations. Comply with NEC and NEMA 12 requirements unless specified otherwise.

1.2 QUALITY ASSURANCE

A. Component Supply and Compatibility:

1. Materials and equipment similar to each other shall be from the same manufacturer for uniformity.

B. Regulatory Requirements:
   1. Permits: Refer to the General Conditions, Supplementary Conditions, and other parts of the Contract Documents for responsibilities relative to obtaining and paying for permits, licenses, and inspection fees.
   2. Codes: Refer to Section 01 42 00, References, for indication of applicable codes.

1.3 SUBMITTALS

A. General:
   1. To the extent practical, submit Shop Drawings and other CONTRACTOR submittals for each Specification Section into the smallest number of submittals possible. Do not furnish partial submittals.
   2. Review of equipment submittals does not relieve CONTRACTOR of responsibility for providing complete and successfully operating systems.

B. Action Submittals: Submit the following:
   1. Shop Drawings:
      a. Internal wiring diagram and drawings indicating all connections to components and numbered terminals for external connections.
      b. Dimensioned plan, section, elevations, and panel layouts showing means for mounting, conduit connection, and grounding.
      c. List of components including manufacturer’s name and catalog number (or part number) for each.
      d. Point-to point interconnection wiring diagrams.
   2. Product Data:
      a. Manufacturer's name and product designation or catalog number.
      b. Electrical ratings.
      c. Manufacturer’s technical data and specifications.
      d. Manufacturer’s indication of compliance with applicable reference standards.
      e. Painting and coating systems proposed.
   3. Test Procedures: Proposed testing procedures and testing limitations for source quality control testing and field quality control testing.

C. Informational Submittals: Submit the following:
   1. Manufacturer’s Instructions:
      a. Installation data and instructions.
      b. Instructions for handling, starting-up, and troubleshooting.
   2. Source Quality Control Submittals: Results for required shop testing.
   3. Field Quality Control Submittals: Results for required field testing.

D. Closeout Submittals: Submit the following:
   1. Record Documentation:
      a. System Record Drawings: Include the following:
         1) One-line wiring diagram of the electrical distribution system.

2) Actual, in-place conduit and cable layouts with schedule of conduit sizes and number, and size of conductors.
3) Layouts of the power and lighting arrangements and the grounding system.
4) Control schematic diagrams, with terminal numbers and control devices identified, for all equipment.

b. Point-to-Point Interconnection Wiring Diagram Drawings: Include the following:
1) External wiring for each piece of equipment, panel, instrument, and other devices and wiring to control stations, lighting panels, and motor controllers.
2) Numbered terminal block identification for each wire termination.
3) Identification of the assigned wire numbers for all interconnections.
4) Identification of wiring by the conduit tag in which the wire is installed.
5) Terminal, junction, and pull boxes through which wiring is routed.
6) Identification of equipment and the submittal transmittal number for equipment from which wiring requirements and termination information was obtained.

c. Record documents shall indicate final equipment and field installation information.

PART 2 – PRODUCTS

A. Performance Criteria:
1. Electrical equipment shall be capable of operating successfully at full-rated load, without failure, with ambient outside air temperature of 105 degrees F to -15 degrees F and an elevation of 500 feet above mean sea level.
2. Unless specified otherwise, electrical equipment shall have ratings based on 75 degrees C terminations.

B. Testing Laboratory Labels: Electrical material and equipment shall bear the label of Underwriters' Laboratories, Inc. or other nationally recognized, independent testing laboratory, where standards have been established and label service applies.

PART 3 – EXECUTION

3.1 INSPECTION

A. Examine conditions under which Work will be performed and notify ENGINEER in writing of conditions detrimental to the proper and timely completion of the Work. Do not proceed with Work until unsatisfactory conditions are corrected.

3.2 INSTALLATION

A. General:
   1. Install materials and equipment in accordance with the Contract Documents, Laws and Regulations, approved (and accepted, as applicable) Shop Drawings and other CONTRACTOR submittals, and manufacturer's recommendations.
   2. Provide tools and equipment required to trace circuits necessary for proper execution of the Work.
   3. Define and identify all wiring, circuit terminations, and equipment to be modified to ensure proper interface of components. The Contract Price includes all costs associated with field services specified for a complete and functional system.

B. Staging, Sequencing, and Coordination with Existing Facilities:
   1. Schedule, sequence, and install materials and equipment in accordance with Section 01 14 16, Coordination with CITY's Operations
   2. Perform the Work in a manner that will not interfere with the existing equipment and facilities or cause interruption of the functions of the Site, unless specified otherwise or otherwise allowed by ENGINEER and CITY.
   3. When operation of existing facilities and Site is disrupted due to CONTRACTOR's operations, comply with Section 01 14 16, Coordination with CITY's Operations, unless otherwise allowed by ENGINEER and CITY.
   4. Where the Work ties in with existing installations, take precautions and provide safeguards in connecting the Work to existing operating circuits to prevent interruption to existing circuits. Connection of Work to existing circuits shall be performed in the presence of CITY and ENGINEER.
   5. Interruptions of existing circuits, not addressed in Section 01 14 16, Coordination with CITY's Operations, shall be coordinated with the CITY who will determine the length of time a circuit may be de-energized to maintain the CITY's processes in dependable and safe operation.

3.3 FIELD QUALITY CONTROL

A. Field Quality Control – General:
   1. Perform field quality control for electrical Work in accordance with the Contract Documents.

B. Site Tests:
   1. Prior to requesting certificate of Substantial Completion, demonstrate to ENGINEER that electrical systems and electrically-operated equipment installed or modified under the Contract operates in accordance with the Contract Documents and operates as required
   2. Perform the following operational tests on electrical systems:
      a. Operate power circuits to verify proper operation and connection to electrical systems materials and equipment, including mechanical key-interlocks for circuit breakers.

b. Remove and re-apply power supply to automatic transfer equipment to verify operation. Activate standby power systems to verify their automatic start-up, proper de-energization, and cool down upon resumption of normal power supply.

c. Operate control circuits, including pushbuttons, indicating lights, and similar devices, to verify proper connection and function. Operate all devices, such as pressure switches, flow switches, and similar devices, to verify that shutdowns and control sequences operate as required.

d. Operate lighting systems and receptacle devices to verify proper operation and connections.

3. Prepare and submit report on the equipment demonstration and operating field quality control tests. Report shall include complete information on the tests performed and results.

C. Manufacturer's Services:

1. Furnish at the Site qualified, factory-trained representative(s) of equipment manufacturers for the services indicated in the Contract Documents.

+ + END OF SECTION + +

SECTION 26 05 13

MEDIUM VOLTAGE CABLES

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install medium voltage cable.

1.2 REFERENCES

A. Standards referenced in this Section are:
   1. AEIC CS8, Specification for Extruded Dielectric Shielded Power Cables Rated 5 through 46 kV.
   2. ANSI C2, National Electrical Safety Code.
   3. ANSI/NETA ATS, Acceptance Testing Specifications for Electrical Power Equipment and Systems
   4. ASTM B3, Specification for Soft or Annealed Copper Wire
   5. ASTM B8, Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard or Soft.
   6. ASTM B33, Specification for Tinned Soft or Annealed Copper Wire for Electrical Purposes.
   7. ICEA S-93-639, 5-46 KV Shielded Power Cables for use in the Transmission and Distribution of Electric Energy.
   8. IEEE 48, Standard Test Procedures and Requirements for Alternating-Current Cable Terminations 2.5kv through 765kv.
   9. IEEE 404, Standard for Extruded and Laminated Dielectric Shielded Cable Joints Rated 2500 V to 500 000 V
   10. UL 1072, Medium-Voltage Power Cables.

1.3 QUALITY ASSURANCE

A. Qualifications:
B. Regulatory Requirements:
   1. Tests by Independent Agencies: Cable shall bear label of Underwriters Laboratories, Inc.
   2. Utilities:
      a. Perform Work in connection with utility service in conformance with requirements of Central Hudson.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Shop Drawings:
      a. Literature identifying the methods and materials proposed for making splices and terminations. Submittal shall consist of manufacturer literature evidencing compatibility of conductor insulation, shield, and jacket of cable with splicing or terminating materials, and methods proposed for use.
      b. Listing of locations where splices are proposed.
   2. Product Data:
      a. Manufacturer's literature and technical information indicating compliance with the Contract Documents.

B. Informational Submittals: Submit the following:
   1. Certificates:
      a. Certification from cable Supplier that cable installation is in accordance with cable manufacturer's recommendations.
   2. Source Quality Control Submittals: Submit results of factory tests. Include testing procedures utilized.
   3. Field Quality Control Submittals: Submit results of field quality control testing. Include testing procedures utilized.
   4. Qualifications Statements:
      a. Qualifications of splicing and termination personnel
      b. Independent testing agency.

C. Closeout Submittals: Submit the following:
   1. Record Documentation:
      a. Include on record documents actual location and routing of medium voltage cable installations in accordance with Section 01 78 39, Project Record Documents.

PART 2 – PRODUCTS

2.1 MATERIALS

A. General:
   1. Cable provided under this Section shall be rated for insulation level of 133 percent at five, or 15, or 35 KV.
   2. Cable insulation shall be thermosetting rubber-based suitable for normal installation indoors or outdoors, in conduit, in air, and intermittent or continuous submergence in water.
   3. Cable shall be single conductor bearing UL label "MV 105" and comply with or exceed applicable ICEA and AEIC standards.

B. Manufacturers: Provide products of one of the following:
   1. Kerite Company.
   2. The Okonite Company.
   3. General Cable Corporation.
   4. Southwire.
   5. Or equal.

C. Materials:
   1. Conductor: Conductors shall be soft or annealed uncoated or tinned coated copper with concentric-lay Class B round stranding in accordance with ASTM B8, and ASTM B3 or ASTM B33.
   2. Insulation System: Cable insulation system shall include two separate screen layers, primary insulation and shield.
      a. Conductor screen shall consist of extruded inner layer of non-conducting energy suppression or semi-conducting material. Conductor screen shall be in intimate contact with outer surface of conductor.
      b. Primary insulation shall be high quality ozone-resistant ethylene-propylene rubber based compound. Insulation system shall be suitable for use at conductor temperatures not exceeding 90 degrees C for normal operation, 130 degrees C for emergency overload conditions, and 250 degrees C for short circuit conditions. Minimum and maximum thickness of insulation system shall be 85/120 mils for five kV systems, 210/220 mils for 15 kV systems, and 400/450 mils for 35 kV systems.
      c. Insulation screen shall be outer layer of thermosetting semi-conducting material. Insulation screen shall be in intimate contact with outer insulation surface.
      d. Insulation shield shall be a five-mil copper tape applied helically with minimum 12.5 percent overlap.
   3. Jacket: Continuous jacket of moisture, heat, oil resistant black polyvinyl chloride shall be applied over insulation and shielding system. Minimum thickness of jacket shall be in accordance with ICEA.

D. Cable Connectors:
   1. Connectors shall be copper, tin-plated, long-barrel compression type. Suitable for voltage applications up to 35 KV.
   2. For sizes 250 MCM and larger, connectors shall be two-hole mount type with provisions for two bolts for joining to apparatus terminal.
   3. Manufacturers: Provide products of one of the following:
      a. FCI-Burndy.
      b. T&B Connectors.
      c. Or equal.

E. Cable Terminations:
   1. Cable terminations shall comply with Class 1 requirements of IEEE 48.
   2. Terminations shall be molded elastomer, wet-process porcelain or heat-shrinkable types with grounding provisions for cable shielding.

3. Manufacturers: Provide products of one of the following:
    a. Elastimold.
    b. G&W Electric Company.
    c. Raychem Corporation.
    d. 3M Company.
    e. Or equal.

F. Cable Splices:
1. Make cable splices using standard splice kits that reinstate cable's insulation and jacket and continue metallic shielding through entire cable joint.
2. Splices shall be premolded, conventional tape or heat-shrinkable type.
3. Manufacturers: Provide products of one of the following:
    a. Elastimold.
    b. G&W Electric Company.
    c. Raychem Corporation.
    d. 3M Company.
    e. Or equal.

G. Pulling Compound:
1. Provide pulling compound to facilitate wiring pulling. Compound shall be UL-listed, waxed or water based type. Compound shall be compatible with all jacket types.
2. Pulling tension coefficient of friction shall not exceed 0.35.
3. Use winter-grade compound for outdoor, low-temperature installations.
4. Manufacturers: Provide products of one of the following:
    a. Ideal Industries.
    b. Greenlee.
    c. Or equal.

H. Fireproofing Tape for Cables in Manholes, Handholes, and Boxes:
1. Tape shall be 30-mils thick of self-extinguishing material that does not support combustion. Tape shall not deteriorate when subjected to water, salt, sewage, or fungus
2. Secure tape with glass cloth tape.

I. Color code cables by applying general purpose, flame-retardant tape, wrapped in overlapping turns covering an area of at least two inches. Colors shall be as follows:
1. Grounded Neutral: White.
2. Phase A: Brown.
3. Phase B: Orange.
4. Phase C: Yellow.

2.2 SOURCE QUALITY CONTROL

A. Factory Testing:
   1. Cables shall be factory tested in accordance with testing standards of ICEA and UL.
   2. Conductors shall comply with electrical resistance requirements of ICEA.
   3. Perform insulation resistance test in accordance with ICEA. Each cable shall have an insulation resistance not less than that corresponding to insulation resistance constant of 20,000 megohms-1000 feet at 15.6 degrees C.
   4. Perform high voltage AC test in accordance with ICEA.
   5. Measure and record shield resistance from end to end on completed cable.
   6. Corona Test: Each reel of completed shielded power cable shall be partial discharge tested in accordance with ICEA.
   7. Record cable physical measurements.

PART 3 – EXECUTION

3.1 INSTALLATION

A. Install cables complete with proper terminations at both ends. Check for proper phase sequence and proper motor rotation.

B. Splice and terminate medium voltage cables in accordance with cable manufacturer's recommendations.
   1. Use experienced personnel familiar with materials and procedures to be employed.
   2. Make splices watertight for below-grade installations, and submersible in manholes and handholes.

C. Pulling:
   1. Use insulating types of pulling compounds containing no mineral oil.
   2. Pulling tension shall be within limits recommended by cable manufacturer.
   3. Use dynamometer when mechanical means are used.
   4. Cut off section subject to mechanical means.

D. Bending Radius: Limit to twelve times cable overall diameter.

E. Slack: Provide maximum slack at terminal points and in manholes.

F. Wrap cables located within manholes, handholes, and boxes with fireproofing tape for cable's entire length for each individual cable. Secure fireproofing tape with glass cloth tape. Fireproof cables in accordance with cable manufacturer's recommendations, and cover cables with tape extending at least one inch into each duct.

G. Identification: Identify conductors by circuit number and phase at each terminal or splice location.

3.2 FIELD QUALITY CONTROL

A. Tests and Inspections:
   1. Perform acceptance testing of medium voltage cable system. Each cable circuit shall be inspected and tested on an individual, per-phase basis. Testing and inspection shall be performed by independent testing agency.
   2. Visual and Mechanical Inspection: Inspect each power cable installation in accordance with ANSI/NETA ATS. Inspect each splice and termination.
   3. Electrical Tests: Perform electrical testing of each power cable in accordance with ANSI/NETA ATS and manufacturer's recommended testing procedures. Testing shall include:
      a. Shield continuity test.
      b. DC or AC high potential test.
      c. Adhere to following procedures before performing over-potential tests:
         1) Disconnect all equipment, including but not limited to: transformers, switches, motors, circuit breakers, and surge arrestors from cable circuit to prevent test interruptions due to flashovers or trip-outs resulting from excessive leakage current.
         2) Establish adequate clearance between circuit test ends and grounded objects and to other equipment not under test.
         3) Ground all circuit conductors not being tested, all cables shields, and nearby equipment.
         4) Clean insulation surfaces.
         5) Keep cable ends dry.
      d. Apply high-potential slowly in eight to ten equal steps to 80 percent of manufacturer's test value. Record leakage current at each test voltage and plot resulting curve on graph paper.
      e. Stop the test if leakage current increases excessively or if a "knee" appears in the curve before reaching maximum test voltage.
      f. Upon reaching specified maximum test voltage, maintain voltage for 15 minutes, record leakage current at 30 seconds, one minute, and at one-minute intervals thereafter. Plot leakage current versus time on the same graph as step voltage curve.
      g. Reduce conductor test potential to zero and measure residual voltage at discrete intervals.
      h. Apply grounds for a time period adequate to drain all insulation stored charge.
      i. Repair or replace and retest new cable that fails tests.
      j. Test curves shall be signed by the individual performing tests and submitted to ENGINEER.

+ + END OF SECTION + +

SECTION 26 05 19

LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals shown, specified, and required to furnish and install low-voltage conductors and cabling.
   2. Types of cabling required include:
      a. Insulated cable for installation in raceways.
      b. Cable for installation in cable trays.
      c. Direct-burial cable.

B. Related Sections:
   1. Section 26 05 53, Identification for Electrical Systems.
   2. Section 31 23 05 Excavation and Fill.

C. Work Included But Specified Elsewhere:
   1. Perform excavation and filling for direct-burial cable in accordance with Section 31 23 05 Excavation and Fill.

1.2 REFERENCES

A. Standards referenced in this Section are:
   1. ANSI/NETA ATS, Acceptance Testing Specifications for Electrical Power Equipment and Systems.
   2. ASTM B3, Specification for Soft or Annealed Copper Wire.
   3. ASTM B8, Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard or Soft.
   4. ASTM D3485, Specification for Smooth-Wall Coilable Polyethylene (PE) Conduit (Duct) for Preassembled Wire and Cable.
   5. ASTM F2160, Solid Wall High Density Polyethylene (HDPE) Conduit Based on Controlled Outside Diameter (OD).
   6. NEMA TC 7, Smooth Wall Coilable Electrical Polyethylene Conduit.
   7. UL 44, Thermoset-Insulated Wires and Cables.
   8. UL 1277, Electrical Power and Control Tray Cables with Optional Optical-Fiber Members.

1.3 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with the following:
   1. NEC Article 300, Wiring Methods.
   2. NEC Article 310, Conductors for General Wiring.
   3. NEC Article 336 Power and Control Tray Cable: Type TC.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Product Data:
      a. Manufacturer's literature, specifications, and engineering data for low volt insulated cable proposed for use.

B. Informational Submittals: Submit the following:
   1. Field Quality Control Submittals:
      a. Written results of field insulation resistance tests.

PART 2 – PRODUCTS

2.1 MATERIALS

A. Insulated Cable In Raceways:
   1. Application: Use for circuits located indoors and outdoors.
   2. Manufacturers: Provide products of one of the following:
      a. Southwire.
      b. The Okonite Company.
      c. American Insulated Wire
      d. General Cable
      e. Or equal.
   3. Material: Single conductor copper cable complying with ASTM B3 and ASTM B8 with flame-retardant, moisture- and heat-resistant insulation rated for 90 degrees C in dry or wet locations, listed by UL as Type XHHW-2 or RHW-2 complying with UL 44.
   4. Wire Sizes: Not smaller than No. 12 AWG for power and lighting and No. 14 AWG for 120-volt control circuits.
   5. Stranding: 600-volt cable shall be stranded, except that solid cable, No. 10 and smaller may be used for lighting circuits.

B. Fire-Rated Cable:
   1. Application:
      a. Use as required to comply with NEC Article 708 and as shown or indicated on the Drawings.
   2. Manufacturers: Provide products of one of the following:
      a. Tyco/Thermal Control VITALink 2000 Fire Rated Cable.

b. Or equal.

3. Material: Single nickel-clad copper conductor with proprietary thermoset ceramifiable layer and thermoset low-smoke zero halogen covering insulation. Cable shall be rated for 90 degrees C in dry locations and 75 degrees C in wet locations. Cable shall comply with UL1709 and shall be suitable for continuous exposure temperature of 670 degrees C and maximum exposure temperature of 1,065 degrees C for at least 60 minutes. Cable shall be UL-labeled.
4. Thermal Barrier: Inorganic layer.
5. Binder Tape: Helically-applied.
6. Jacket: Black low-smoke zero halogen polyolefin.
7. Splicing: Manufacturer's recommended method.
8. Wire Sizes: Not smaller than No. 12 AWG and not larger than 500 KCMIL.
9. Stranding: 600-volt cable shall be stranded.

C. Cable for Installation in Trays:

1. Manufacturers: Provide products of one of the following:
   a. Southwire.
   b. The Okonite Company.
   c. Prysmian Cables & Systems.
   d. General Cable.
   e. Or equal.
2. Material: Factory-assembled single- or multi-conductor control, signal, or power cable that bears UL label Type TC and are specifically approved for installation in cable trays. Overall jacket shall be sunlight-resistant PVC. Cable shall be rated for 90 degrees C wet or dry, complying with UL 44 and UL 1277.

D. Direct-Burial Cable:

1. Manufacturers: Provide products of one of the following:
   a. The Okonite Company.
   b. Prysmian Cables & Systems.
   c. American Insulated Wire.
   d. Southwire.
   e. Or equal.
2. Material: Single- or multi-conductor, stranded copper conductors, 60 mils butadiene styrene or ethylene propylene insulation, overall jacket of neoprene or PVC complying with UL 44 and UL 1277. Cable shall be UL-labeled.

E. Cable Connectors, Solderless Type:

1. Products and Manufacturers: Provide products of one of the following:
   a. T&B Sta-Kon.
   b. Burndy Hylug.
   c. Or equal.
2. For wire sizes No. 4 AWG and above, use either compression type or bolted type with silver-plated contact faces.

3. For wire sizes up to and including No. 6 AWG, use compression type. Alarm and control wire shall be terminated using forked type connectors at terminal boards.
4. For wire sizes No. 250 KCMIL and larger, use connectors with at least two cable clamping elements or compression indents and provision for at least two bolts for joining to apparatus terminal.
5. Properly size connectors to fit fastening device and wire size. Connectors shall be rated for 90 degree C, 600 volts.

F. Cable Splices:
1. Products and Manufacturers:
a. Compression-Type Splices: Provide one of the following:
1) Burndy Hylink.
2) T&B Color-Keyed Compression Connectors.
3) Or equal.
b. Spring Connectors: Provide one of the following:
1) Buchanan B-Cap.
2) T&B Wire Connector.
3) Or equal.
2. For wire sizes No. 8 AWG and larger, splices shall be made up with compression type copper splice fittings. Splices shall be taped and covered with materials recommended by cable manufacturer to provide insulation equal to that on conductors.
3. For wire sizes No. 10 AWG and smaller, splices may be made up with pre-insulated spring connectors.
4. For wet locations, splices shall be waterproof. Compression type splices shall be waterproofed by sealant-filled, thick wall, heat shrinkable, thermosetting tubing or by pouring thermosetting resin into mold that surrounds the joined conductor. Spring connector splices shall be waterproofed with sealant filler.
5. Splices shall be suitably sized for cable, rated 90 degrees C, and 600 volts.

G. Wire and Cable Markers:
1. Provide wire and cable markers in accordance with Section 26 05 53, Identification for Electrical Systems.

2.2 SOURCE QUALITY CONTROL

A. Factory Tests:
1. Factory-test wire and cable in accordance with UL standards.

PART 3 – EXECUTION

3.1 INSTALLATION

A. Install cables complete with proper terminations at both ends. Check and correct for proper phase sequence and proper motor rotation.

B. Pulling:
   1. Use insulating types of pulling compounds containing no mineral oil.
   2. Pulling tension shall be within limits recommended by wire and cable manufacturer.
   3. Use dynamometer where mechanical means are used.
   4. Cut off section subject to mechanical means.

C. Bending Radius: Limit to minimum of six times cable overall diameter.

D. Slack: Provide maximum slack at all terminal points.

E. Splices:
   1. Where possible, install cable continuous, without splice, from termination to termination.
   2. Where required, splice as shown and also where required for cable installation. Splices below grade, in manholes, handholes, and wet locations shall be waterproof.
   3. Splices are not allowed in conduits.

F. Identification:
   1. Identify conductors in accordance with Section 26 05 53, Identification for Electrical Systems.
   2. Identify power conductors by circuit number and phase at each terminal or splice location.
   3. Identify control and status wiring using numeral tagging system.

G. Color-code power cables as follows:
   1. No. 8 AWG and Smaller: Provide colored conductors.
   2. No. 6 AWG and Larger: Apply general purpose, flame retardant tape at each end, wrapped in overlapping turns to cover an area of at least two inches.
   3. Colors: Match color scheme in use at the Site. If the Site does not have an existing color scheme, use the following colors:

System	Conductor	Color
All Systems	Equipment Grounding	Green
240/120 Volts Single-Phase, Three-Wire	Grounded Neutral One Hot Leg Other Hot Leg	White Black Red
208Y/120 Volts Three-Phase, Four-Wire	Grounded Neutral Phase A Phase B Phase C	White Black Red Blue
240/120 Volts Three-Phase, Four-Wire Delta, Center Tap Ground on Single-Phase	Grounded Neutral Phase A High (wild) Leg Phase C	White Black Orange Blue
480Y/277 Volts Three-Phase, Four-Wire	Grounded Neutral Phase A Phase B Phase C	Gray Brown Orange Yellow

3.2 FIELD QUALITY CONTROL

A. Site Tests:
   1. Test each electrical circuit after permanent cables are in place, to demonstrate that circuit and equipment are connected properly and will perform satisfactorily, free from improper grounds and short circuits.
   2. Individually test 600-volt cable mechanical connections after installation and before they are put in service, with calibrated torque wrench. Values shall be in accordance with manufacturer's recommendations.
   3. Individually test 600-volt cables for insulation resistance between phases and from each phase to ground. Test after cables are installed and before they are put in service, with Megger for one minute at voltage rating recommended by cable manufacturer or in accordance with ANSI/NETA ATS recommendations.
   4. Insulation resistance for each conductor shall not be less than value recommended by cable manufacturer. Cables not meeting recommended value or that fail when tested under full load conditions shall be replaced with a new cable for full length.
   5. Where existing cables are spliced to cables provided under the Project, test existing cables prior to splicing. Test cables at 1,000 vdc for one minute. Entire spliced cable installation shall be re-tested after splice is completed. Existing cable that fails or has value less than two megohms shall be brought to attention of ENGINEER and splicing shall not proceed until condition is acceptable.

+ + END OF SECTION + +

SECTION 26 05 23

INSTRUMENTATION AND COMMUNICATION CABLES

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals shown, specified, and required to furnish and install instrumentation and communication cables.
   2. Types of cables include the following:
      a. Shielded instrumentation cables.
      b. Data communication cables.

B. Related Sections:
   1. Section 26 05 33.13, Rigid Conduits.
   2. Section 26 05 53, Identification for Electrical Systems.
   3. Section 26 05 36, Cable Trays For Electrical Systems.

1.2 TERMINOLOGY

A. The following words or terms are not defined but, when used in this Section, have the following meaning:
   1. "CPE" means chlorinated polyethylene.
   2. "FEP" means fluorinated ethylene-propylene.
   3. "XLPE" means cross-linked polyethylene.

1.3 REFERENCES

A. Standards referenced in this Section are:
   1. ASTM A510, Specification for General Requirements for Wire Rods and Coarse Round Wire, Carbon Steel.
   2. ASTM B633, Specification for Electrodeposited Coatings of Zinc on Iron and Steel.
   3. ANSI/TIA/EIA-568, Commercial Building Telecommunications Cabling (requirements and restrictions of Technical Service Bulletins (TSBs) apply.)
   4. TIA/EIA-485, Electrical Characteristics of Generators and Receivers for Use in Balanced Digital Multipoint Systems (known as RS-485).
   5. UL 13, Power-Limited Circuit Cables.
   6. UL 1581, Electrical Wires, Cables and Flexible Cords.
   7. UL VW-1, Vertical Wire Flame Test.

8. UL 910, Safety Test for Flame-Propagation and Smoke-Density Values for Electrical and Optical-Fiber Cables Used in Spaces Transporting Environmental Air

1.4 QUALITY ASSURANCE

A. Regulatory Requirements:
   1. NEC 725, Class 1, Class 2, and Class 3 Remote-Control, Signaling and Power-Limited Circuits.
   2. NEC 727, Instrumentation Tray Cable.
   3. NEC 800, Communications Circuits.

1.5 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Product Data: Manufacturer's technical information for instrumentation cables and communications cables proposed.

B. Informational Submittals: Submit the following:
   1. Field Quality Control Submittals: Written report of results of field quality control testing specified in this Section.

PART 2 – PRODUCTS

2.1 MATERIALS

A. General:
   1. Cables shall bear the UL label.

B. Single Shielded Pair Instrument Cables:
   1. Manufacturers: Provide products of one of the following:
      a. Belden Company.
      b. Okonite Company.
      c. Dekoron Wire and Cable Company.
      d. Or equal.
   2. Tinned copper, XLPE-insulated, stranded conductors, not less than no. 16 AWG, twisted pair, with overall shield, stranded tinned no. 18 AWG copper drain wire and overall PVC or CPE jacket. Rated for not less than 600 volts and complying with UL 1581.
   3. 300V, listed PLTC, single-pair no. 16 AWG tinned copper, shielded with PVC jacket, Belden No. 9316 or equal.

C. Multi-Paired Shielded Instrument Cables:
   1. Manufacturers: Provide products of one of the following:
      a. Belden Company.

b. Okonite Company.
c. Dekoron Wire and Cable Company.
d. Or equal.

2. Tinned copper, XLPE-insulated stranded conductors, not less than no. 16 AWG, twisted pairs with shield over each pair, stranded tinned no. 18 AWG copper drain wire, and overall PVC or CPE outer jacket. Rated for not less than 600 volts and complying with either UL 1581 or UL 13.

D. Multi-Conductor Shielded Instrument Cables:

1. Manufacturers: Provide products of one of the following:
   a. Belden Company.
   b. Okonite Company.
   c. Dekoron Wire and Cable Company.
   d. Or equal.
2. Tinned copper, XLPE-insulated stranded conductors, not less than no. 16 AWG, stranded tinned no. 18 AWG copper drain wire, with overall 100 percent foil shield and overall PVC or CPE jacket. Rated for not less than 600 volts.

E. Multi-Conductor Shielded High-Temperature Instrument Cables:

1. Manufacturers: Provide products of one of the following:
   a. Belden Company.
   b. Okonite Company.
   c. Dekoron Wire and Cable Company.
   d. Or equal.
2. Silver-plated copper, extruded Teflon insulation, stranded conductors, not less than no. 16 AWG, with overall 90 percent silver-plated copper braid shield and overall Teflon tape-wrapped jacket. Rated for not less than 600 volts and complying with UL VW-1.

F. Multi-Conductor Shielded Plenum-Rated Instrument Cables:

1. Manufacturers: Provide products of one of the following:
   a. Belden Company.
   b. Okonite Company.
   c. Dekoron Wire and Cable Company.
   d. Or equal.
2. Tinned copper, FEP insulation, stranded conductors, not less than no. 16 AWG, with overall foil shield plus 85 percent tinned copper braid shield and overall FEP jacket (non-conduit). Rated for 600 volts and complying with UL 910.

G. Multi-Conductor Telephone Cables:

1. Manufacturers: Provide products of one of the following:
   a. General Cable Company.
   b. Belden
   c. Or equal.
2. Trunk and Extension Lines, Underground Installation:

a. Solid annealed copper, conductors, no. 24 AWG, polyethylene-insulated, with the number of twisted pairs as shown on the Drawings.
b. Assemble cable in groups of 25 pairs, filled with sealing compound and tape-wrapped with overlap.
c. Cable shall include aluminum shield, water blocking compound, and polyethylene jacket over all.
d. Rated for not less than 300 volts.

3. Extension-Riser Lines, Indoor Insulation:
   a. Solid annealed copper, conductors, no. 24 AWG, PVC- or polyethylene-insulated, with the number of pairs as shown on the Drawings.
   b. Cable core shall be tape-wrapped with overlap and include aluminum shield and PVC jacket.
   c. Rated for not less than 300 volts.
4. Phones:
   a. Solid copper, no. 24 AWG, four conductor, PVC- or polyethylene-insulated, and PVC jacket.
   b. Rated not less than 300 volts.

H. Cable Terminals:
1. Manufacturers: Provide products of one of the following:
   a. T&B Sta-Kon.
   b. Burndy Insulug.
   c. Or equal.
2. Fork type copper compression terminals with nylon insulation for termination of cable at terminal blocks.

I. Horizontal Unshielded Twisted Pair (UTP) Cables:
1. Horizontal cabling is cabling between and including the telecommunications outlet/connector and patch panel or termination block.
2. Manufacturers: Provide products of one of the following:
   a. Bertek.
   b. Belden.
   c. Mohawk
   d. Or equal.
3. Cables shall consist of no. 24 AWG, thermoplastic-insulated, solid conductors formed into four individually-twisted pairs and enclosed by thermoplastic jacket.
4. Comply with ANSI/TIA/EIA-568, Part 10.2.
5. Riser-rated where installed in conduit. Other installations shall be plenum-rated.
6. Rated for Category 6 use.

J. Patch Cords:
1. Patch cords are used for connecting patch panel to hub, or wall jack to equipment.
2. Manufacturer: Provide products of one of the following:

a. Bertek.
b. Belden.
c. Mohawk
d. Or equal.

3. Cables shall consist of no. 24 AWG, thermoplastic-insulated, stranded conductors formed into four individually-twisted pairs and enclosed by thermoplastic jacket.
4. Cables shall be riser-rated.
5. Rated for Category 6 use.
6. Cables shall incorporate integral strain relief into the connector at each end. Connectors shall be RJ45 plugs.
7. Provide the following patch cords:
   a. One 10-foot cable per wall jack installed.
   b. One 3-foot cable per every two wall jacks installed.
   c. One 5 foot cable per every two wall jacks installed.

K. Connecting Hardware for Unshielded Twisted Pair (UTP) Cables:
1. Hardware used to terminate UTP cable shall comply with ANSI/TIA/EIA-568, Part 10.4.
2. Connecting hardware shall be compatible with wiring specified in the Contract Documents.
3. Rated for Category 6 use.
4. Connecting hardware shall utilize 110-type terminal blocks to coordinate with patch panels and termination blocks specified the Contract Documents.
5. Telecommunications Outlets/Connectors:
   a. Manufacturers: Provide products of one of the following:
      1) Hubbell.
      2) Or equal.
   b. Outlets and connectors shall utilize RJ45 (eight-pin modular) plug/receptacle configuration.
   c. Outlets and connectors shall utilize T568B pin/pair assignments, and be coordinated with wire type (solid or stranded conductor).
   d. Outlets shall be flush-mount type or surface-mount type, as indicated on the Drawings.

L. Patch Panels:
1. Manufacturers: Provide products of one of the following:
   a. Black Box.
   b. Or equal.
2. Patch panels shall utilize RJ45 (eight-pin modular) plug/receptacle configuration, and utilize T568B pin/pair assignments for receptacles.
3. Coordinate patch panel terminations with wire type (solid or stranded conductor).
4. Patch panels shall be wall-mount type or rack-mount type, as indicated on the Drawings.
5. Listed as Category 6.

6. Provide quantity of ports not less than the quantity of wall jacks installed in the building/area served, plus 50 percent additional as spares.

M. Cable Support Hardware:
1. Wire Basket:
a. Materials and Finishes:
1) Yellow Zinc Dichromate: Straight sections shall be steel complying with ASTM A510, and shall be electro-plated yellow zinc dichromate in accordance with ASTM B633 Type SC2.
b. Straight section longitudinal wires shall be straight, without bends.
c. Wire basket runway shall be made of high-strength steel wires and formed into a standard two-inch by four-inch wire mesh pattern with intersecting wires welded together. Wire ends along runway sides (flanges) shall be rounded.
d. Wire basket sizes shall comply with the following:
1) Straight sections shall be furnished in standard lengths of nine feet ten inches.
2) Wire basket shall have one-inch usable loading depth by 12 inches wide.
3) Wire basket shall have two-inch usable loading depth by 18 inches wide.
4) Wire basket shall have four-inch usable loading depth by 24 inches wide.
a) Fittings shall be field-formed as required.
b) Splicing assemblies shall be bolted type with serrated flange locknuts. Hardware shall be either yellow zinc dichromate in accordance with ASTM B633 Type SC2, or AISI Type 304 stainless steel.
c) Wire basket runway supports shall be center-support hangers, trapeze hangers, or wall brackets, manufactured by Cooper B-Line, or equal.
d) Trapeze hangers or center-support hangers shall be supported by 1/4-inch or 3/8-inch diameter rods.
e) Provide special accessories as required to protect, support, and install wire basket runway system.
2. Conduit:
a. Where conduit is shown or indicated on the Drawings, comply with Section 26 05 33.13, Rigid Conduits.

N. Modbus Cables (RS-232):
1. Products and Manufacturers:
a. Non-Plenum-Rated Modbus Cables: Provide one of the following:
1) Belden 8777.
2) Or equal.
b. Plenum-Rated Modbus Cables: Provide one of the following:
1) Belden 88777.

2) Or equal.

2. Cables shall consist of six tinned copper, no. 22 AWG, stranded conductors, polypropylene-insulated, twisted into three pairs, each pair individually shielded with 100-percent aluminum-polyester shield, one no. 22 AWG, stranded, tinned copper drain wire per pair, covered with an overall PVC jacket.
3. Where plenum rating is required, cable insulation and jacket shall be FEP in lieu of insulation and jacket materials otherwise specified in this Section for Modbus cables.
4. When portion of cable run is not contained in conduit or appropriate enclosure, cable shall be plenum- or riser-listed and marked in accordance with NEC 800.

O. Devicenet (Thick) Cables:
1. Product and Manufacturers: Provide one of the following:
   a. Belden 3082A.
   b. Or equal.
2. Cables shall consist of two tinned copper, no. 15 AWG, stranded power conductors, PVC-insulated, with 100-percent aluminum-polyester shield, two tinned copper no. 18 AWG stranded data conductors, foam polyethylene-insulated, and twisted into a single pair, with 100-percent aluminum-polyester shield, with no. 18 AWG stranded tinned copper drain wire. Cables shall be covered by overall 65-percent tinned copper braided shield, and sunlight- and oil-resistant overall PVC jacket.
3. When portion of cable run is not contained in conduit or appropriate enclosure, cables shall be plenum- or riser-listed and marked in accordance with NEC 800.

P. Devicenet (Thin) Cables:
1. Products and Manufacturers: Provide one of the following:
   a. Belden 3084A.
   b. Or equal.
2. Cables shall consist of two tinned copper, no. 22 AWG, stranded power conductors, PVC-insulated with 100-percent aluminum-polyester shield, two tinned copper no. 24 AWG stranded data conductors, foam polyethylene-insulated, and twisted into single pair, with 100-percent aluminum-polyester shield, with no. 22 AWG stranded tinned copper drain wire. Cables shall be covered by overall 65-percent tinned copper braided shield, and sunlight- and oil-resistant overall PVC jacket.
3. When portion of cable run is not contained in conduit or appropriate enclosure, cables shall be plenum- or riser-listed and marked in accordance with NEC 800.

Q. RS-485 Half Duplex Cables:
1. Products and Manufacturers:
   a. Non-Plenum-Rated RS-485 Half Duplex Cables: Provide one of the following:

1) Belden 9841.
2) Or equal.

b. Plenum-Rated RS-485 Half Duplex Cables: Provide one of the following:
1) Belden 89841.
2) Or equal.

2. Cables shall consist of two tinned copper stranded, no. 24 AWG, conductors, polyethelene-insulated and twisted into a single pair, 100-percent aluminum-polyester shield, 90-percent tinned copper braided shield, no. 24 AWG tinned copper drain wire, and overall PVC jacket.
3. When plenum rating is required, cables insulation shall be foam FEP and jacket shall be low-smoke PVC, in lieu of insulation and jacket materials specified in this Section for RS-485 half-duplex cables.
4. Cables shall comply with TIA/EIA RS-485.
5. When portion of cable run is not contained in conduit or appropriate enclosure, cables shall be plenum- or riser-listed and marked in accordance with NEC 800.

R. RS-485 Full Duplex Cables:
1. Products and Manufacturers:
a. Non-Plenum-Rated RS-485 Full Duplex Cables: Provide one of the following:
1) Belden 9842.
2) Or equal.

b. Plenum-Rated RS-485 Full Duplex Cables: Provide one of the following:
1) Belden 82842.
2) Or equal.

2. Cables shall consist of four tinned copper stranded, no. 24 AWG conductors, polyethelene-insulated and twisted into two pairs, 100-percent aluminum-polyester shield, 90-percent tinned copper braided shield, no. 24 AWG tinned copper drain wire, and overall PVC jacket.
3. Cables shall comply with TIA/EIA RS-485.
4. When plenum rating is required, cables insulation shall be foam FEP and jacket shall be low-smoke PVC, in lieu of insulation and jacket materials otherwise specified in this Section for RS-485 full duplex cables.
5. When portion of cable run is not contained in conduit or appropriate enclosure, cables shall be plenum- or riser-listed and marked in accordance with NEC 800.

PART 3 – EXECUTION

3.1 INSPECTION

A. Examine conditions under which materials and equipment will be installed and notify ENGINEER in writing of conditions detrimental to proper and timely completion of

the Work. Do not proceed with the Work until unsatisfactory conditions are corrected.

3.2 INSTALLATION

A. General:
   1. Install cables complete with proper terminations at both ends.
   2. Install in conduit separate from power cables, unless shown or indicated otherwise.
   3. Ground shield on shielded cables at one end only and as recommended by instrument manufacturer.
   4. Identify conductors in accordance with Section 26 05 53, Identification for Electrical Systems.
   5. Install and terminate Supplier-furnished cable in accordance with equipment manufacturer requirements and cable manufacturer's recommendations.
   6. Install in accordance with Laws and Regulations, including NEC.

3.3 FIELD QUALITY CONTROL

A. Site Tests:
   1. Test shielded instrumentation cable shields with ohmmeter for continuity along full length of cables, and for shield continuity to ground.
   2. Connect shielded instrumentation cables to calibrated 4 to 20 mA dc signal transmitter and receiver. Test at 4 and 20 mA transmitter settings.
   3. Replace with new cables the full length of cables that fail test.
   4. Test equipment shall be provided by CONTRACTOR.
   5. For testing of communications cables, test equipment used shall comply with the following:
      a. Equipment shall consist of a "master" and a "remote" unit.
      b. Test of all aspects of cables shall be automatic and initiated with a single command. Test over entire frequency range. Test unit shall be capable of accepting cable identification tag for reporting. Test unit shall return "pass/fail" status for cables and, if "fail", shall indicate reason for failure.
      c. Test unit shall be capable of storing all test results internally and printing the results later.
      d. For unshielded twisted pair cables, test unit shall be specifically designed and manufactured to certify cabling relative to Category 6 compliant.

+ + END OF SECTION + +

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SECTION 26 05 26

GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install complete grounding for electrical systems, structures, and equipment.

1.2 REFERENCES

A. Standards referenced in this Section are:
   1. ANSI/NETA ATS, Acceptance Testing Specifications for Electrical Power Equipment and Systems.
   2. ASTM B8, Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard or Soft.
   3. UL 467, Grounding and Bonding Equipment.

1.3 QUALITY ASSURANCE

A. Qualifications:

B. Regulatory Requirements
   1. National Electrical Code, (NEC).
      a. NEC Article 250, Grounding and Bonding.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Shop Drawings:
      a. Listing of grounding connector types identifying where each will be used.
      b. Layouts of each structure's ground grid.
      c. Test point construction details.
   2. Product Data:
      a. Manufacturer's technical information for grounding materials proposed for use.
   3. Testing Plans:
      a. Ground resistance test procedure.

B. Informational Submittals: Submit the following:
   1. Field Quality Control Submittals
      a. Results of ground resistance tests at each test point.

PART 2 – PRODUCTS

2.1 MATERIALS

A. Bare Ground Cable:
   1. Manufacturers: Provide products of one of the following:
      a. Cablec Corporation.
      b. General Cable Corporation.
      c. Southwire Cable Company.
      d. Or equal.
   2. Material: Soft-drawn, bare copper stranded cable complying with ASTM B8. No. 4/0 AWG minimum size unless otherwise shown or indicated on the Drawings.

B. Ground Rods:
   1. Manufacturers: Provide products of one of the following:
      a. Copperweld, Bimetallics Division.
      b. ITT Blackburn Company.
      c. Or equal.
   2. Material: Copper-clad rigid steel rods, 3/4-inch diameter, ten feet long.

C. Grounding Connectors:
   1. Products and Manufacturers: Provide one of the following:
      a. Pressure Connectors:
         1) O.Z./Gedney, Division of General Signal Corporation.
         2) Burndy Corporation.
         3) Or equal.
      b. Welded Connections:
         1) Cadweld by Erico Products, Incorporated.
         2) Therm-O-Weld by Burndy Corporation.
         3) Or equal.
   2. Material: Pressure connectors shall be copper alloy castings, designed and fabricated specifically for items to be connected and assembled with Durium or silicone bronze bolts, nuts, and washers. Welded connections shall be by exothermic process utilizing molds, cartridges, and hardware designed specifically for connection to be made.

D. Grounding Additive:
   1. Grounding additive, in its set form, shall have resistivity of not more than 20 ohm-cm.
   2. Product and Manufacturer:
      a. Ground Enhancement Material (GEM) by Erico
      b. Or equal.
   3. Grounding additive shall be permanent and maintenance-free, without requiring recharging with salts or chemicals that may be corrosive, and shall maintain its earth resistance with time.

4. Grounding additive shall set up firmly and not dissolve or decompose or otherwise pollute soil or groundwater.
5. Grounding additive shall be suitable for installation in dry form or in slurry form.
6. Grounding additive shall not depend on continuous presence of water to maintain its conductivity.

E. Ground Test Well
1. Provide heavy-duty test well suitable for heavy-duty traffic.
2. Manufacturer
   a. Advanced Lightning Technology
   b. Or equal.
3. Diameter and Material: 12.75-inch outside diameter, Schedule 80 PVC.
4. Depth: Two feet.
5. Cover: Provide test well with cast iron cover marked, "Ground" with cast iron ring to support lid.

F. Ground system components shall comply with UL 467.

PART 3 – EXECUTION

3.1 INSPECTION

A. Examine conditions for the Work and notify ENGINEER in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with Work until unsatisfactory conditions are corrected.

3.2 STRUCTURE GROUND SYSTEM

A. Provide ground grids as shown and indicated on the Drawings.

B. Provide No. 4/0 bare copper cable around exterior perimeter of structures at not less than 2.5 feet below grade, unless otherwise shown or indicated on the Contract Documents.

C. For structures with steel columns, provide No. 4/0 ground cable from grid to each column around perimeter of structure. Connect cable to steel with exothermic welds.

D. Connect grids to continuous underground water pipe system, when practical.

E. For new structures with concrete foundation or footings, connect structure's reinforcing steel or other concrete-encased electrode to grounding grid.

F. Provide accessible test points for measuring the ground resistance of each grid.

G. Weld all buried connections except for test points.

3.3 EQUIPMENT GROUNDING

A. Ground electrical equipment in compliance with Laws and Regulations and the Contract Documents.

B. Equipment grounding conductors shall be bare stranded copper cable of adequate size installed in metal conduit where required for mechanical protection. Ground conductors, pulled into conduits with non-grounded conductors, shall be insulated. Insulation shall be green.

C. Control panels grounding conductors shall be bare stranded copper cable of adequate size to ground grid from AC ground bus, and an insulated stranded copper cable of adequate size to ground grid from DC ground bus.

D. Connect ground conductors to conduit with copper clamps, straps, or with grounding bushings.

E. Connect to piping by welding or brazing. Use copper bonding jumpers on gasketed joints.

F. Connect to equipment by means of lug compressed on cable end. Bolt lug to equipment frame using holes or terminals provided on equipment specifically for grounding. Do not use hold-down bolts. Where grounding provisions are not included, drill suitable holes in locations recommended by equipment manufacturer or designated by ENGINEER.

G. Connect to motors by bolting directly to motor frames, not to soleplates or supporting structures.

H. Connect to service water piping by means of copper clamps. Use copper bonding jumpers on gasketed joints.

I. Scrape bolted surfaces clean and coat with conductive oxide-resistant compound.

3.4 FIELD QUALITY CONTROL

A. Site Tests:
   1. Test completed grounding systems for resistance to ground using an electrical three-terminal ground resistance tester. Test all grounded cables and metal parts for continuity of connection. ENGINEER will witness the testing.
   2. Grounding system maximum resistance shall not exceed five ohms under normally dry conditions when measured by resistance tester. Resistance values above five ohms shall be brought to ENGINEER's attention. Provide additional ground rods as required to attain a resistance to ground of less than five ohms for each ground grid. Add grounding additive installing additional ground rods to increase their effectiveness.
   3. Acceptance Testing:

a. Perform acceptance testing of grounding system. Testing shall be performed by testing firm in accordance with ANSI/NETA ATS.

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SECTION 26 05 29

HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install hangers and supports for electrical systems.
   2. Area Classifications: Materials shall by suitable for the area classification(s) shown or indicated on the Drawings, and specified in Section 26 05 05, General Provisions for Electrical Systems.

B. Related Sections:
   1. Section 05 05 33, Anchor Systems.
   2. Section 26 05 05, General Provisions for Electrical Systems.
   3. Section 26 05 33.13, Rigid Conduits.

1.2 REFERENCES

A. Standards referenced in this section are:
   1. ASTM A123/A123M, Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
   2. ASTM A1011/A1011M, Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength.
   3. ASTM E84, Test Method For Surface Burning Characteristics of Building Materials

1.3 QUALITY ASSURANCE

A. None

1.4 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Shop Drawings:
      a. Detailed installation drawings showing dimensions and compatibility with proposed layout.
   2. Product Data:
      a. Manufacturer's name, product designation, and catalog number of each material item proposed for use.

b. Manufacturer's specifications including material, dimensional and weight data, and load capacity for each supporting system component proposed for use.
c. Pictorial views and corresponding identifying text of each component proposed for installation.
d. Documentation that confirms product compatibility with Laws and Regulations.

B. Informational Submittals: Submit the following:
1. Certifications:
a. Submit certifications required under this Section.
2. Manufacturer's Instructions:
a. Manufacturer's installation instructions, including recommended tightening torque values for all nuts and bolts.

PART 2 – PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Provide products of one of the following:
1. B-Line.
2. Kindorf.
3. Unistrut
4. Or equal.

2.2 MATERIALS

A. Strut, Fittings, and Accessories:
1. General
a. Unless otherwise shown or indicated, strut shall be 1-5/8 inches by 1-5/8 inches. Double struts shall be two pieces of the same strut, welded back-to-back at the factory.
b. Attachment holes, when required, shall be factory-punched on hole centers approximately equal to the cross-sectional width and shall be 9/16-inch diameter.
c. Fittings, braces, brackets, hardware, and accessories shall be Type 316 stainless steel.
d. Strut nuts shall be spring captured Type 316 stainless steel.
e. Square and round washers shall be Type 316 stainless steel.
2. Strut materials shall be suitable for area classifications indicated in Section 26 05 05, General Provisions for Electrical Systems, and shown or indicated on the Drawings.
a. Dusty Locations:
1) Strut shall be 12-gage carbon steel, hot-dip galvanized after fabrication, complying with ASTM A123/A123M.
b. Wet Locations:

1) Strut shall be 12-gage aluminum (Alloy 6063-T6).

c. Corrosive Locations:

1) Strut shall be 12-gage aluminum (Alloy 6063-T6).

B. Hanger Rods:

1. Material:

a. Dry Locations: All-thread, zinc-coated

b. Wet, Corrosive, or Hazardous Areas: Stainless steel.

2. Size: Not less than 3/8-inch diameter, unless otherwise shown on the Drawings or specified.

C. Beam Clamps for Attaching Threaded Rods or Bolts to Beam Flanges for Hanging Struts or Conduit Hangers:

1. Beam clamps shall be stainless steel equipped with stainless steel square-head set screw, and shall include threaded hole sized for attaching the all-thread rod or threaded bolt.

D. Miscellaneous Hardware:

1. Bolts, screws, and washers shall be stainless steel.

2. Hex Nuts: Shall be stainless steel and include nylon inserts.

PART 3 – EXECUTION

3.1 INSPECTION

A. Examine conditions under which the Work will be installed and notify ENGINEER in writing of conditions detrimental to the proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions are corrected.

3.2 INSTALLATION

A. Provide hangers and supports for electrical systems with necessary channels, fittings, brackets, and related hardware for mounting and supporting materials and equipment. Provide anchor systems, concrete inserts, and associated hardware for proper support of electrical systems.

B. Install equipment and devices on hangers and supports as shown on the Drawings, as specified, and as required.

C. Install hangers and supports level, true, free of rack, and parallel and perpendicular to building walls and floors, so that the hangers and supports are installed in a neat, professional, workmanlike manner.

D. Holes in suspended ceilings for rods for hangers and supports and other equipment shall be provided adjacent to bars, where possible, to facilitate removal of ceiling panels.

E. Coordinate installation of hangers and supports with equipment, cabinets, consoles, panels, enclosures, boxes, conduit, cable tray, wireway, busway, cablebus, piping, ductwork, lighting fixtures, and other systems and equipment. Locate hangers and supports clear of interferences and access ways.

F. Anchor Bolts, Expansion Anchors, and Concrete Inserts: Shall be in accordance with Section 05 05 33, Anchor Systems, and requirements of this Section.

G. Mounting of Conduit:
   1. Provide space of not less than 1/4-inch between conduit surfaces and abutting or near surfaces except struts, cable trays, steel beams, and columns.
   2. Fasten conduit to struts, cable trays, steel beams, and columns using specified clamps and straps as shown, specified, and required.
   3. Devices shall be compatible with size of conduit and type of support. Following installation, size identification shall be visible and legible.
   4. Install conduit supports and fasteners in accordance with Section, 26 05 33.13, Rigid Conduits.

H. Supports for Cabinets, Consoles, Panels, Enclosures, and Boxes:
   1. Freestanding: Unless otherwise specified or shown on the Drawings, provide supports for floor-mounted equipment, cabinets, consoles, panels, enclosures, and boxes. Such supports shall be 3.5-inch high concrete equipment base with a 45 degree chamfered edge. Base shall extend two inches beyond outside dimensions of equipment on all sides.
   2. Wall-Mounted:
      a. Provide space not less than 1/4-inch between cabinets, consoles, panels, enclosures, and boxes and the surface on which each is mounted. Provide non-metallic or stainless steel spacers as required.
      b. Do not mount equipment, enclosures, panels, and boxes directly to beams or columns. Mount struts to beams or columns using beam clamps, and mount equipment, enclosures, panels, and boxes to the struts.
   3. Floor Stand Rack:
      a. Where equipment, cabinets, consoles, panels, enclosures, and boxes cannot be wall-mounted, provide an independent floor stand rack.
      b. Floor stand rack shall consist of struts, plates, brackets, connection fittings, braces, accessories, and hardware assembled in a rigid framework suitable for mounting of intended materials and equipment.
      c. Equip floor stand racks with brackets and bases for rigidly-mounting the framework to the ceiling or floor, as applicable; or equip floor stand racks with beam clamps, angle plates, washers, and bolts for fastening to beam flanges, as applicable.

d. When equipment, cabinets, consoles, panels, enclosures, and boxes weigh more than 100 pounds:
   1) Main vertical supports of floor stand rack assemblies shall be back-to-back struts.
   2) Bracing, clamping and anchoring of each floor stand rack shall be sufficient to ensure rigidity of the floor stand rack with the intended equipment, enclosures, conduit, cable tray, busway, cablebus, and wireway installed. Floor stand racks shall not be deflected more than 1/8-inch by a 100-pound force applied at any point on the floor stand rack in any direction.

I. Drilling into beams or columns is not allowed unless authorized by ENGINEER.

J. Tighten nuts and bolts to the manufacturer's recommended torque values.

K. Field Cutting:
   1. Cut edges of strut and hanger rod shall have rounded corners, edges beveled, and burrs removed. If field cutting the strut is required, use clean, sharp, dedicated tools. Remove oil, shavings, and other residue of cuttings prior to installation.

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SECTION 26 05 33.13

RIGID CONDUITS

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals shown, specified, and required to furnish and install conduit and fittings to form complete, coordinated, and grounded raceway systems.
   2. When specific, detailed conduit routings for various systems within buildings and other areas are not shown, CONTRACTOR shall establish routings based on single-line, riser, and interconnection diagrams and other information on the Drawings. CONTRACTOR shall provide for the proper installation of conduits in each system.
   3. Conduit types and the installation methods shall comply with the following, unless otherwise shown or indicated in the Contract Documents:
      a. Use steel conduit (rigid steel or intermediate metallic) for exposed indoor conduit runs in non-corrosive areas.
      b. Use PVC-coated rigid steel or aluminum conduit for exposed interior or exterior conduit runs in hazardous, wet, and corrosive locations.
      c. Use PVC-coated rigid steel conduit for individual conduits direct-buried in the ground.
      d. Use Schedule 40 PVC or steel conduit for concrete-encased duct bank runs.
      e. Use steel or Schedule 40 PVC conduit for conduit runs embedded in structural concrete slabs.
      f. Use steel conduit for plant monitoring and control (PMCS) systems, system control and data acquisition (SCADA) systems, and communication systems, regardless of the installation. Conduit shall be aluminum in hazardous, wet, and corrosive locations.

B. Coordination:
   1. Conduit runs shown are diagrammatic. Coordinate conduit installation with piping, ductwork, light fixtures, and other systems and equipment and locate to avoid interferences.
   2. For conduits to be embedded in concrete slabs, confirm adequate slab thickness and coordinate location of conduits with placement of reinforcing steel, waterstops, expansion joints, and other features of the concrete slab.

C. Related Sections:
   1. Section 01 73 29 Cutting and Patching
   2. Section 31 23 05 Excavation and Fill.
   3. Section 32 12 00, Flexible Paving.

4. Section 05 05 33, Anchor Systems.
5. Section 26 05 29, Hangers and Supports for Electrical Systems.
6. Section 26 05 53, Identification for Electrical Systems.

1.2 REFERENCES

A. Standards referenced in this Section are:
   1. ANSI C80.1, Standard for Rigid Electrical Steel Conduit (ERSC).
   2. ANSI/NEMA FB1, Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing and Cable.
   3. NEMA TC2, Electrical Polyvinyl Chloride (PVC) Conduit.
   4. NEMA TC3, Polyvinyl Chloride (PVC) Fittings for Use with Rigid PVC Conduit and Tubing.
   5. NEMA TC14, Reinforced Thermosetting Resin Conduit (RTRC) and Fittings.
   6. UL 6, Electrical Rigid Metal Conduit – Steel.
   7. UL 514B, Conduit, Tubing, and Cable Fittings.
   8. UL 651, Safety Schedule 40 and 80 Rigid PVC Conduit and Fittings.
   9. UL 886, Outlet Boxes and Fittings for Use in Hazardous (Classified) Locations.
   10. UL 1242, Electrical Intermediate Metal Conduit – Steel.

1.3 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with the following:
   1. NEC Article 342, Intermediate Metal Conduit
   2. NEC Article 344, Rigid Metal Conduit.
   3. NEC Article 352, Rigid Nonmetallic Conduit.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Shop Drawings:
      a. Assembly details of conduit racks and other conduit support systems.
      b. Layout drawings showing proposed routing of exposed conduits, conduits embedded in structural concrete, and conduits directly buried in the ground. Shop Drawings shall show locations of pull and junction boxes and penetrations in walls and floors. Shop Drawings of embedded conduits shall include cross-sections showing thickness of concrete slabs and locations of conduits relative to reinforcing steel, waterstops, and other features of the slab.
   2. Product Data:
      a. Manufacturer's catalog cuts and product data for conduit, fittings, and appurtenances.

B. Informational Submittals: Submit the following:
   1. Manufacturer's Instructions:
      a. When requested by ENGINEER, provide copies of manufacturer's recommendations for handling and installing products.
   2. Site Quality Control Submittals:
      a. When requested by ENGINEER, provide copies of results of specified Site quality control testing.

C. Closeout Submittals: Submit the following:
   1. Record Drawings:
      a. Show actual routing of exposed and concealed conduit runs in record documents in accordance with Section 01 78 39, Project Record Documents.

PART 2 – PRODUCTS

2.1 MATERIALS

A. Rigid Steel Conduit, Elbows, and Couplings:
   1. Manufacturers: Provide products of one of the following:
      a. Allied Tube and Conduit.
      b. Wheatland Tube Company.
      c. Western Tube and Conduit Corporation.
      d. Or equal.
   2. Material: Rigid, heavy-wall, mild steel, hot-dip galvanized, smooth interior, tapered threads and carefully reamed ends; 3/4-inch NPS minimum size.

B. PVC-coated Rigid Steel Conduit, Elbows, and Couplings:
   1. Manufacturers: Provide products of one of the following:
      a. Robroy Industries.
      b. Perma-Cote Industries.
      c. OCAL, Inc.
      d. Or equal.
   2. Material: Rigid, heavy-wall, mild steel, hot-dip galvanized, smooth urethane interior coating, tapered threads, carefully reamed ends, 3/4-inch NPS minimum size with factory exterior coating of 40-mil thick PVC.
   3. Color: Color of coating shall be the same on all conduit and fittings.

C. Intermediate Metallic Conduit, Elbows, and Couplings:
   1. Manufacturers: Provide products of one of the following:
      a. Allied Tube and Conduit.
      b. Wheatland Tube Company.
      c. Western Tube and Conduit Corp.
      d. Or equal.

2. Material: Rigid-type steel, work-hardened, hot-dip galvanized, smooth interior, tapered threads and carefully reamed ends; 3/4-inch NPS minimum size.
3. Couplings: Same as for rigid steel conduit.
4. Elbows: Factory formed of same material specification as for intermediate metallic conduit.

D. Aluminum Conduit, Elbows, and Couplings:
1. Manufacturers: Provide products of one of the following:
   a. Allied Tube and Conduit.
   b. Wheatland Tube Company.
   c. Or equal.
2. Material: Rigid, heavy-wall aluminum, smooth interior, tapered threads and carefully reamed ends; 3/4-inch NPS minimum size.

E. Metallic Conduit Fittings, and Outlet Bodies:
1. Manufacturers: Provide products of one of the following:
   a. Crouse-Hinds Company.
   b. Appleton Electric Company.
   c. Or equal.
2. Material and Construction: Cast gray iron alloy, cast malleable iron or aluminum bodies and covers consistent with conduit material. Units shall be threaded type with five full threads. Materials shall comply with ANSI/NEMA FB1 and be listed by UL. Do not use "LB" fittings. Use type "LBD" fittings where use of fittings is unavoidable.
3. Use: Conduits shall be gasketed and watertight in hazardous, wet, and corrosive locations.

F. PVC-coated Conduit Fittings, and Outlet Bodies:
1. Manufacturers: Provide products of one of the following:
   a. Robroy Industries.
   b. Perma-Cote Industries.
   c. OCAL, Inc.
   d. Or equal.
2. Material and Construction: Cast gray iron alloy, cast malleable iron bodies and covers with factory coating of 40-mil thick PVC and smooth urethane interior coating. Units shall be threaded type with five full threads. Material shall comply with ANSI/NEMA FB1 and be listed by UL. Do not use "LB" fittings. Use type "LBD" fittings where use of fittings is unavoidable.
3. Use: Provide PVC-coated or aluminum conduit fittings and outlet bodies in hazardous, wet, and corrosive locations. Fitting material shall be consistent with conduit material.

G. Non-metallic Conduit and Fittings:
1. PVC Plastic Conduit:
   a. Manufacturers: Provide products of one of the following:
      1) Amoco Chemicals Corp.

2) Carlon Electrical Products.
3) Or equal.

b. Material: Schedule 40 PVC, rated for 90 degrees C, complying with NEMA TC3 and UL 514B and 651.

c. Fittings: Form elbows, bodies, terminations, expansions, and fasteners of same material and manufacturer as base conduit. Provide cement by same manufacturer as base conduit.

2. Fiberglass Conduit:

a. Description: Filament-wound, fiberglass reinforced epoxy conduit complying with NEMA TC14A.

b. Manufacturers: Provide products one of the following:
1) Champion Fiberglass, Inc.
2) Smith Fiberglass Products Company.
3) United Fiberglass of American, Inc.
4) Or equal.

c. Joining Method: Integral bell and spigot, adhesive bonded, or silicone sealed for watertight connection.

d. Fittings: Elbows, adaptors, and fittings constructed from same materials and manufacturing process as conduit.

e. Ultraviolet Protection: Conduit and fittings shall include an ultraviolet inhibitor.

f. Ultimate Tensile Strength: 11,000 psi minimum at 75 degrees F.

H. Conduit Hubs:

1. Manufacturers: Provide products one of the following.
a. Myers Electrical Products Company.
b. Or equal.

2. Material: Threaded conduit hub, vibration-proof, weatherproof, with captive O-ring seal, zinc metal with insulated throat and bonding screw.

3. Use: Provide for all conduit terminations to boxes, cabinets, and other enclosures in areas designated as wet locations.

I. PVC-coated Conduit Hubs:

1. Manufacturers: Provide products one of the following:
a. Robroy Industries.
b. Perma-Cote Industries.
c. OCAL, Inc.
d. Or equal.

2. Material: Threaded conduit hub, vibration-proof, weatherproof, with captive O-ring seal, zinc metal with insulated throat and bonding screw, and factory coating of 40-mil thick PVC and smooth urethane interior coating.

3. Use: Provide for PVC-coated steel or aluminum conduit terminations to boxes, cabinets, and other enclosures in areas designated as corrosive location.

J. Conduit Bushings and Locknuts:

1. Manufacturers: Provide products one of the following:

a. O-Z/Gedney.
b. Appleton Electric Company.
c. Or equal.

2. Insulated Bushings: Malleable iron body with plastic liner. Threaded type with steel clamping screw. Provide with bronze grounding lug, as required.
3. Locknuts: Steel for sizes 3/4-inch through two-inch diameter and malleable iron for sizes 2.5-inch through four-inch diameter.
4. Use: Provide for all conduit terminations to boxes, cabinets and other enclosures except threaded type in areas designated as dusty locations.

K. Thruwall Seals
1. For new construction through exterior subsurface walls and exterior concrete walls.
   a. Manufacturer: Provide one of the following:
      1) Type WSK and WSCS by O-Z/Gedney.
      2) Or equal.
2. For new construction passing through concrete floors and floor slabs.
   a. Manufacturer: Provide one of the following:
      1) Type FSK and FSCS floor seals by O-Z/Gedney.
      2) Or equal.
3. For conduits passing through new exterior masonry block walls or through core-drilled holes in existing exterior subsurface walls, exterior concrete walls, floor slabs, and roof slabs, and for conduits passing through existing interior concrete walls or floors and interior masonry block walls.
   a. Manufacturer: Provide one of the following:
      1) Type CSMI sealing bushing at the inside of the structure and Type CSMC sealing bushing at the outside of the structure by O-Z/Gedney.
      2) Or equal.

2.2 ACCESSORIES

A. Fasteners: To the extent possible, fastener material shall be consistent with conduit material. For PVC-coated rigid steel conduit runs, fasteners shall have factory applied PVC coating or be stainless steel. Fasten raceway systems to supporting structures using the following:
1. To Wood: Wood screws.
2. To Hollow Masonry Units: Toggle bolts, in accordance with Section 05 05 33, Anchor Systems.
3. To Brick Masonry: Expansion bolts by Price, or equal.
4. To Concrete: Anchors in accordance with Section 05 05 33, Anchor Systems.
5. To Steel: Beam clamps in accordance with Section 26 05 29, Hangers and Supports for Electrical Systems.

B. Duct Sealing Compound
1. Soft, fibrous, slightly tacky, non-hardening sealing compound.

2. Remains workable at all temperatures.
3. Manufacturer:
   a. Type DUX by O-Z/Gedney.
   b. Or equal.

2.3 IDENTIFICATION

A. Conduit Labels:
   1. Provide conduit labels in accordance with Section 26 05 53, Identification for Electrical Systems.

B. Warning Tape:
   1. Provide warning tape in accordance with Section 26 05 53, Identification for Electrical Systems.

PART 3 – EXECUTION

3.1 INSPECTION

A. Examine conditions under which the Work will be performed and notify ENGINEER in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with installation until unsatisfactory conditions are corrected.

3.2 INSTALLATION

A. Install in accordance with Laws and Regulations.

B. Supports:
   1. Rigidly support conduits by clamps, hangers, or Unistrut-type channels. Conduit supports and accessories shall be in accordance with Section 26 05 29, Hangers and Supports for Electrical Systems.
   2. Support single conduits by means of one-hole pipe clamps in combination with one-screw back plates, to raise conduits from the support surface. Support multiple runs of conduits on trapeze type hangers.

C. Fastenings: Fasten raceway systems rigidly and neatly to supporting structures using specified materials.

D. Exposed Conduit:
   1. Install parallel or perpendicular to structural members or walls.
   2. Where possible, run in groups. Provide conduit racks of suitable width, length, and height, arranged to suit field conditions. Provide support every ten feet, minimum.
   3. Install on structural members in protected locations.
   4. Locate clear of interferences.

5. Provide six inches of clearance from hot fluid lines and 1/4-inch from walls.
6. Install vertical runs plumb. Unsecured drop length shall not exceed 12 feet.

E. Conduit Embedded in Structural Concrete:
1. Run embedded conduit in structural concrete in center of slabs and walls and above waterstops. Conduit connections shall be made watertight.
2. Before placing concrete, arrange for observation of conduit installation by RPR or ENGINEER and make necessary conduit location measurements and provide required information on record documents.
3. Confirm that concrete thickness is sufficient for embedding the quantity of conduits intended. Unless specifically shown or indicated otherwise, embedded conduits shall be in accordance with the following criteria:
   a. Minimum concrete thickness shall be as follows:
      1) For concrete 16 inches thick and less, minimum concrete thickness shall be 11.5 inches plus the depth of largest conduit assembly. Conduit assembly depth shall be from the top of uppermost conduit to bottom of lowest conduit.
      2) For concrete greater than 16 inches thick, minimum concrete thickness shall be 13.5 inches plus depth of largest conduit assembly.
      3) For concrete at foundation slabs, provide an one inch additional to minimum concrete thicknesses specified.
   b. Conduit spacing shall be as follows:
      1) Two adjacent conduits shall be separated by center-to-center distance of three times the outer diameter of larger conduit
      2) When conduits cross at a point, conduits may be in direct contact and angle of cross shall be 45 degrees or greater. Conduits may also cross within the vertical spacing of multi-conduit layer assembly.
      3) When conduits cross structural expansion joint, two adjacent conduits shall be separated by center-to-center distance of three times the outer diameter of conduit fitting of the larger conduit

F. Underground Conduits:
1. Install individual, underground conduits minimum of 20 inches below grade, unless otherwise shown or indicated.
2. Perform excavation, bedding, backfilling, and surface restoration, including pavement replacement where required, in accordance with Section 31 23 05 Excavation and Fill, and Section 32 12 00, Flexible Paving.
3. Install warning tape 12 inches below finished grade over buried conduits.

G. Empty Conduits:
1. Install nylon pull wire in each empty conduit and cap conduits not terminating in boxes with permanent fittings designed for the purpose.

H. Field Bends: No indentations. Diameter of conduit shall not vary more than 15 percent at bends.

I. Joints:
   1. Apply conductive compound to joints before assembly.
   2. Make up joints tight and ground thoroughly.
   3. Use standard tapered pipe threads for conduit and fittings.
   4. Cut conduit ends square and ream to prevent damaging wire and cable.
   5. Use full threaded couplings. Split couplings are not allowed.
   6. Use strap wrenches and vises to install conduit. Replace conduit with wrench marks.
   7. Apply zinc-rich paint to exposed threads and other areas of galvanized conduit system where base metal is exposed.

J. Terminations:
   1. Install insulated bushings on conduits entering boxes or cabinets, except when threaded hubs are used.
   2. Provide locknuts on both inside and outside of enclosure, except when threaded hubs are used.
   3. Use of bushings in lieu of locknuts is not allowed.
   4. Install conduit hubs on conduits entering boxes or cabinets in wet and corrosive areas.

K. Moisture Protection:
   1. Plug or cap conduit ends at time of installation to prevent entrance of moisture and foreign materials.
   2. Underground and embedded conduit connections shall be watertight.
   3. Thruwall Seals and Conduit Sealing Bushings: Install for conduits passing through concrete slabs, floors, walls, or concrete block walls.
   4. Drainage: Conduit runs shall be fully drainable. Where possible install conduit runs to drain to one end and away from building. Avoid pockets or depressions in conduit runs.
   5. Seal conduit openings within control and instrumentation panels and distribution equipment with duct sealing compound to provide watertight seal.

L. Corrosion Protection:
   1. Conduit Curb:
      a. For conduits routed in concrete slabs or floors and stub-ups through floor, provide four-inch high concrete curb, extending two inches from outer surface of conduit penetrating floor, to prevent corrosion. For floor-mounted equipment, concrete equipment base shall be in lieu of concrete curb.
      b. Conduit stub-ups shall be 90-degree, PVC-coated, rigid, galvanized steel conduit elbow. PVC-coated elbow shall extend a minimum of 1/2-inch above top of concrete curb or equipment base. Should elbow not reach specified height, provide PVC-coated conduit extension to accommodate specified requirements. Provide coupling or fitting for transition from rigid galvanized steel conduit or PVC conduit in slab to PVC-coated elbow.

c. For conduits stubbing up and terminating at equipment enclosure mounted on concrete base, provide insulated grounding bushing on PVC-coated rigid steel elbow.
d. For conduits stubbing up and extending to boxes, cabinets, and other enclosures above the concrete curb in wet and dusty areas, provide conduit coupling/fittings between the PVC-coated rigid steel elbow and rigid steel conduit for transition between the two conduit types.
e. For conduits stubbing up and extending to boxes, cabinets, and other enclosures above the concrete curb or equipment base in corrosive areas, continue conduit system with PVC-coated rigid steel conduit

2. Dissimilar Metals:
   a. Prevent occurrence of electrolytic action between dissimilar metals.
   b. Do not use copper products in connection with aluminum, and do not use aluminum in locations subject to drainage of copper compounds on bare aluminum.
   c. Back paint aluminum in contact with masonry or concrete with two coats of aluminum-pigmented bituminous paint.

M. Reused Existing Conduits:
   1. Pull rag swab through conduits to remove water and to clean conduit prior to installing new cable.
   2. Repeat swabbing until all foreign material is removed.
   3. Pull mandrel through conduit, if necessary, to remove obstructions.

N. Core drill for individual conduits passing through existing concrete slabs and walls. Notify ENGINEER in writing in advance of core drilling. Prior to core drilling, drill sufficient number of small exploratory holes to establish that the area to be core drilled is free of existing embedded conduits. Additional perform inspections as described in Section 01 73 29 Cutting and Patching. Seal spaces around conduit as indicated in Paragraph 3.2.K.3 of this Section.

O. Non-metallic Conduit:
   1. Install in accordance with manufacturer's recommendations.
   2. Provide manufacturer's recommended adhesives or sealants for watertight connections.
   3. Provide expansion fittings for expansion and contraction to compensate for temperature variations. Fittings shall be watertight and suitable for direct burial.
   4. Transition to PVC-coated rigid steel conduit before making turn up to enclosures.

P. PVC-coated Rigid Steel Conduit:
   1. Install in accordance with manufacturer's recommendations.
   2. Install with manufacturer's installation tools to avoid damage to PVC coating.
   3. Repair damaged PVC coating with manufacturer's recommended touch-up compound.

Q. Identify conduits, including spares, in accordance with Section 26 05 53, Identification for Electrical Systems.

3.3 FIELD QUALITY CONTROL

A. Site Tests:
   1. Test conduits by pulling through each conduit a cylindrical mandrel with length not less than two pipe inside diameters, having an outside diameter equal to 90 percent of conduit's inside diameter.
   2. Maintain a record, by number, of all conduits successfully tested.
   3. Repair or replace conduits that do not successfully pass testing, and re-test.

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SECTION 26 05 33.16

FLEXIBLE CONDUITS

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals shown, specified, and required to furnish and install flexible metallic conduit and fittings.

1.2 REFERENCES

A. Standards referenced in this Section are:
   1. UL 360, Liquid-Tight Flexible Steel Conduit.

1.3 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with the following:
   1. NEC Article 350, Liquid-Tight Flexible Metal Conduit.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Product Data:
      a. Manufacturer's literature and technical information for flexible conduit and fittings proposed for use.

PART 2 – PRODUCTS

2.1 MATERIALS

A. Flexible Conduit (Non-hazardous Areas and Class 1, Division 2, Hazardous Areas):
   1. Material: Flexible galvanized steel core with smooth, abrasion-resistant, liquid-tight, polyvinyl chloride cover. Continuous copper ground built in for sizes 3/4-inch through 1.25-inch. Material shall be UL-listed.
   2. Products and Manufacturers: Provide one of the following:
      a. Anaconda Sealtite Type UA by Anamet Electrical, Inc.
      b. Liquatite Type L.A. by Electric-Flex Company.
      c. Or equal.

B. Flexible Conduit (Class 1, Group D, Division 1, Hazardous Areas):
   1. Material: Flexible brass inner core with bronze outer braid and protective neoprene plastic coating. Steel, brass, or bronze end fittings. Minimum of 12 inches long.
   2. Products and Manufacturers: Provide one of the following:
      a. Type ECGJH or ECLK by Crouse Hinds Company.
      b. Type EXGJH or EXLK by Appleton Electric Company.
      c. Or equal.

C. Flexible Conduit Fittings:
   1. Material and Construction: Malleable iron with cadmium finish. Fittings shall adapt the conduit to standard threaded connections, shall have an inside diameter not less than that of the corresponding standard conduit size and shall be UL listed.
   2. Manufacturers: Provide products of one of the following:
      a. Crouse-Hinds Company.
      b. Appleton Electric Company.
      c. Or equal.
   3. Use: Provide on flexible conduit in non-hazardous and Class 1, Division 2 hazardous areas.

D. PVC-Coated Conduit Fittings:
   1. Material and Construction: Malleable iron with standard finish and 40-mil PVC exterior coating. Fittings shall adapt the conduit to standard threaded connections, and shall have an inside diameter not less than that of the corresponding standard conduit size.
   2. Manufacturers: Provide products of one of the following:
      a. Robroy Industries.
      b. Permacote Industries.
      c. OCAL, Inc.
      d. Or equal.
   3. Use: Provide on flexible conduit in areas designated as corrosive locations.

PART 3 – EXECUTION

3.1 INSPECTION

A. Examine conditions under which the Work will be installed and notify ENGINEER in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions are corrected.

3.2 INSTALLATION

A. Install at motors, transformers, field instruments, and equipment subject to vibration or require movement for maintenance purposes. Provide necessary reducer where

equipment furnished cannot accept 3/4-inch diameter flexible conduit. Limit flexible conduit length to three feet maximum.

B. Install in conformance with the Laws and Regulations.

+ + END OF SECTION + +

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SECTION 26 05 33.23

SEALED FITTINGS

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install conduit sealing fittings with sealing fiber and sealing compound.

1.2 REFERENCES

A. Standards referenced in this Section are:
   1. UL 886, Outlet Boxes and Fittings for Use in Hazardous (Classified) Locations, Class 1, Groups A, B, C and D and Class II, Groups E, F and G.

1.3 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with the following:
   1. NEC Article 500, Hazardous (Classified) Locations.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Shop Drawings:
      a. Listing of locations where fittings are to be used.
   2. Product Data:
      a. Manufacturer's literature and technical information for sealing fittings, sealing fiber, and sealing compound proposed for use.

PART 2 – PRODUCTS

2.1 MATERIALS

A. Manufacturers: Provide products of one of the following:
   1. Crouse Hinds Company.
   2. Appleton Electric Company.
   3. Or equal.

B. Materials and Construction:
   1. Cast gray iron alloy, or cast malleable iron, or copper free aluminum bodies with zinc electroplate and lacquer or enamel finish.

2. Ample opening with threaded closure for access to conduit hub for making dam.
3. In corrosive locations, fittings shall include factory-applied 40-mil PVC coating.
4. Construct fitting to allow 40 percent cross-sectional fill.

C. Sealing fiber for forming the dam within the hub and sealing compound shall be suitable for use with fittings furnished, and shall be products of fitting manufacturer.

D. Sealing fitting, fiber, and sealing compound shall conform to UL 886.

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine conditions under which the Work is to be installed and notify ENGINEER in writing of conditions detrimental to the proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions are corrected.

3.2 INSTALLATION

A. Install for hazardous locations as required by Laws and Regulations and as shown.

B. Provide fittings for proper use relative to mounting position.

C. Use oversized fittings with reducing bushings when necessary to maintain cable fill requirements of the conduit system.

+ + END OF SECTION + +

SECTION 26 05 33.26

EXPANSION/DEFLECTION FITTINGS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install conduit expansion and deflection fittings.

1.2 REFERENCES

A. Standards referenced in this Section are:
   1. UL 514B, Conduit, Tubing, and Cable Fittings.
   2. UL 467, Grounding and Bonding Equipment.

1.3 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with the following:
   1. NEC Article 300, Wiring Methods.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Shop Drawings:
      a. Listing of locations where fittings are required.
   2. Product Data:
      a. Manufacturer's literature and technical information for expansion and deflection fittings proposed for use.

PART 2 – PRODUCTS

2.1 MATERIALS

A. Products and Manufacturers: Provide one of the following:
   1. Type DX for expansion/deflection or AX for expansion only, by O-Z Gedney Company.
   2. Type XD for expansion/deflection or XJ for expansion only, by Crouse Hinds Company.
   3. Type DF for expansion/deflection or XJ for expansion only, by Appleton Electric Company.
   4. Or equal.

B. Cast gray iron alloy or bronze end couplings, malleable iron, or hot-dipped galvanized body, stainless steel clamps and tinned copper braid bonding jumper. Fitting shall be watertight, corrosion-resistant, UL-listed, and compatible with the conduit system.

C. Features:
   1. Expansion/Deflection Fittings:
      a. Axial expansion or contraction up to 3/4-inch.
      b. Angular misalignment up to 30 degrees.
      c. Parallel misalignment up to 3/4-inch.
   2. Expansion Fittings:
      a. Expansion/Contraction: Eight-inch total movement.

C. Expansion/Deflection fittings shall comply with UL 514B and UL 467.

PART 3 – EXECUTION

3.1 INSPECTION

A. Examine conditions under which the Work will be performed and notify ENGINEER in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions are corrected.

3.2 INSTALLATION

A. Install fittings in accordance with Laws and Regulations.

B. Provide expansion fittings on exposed conduit runs crossing structural expansion joints and where necessary to compensate for thermal expansion and contraction. Provide expansion fittings on exposed conduit runs exceeding 200 feet.

C. Provide expansion/deflection fittings on embedded conduit runs crossing structural expansion joints. Provide fittings above waterstops.

D. Unless specifically shown or indicated otherwise, when crossing structural expansion joints larger than one inch, provide expansion fitting together with expansion/ deflection fitting. Install fittings on each conduit run in accordance with manufacturer's recommendations to accommodate additional movement necessary.

E. Provide expansion/deflection fittings for underground conduit runs at penetrations of buildings, manholes, handholes, and outdoor concrete equipment pads.

F. Where required in non-metallic conduit and duct systems, provide rigid metal conduit nipples and metal rigid-to-PVC adapters for connection to fittings. Ensure that joints exposed to water or other liquid are made watertight.

+ + END OF SECTION + +

SECTION 26 05 33.33

PULL, JUNCTION, AND TERMINAL BOXES

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install pull, junction, and terminal boxes.

B. Related Sections:
   1. Section 26 05 05, General Provisions for Electrical Systems.
   2. Section 26 05 29, Hangers and Supports for Electrical Systems.
   3. Section 26 05 53, Identification for Electrical Systems.

1.2 REFERENCES

A. Standards referenced in this Section are.
   1. AASHTO, Standard Specifications for Highway Bridges.
   2. UL 886, Outlet Boxes and Fittings for Use in Hazardous (Classified) Locations.

1.3 QUALITY ASSURANCE

A. Regulatory Requirements:
   1. NEC Article 314, Outlet, Device, Pull and Junction Boxes; Conduit Bodies; Fittings; and Handhole Enclosures.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Product Data:
      a. Manufacturer's technical information for pull, junction, and terminal boxes proposed for use.

PART 2 – PRODUCTS

2.1 MATERIALS

A. Pull, Junction, and Terminal Boxes:
   1. General – Applicable to All Boxes:
      a. Description and Performance Criteria:
         1) Provide pull, junction, and terminal boxes rated at not less than

NEMA 12. Boxes shall be appropriate for each location in accordance with NEMA requirements and as required for area classifications specified in Section 26 05 05, General Provisions for Electrical Systems.

2) For flush-mounted pullboxes in slabs or pavement potentially subject to vehicular traffic, boxes and covers shall be constructed for H-20 loading in accordance with AASHTO Standard Specifications for Highway Bridges.

b. Manufacturers: Provide products of one of the following:
   1) Appleton Electric Company.
   2) Crouse-Hinds Company.
   3) Hoffman Engineering Company.
   4) Or equal.

c. Materials: Pull boxes embedded in concrete slabs shall be cast iron.

d. Terminal strips and terminal blocks in terminal boxes shall be mounted on terminal box sub-panels.

e. Identification: Boxes shall be identified in accordance with Section 26 05 53, Identification for Electrical Systems.

2. Materials and Construction – Dusty Locations:
   a. Material: Welded and galvanized sheet steel of USS gage.
   b. Gasket: Oil-resistant gasket.
   c. Access: Lift-off hinges and quick-release latches.
   d. Material Thickness:
      1) Boxes with dimension two feet and smaller shall be 14-gage.
      2) Boxes with dimension between two and three feet shall be 12 gage.
      3) Boxes with dimension of three feet or more in any direction shall be 10-gage.

3. Materials and Construction - Wet, Corrosive, or Hazardous Locations:
   a. Rating:
      1) Pull boxes in wet, corrosive, or outdoor areas shall be NEMA 4X.
      2) Boxes for areas classified as hazardous locations, where required by NEC, shall be explosion-proof and comply with UL 886.
   b. Material:
      1) Cast gray iron alloy with hot-dip galvanized finish, or cast malleable iron bodies and covers.
      2) Large boxes not generally available in cast iron construction shall be copper-free aluminum alloy or Type 316 stainless steel, as required by location.
      3) In corrosive locations, where the conduit system is PVC-coated, boxes shall be cast metal with factory-applied 40-mil PVC coating, Type 316 stainless steel, or non-metallic thermoplastic or fiberglass reinforced plastic material.
   c. Gasket:
      1) Provide neoprene gaskets for wet and corrosive locations.
      2) Gaskets shall be an approved type designed for the purpose. Improvised gaskets are not acceptable.
   d. Access: Stainless steel cover bolts.
   e. Features:

1) External mounting lugs.
2) Drilled and tapped conduit holes.
3) Boxes where conduits enter building or structure below grade shall have 1/4-inch drain hole at bottom of the box.
4) Provide threaded connections for explosion proof boxes.

B. Terminal Blocks:
   1. Products and Manufacturers: Provide one of the following:
      a. Allen-Bradley Company, Bulletin, Model 1492.
      b. General Electric Company, Model CR151K.
      c. Or equal.
   2. Material and Construction:
      a. NEMA-rated nylon modular terminal blocks.
      b. 600-volt rated.
      c. Control and alarm circuit terminals shall be screwed type with permanently affixed numeric identifiers beside each connection.
      d. Power terminals shall be copper and rated for the circuit ampacity.

PART 3 – EXECUTION

3.1 INSPECTION

A. Examine conditions under which the Work will be installed and notify ENGINEER in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions are corrected.

3.2 INSTALLATION

A. Mount boxes so that sufficient access and working space is provided and maintain clearance of not less than 1/4-inch from walls.

B. Securely fasten boxes to walls or other structural surfaces on which boxes are mounted. Provide independent supports that comply with Section 26 05 29, Hangers and Supports for Electrical Systems, where boxes will not be mounted on walls or other structural surface.

C. Install pull boxes where shown or indicated, and provide pull boxes where one or more of the following conditions exist:
   1. Conduit runs containing more than three 90-degree bends.
   2. Conduit runs exceeding 200 feet in length.

D. Provide removable, flame-retardant, insulating cable supports in boxes with any dimension exceeding three feet.

E. Field-apply PVC touch-up to scratched PVC boxes damaged during installation. Touch-up work shall be in accordance with manufacturer's recommendations and

instructions.

F. Size junction, pull, and terminal boxes in accordance with NEC Article 314 and other Laws and Regulations.

G. Provide terminal blocks in boxes where shown and where cable terminations or splices are required.

+ + END OF SECTION + +

SECTION 26 05 33.36

OUTLET BOXES

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install outlet boxes for mounting wiring devices and lighting fixtures.

B. Related Sections:
   1. Section 26 05 05, General Provisions for Electrical Systems.
   2. Section 26 05 29, Hangers and Supports for Electrical Systems.
   3. Section 26 05 53, Identification for Electrical Systems.
   4. Section 26 27 26.13, Low-Voltage Receptacles.
   5. Section 26 27 26.23, Snap Switches.

1.2 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with the following:
   1. NEC Article 314, Outlet, Device, Pull and Junction Boxes; Fittings; and Handhole Enclosures.
   2. NEC Article 501, Class I locations.
   3. UL 514A, Metallic Outlet Boxes.
   4. UL 514B, Fittings for Conduit and Outlet Boxes.

1.3 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Product Data:
      a. Manufacturer's technical information for outlet boxes proposed for use.

PART 2 – PRODUCTS

2.1 MATERIALS

A. Device Boxes:
   1. Manufacturers: Provide products of one of the following:
      a. Crouse-Hinds Company.
      b. Appleton Electric Company.
      c. Or equal.
   2. Material:

a. In Wet Locations: Cast gray iron alloy or cast malleable iron with zinc electroplate finish, or aluminum bodies consistent with conduit material.
b. In Dusty Locations: Zinc-coated sheet steel or aluminum bodies consistent with conduit material.
c. Where conduit is installed concealed, boxes shall include suitable extension rings and covers, as required.
d. Where used with PVC-coated conduit system, boxes shall include factory applied 40-mil-thick PVC coating.
e. Cast boxes shall be hub-type and include external mounting lugs.
f. Metallic outlet boxes shall comply with UL 514A.
g. Fittings for outlet boxes shall comply with UL 514B.

3. NEMA rating of box shall be as required for area classifications specified in Section 26 05 05, General Provisions for Electrical Systems.
4. Cover Plates:
   a. Type 302 stainless steel alloy for indoor finished areas.
   b. Plates in corrosive locations shall include factory-applied 40-mil PVC coating.
   c. Stainless steel screws and hardware.
   d. For receptacle and switch cover plates, comply with Section 26 27 26.13, Low-Voltage Receptacles, and Section 26 27 26.23, Snap Switches.

B. Flexible Fixture Hangers:
1. For Class I, Division 1 Hazardous Areas:
   a. Product and Manufacturers: Provide one of the following:
      1) Type EFH by Crouse-Hinds.
      2) Or equal
   b. Materials:
      1) Iron alloy with electro-galvanizing and aluminum acrylic paint.
      2) Products shall have brass bellows and stainless steel spring.
      3) Product shall be capable of 15 degree swing from perpendicular in all directions.
      4) Product shall allow fixtures to be pendant-hung in accordance with NEC Article 501.130(A)
2. For Class I, Division 2 Hazardous Areas:
   a. Product and Manufacturers: Provide one of the following:
      1) Type AHG by Crouse-Hinds.
      2) Or equal
   b. Materials:
      1) Malleable iron top section and removable malleable iron bottom fixture support assembly with electro-galvanizing and aluminum acrylic paint.
      2) Include vapor-tight cushion to support fixture stem.
      3) Provide neoprene diaphragm to exclude moisture and dirt from conduit system.
      4) Provide with manufacturer's neoprene gasket between fixture hanger and box.
      5) Product shall be capable of eight-degree swing from perpendicular in

all directions, before and after coating.

6) Product shall allow fixtures to be pendant-hung in accordance with NEC Article 501.130 (B).

PART 3 – EXECUTION

3.1 INSPECTION

A. Examine conditions under which the Work is to be installed and notify ENGINEER in writing of conditions detrimental to the proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions are corrected.

3.2 INSTALLATION

A. Fasten boxes rigidly and neatly to supporting structures.

B. Securely fasten equipment to walls or other surfaces on which materials or equipment is mounted. Provide independent supports complying with Section 26 05 29, Hangers and Supports for Electrical Systems, where boxes are not mounted on walls or other surface capable of supporting the materials or equipment.

C. For units mounted on masonry or concrete walls, provide suitable 1/2-inch spacers to prevent mounting back of box directly against wall.

D. Leave no open conduit holes in boxes. Close unused openings with capped bushings.

E. Label each circuit in boxes and identify each circuit in accordance with Section 26 05 53, Identification for Electrical Systems.

F. Install outlet boxes in accordance with NEC Article 314.

+ + END OF SECTION + +

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SECTION 26 05 36

CABLE TRAYS FOR ELECTRICAL SYSTEMS

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install cable trays.

B. Coordination:
   1. Coordinate installation of cable trays with piping, ductwork, lighting fixtures and other systems and equipment. Locate cable trays clear of interferences.
   2. Review installation procedures under this and other Sections and coordinate installation of items to be installed with or before cable tray Work.

1.2 REFERENCES

A. Standards referenced in this Section are:
   1. NEMA VE 1, Metal Cable Tray Systems.

1.3 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with electrical code in effect at the Site and the following:
   1. NEC Article 392, Cable Trays.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Product Data:
      a. Manufacturer's technical information for cable tray materials and system proposed for use.

PART 2 – PRODUCTS

2.1 MATERIALS

A. Manufacturers: Provide products of one of the following:
   1. B-Line Systems.
   2. Chalfant Manufacturing Company.
   3. Enduro Systems, Inc.

4. Or equal.

B. Cable Tray System:
   1. Type: Ladder, rungs welded to side rails.
   2. Material: Aluminum.
   3. Rung Spacing: Nine inches on centers, minimum.
   4. Inside Depth: Five inches minimum or as otherwise shown or indicated.
   5. Radius: Six inches to two feet as shown, indicated, or required.
   6. Width: Six inches to three feet as shown, indicated, or required.
   7. Support Span: Not to exceed twelve feet, unless otherwise shown or indicated.
   8. Loading Capacity: NEMA 12C or greater.
   9. Cable tray system shall comply with NEC Article 392 and NEMA VE1.
   10. Cable Try Conduit Clamps: Furnish as required, as follows:
      a. Non-corrosive Locations: Provide B-Line Catalog Number 9ZN-1158, or equal.
      b. Corrosive Locations: Provide B-Line Catalog Number 9F Series non-metallic, or equal

PART 3 – EXECUTION

3.1 INSPECTION

A. Examine conditions under which the Work will be installed and notify ENGINEER in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions are corrected.

3.2 INSTALLATION

A. Installation, General:
   1. Install cable trays in accordance with Laws and Regulations, and manufacturer's instructions and recommendations. Provide complete cable tray system prior to installing cables.
   2. Install cable trays exposed and in accessible locations.
   3. Ground cable tray system components.
   4. Where required, connect conduit to cable tray using cable tray conduit clamps.
   5. Provide required fittings and transitions for tie-ins to existing cable tray systems.
   6. Provide barrier strips in cable trays to isolate instrumentation and communication cables from 120VAC and greater power and control wiring.

+ + END OF SECTION + +

SECTION 26 05 43.13

UNDERGROUND DUCTBANKS FOR ELECTRICAL SYSTEMS

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install underground ductbanks.

B. Coordination:
   1. Ductbank routing on the Drawings is diagrammatic. Coordinate installation with piping and other Underground Facilities and locate ductbanks clear of interferences.
   2. Review installation procedures under this and other Sections and coordinate installation of items to be installed with or before underground ductbank Work.
   3. Notify other contractors in advance of installing underground ductbanks to provide other contractors with sufficient time for installing items included in their contracts that will be installed with or before underground ductbank Work.

C. Related Sections:
   1. Section 31 23 05 Excavation and Fill.
   2. Section 03 20 00, Concrete Reinforcing.
   3. Section 03 30 00, Cast-in-Place Concrete.
   4. Section 26 05 26, Grounding and Bonding for Electrical Systems.
   5. Section 26 05 53, Identification for Electrical Systems.
   6. Section 26 05 33.13, Rigid Conduits.
   7. Section 26 05 33.26, Expansion/Deflection Fittings.

1.2 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Shop Drawings:
      a. Layouts showing proposed routing of ductbanks and locations of manholes, handholes, and areas of reinforcement.
      b. Profiles of ductbanks showing crossings with piping and other Underground Facilities.
      c. Typical cross sections for each ductbank.

B. Informational Submittals: Submit the following:
   1. Special Procedure Submittals:
      a. Installation procedures.
   2. Field Quality Control Submittals:

a. Field test report.

C. Closeout Submittals: Submit the following:
1. Record Drawings:
a. Include actual routing of underground ductbank runs on record documents in accordance with Section 01 78 39, Project Record Documents.

PART 2 – PRODUCTS

2.1 MATERIALS

A. Duct: Provide conduit and fittings in accordance with Section 26 05 33.13, Rigid Conduits. Conduit types shall be as follows:
1. Schedule 40 PVC conduits for power circuits.
2. Galvanized rigid steel conduits for the following types of circuits: low voltage status, analog, and communication.

B. Backfill: Provide backfill, including select backfill, in accordance with Section 31 23 05 Excavation and Fill.

C. Reinforcing: Provide Ductbank reinforcing in accordance with Section 03 20 00, Concrete Reinforcing.

D. Concrete: Provide ductbank concrete in accordance with Section 03 30 00, Cast-in-Place Concrete.

E. Grounding: Provide ground cable in accordance with Section 26 05 26, Grounding and Bonding for Electrical Systems.

F. Conduit Spacers: Conduit spacers shall be nonmetallic, interlocking type to maintain spacing between conduits. Provide spacers suitable for all conduit types used in multiple sizes.

G. Duct Sealing Compound:
1. Products and Manufacturers: Provide one of the following:
a. 0-Z/Gedney, Type DUX.
b. Or equal.

PART 3 – EXECUTION

3.1 INSPECTION

A. Examine conditions under which the Work is to be installed and notify ENGINEER in writing of conditions detrimental to proper and timely completion of the Work.

Do not proceed with the Work until unsatisfactory conditions are corrected.

3.2 INSTALLATION

A. Excavation and Backfilling:
   1. Provide excavation and backfilling for ductbank installation in accordance with Section 31 23 05 Excavation and Fill.
   2. Do not backfill with material containing large rock, paving materials, cinders, large or sharply angular substances, corrosive material, or other materials that can damage or contribute to corrosion of ducts or cables, or prevent adequate compaction of backfill.

B. Ductbank Layout:
   1. Top of ductbank concrete shall be a minimum of 2.5 feet below grade, unless shown or indicated otherwise on the Drawings.
   2. Slope ductbank runs for drainage toward manholes and away from buildings with slope of approximately three inches vertical per 100 feet of run.

C. Ductbank Assembly:
   1. Assemble ductbanks using non-magnetic saddles, spacers, and separators. Position separators to provide minimum three-inch concrete separation between outer surfaces of each conduit. Provide side forms for each ductbank.
   2. Make bends with sweeps of not less than four-foot radius or five-degree angle couplings.

D. Concrete Placing:
   1. Provide minimum four-inch concrete covering on each side, top, and bottom of concrete envelopes around conduits. Concrete covering shall be as shown or indicated on the Drawings.
   2. Provide red dye in concrete for easy identification during subsequent excavation; all concrete in entire ductbank, including top and bottom, shall be dyed.
   3. Firmly fix conduits in place during concrete placing. Carefully place and vibrate concrete to fill spaces between conduits.

E. Conduit Transitions:
   1. Conduit installations shall be watertight throughout entire length of ductbank.
   2. Transition from non-metallic to galvanized rigid steel conduit where ductbanks enter structure walls and slabs.
   3. Terminate conduits in insulated grounding bushings.
   4. Continue conduits inside buildings in accordance with Section 26 05 33.13, Rigid Conduits, and as shown or indicated in the Contract Documents.
   5. If ducts are not concrete-encased, provide expansion and deflection fittings in accordance with Section 26 05 33.26, Expansion/Deflection Fittings.
   6. Plug and seal empty spare conduits entering structures. Conduits in use entering structures shall be sealed watertight with duct sealing compound.

F. Ductbank Reinforcing:
   1. Provide reinforcing for all ductbanks:
   2. Install ductbank reinforcement as shown or indicated on the Drawings.
   3. Provide maximum clearance of 1.5 inches from bars to edge of concrete encasement.

G. Connections to Structures:
   1. Firmly anchor ductbanks to structure walls or slabs. Epoxy-grout ductbank rebar into structure concrete to eliminate sheer forces between ductbank and structure wall concrete.
   2. Ductbank penetrations through structure walls shall be watertight.

H. Grounding:
   1. Provide bare stranded copper ductbank ground cable in each ductbank envelope. Make ground electrically continuous throughout entire ductbank system.
   2. Connect ground cable to building and station ground grid or to equipment ground buses. Also, connect ground cable to steel conduit extensions of underground ductbank system.
   3. Provide ground clamp and bonding of each steel conduit extension to maintain continuity of ground system.
   4. Terminate ground cable at last manhole or handhole for outlying structures.

I. Detectable Underground Warning Tape:
   1. Provide detectable underground warning tapes complying with Section 26 05 53, Identification for Electrical Systems, over the full length of each underground ductbank.
   2. Install warning tapes approximately 12 inches below grade.
   3. Provide multiple tapes across the width of each ductbank. Locate center of a warning tape above each edge of ductbank, and at intervals across top width of ductbank so that clear space between tapes does not exceed six inches.

J. Reused Existing Ducts:
   1. Pull rag swab through duct to remove water and to clean conduits prior to installing new cable.
   2. Repeat swabbing until all foreign material is removed.
   3. Pull mandrel through duct, if necessary, to remove obstructions.

+ + END OF SECTION + +

SECTION 26 05 43.23

MANHOLES AND HANDHOLES FOR ELECTRICAL SYSTEMS

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install manholes and handholes for electrical systems Work.

B. Coordination:
   1. Coordinate manhole and handhole installation with piping, sheeting other excavation supports, and other Underground Facilities, and locate clear of interferences.
   2. Review installation procedures under this and other Sections and coordinate installation of items to be installed with or before manhole and handhole for electrical systems Work.
   3. Notify other contractors in advance of installing manholes and handholes for electrical systems to provide other contractors with sufficient time for installing items included in their contracts that will be installed with or before manhole and handhole for electrical systems Work.

C. Related Sections:
   1. Section 31 23 05 Excavation and Fill.
   2. Section 03 20 00, Concrete Reinforcing.
   3. Section 03 30 00, Cast-in-Place Concrete.

1.2 REFERENCES

A. Standards referenced in this Section are:
   1. AASHTO, Specifications for Highway Bridges.
   2. ANSI A14.3, Fixed Ladders – Safety Requirements.
   3. ANSI/SCTE 77, Specification for Underground Enclosure Integrity.
   4. ASTM A48/A48M, Specification for Gray Iron Castings.
   5. ASTM A615/A615M, Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
   6. ASTM C478, Specification for Precast Reinforced Concrete Manhole Sections
   7. ASTM C1028, Test Method for Determining the Static Coefficient of Friction of Ceramic Tile and Other Like Surfaces by the Horizontal Dynamometer Pull-Meter Method.
   8. ASTM D4101, Specification for Polypropylene Injection and Extrusion Materials

1.3 QUALITY ASSURANCE

A. Component Supply and Compatibility:
   1. Obtain all manholes and handholes furnished under this Section from a single Supplier, unless otherwise acceptable to ENGINEER.
   2. Manhole and handhole Supplier shall review and approve the Shop Drawing submittals for the manholes and handholes furnished.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Shop Drawings:
      a. Manholes: Plan and section drawings showing arrangement of each manhole, including interior and exterior dimensions, elevations, location of manhole wall penetrations, details of typical openings, jointing, inserts, and reinforcing.
      b. Handholes: Submit schedule of handholes to be furnished and dimensions and pertinent data for each.
      c. Castings:
         1) Schedule of casting types and models to be furnished, with dimensional data and other pertinent data for each.
         2) Fabrication and erection of all frame and cover assemblies. Include plans, elevations, and details of sections and connections. Show anchorage and accessory items. Provide setting drawings for location and installation of castings and anchorage devices.
         3) Where Site-specific castings are specified with unique lettering on manhole or handhole cover, provide Shop Drawing for castings indicating appropriate detail to indicate conformance to the Contract Documents.
      d. Layout of Manhole Electrical Systems: Where manholes have extensive electrical systems and supports for electrical systems, submit for each plans, sections, and details indicating proposed layout of such materials and equipment in each manhole.
   2. Product Data:
      a. Manufacturer's technical information, specifications, and literature for manholes, handholes, castings, and accessories proposed for use.

PART 2 – PRODUCTS

2.1 MATERIALS

A. Material and Construction:
   1. Material shall be precast reinforced concrete. Reinforcing shall be in accordance with Section 03 20 00, Concrete Reinforcing. Concrete shall be in accordance with Section 03 30 00, Cast-in-Place Concrete.

2. Provide minimum interior dimensions as shown or indicated. Provide a 12-inch by 12-inch by six-inch deep sump in manhole floor
3. Duct entrances shall be sized and located to suit the ductbanks.
4. Precast Manholes:
    a. Except where otherwise specified, precast manhole components shall consist of reinforced concrete pipe sections specially designed and constructed for use as manholes and manufactured in accordance with ASTM C478, except as modified in this Section.
    b. Precast, reinforced concrete manhole bases, riser sections, flat slabs, and other components shall be manufactured by wet-cast methods, using forms that provide smooth surfaces free of irregularities, honeycombing, and other imperfections.
    c. Joints between manhole components shall be tongue-and-groove type employing a single, continuous rubber O-ring gasket. Circumferential and longitudinal steel reinforcing shall extend into bell and spigot ends of joint without breaking steel continuity. Joints between base sections, riser sections, and top slabs of manholes six feet in diameter and less shall be rubber and concrete joints. Joints for manhole components greater than six-foot diameter shall have steel bell and spigot rings.
    d. Precast manhole components shall:
        1) have sufficient strength to withstand loads imposed upon them; and
        2) be constructed for minimum earth cover loading of 130 pounds per cubic foot, AASHTO H-20 wheel loading, and an allowance of 30 percent in roadways and 15 percent in rights-of-way for impact.
        3) Manhole bases shall have two cages of reinforcing steel in the walls, each reinforcing cage shall be of area equal to that required in the riser sections.
        4) Wall thickness shall be not less than five inches.
        5) Concrete top slabs shall be not less than eight inches thick.
    e. Lifting holes, when provided, shall be tapered. Not more than two lifting holes shall be cast into each section. Provide tapered, solid rubber plugs to seal lifting holes. Lifting holes shall be made to be sealed by plugs driven from the outside face of section only.
    f. Point of intersection (P.I.) of ductbank centerlines shall be marked with 1/4-inch diameter steel pin firmly enclosed in floor of each manhole base and protruding approximately one-inch above finished floor of base.
    g. Mark date of manufacture and name or trademark of manufacturer on inside of manhole barrel.
    h. Barrel of manhole shall be constructed of various lengths of riser pipe manufactured in increments of one foot to provide correct height with the fewest joints. Provide not less than one foot clear between openings in barrel of manholes for ductbanks or other penetrations and the nearest joint. Provide special manhole base or riser sections as required.
    i. Provide at top of manhole barrel a precast or cast-in-place slab, or precast eccentric cone, as shown or approved, to receive manhole frame and cover.

B. Accessories:
   1. Frames and Covers:
      a. Manufacturers: Provide products of one of the following:
         1) Neenah Foundry Company.
         2) Campbell Foundry Company.
         3) Or equal.
      b. Material: Covers and frames shall be cast aluminum alloy, rated for AASHTO H-20 loading.
      c. Covers: Watertight, sealed type marked "ELECTRICAL" in raised two-inch letters. Identify covers as shown or indicated on the Drawings.
      d. Grout the frame to the manhole or handhole.
   2. Pulling Irons:
      a. Products and Manufacturers: Provide one of the following:
         1) Catalog No. 8119 by A.B. Chance Company.
         2) Catalog No. DU2T3 by McGraw Edison Company.
         3) Or equal.
      b. Material: Galvanized steel.
      c. Cast in the wall opposite to centerline of each incoming ductbank and 12 inches below centerline of bottom line of ducts.
   3. Cable Racks:
      a. Products and Manufacturers: Provide one of the following:
         1) Catalog No. J5125 by MacLean Power Systems.
         2) Catalog No. C203-1125 by A.B. Chance Company.
         3) Or equal.
      b. Material: Galvanized steel.
      c. Cable racks shall adequately support cables with space allowed for future cables.
      d. Each rack shall be a vertical assembly of two-foot cable racks extending from within six inches of manhole roof slab to within six inches of manhole floor.
   4. Cable Hooks:
      a. Products and Manufacturers: Provide one of the following:
         1) Catalog No. J5132A by MacLean Power Systems.
         2) Catalog No. C203-1132 by A.B. Chance Company.
         3) Or equal.
      b. Material: Galvanized steel.
      c. Length: 7.5-inch minimum.
   5. Insulators:
      a. Products and Manufacturers: Provide one of the following:
         1) Catalog No. J5122 by MacLean Power Systems.
         2) Catalog No. C203-1120 by A.B. Chance Company.
         3) Or equal.
      b. Material: Porcelain.
   6. Manhole Steps - Aluminum:
      a. Products and Manufacturers: Provide one of the following:
         1) R-1982-W, by Neenah Foundry Company.
         2) Part No. FR14-OR, by Washington Aluminum Company

3) Aluminum manhole step by Campbell Foundry Company.
4) Or equal.

b. Material: Extruded aluminum.
c. Provide manhole steps as shown or indicated. Comply with ANSI A14.3 and OSHA requirements
d. Space steps uniformly at maximum of 12 inches on centers, and project evenly from manhole or chamber walls.

2.2 SMALL HANDHOLES

A. Material and Construction:
1. Manufacturer: Provide products of one of the following:
   a. Strongwell Quazite
   b. Or equal
2. Material: Precast polymer concrete.
3. Duct entrances sized and located to suit ductbanks.
4. Enclosures and covers shall be UL-listed.
5. Enclosures, boxes, and covers shall comply with test provisions of ANSI/SCTE 77 for Tier 15 applications.
6. Covers shall have coefficient of friction of not less than 0.50, in accordance with ASTM C1028.

PART 3 – EXECUTION

3.1 INSPECTION

A. Examine conditions under which the Work will be installed and notify ENGINEER in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions are corrected.

3.2 INSTALLATION

A. Excavation and Backfill:
1. Provide manholes and handholes for electrical systems where shown or indicated and verify at the Site the required locations.
2. Perform excavation and filling required for installing manholes and handholes for electrical systems, in accordance with Section 31 23 05 Excavation and Fill.
3. Provide manholes and handholes on granular subbase course as shown or indicated. If not shown, provide layer of compacted select fill not less than six inches deep on which manhole or handhole for electrical systems will be installed.
4. Carefully set, level, and align at proper grade manhole bases and handholes.

C. Manhole and handhole structures shall be watertight. Provide foam sealant to seal all penetrations into manholes and handholes for electrical systems.

D. Cable Supports in Manholes:
   1. Attach cable racks with three-inch by 3/8-inch diameter "tamp-in" studs mounted in one-inch holes drilled into walls of manholes in absence of inserts. Provide PVC coating on racks.
   2. Provide cable hooks to support each cable on each rack along the cable run within manholes. Provide PVC coating on hooks.
   3. Individually support each cable at each hook on porcelain insulators. Provide sufficient slack for each cable.
   4. Securely tie each cable in place at each insulator block to prevent excessive movement of insulators, cables, or fireproof tape. Tie cables with non-metallic 3/4-inch strapping tape manufactured by 3M or equal, or tie down with nylon straps.

E. Grounding:
   1. Provide 3/4-inch by 10-foot copper-clad ground rod for each manhole.
   2. Bond all exposed metal manhole accessories and concrete reinforcing rods with No. 4 AWG minimum bare copper wire and connect to ground rod and to the ductbank ground cable.

F. Metal Pull Box:
   1. Provide NEMA 4X, stainless steel, wall-mounted pull box inside each manhole and handhole for electrical systems where analog signal cables are mixed with power cables.
   2. Route conduits for analog cables directly into and out of metal pull box so that analog cables are not exposed.

G. Grade Rings:
   1. Provide grade rings for manholes when required to adjust cover to proper grade. Construct grade ring on manhole roof slab or cone section on which manhole frame and cover will be placed.
   2. Height of grade ring shall be as required to bring frame to proper grade and shall not exceed 12 inches in height.

H. Grading at Manholes and Handholes:
   1. Unpaved Areas:
      a. Install manholes and handholes in unpaved areas as shown or directed by ENGINEER to rim elevation higher than finished grade.
      b. Grade the ground surface to drain away from manholes and handholes.
      c. Provide fill around manholes and handholes to level of upper rim of manhole or handhole frame, and evenly grade the surface to a one (vertical)-to-five (horizontal) slope to surrounding grade, unless otherwise shown or directed by ENGINEER.
   2. Paved or Travelled Areas:
      a. Install manholes and handholes in paved or travelled areas to meet final grade of paved or concrete surface.

b. In paved areas in state or county highways or municipal streets or roads, manholes and handholes shall be 1/2-inch below elevation of final surface course (also known as top course or wearing course) of pavement.

c. Manholes and handholes shall not project above finished roadway pavement.

3. CONTRACTOR shall be solely responsible for proper height of manholes and handholes necessary to reach final grade. ENGINEER's review of Shop Drawings and other submittals for manholes and handholes is general in nature. Provide random-length precast manhole riser sections to adjust manholes to accommodate field conditions for final grading and final elevations.

3.3 FIELD QUALITY CONTROL

A. Watertightness:

1. Manholes and handholes for electrical systems shall be free of visible leakage. Inspect each manhole and handhole accompanied by ENGINEER, and repair leaks.

+ + END OF SECTION + +

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SECTION 26 05 45

UTILITY SERVICES FOR ELECTRICAL SYSTEMS

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install electric and telephone services and associated equipment at the Site.
   2. CONTRACTOR shall furnish and install the following Work regarding electric service:
      a. Riser pole and pole-mounted isolation switch, lightning arresters, and cable terminators.
      b. Grounding platform and associated grounding.
      c. 15 KV primary cable and connections.
      d. Overhead conductors from metering pole to riser pole, including dead end insulators.
   3. Electric utility company, Central Hudson, Carrine Brown, PMP, Associate District Director, Business Development, Phone (845) 563-4570, cbrown@cenhud.com, will provide the following:
      a. Metering pole.
      b. Metering transformers, meters, enclosure, and associated metering equipment.
      c. Pole mounted fused cutouts.
   4. Work in connection with electric services shall be in accordance with requirements of the electric utility company.

B. Coordination:
   1. CONTRACTOR shall coordinate with electric utility company and local telephone company relative to electric and telephone service connections and requirements. CONTRACTOR shall make all necessary arrangements with electric utility.
   2. The Contract Price as awarded includes all costs associated with providing electric service to the Site.

C. Related Section:
   1. Section 26 05 13, Medium Voltage Cables

1.2 REFERENCES

A. Standards referenced in this Section are:

1. ANSI C37.35, Guide for the Application, Installation, Operation and Maintenance of High Voltage Air Disconnecting and Load Interrupter Switches.
2. ANSI C37.46, Specifications for Power Fuses and Fuse Disconnecting Switches
3. ANSI/IEEE C62.11, IEEE Metal Oxide Surge Arresters of AC Power Circuits.
4. ANSI C135.1, Galvanized Steel Bolts and Nuts for Overhead Line Construction.
5. ANSI C135.2, Threaded Zinc-Coated Ferrous Strand-Eye Anchor Rods and Nuts for Overhead Line Construction.
6. AWPA C4, Poles - Preservative Treatment by Pressure Processes.

1.3 QUALITY ASSURANCE

A. Pre-installation Conference:
   1. Prior to transmitting submittals for materials and equipment related to electrical service or telephone service, and prior to installing materials and equipment associated with electrical service, arrange a conference at the Site with the following:
      a. Electric utility company.
      b. Supplier representatives (as required) for materials and equipment associated with electrical service.
      c. Installers of other work related to and adjacent to electric services Work.
      d. ENGINEER and Resident Project Representative (as applicable).
      e. Other representatives directly concerned with performance of electric service Work.
   2. Review at the conference the following relating to electrical service Work:
      a. Review Project requirements including Contract Documents, approved Shop Drawings and other submittals, requests for interpretation transmitted by CONTRACTOR to ENGINEER, and other pertinent documents.
      b. Review scope of Work and scope of utility company work.
      c. Review required samples and submittals, both completed and to be completed.
      d. Review proposed costs for work that will be invoiced by utility companies.
      e. Review status of Work related to utility services and Progress Schedule related to utility services.
      f. Review availability of materials, tradesmen, equipment, and facilities required for progress, to avoid delays, and to protect the Work from damage.
      g. Review required inspection, testing, certifying, and quality control procedures.
      h. Review methods for complying with requirements of utility companies.
   3. Reconvene conference at earliest opportunity if additional information must be developed to conclude the required topics of the conference.
   4. Record in writing discussions of conference and decisions and agreements and

disagreements; and revisions or changes agreed upon, reasons therefore, and parties agreeing or disagreeing with them. Furnish copy of record to each party attending, the CITY, and the DEPARTMENT.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Shop Drawings:
      a. Drawings showing proposed layout of electrical utility service.
   2. Product Data:
      a. Manufacturer's literature and technical information, including technical specifications, indicating compliance with the Contract Documents for materials and equipment and construction procedures specified in this Section.

PART 2 – PRODUCTS

2.1 MATERIALS

A. Riser Pole and Miscellaneous Equipment:
   1. General: Work related to the pole and associated equipment shall comply with NESC Grade C. Insulation levels shall be in accordance with 15 KV class minimum.
   2. Materials and equipment shall be new and of current manufacture.
   3. Pole: Pole shall be Class 2, fifty feet tall, southern yellow pine, and treated over its full length with pentachlorophenol, chromated copper arsenate **(**CCA**),** or creosote in accordance with AWPA Section C4.
   4. Framing: Pole shall be framed with three-inch by four-inch by eight-foot cross arms of southern yellow pine or Douglas fir. Cross arms shall be braced with one-inch by 1.75-inch wood braces. Cross arms and braces shall be pressure treated with pentachlorophenol.
   5. Line Conductors and Connectors: Line conductors shall be sized as shown on the drawings AWG, types shall be ACSR, AAAC, copper, or copper-weld with polyethylene covering. Ground wires shall be 7/16-inch, high strength, zinc-coated steel with minimum breaking strength of 14,500 pound-force. Connections shall be ANSI Class A.
   6. Insulators: Shall be porcelain, line-post or suspension type, except for dead end type insulators. Insulator class shall be in accordance with requirements of electric utility company.
   7. Pole Line Hardware: Nuts, bolts, washers and miscellaneous hardware shall be of type specifically developed for pole line installations. Steel or wrought iron hardware shall be hot-dip galvanized in accordance with ANSI C135.1.
   8. Anchor Systems:
      a. Guy wire shall be hot-dipped galvanized 3/8-inch extra-high strength steel with Class B coating. Guy wire shall include suitable strain

insulators. Insulators shall be located at least eight feet above grade and six feet from pole top.

b. Guy hardware shall have 15,000-pound rating minimum. Anchors shall be either cross-plate or screw type. Anchors shall be galvanized in accordance with ANSI C135.2. Cross-plate anchors shall have cross section of 200 square inches minimum with 3/4-inch by eight-foot rod. Screw anchors shall be an eight-inch diameter helix; 7,000 foot-pound-rated with 3/4-inch by seven-foot rod.

B. Lightning Arresters:

1. Arresters: Arresters shall be standard distribution class valve arresters, metal-oxide type, suitable for operation on both overhead and underground distribution systems. Arresters shall be capable of cross arm mounting and shall have line and ground terminals capable of accepting copper or aluminum conductors from No.6 solid to No. 2 stranded. Test arresters in accordance with ANSI C62.11.
2. Ratings: Arresters shall be rated for (--11--) KV.
3. Identification: Provide each arrester unit with permanent nameplate that shall include the following:
   a. Manufacturer.
   b. Model.
   c. Voltage rating.
   d. Date of manufacturer.
   e. Duty cycle rating.
4. Manufacturers: Provide products of one of the following:
   a. Cooper Power Systems.
   b. ABB Company.
   c. Or equal.

C. Cable Terminators:

1. Terminators: Shall be slip-on type porcelain; factory assembled and shall include built-in stress relief and insulating material for bracket mounted on metering/ riser pole. Equip each terminator with adapter kits and connectors suitable for use with copper shielded cable of type specified in Section 26 05 13, Medium Voltage Cables.
2. Ratings: 18 KV, 90 KV BIL suitable for operation on a 15 KV supply. Current rating to be the same as for the cable.
3. Manufacturers: Provide products of one of the following:
   a. G and W Electric Company.
   b. Joslyn Manufacturing Company.
   c. Or equal.

PART 3 – EXECUTION

3.1 INSTALLATION

A. Install electric service materials and equipment in accordance with requirements of electric utility company. Install materials and equipment in accordance with NESC.

B. Install equipment in accordance with manufacturer's written recommendations.

C. Install aerial ground conductors in parallel to and above line conductors to shield lines from lightning.

D. Install guys where lines begin, end, and change direction to balance line tensions as required to suit the installation.

E. Set pole to depth of seven feet below grade and install ground rod adjacent to base of pole. Install 1/0 ground cable up the pole for grounding of pole devices. Protect ground cable with wood molding.

+ + END OF SECTION + +

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SECTION 26 05 53

IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals shown, specified, and required to furnish and install identification for electrical apparatus and electrical Work.

B. Related Sections:
   1. Section 26 05 19, Low Voltage Electrical Power Conductors and Cables.
   2. Section 26 05 23, Instrumentation and Communication Cable.
   3. Section 26 05 13, Medium Voltage Cables.
   4. Section 26 05 33.13, Rigid Conduits.
   5. Section 26 05 36, Cable Trays for Electrical Systems.
   6. Section 40 61 13, Process Control Systems General Provisions.
   7. Section 26 24 13, Switchboards.
   8. Section 26 24 16, Panelboards.
   9. Section 26 28 16.33, Disconnect Switches.
   10. Section 26 28 17, Enclosed Circuit Breakers.
   11. Section 26 29 23, Low-Voltage Variable-Frequency Drives.
   12. Section 26 29 33, Control Stations.

1.2 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with the following:
   1. NEC Article 110, Requirements for Electrical Installation.
   2. NEC Article 210, Branch Circuits.
   3. NEC Article 215, Feeders.
   4. NEC Article 504, Intrinsically Safe Systems.
   5. NEC Article 700, Emergency Systems.
   6. NEC Article 701, Legally Required Standby Systems.
   7. NEC Article 702, Optional Standby Systems.
   8. 40 CFR 1910.145 (OSHA) – Specification for Accident Prevention Signs and Tags.
   9. NFPA 70E, Electrical Safety in the Workplace.

1.3 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Shop Drawings: Submit the following:

a. Complete description and listing of proposed electrical identification and electrical identification devices for associated equipment or systems.
b. Conduit and wire identification numbering system and equipment signage.

2. Product Data:
   a. Manufacturer's literature, cut sheets, specifications, dimensions and technical data for all products proposed under this Section.

PART 2 – PRODUCTS

2.1 MANUFACTURED UNITS

A. Engraved Identification Devices (Nameplates and Legend Plates):
   1. Nameplates:
      a. Laminated thermoset plastic, 1/16-inch thick, engraved condensed block black lettering on white background, square corners, and beveled front edges, or match existing.
      b. Size: As required.
      c. Letter Size: Minimum 3/16-inch.
      d. Nameplates one-inch or less in height shall have one mounting hole at each end. Nameplates greater than one-inch in height shall have mounting holes in the four corners.
   2. Legend Plates:
      a. Legend plates for pushbuttons, pilot lights, selector switches, and other panel-mounted devices shall be large size with dimensions of approximately 2-7/16 inches wide by 2-13/32 inches tall (Allen Bradley large automotive size), plastic, custom engraved with black letters on white background.
         1) Provide standard-size legend plates where devices are mounted on motor control centers and spacing of devices precludes using automotive-size legend plates.
      b. Lettering size and line weight shall be the same for all legend plates on the same panel or enclosure. Maximum size shall be 1/4-inch and minimum size shall be 1/8-inch.

B. Safety Signs and Voltage Markers:
   1. Provide high voltage signs for equipment operating over 600 volts.
   2. High-Voltage Safety Signs for Outdoor Applications:
      a. Products and Manufacturers: Provide one of the following:
         1) B-120-45471 by Brady.
         2) Or equal.
      b. Unless otherwise shown or indicated, high voltage safety signs shall be not less than 10 inches high by 14 inches wide, of fiberglass reinforced plastic, and shall comply with 40 CFR 1910.145. Signs shall resist fading from exposure to temperature extremes, ultraviolet light,

abrasive, and corrosive environments, and shall read, "DANGER – HIGH VOLTAGE – KEEP OUT"

c. Mounting hardware shall be Type 316 stainless steel.

3. High-Voltage Safety Signs for Indoor Applications:
   a. Products and Manufacturers: Provide one of the following:
      1) B-302-84084 by Brady.
      2) Or equal.
   b. High voltage safety signs for installation on indoor equipment shall be either pressure-sensitive acrylic or vinyl, and shall be not less than 10 inches high by 14 inches wide, shall comply with 40 CFR 1910.145, and shall read, "DANGER – HIGH VOLTAGE – KEEP OUT".
4. Cable Tray Safety Signs:
   a. Products and Manufacturers: Provide one of the following:
      1) B-302-86139 by Brady.
      2) Or equal.
   b. Cable tray safety signs shall be pressure-sensitive vinyl conforming to 40 CFR 1910.145, 5 inches by 3.5 inches in size, and shall read, "DANGER – HIGH VOLTAGE"
5. Low-Voltage Safety Signs:
   a. Products and Manufacturers: Provide one of the following:
      1) B-302-86060 by Brady.
      2) Or equal.
   b. Low voltage safety signs shall be pressure-sensitive vinyl complying with 40 CFR 1910.145, five inches by 3.5 inches in size, and shall read, "DANGER – 480 VOLTS".
6. Low-Voltage Markers:
   a. Products and Manufacturers: Provide one of the following:
      1) CV442xx by Brady.
      2) Or equal.
   b. Low voltage markers shall be either pressure-sensitive vinyl or vinyl cloth with black lettering on orange background and shall read, "120 VOLTS", "208 VOLTS", "120/208 VOLTS", or "240 VOLTS" as required.

C. Arc-flash Safety Signs:
   1. Products and Manufacturers: Provide one of the following:
      a. Brady.
      b. Or equal.
   2. Warning signs shall be adhesive-backed polyester.
   3. Warning signs shall read, "Warning – Arc Flash and Shock Hazard. Appropriate PPE Required. Arc flash warning signs shall indicate the flash protection boundary, incident energy in calories per square centimeter, hazard level, description of required protective clothing, shock hazard, limited approach boundary, restricted approach boundary, prohibited approach boundary, and equipment name.

D. Voltage System Identification Directories:
   1. General:
      a. Directories shall be laminated thermoset plastic, 1/16-inch thick, engraved block black letters on white background, square corners, and beveled front edges.
      b. Directories shall identify all voltage systems within building or structure.
      c. Directories shall list the colors that identify ungrounded and grounded conductors of each system.
      d. Colors shall be in accordance with Section 26 05 19, Low Voltage Electrical Power Conductors and Cables, Section 26 05 13.23, 15KV Cable, and Section 26 05 13.26, 5KV Cable.
      e. Example Directory Text:

Voltage System Identification		
System	**A, B, C**	**Neutral**
277/480	Brown, Orange, Yellow	Gray
120/208	Black, Blue, Red	White

   2. Large directories for rooms shall have text height not less than 1/2-inch.
   3. Small directories for equipment shall have text height of not less than 1/4-inch.

E. Conduit Labels:
   1. Products and Manufacturers: Provide one of the following:
      a. B-915-xxxxx by Brady.
      b. Or equal.
   2. Shall be pre-tensioned acrylic/vinyl construction coiled to completely encircle conduit for conduit up through five-inch diameter, or pre-molded to conform to circumference of conduit six-inch diameter and larger.
   3. Attach strap-on style for six-inch diameter conduit with stainless steel springs.
   4. Shall be blank for use with custom printed labels.
   5. Custom Labels:
      a. Shall have black lettering on yellow background.
      b. Shall not contain abbreviations in legend.
      c. Shall be custom printed on continuous tape with permanent adhesive using thermal printer specified below.

F. Wire Identification:
   1. Heat Shrinkable Wire and Cable Labeling System:
      a. Products and Manufacturers: Provide one of the following:
         1) B-341 PS-xxx-2W by Brady.
         2) Or equal.
      b. White heat-shrinkable irradiated polyolefin shrink-on sleeves. Labels shall be thermal printed. Labels shall be not less than two inches wide.
   2. Wrap-Around Wire and Cable Labeling System:

a. Products and Manufacturers: Provide one of the following:
   1) THT-XX-427 by Brady.
   2) Or equal.
b. Self-laminating white/transparent self extinguishing vinyl strips. Length shall be sufficient to provide at least 2.5 wraps. Labels shall be thermally printed and not less than two inches wide.

G. Detectable Underground Warning Tape:
1. Products and Manufacturers: Provide one of the following:
   a. Indentoline by Brady.
   b. Or equal.
2. Material: Polyethylene or polyester with detectable metal core and polyester underlaminate.
3. Width: Two inches.
4. Color and Labeling: Yellow or red with permanently imprinted black letters: "CAUTION – Buried Electric Line", repeated continuously over full length of tape.

H. Thermal Printing System:
1. Utilize thermal transfer process to provide non-smearing labels and markers.
2. Wire and Cable Markers:
   a. Portable, Products and Manufacturers: Provide one of the following:
      1) TLS2200 by Brady.
      2) Or equal.
   b. Desktop, Products and Manufacturers: Provide one of the following:
      1) 200M by Brady.
      2) Or equal.
3. Cable Markers:
   a. Portable, Products and Manufacturers: Provide one of the following:
      1) Handimark by Brady.
      2) Or equal.
   b. Desktop, Products and Manufacturers: Provide one of the following:
      1) Labelizer PLUS by Brady.
      2) Or equal.

I. Generator System Warning Signs:
1. Generator warning signs shall be labeled in accordance with NEC Article 700, NEC Article 701, or NEC Article 702.
2. Material, Colors, Letters: Plastic with white letters on red background. Letters shall be not less than 3/8-inch high.
3. Attachment: Use stainless steel self-tapping screws.
4. Location warning sign shall read, "WARNING – THIS SITE EQUIPPED WITH A DIESEL DRIVEN STAND-BY GENERATOR LOCATED IN AN ADJACENT ROOM".
5. Generator ground warning sign shall read, "WARNING – GENERATOR GROUNDED CIRCUIT CONDUCTOR IS CONNECTED TO THE GROUNDING ELECTRODE CONDUCTOR IN THIS ENCLOSURE.

DO NOT OPERATE GENERATOR WHILE EITHER CONDUCTOR IS DISCONNECTED TO AVOID SEVERE SHOCK HAZARD AND POSSIBLE EQUIPMENT DAMAGE."

2.2 FABRICATION

A. Engraved Identification Devices (Nameplates and Legend Plates):
   1. Nameplate and legend plate text is preliminary and subject to change pending final review and approval of nomenclature by ENGINEER after start-up and testing.

PART 3 – EXECUTION

3.1 INSTALLATION

A. Provide electrical identification in accordance with manufacturer recommendations and as required for proper identification of equipment and materials.

B. Engraved Identification Devices (Nameplates and Legend Plates):
   1. Unless otherwise indicated in the Contract Documents, attach permanent nameplates with permanent adhesive and with 3/16-inch diameter, round head, stainless steel machine screws into drilled and tapped holes.
   2. Provide nameplate with 1.5-inch high letters to identify each console, cabinet, panel, or enclosure as shown or indicated.
   3. Provide nameplates for field-mounted motor starters, disconnect switches, manual starter switches, pushbutton stations, and similar equipment operating components, which shall describe motor or equipment function and circuit number.
   4. Provide nameplates with 1/2-inch high letters to identify each junction and terminal box shown or indicated.
   5. On switchgear, provide nameplates for each main and feeder circuit including control fuses, and for each indicating light and instrument.
      a. Provide nameplate with 1.5-inch high letters giving switchgear designation, voltage rating, ampere rating, short circuit rating, manufacturer's name, general order number, and item number.
      b. Identify individual door for each compartment with nameplate giving item designation and circuit number.
   6. Motor Control Centers:
      a. Provide nameplate with 1.5-inch letters with motor control center designation.
      b. Identify individual door for each unit compartment with nameplate identifying controlled equipment.
   7. Except conduit, all electrical appurtenances including lighting panels, convenience outlets, fixtures, and lighting switches, shall be provided with nameplates indicating appropriate circuit breaker number(s).

8. Push Buttons:
   a. Provide legend plates for identification of functions.
   b. Provide nameplates for identification of controlled equipment.
   c. Provide red buttons for stop function.
   d. Provide black buttons for other functions.
9. Pilot Lights:
   a. Provide legend plates for identification of functions.
   b. Provide nameplates for identification of controlled equipment.
   c. Shall have lens colors as shown or indicated. Where no color is indicated, provide the following lens colors:

Color	Legend
Green	Running, Open
Red	Stopped, Closed
Amber	Alarm
Blue	Power
White	Status

10. Selector Switches:
    a. Provide legend plates for identification of functions.
    b. Provide nameplates for identification of controlled equipment.
11. Panel Mounted Instruments:
    a. Provide nameplates for identification of function.
12. Interiors of Cabinets, Consoles, Panels, Terminal Boxes, and Other Enclosures:
    a. Provide nameplates for identification.
    b. Provide each item inside cabinet, console, panel, terminal box, or enclosure with laminated plastic nameplate as shown on approved Shop Drawings and CONTRACTOR's other submittals. Install nameplates with adhesive.
    c. Interior items requiring nameplates include:
       1) Terminal blocks and strips.
       2) Bus bars.
       3) Relays.
       4) Rear of face-mounted items.
       5) Rear of door-mounted items.
       6) Interior mounted items that require identification when mounted externally.
    d. Circuit Breaker Directory:
       1) Provide engraved laminated plastic directory listing function and load controlled for each circuit breaker within panel used for power distribution.
13. Re-label existing equipment whose designation have changed.

C. Safety Signs and Voltage Markers:
   1. Provide safety signs and voltage markers on and around electrical equipment as shown or indicated.

a. Install rigid safety signs using stainless steel fasteners.
b. Clean surfaces before applying pressure-sensitive signs and markers.

2. Install high voltage safety signs on all equipment doors providing access to uninsulated conductors, including terminal devices, greater than 600 volts.
3. Provide cable tray safety signs on both sides of cable trays at maximum intervals of 20 feet. Install signs on side rails of tray as acceptable to ENGINEER.
   a. Label cable trays that contain conductors greater than 600 volts with cable tray safety signs.
   b. Cable trays that contain conductors greater than 208 volts and less than 600 volts shall be labeled with low voltage safety signs.
   c. Cable trays that contain conductors of 120/208 volts shall be labeled with low voltage markers.
   d. Do not label cable trays that contain only instrument signal cables.
   e. Label cable trays that contain intrinsically safe wiring or cables in accordance with NEC Article 504.
4. Install low voltage safety signs on equipment doors that provide access to uninsulated 480-volt conductors, including terminal devices.
5. Install low voltage markers on each terminal box, safety disconnect switch, and panelboard installed, modified, or relocated as part of the Work and containing 120/208 volt conductors.

D. Voltage System Identification Directories
1. Provide voltage system identification directories as required by NEC Article 210 and NEC Article 215.
2. Provide in each electrical room voltage system identification directory mounted on wall or door at each entrance to room.
3. For panelboards, switchboards, motor control centers, and other branch circuit or feeder distribution equipment that are not located in electrical rooms, provide voltage system identification directory mounted on equipment.
   a. Directories shall be affixed using epoxy glue. Screws or bolts shall not penetrate equipment enclosures.
   b. Directories shall be readily visible and not obscure labels and other markings on equipment.

E. Arc-flash Safety Signs:
1. Provide arc-flash safety signs as required by NEC Article 110.
2. Provide signs for switchboards, panelboards, motor control centers, and industrial control panels. Provide signs for control panels that contain 480 volt equipment. Provide arc flash warning signs on other equipment where the incident energy is greater than 1.2 calories per square centimeter.

F. Conduit Labels:
1. Provide conduits with conduit labels unless otherwise shown or indicated.
2. Do not label flexible conduit.

3. Do not label exposed single conduit runs of less than 25 feet between local disconnect switches and their associated equipment.
4. Conduit labels shall indicate the following information:
   a. Contract Number: Alphanumeric, three or four digits, as applicable.
   b. Conduit Number: Alphanumeric as shown on the Drawings, as assigned by CONTRACTOR for unlabelled conduits, and in accordance with approved submittals.
5. Conduits that contain intrinsically safe wiring shall have an additional pipe marker provided that has blue letters on white background and reads, "INTRINSICALLY SAFE WIRING".
   a. Install intrinsically safe pipe markers in accordance with NEC Article 504 along entire installation. Spacing between labels shall not exceed 25 feet.
6. Provide conduit labels at the following locations:
   a. Where each conduit enters and exits walls, ceilings, floors, or slabs.
   b. Where conduit enters or exits boxes, cabinets, consoles, panels, or enclosures, except pull boxes and conduit bodies used for pull boxes.
   c. At maximum intervals of 50 feet along length of conduit.
7. Orient conduit labels to be readable.

G. Wire and Cable Identification:
1. Color-coding of insulated conductors shall comply with Section 26 05 19, Low Voltage Electrical Power Conductors and Cables, Section 26 05 13, Medium Voltage Cable.
2. Use heat-shrinkable wire labels where wire or cable is terminated. Use wrap-around labels where wire or cable is to be labeled but is not terminated.
3. Do not provide labels for the following:
   a. Bare (uninsulated) conductors, unless otherwise shown or indicated as labeled.
4. Provide wire and cable labels for the following:
   a. New, rerouted, or revised wire or cable.
   b. Insulated conductors.
   c. Wire and cable terminations:
      1) Wire labels shall be applied between 1/2-inch and one inch of completed termination
      2) Apply cable labels between 1/2-inch and one inch of cable breakout into individual conductors.
         a) Label individual conductors in a cable after breakout as specified for wires.
   d. Wire or cable exiting cabinets, consoles, panels, terminal boxes, and enclosures.
      1) Label wires or cables within two inches of entrance to conduit.
   e. Wire or cable in junction boxes and pull boxes
      1) Label wires or cables within two inches of entrance to conduit.
   f. Wire and cable installed in cable tray.
      1) Wire and cable shall have labels at maximum intervals of 20 feet.

g. Wire and cable installed without termination in electrical manholes.
   1) Wire and cable shall have wrap-around labels applied within one foot of exiting manhole.

5. Wire and Cable Identification System:
   a. Wire and cable labels shall be imprinted with an identifying designator.
      1) Wire and cable extending between two devices or items and that does not undergo a change of function shall be identified by a single unique designator as specified below.
   b. Field Wiring:
      1) Wire or cable designator shall consist of:
         a) Three left-most characters shall consist of the Contract number under which wiring or cable was installed.
         b) Fourth character from the left shall be an asterisk (*), a plus sign (+) or a hyphen (-). Do not use other punctuation symbols in a wire designator.
         c) Remaining characters shall be alphanumeric and make wire designator unique.
         d) Numbering shall reflect actual designations used in the Work and shall be documented in record documents.
   c. Cabinet, Console, Panel, and Enclosure Wiring, Internal:
      1) New Cabinets, Consoles, Panels, and Enclosures:
         a) Wire and cable inside cabinets, consoles, panels, and enclosures shall have designators as specified in Section 40 61 13, Process Control Systems General Provisions.
6. Modified Cabinets, Consoles, Panels, and Enclosures:
   a. New or rerouted wire or cable in existing cabinets, consoles, panels, and enclosures shall be labeled as shown on the Drawings or be assigned a ten-character designator equivalent to field wire designator.

H. Terminal Strip Labeling:
   1. Label panel side of terminal to match panel wire number.
   2. Label field side of terminal to match field wire number. Terminal number shall not include the Contract number.

I. Generator System Warning Signs:
   1. Provide warning signs for generator systems as required by NEC.
   2. Install generator location warning sign on or immediately adjacent to service equipment, or to “normal” source disconnecting means when generator is located out of sight of service equipment or disconnecting means.
   3. Install generator grounding warning sign on enclosure or immediately adjacent to point where generator neutral is connected to grounding electrode system if connection is made remote from generator.

+ + END OF SECTION + +

SECTION 26 05 73

ELECTRICAL POWER DISTRIBUTION SYSTEM STUDIES

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment, professional services, and incidentals required to perform electrical power distribution system studies.
   2. Motor starting and transformer information used in electrical power distribution system studies shall be based on equipment provided by CONTRACTOR, equipment provided by other contractors on the Project, and, where applicable, existing equipment ratings and settings.
   3. Electrical power distribution system studies shall include the following, as specified in this Section:
      a. Short-circuit study.
      b. Protective device evaluation study.
      c. Protective device coordination study.
      d. Arc flash analysis.

B. Related Sections:
   1. Section 26 05 53, Identification for Electrical Systems.

1.2 REFERENCES

A. Standards referenced in this Section are:
   1. ANSI/IEEE C37.91, Guide for Protective Relay Applications to Power Transformers
   2. ANSI/NCSL Z540.3 Requirements for the Calibration of Measuring and Test Equipment.
   3 IEEE 141, Recommended Practice for Electric Power Distribution in Industrial Plants (IEEE Red Book).
   4. IEEE 242, Recommended Practice for Protection and Coord. of Industrial and Commercial Power Systems (IEEE Buff Book).
   5. IEEE 399, Analysis (IEEE Brown Book), Recommended Practice for Power System Analysis.
   6. IEEE 1584, Guide for Performing Arc-Flash Hazard Calculations.
   7. NFPA 70E, Electrical Safety in the Workplace.

1.3 QUALITY ASSURANCE

A. Qualifications:
   1. Professional Engineer:
      a. Engage a registered professional engineer legally qualified to practice in the jurisdiction where the Project is located and experienced in providing engineering services of the kind indicated. Professional engineer may be employed by independent consulting firm or manufacturer of power distribution equipment.
      b. Professional engineer shall have not less than five years of experience performing electrical power distribution system studies similar in scope and size to the studies required for the Project.
      c. Submit qualifications data.
      d. Responsibilities include but are not necessarily limited to:
         1) Performing or supervising the performance of electrical power distribution system studies and related field services.
         2) Preparing or supervising the preparation of test plans and test reports, and interpretation and engineering analysis of test data. Test reports shall bear the seal and signature of the professional engineer. State of licensure, license number, and professional engineer's name shall be clearly legible on the seal.
         3) Certifying that tests performed and results achieved conform to the Contract Documents.
   2. Field Engineer:
      a. Field engineer performing protective device testing shall be experienced in type of testing required and testing equipment used on the Project.
      b. Field engineer may be an employee of the protective device equipment manufacturer.

B. Test equipment and instrument calibration shall comply with accuracy standards of NIST and ANSI/NCSL Z540.3.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Studies:
      a. Calculations and results of the short-circuit study, protective device evaluation, and coordination studies in report format. Report shall be sealed and signed by the professional engineer retained for the studies. Submit preliminary reports (when specified) and final reports.
      b. Time current curves for protective devices included within the power system studies.
      c. Calculations and results of arc-flash analysis in report format sealed and signed by professional engineer retained for the studies. Submit preliminary reports (when specified) and final reports.

2. Testing Plan: Submit work plan for field testing. Submit and obtain ENGINEER's approval prior to performing tests. Plan shall indicate schedule of field testing, time frames for tests, and duration of equipment outage for testing. Submit shutdown requests for each outage in accordance with Section 01 14 16, Coordination with CITY's Operations.
3. Field Survey Plan: Submit work plan for field survey and data gathering prior to beginning work. Plan shall indicate the schedule of work, time frames for data collection, and duration that equipment will be temporarily out of service. Submit shutdown requests for each outage in compliance with Section 01 14 16, Coordination with CITY's Operations.

B. Informational Submittals: Submit the following:
1. Test Reports:
   a. Results of field testing.
2. Qualifications Statements:
   a. Professional engineer.
   b. Field engineer, when required by ENGINEER.

C. Closeout Submittals: Submit the following:
1. Final settings of protective devices. Submit compilation of final settings for each equipment lineup within 10 days of programming the associated protective devices.
2. Electronic Files:
   a. Protective Devices:
      1) Settings for all microprocessor-based protective devices.
      2) Software versions used to program the protective devices.
   b. Electrical Power Distribution System Studies:
      1) Upon ENGINEER's approval or acceptance, as applicable, of submittals required under this Section, submit for CITY's use all electronic files developed for the Work under this Section associated with the approved or accepted, as applicable, submittal to ENGINEER.
      2) Electronic files submitted for CITY's use shall become CITY's property.
      3) Source files for power studies performed under this Section.

1.5 ELECTRICAL POWER DISTRIBUTION SYSTEM STUDIES

A. General:
1. Perform a current and complete short-circuit study, protective device evaluation study, and protective device coordination study for the Site's electrical distribution system. Perform studies in accordance with IEEE 141, IEEE 242, and IEEE 399.
2. Studies shall include all portions of high-, medium-, and low-voltage electrical power distribution systems, from the normal and alternate sources of power through low-voltage distribution system. Thoroughly cover in the

study normal system operating method, alternate operation, and operations that could result in maximum fault conditions.

3. Perform a complete study to evaluate both new and existing devices, and include recommendations on required adjustments. Studies shall include both the normal utility supply and standby generator systems.
4. Promptly bring to attention of ENGINEER and CITY problem areas and inadequacies in equipment.

B. Short-circuit Study:
1. Perform short-circuit evaluation using computer software specifically designed for such use.
2. Input data shall include electric utility company's short-circuit, single-, and three-phase contributions, with reactance/resistance (X/R) ratio, resistance and reactance components of each branch impedance, motor and generator contributions, base quantities selected, and other applicable circuit parameters.
3. Calculate short-circuit momentary duties and interrupting duties on the basis of maximum available fault current at each switchgear bus, switchboard, motor control center, distribution panelboard, pertinent branch circuit panelboards, and other significant locations through the system.
4. Short-circuit tabulations shall include symmetrical fault currents and X/R ratios. For each fault location, total duty on the bus and individual contribution from each connected branch, including motor back electro-motive force (EMF) current contributions, shall be listed with its associated X/R ratio.

C. Protective Device Evaluation Study:
1. Determine adequacy of circuit breakers, controllers, surge arresters, busways, switches, and fuses by tabulating and comparing short-circuit ratings of these devices with the available fault currents.
2. Apply appropriate multiplying factors based upon system X/R ratios and protective device rating standards.

D. Protective Device Coordination Study:
1. Perform study to select or to check selections of power fuse ratings, protective relay characteristics and settings, ratios and characteristics of associated voltage and current transformers, and low-voltage breaker trip characteristics and setting.
2. Overcurrent device settings estimated in the protective device coordination study shall provide complete, 100 percent selectivity. Selectively coordinate system such that only the device nearest a fault will operate to remove the faulted circuit. System selectively shall be based on both the magnitude and duration of a fault current.
3. Study shall include all voltage classes of equipment starting at electric utility's incoming line protective device, down to and including medium- and low-voltage equipment. Phase and ground overcurrent and phase and

ground fault protection shall be included, and settings for other adjustable protective devices.

4. Plot time-current characteristics of installed protective devices on appropriate log-log paper. Maintain reasonable coordination intervals and separation of characteristic curves. Provide coordination plots for phase and ground protective devices for complete system. Use sufficient curves to clearly indicate selective coordination achieved through electric utility's main breaker, power distribution feeder breakers, and overcurrent devices at each major load center.
5. Show maximum of eight protective devices per plot. Appropriately title each plot and include the following information as required for the circuits shown:
   a. Representative one-line diagram, legends, and types of protective devices selected.
   b. Power company's relays or fuse characteristics.
   c. Significant motor starting characteristics.
   d. Parameters of transformers, magnetizing inrush and withstand curves in accordance with ANSI C37.91.
   e. Operating bands of low-voltage circuit breaker trip curves, and fuse curves.
   f. Relay taps, time dial and instantaneous trip settings.
   g. Cable damage curves.
   h. Symmetrical and asymmetrical fault currents.
6. Provide selection and settings of protective devices separately in tabular format listing circuit identification, IEEE device number, current transformer ratios, manufacturer, type, range of adjustment, and recommended settings. Provide a tabulation of recommended power fuse selection for all fuses in system.

E. Arc-Flash Analysis:
   1. Conduct arc flash analysis after acceptance by ENGINEER of short-circuit study and coordination study. Perform arc flash analysis for each operating mode of the system, in accordance with IEEE 1584 and NFPA 70E.
   2. Document the protection and calculation procedures and coordination review in testing report. Present analysis results in tabular format showing the following:
      a. Bus and protection device name.
      b. Bolted and arcing fault values.
      c. Protective device trip times.
      d. Arc flash boundary, working distance, and incident energy.
      e. Required protective flame-resistant (FR) clothing class.

1.6 STUDY REPORT

A. Summarize results of electrical power distribution system studies in a typed or computer-printed report that includes the following:

1. Description, purpose, basis, written scope, and single-line diagram of power distribution systems evaluated.
2. Tabulations of circuit breaker, fuses, and other equipment ratings versus calculated short-circuit duties. Evaluation of short-circuit calculations and identification of underrated equipment.
3. Protective device time versus current coordination curves, tabulations of relay and circuit breaker trip settings, and fuse selection. Include an evaluation and discussion of logical compromises for proposed protection.
4. Fault current tabulation including definition of terms and guide for interpretation.
5. Tabulation of appropriate tap settings for relay seal-in units.
6. Tabulation of equipment survey information.

B. Electrical power distribution system studies report shall include a separate section addressing arc flash analysis. In addition to protection and calculation procedures, and coordination review and analysis results, report shall include protective device evaluation for each high-incident energy case to determine if adjustments can improve system performance relative to arc flash hazard level.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION

3.1 PREPARATION

A. General:
1. Coordinate with professional engineer performing the studies and assist professional engineer with collecting information necessary to complete the specified studies.
2. Prior to performing studies, obtain information pertaining to existing system necessary for performing studies.

3.2 FIELD SERVICES

A. CONTRACTOR's professional engineer shall conduct an equipment survey and data gathering of existing devices and information necessary to perform electrical power distribution system studies.

B. To the extent applicable, perform survey that includes the following information:
1. Manufacturer, type, and size of each power fuse.
2. Manufacturer, type, model, and settings for each protective relay, trip unit, and circuit breaker.
3. Current transformer ratios for each protective relay.
4. Appropriate data for motors and transformers included with the study.

C. CONTRACTOR's professional engineer shall confirm and establish proper settings for protective devices. Professional engineer shall collect data and coordinate with equipment Suppliers to establish proper settings for the devices provided. Document in the study all devices and settings.

3.3 FIELD TESTING

A. Site Tests:
   1. Provide protective device field testing in accordance with manufacturers' recommendations. Field testing shall be by CONTRACTOR's field engineer, after submittal of and ENGINEER's acceptance of electrical power distribution system studies. Field testing results shall be documented in a report that shall include final settings of protective devices.
   2. Field engineer shall provide necessary tools and equipment and adjust, set, calibrate, and test protective devices. Protective relays and meters in medium- and low-voltage equipment shall be set, adjusted, calibrated, and tested in accordance with manufacturers' recommendations and the coordination study. Provide minor adjustments, repairs, and lubrication necessary for proper operation.
   3. Electromechanical protective relays provided in accordance with the Contract Documents shall be set and tested for acceptance. Testing shall include visual and mechanical inspection. Testing shall include overcurrent time and pick-up tests.
   4. Solid state and multi-function trip devices shall be set, including required programming necessary for the protection required. Devices shall be checked, configured, and tested for setting and proper operation.

3.4 MAINTENANCE OF OPERATIONS

A. Field testing may require that certain equipment be temporarily taken out of service. CONTRACTOR shall perform the Work with due regard to the need of CITY for continuance of operations and in accordance with sequencing required in the Contract Documents, and in accordance with Section 01 14 16, Coordination with CITY's Operations. Submit testing procedures and schedules and obtain acceptance by ENGINEER prior to starting testing and related Work.

3.5 INSTALLATION

A. Provide personnel protective equipment labels in accordance with Section 26 05 53, Identification for Electrical Systems.
   1. Supplier Services: Provide training for CITY's operation and maintenance personnel in personnel protection equipment. Provide at least eight hours of training, in accordance with Section 01 79 23, Instruction of Operations and Maintenance Personnel.

+ + END OF SECTION + +

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SECTION 26 22 14

DRY-TYPE LOW-VOLTAGE DISTRIBUTION TRANSFORMERS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment and incidentals as shown, specified, and required to furnish and install dry type low-voltage distribution transformers.

B. Related Sections:
   1. Section 26 05 05, General Provisions for Electrical Systems.
   2. Section 26 05 26, Grounding and Bonding for Electrical Systems.
   3. Section 26 05 53, Identification for Electrical Systems.

1.2 REFERENCES

A. Standards referenced in this Section are:
   1. NEMA ST-20, Dry Type Transformers for General Applications.
   2. NEMA TP-1, Guide for Determining Energy Efficiency for Distribution Transformers.
   3. NEMA TP-2, Standard Test Method for Measuring the Energy Consumption for Distribution Transformers.
   4. UL 1561, Dry Type General Purpose and Power Transformers.

1.3 QUALITY ASSURANCE

A. Regulatory Requirements:
   1. NEC Article 450, Transformers and Transformer Vault (Including Secondary Ties).

1.4 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Shop Drawings:
      a. Schedule of transformers to be furnished with ratings and other required technical data.
      b. Proposed location for each transformer, including pad layout, dimensions, and appurtenances.
   2. Product Data:
      a. Supplier’s technical information for transformers proposed for use.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Dry Type Two-Winding Transformer:
   1. Type: Dry type, air cooled, low temperature rise. Transformers 15 kVA and larger shall be energy efficient, complying with NEMA TP-1 Class 1 efficiency levels. Transformers less than 15 kVA shall be general purpose.
   2. Rating: KVA, primary voltage and connection, secondary voltage and connection, frequency and number of phases shall be as shown on the Drawings.
   3. Insulation: Insulation and average winding temperature rise (in a 40 degree C maximum ambient) for rated kVA per the following table. Energy efficient transformers shall be capable of 15 percent continuous overload at 150 degrees C temperature rise.

kVA Rating	Insulation Class (degrees C)	Temperature Rise (degrees C)
1 to 15 kVA	185	115
25 to 500 kVA	220	115

   4. Winding Taps, Transformers 15 kVA and Less: Two 5-percent below rated voltage, full capacity taps on primary winding.
   5. Winding Taps, Transformers 25 kVA and Larger: Two 2-1/2-percent above rated voltage and four 2-1/2+ percent below rated voltage, full capacity taps on primary.
   6. Basic impulse level shall be 10 kV.
   7. Sound Level: NEMA ST-20 standard.
   8. Enclosure: UL listed for the application.
   9. Identification: Identify transformers in accordance with Section 26 05 53, Identification for Electrical Systems, with the transformer number and voltages, connection data, kVA ratings, impedance, and overload capacity.
   10. Transformers shall comply with NEMA ST-20, NEMA TP-1, NEMA TP-2, and UL 1561.
   11. Transformers shall bear the label of the Underwriters' Laboratories, Inc.

B. Non-Linear Load, K Factor Rated Transformer:
   1. K Factor rated transformers shall meet the requirements specified in this Section for dry-type two-winding transformers and, in addition, the following:
      a. Type: 100 percent non-linear rated, specifically designed to handle non-linear loads with double size neutral. Transformer shall include an electrostatic shield grounded to the transformer core.
      b. UL K Factor: K = 13.
      c. Impedance: Three percent minimum, five percent maximum.

C. Dry Type Buck and Boost Transformer:
   1. Buck and boost transformers shall meet the requirements specified in this Section for dry-type two-winding transformers, except as specified below:
      a. Insulation and average winding temperature rise for rated kVA as follows:

kVA Rating	Insulation Class (degree C)	Temperature Rise (degree C)
0.25 to 2 kVA	185	115
3 to 7.5 kVA	185	115

D. Dry Type Shielded Isolation Transformer:
   1. Shielded isolation transformers shall meet the requirements specified in this Section for dry-type two-winding transformers, except as specified below:
      a. Transformers shall be provided with quality, full width electrostatic shields in a maximum effective coupling capacitance between primary and secondary of 33 picofarads. With transformers connected under normal, loaded operating conditions, the attenuation of line noise and transients shall equal or exceed the limits listed in the table in Paragraph 2.1.D.1.b of this Section.
      b. Common mode noise attenuation:

Frequency	Attenuation
0 to 1.5k Hz	120 db
1.5 k Hz to 10k Hz	90 db
10 k Hz to 100k Hz	65 db
100 k Hz to 1M Hz	40 db

      c. Transverse mode noise attenuation:

Frequency	Attenuation
1.5 to 10k Hz	52 kb
10 to 100k Hz	30 db
100k to 1M Hz	30 db

      d. Provide electrostatic shield between the primary and secondary winding and grounded to the transformer core.
      e. Isolate core and coil from enclosure using vibration absorbing mounts.

E. Manufacturers: Provide products of one of the following:
   1. Cutler-Hammer.
   2. General Electric Company.
   3. Square D Company.
   4. Siemens.
   5. Or equal.

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine the conditions under which the dry type transformers are to be installed and notify ENGINEER in writing of conditions detrimental to the proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install transformers on walls or floors at locations shown. Install floor mounted transformers on raised concrete bases. Provide sufficient access and working space for convenient and safe operation and maintenance.

B. Mount transformers so that vibrations are not transmitted to the building structural parts and other equipment. Make connections to transformers with flexible conduit.

C. Adjust tap settings to provide proper voltage at panelboards.

D. Install dry type transformers in conformance with governing codes and manufacturer's instructions and recommendations, and the Contract Documents.

+ + END OF SECTION + +

SECTION 26 24 13

SWITCHBOARDS

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment, services, and incidentals as shown, specified, and required to furnish and install switchboards.

B. Related Sections:
   1. Section 40 05 96, Vibration, Seismic and Wind Controls.
   2. Section 26 05 53, Identification for Electrical Systems.
   3. Section 26 05 73, Electrical Power Distribution System Studies.
   4. Section 26 43 00, Surge Protective Devices.

1.2 REFERENCES

A. Standards referenced in this Section are:
   1. NEMA PB2, Dead-Front Distribution Switchboards.
   2. UL 891, Dead-Front Switchboards.

1.3 QUALITY ASSURANCE

A. Qualifications:
   1. Manufacturer: Shall have not less than five years experience manufacturing and servicing materials and equipment substantially similar to those required and upon request shall submit documentation of not less than five installations in satisfactory operation for at least five years each.
   2. Manufacturer shall manufacture circuit protective devices within the assembly.

B. Component Supply and Compatibility:
   1. Obtain all materials and equipment included in this Section regardless of component manufacturer from a single switchboard manufacturer.
   2. Switchboard manufacturer shall review and approve or prepare all Shop Drawings and other submittals for all components furnished under this Section.
   3. Components shall be suitable for the specified service conditions and shall be integrated into overall assembly by switchboard manufacturer.

C. Regulatory Requirements: Comply with the following:
   1. NEC Article 408, Switchboards and Panelboards.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Shop Drawings:
      a. Three-line diagrams.
      b. Dimensional information including front view elevation and plan view.
      c. Construction details of enclosures with conduit entry locations and connection details between assemblies.
      d. Components list and nameplate schedule.
      e. Summary sheets with schedules of equipment.
      f. Key interlock scheme and sequence of operation.
   2. Product Data:
      a. Manufacturer’s technical information, including catalog information.
      b. Manufacturer's technical specifications with assembly and component ratings.
      c. Time current curves for protective devices.
   3. Testing Plans, Procedures, and Testing Limitations:
      a. At least thirty days prior to factory testing, submit description of proposed factory testing methods, procedures, and apparatus.
      b. At least thirty days prior to field testing, submit description of proposed testing methods, procedures, and apparatus.

B. Informational Submittals: Submit the following:
   1. Certificates:
      a. Certifications required in this Section, including seismic requirements.
   2. Source Quality Control Submittals:
      a. Report of results of testing and inspections performed at manufacturer’s shop.
   3. Site Quality Control Submittals:
      a. Report of results of field testing.
   4. Supplier Reports:
      a. Submit written report of results of each visit to Site by Supplier’s service technician, including purpose and time of visit, tasks performed, and results obtained. Submit within two days of completion of visit to the Site.
   5. Qualifications Statements:
      a. Manufacture, when requested by ENGINEER.

C. Closeout Submittals: Submit the following:
   1. Operations and Maintenance Data:
      a. Submit in accordance with Section 01 78 23, Operations and Maintenance Data.

b. Include acceptable test reports, maintenance data and schedules, description of operation, wiring diagrams, and list of spare parts recommended for one year of operation with current price list.
c. Include record drawings of control schematics, with point-to-point wiring diagrams.

1.5 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Delivery:
1. Upon delivery, check for evidence of water that may have entered equipment during transit.

B. Handle equipment in accordance with manufacturer's instructions. One copy of these instructions shall be furnished with equipment at time of delivery.

C. Storage:
1. Store switchboards equipment in a clean, dry location with controls for uniform temperature and humidity. Protect equipment with coverings and maintain environmental controls.

PART 2 – PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Provide equipment of one of the following:
1. Eaton/Cutler-Hammer.
2. General Electric.
3. Schneider Electric/Square D Company.
4. Or equal.

2.2 SWITCHBOARD EQUIPMENT

A. Ratings:
1. Switchboard shall be 600-volt class, suitable for operation on three-phase, 60-Hertz system.
2. System operating voltage, number of wires, bus ampacity, and short circuit withstand capability and interrupting rating shall be as shown on the Drawings, or as otherwise indicated in the Contract Documents.

B. General:
1. Switchboards, as-noted, shall be dead-front type with individual and group-mounted devices, front-accessible.

2. Arrange switchboards with number of sections and compartments required for distribution arrangement shown.

3. Provide switchboard in accordance with the arrangement shown on the Drawings. Switchboard shall consist of bus system, structure, circuit breakers, metering, surge protective device (SPD), and enclosure.
4. Switchboards shall be in accordance with NEMA PB2, UL 891, and NEC Article 408.
5. Switchboard shall be service entrance type and UL-labeled as such. Equip service entrance switchboards with bonding jumper to bond enclosure and ground bus to the neutral bus, and a barrier to isolate service bus bars and terminals.

C. Bus Bars:
1. Switchboard bus bars shall be tin-plated copper, supported with high-impact, non-tracking insulating material. Secure bus joints with Belleville type washers, and braced bus joints for mechanical forces exerted during short circuit conditions. Mount main horizontal bus bars with all three phases arranged in the same vertical plane.
2. Bus bar sizes shall be based upon a maximum temperature rise of 65 degrees C over a 40-degree C ambient in accordance with NEMA PB2 and UL 891.
3. Provide copper ground bus, minimum size of 1/4-inch by two inches, secured to each vertical section and extending entire length of equipment. Ground bus current capacity shall equal one-half the capacity of main power bus.
4. Conductor hardware shall be high-tensile strength and zinc-plated. Provide bus joints with conical spring-type washers.

D. Structure:
1. Equipment structure shall be completely self-supporting and shall include required number of vertical sections bolted together to form a single metal-enclosed enclosure.
2. Enclosure shall be rated NEMA 1.
3. Enclosure structure frame shall be die-formed, 12-gauge steel bolted together and reinforced.
4. Equipment shall have identifying nameplates in accordance with Section 26 05 53, Identification for Electrical Systems. Provide nameplates for each breaker circuit and provide typewritten directory of circuits.
5. Cover sides and rear of enclosure with removable, bolt-on covers. Edges of front covers or hinged front panels shall be formed. Provide adequate ventilation within enclosure.
6. Sections of switchboard shall be front- and rear-aligned with depth as shown on the Drawings. Devices shall be front-removable and load connections shall be front-accessible.
7. Provide assembly with adequate lifting means so that assembly is capable of being moved to its installation position.
8. Conduit entry and exit shall be bottom entry and coordinated by CONTRACTOR.

9. Quantity of conduits and cables associated with each feeder shall be as shown or indicated on the Drawings.

E. Circuit Breakers:
1. Circuit breakers shall be molded case type with quantity of poles, voltage, and current ratings shown.
2. Breakers shall be manually-operated thermal magnetic type, including inverse-time overload and instantaneous short-circuit protection. Contacts shall be non-welding silver alloy and arc extinction shall be accomplished by arc chutes.
3. Breakers shall be operated by a toggle-type handle and shall have quick-make/quick-break over-center switching mechanism that is mechanically trip-free. Automatic tripping of breakers shall be clearly indicated by handle position.
4. Where shown or required due to capacity, breakers shall be insulated case type. Insulated case breakers shall be manually-operated with stored energy mechanisms. Breakers shall include open-close pushbuttons, five-cycle close time, and rotary operated stored energy handle mechanism providing quick make/quick-break protection.
5. Breakers shall have 100-amp frames, minimum. Provide overload protection on all poles, with trip settings as shown. Breakers with frame sizes 250 amps and below shall have thermal-magnetic trip units and inverse time-current characteristics, or equal.
6. Provide breakers 400-amp frame and larger with an electronic solid state programmable trip unit. For four-wire power systems and circuits, provide a neutral current transformer, and trip unit shall be suitable to accept neutral input. Provide push-to-trip button on front of circuit breaker to provide local manual means of exercising trip mechanism. Electronic trip system shall include:
   a. Plug-in protection programmer, flux shift trip device, and current sensor package. Construct programmer, sensor, and flux-shifting trip device as integral elements of breaker, requiring no externally mounted assemblies for proper operation.
   b. Solid state, microprocessor-based, nine-function programmer shall provide true RMS current sensing and include adjustable continuous and instantaneous current elements with adjustable long time, short time, zero sequence ground fault pickup and delay and zone selective interlocking. Main, tie and feeder circuit breakers shall be connected for zone selective interlocking to allow instantaneous bus protection.
7. Where shown, provide breakers with shunt trips, bell alarms, and auxiliary devices.

F. Provide main meter device as shown on the Drawings, and in accordance with the following.
1. Type 1 Microprocessor-based Monitoring Device:

a. Device shall provide complete electrical metering in one package. Device shall include self-contained potential transformers and self-protected internal fuses.
b. Mount device on compartment door to allow personnel access to meter menu and display.
c. Device shall include trend analysis, event logging, and recording. Device shall include the following direct reading metered values:

1) Volts:	0.2 percent accuracy.
2) Amperes:	0.2 percent accuracy
3) Watts, Vars, and VA:	0.5 percent accuracy
4) Power Factor:	1.0 percent accuracy
5) Frequency:	0.05 percent accuracy
6) Watts, and VA Hours:	0.5 percent accuracy
7) Var Hours:	1.0 percent accuracy
8) Watts, Var, and VA Demand:	0.4 percent accuracy
9) THD-Voltage:	50th harmonic
10) THD-Current:	50th harmonic
11) Individual Ampere Harmonics:	50th harmonic
12) Individual Voltage Harmonics:	50th harmonic

d. Metering device shall have the following additional features:
   1) Trend analysis that shall display minimum and maximum values for each metered parameter with date and time of each occurrence.
   2) Input range of device shall accommodate external current transformers with ranges from 100/5 to 5000/5 and potential transformers from a ratio of 120:120 to 500,000:120. Three current transformers suitably rated shall be included.
   3) Alarm contacts rated five amps at 120 vac.
   4) Three analog outputs programmable to reflect the metered parameters, except kilowatt hours and kilovar hours.
   5) Communication capability, using RS-485, Modbus RTU Protocol or Ethernet as indicated on the Drawings

2. Control power shall be drawn from the monitored incoming AC line. Device shall have non-volatile memory and not require battery backup. During power failure, device shall retain preset parameters.

G. Wiring/Terminations:
1. Provide small wiring, necessary fuse blocks, and terminal blocks in switchboard as required. Control components mounted in assembly, such as fuse blocks, relays, pushbuttons, switches, and other components, shall be suitably marked for identification corresponding to appropriate designations on manufacturer's wiring diagrams.
2. Provide mechanical-type terminals for all line and load terminations suitable for copper or aluminum cable rated for 75 degrees C of size indicated on the Drawings.

3. Provide lugs in incoming line section for connection of main grounding conductor. Provide additional lugs for connection of other grounding conductors as indicated on Drawings.
4. Control wire shall be Type SIS, bundled and secured with nylon ties. Provide insulated locking spade terminals for all control connections, except where saddle type terminals are provided integral to a device. Current transformer secondary leads shall first be connected to conveniently accessible short-circuit terminal blocks before connecting to another device. Provide groups of control wires leaving switchboard with terminal blocks with suitable numbering strips. Provide wire markers at each end of all control wiring.

H. Accessories:
1. Provide a surge protective device in accordance with Section 26 43 00, Surge Protective Devices, for each switchboard bus shown or indicated on the Drawings. Each surge protective device shall be included and factory-mounted within switchboard-by-switchboard manufacturer. Surge protective device monitoring and display shall be visible from switchboard front.

I. Miscellaneous Devices:
1. Provide control power transformers with primary and secondary protection, as indicated on the Drawings or as required for proper operation of equipment.

J. Finishing:
1. Exterior and interior steel surfaces of switchboard shall be properly cleaned and provided with rust-inhibiting phosphatized coating by switchboard manufacturer. Color and finish of switchboard shall be light gray.

2.3 SOURCE QUALITY CONTROL

A. Tests:
1. Factory-test switchboards in accordance with NEMA PB2 and UL 891
2. Perform factory tests on equipment prior to shipment. Tests shall consist of the manufacturer's standard tests, and shall include:
   a. Physical inspection and checking of all components.
   b. Operation and device function tests under simulated service conditions to verify accuracy of wiring and functioning of all equipment.
   c. Primary, control, and secondary wiring hi-pot tests.

PART 3 – EXECUTION

3.1 INSPECTION

A. Examine conditions under which materials and equipment will be installed and notify ENGINEER in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions are corrected.

3.2 INSTALLATION

A. Install equipment so that sufficient access and working space is provided for ready and safe operation and maintenance.

B. Install equipment on concrete pad, as shown. Coordinate pad dimensions to fit equipment furnished.

C. Install in accordance with Laws and Regulations, manufacturer's recommendations, and the Contract Documents. Do not energize equipment without permission of CITY and ENGINEER.

3.3 FIELD QUALITY CONTROL

A. Site Tests:
   1. After installation, inspect and perform field testing of each switchboard. Testing and inspections shall by Supplier's factory-trained representative, in accordance with manufacturer's recommendations. Inform CITY and ENGINEER when Supplier's representative indicates that equipment is correctly installed.
   2. Perform the following tests and checks before energizing equipment:
      a. Verify proper installation.
      b. Inspect all mechanical and electrical devices for proper operation.
      c. Check tightness of bolted connections.
      d. Measure insulation resistance of each bus section, phase-to-phase and phase-to-ground.
      e. Measure insulation resistance of each circuit breaker, pole-to-pole and from pole-to-ground.
      f. Check for proper anchorage, required area clearances, physical damage, and proper alignment.
      g. Clean and lubricate as required.
      h. Perform other tests and adjustments recommended by equipment manufacturer.

B. Manufacturer's Services: Provide services of qualified, factory-trained serviceman to perform the following:
   1. Instruct CONTRACTOR in installing equipment.
   2. Inspect and adjust equipment after installation and ensure proper operation.

3. Instruct operations and maintenance personnel in operation and maintenance of the equipment.
4. Manufacturer's technician shall make visits to the Site as follows:
   a. First visit shall be for instructing CONTRACTOR in proper equipment installation, and assisting in installing equipment. Minimum number of hours on-Site: 8 hours.
   b. Second visit shall be for checking completed installation, start-up of system; and performing field quality control testing. Minimum number of hours on-Site: 4 hours.
   c. Third visit shall be to instruct operations and maintenance personnel.
      1) Furnish services of manufacturer's qualified, factory-trained specialists to instruct CITY's operations and maintenance personnel in recommended operation and maintenance of equipment.
      2) Training requirements, duration of instruction and qualifications shall be in accordance with Section 01 79 23, Instruction of Operations and Maintenance Personnel.
      3) Number of hours on-Site shall be in accordance with Section 01 79 23, Instruction of Operations and Maintenance Personnel.
   d. Technician shall revisit the Site as often as necessary until installation is acceptable.
5. All costs, including expenses for travel, lodging, meals and incidentals, and cost of travel time, for visits to the Site shall be included in the Contract Price.

3.4 ADJUSTING

A. Calibrate, set and program protective devices. Coordinate the protective devices furnished under this Section and provide proper settings of devices per the results of the study specified in Section 26 05 73, Electrical Power Distribution System Studies.

+ + END OF SECTION + +

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SECTION 26 24 16

PANELBOARDS

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install panelboards.

B. Related Sections:
   1. Section 26 05 05, General Provisions for Electrical Systems.
   2. Section 26 05 53, Identification for Electrical Systems.
   3. Section 26 22 14, Dry-Type Low-Voltage Distribution Transformers
   4. Section 26 43 00, Surge Protective Devices.

1.2 REFERENCES

A. Standards referenced in this Section are:
   1. NEMA PB 1, Panelboards.
   2. UL 67, Panelboards.

1.3 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Shop Drawings:
      a. Listing of panelboards to be furnished with identification of their proposed location, and all electrical characteristics, including number and rating of branch circuit breakers and enclosure type.
   2. Product Data:
      a. Manufacturer's technical information for panelboards proposed for use, including product literature and specifications. Indicate options and features to be provided.

1.4 QUALITY ASSURANCE

A. Regulatory Requirements; Comply with the following:
   1. NEC Article 408, Switchboards and Panelboards.

1.5 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Packing, Shipping, Handling, and Unloading:
   1. Packing:

a. Inspect prior to packing to assure that assemblies and components are complete and undamaged.
b. Protect mating connections.
c. Cover all openings into enclosures with-vapor inhibiting, water-repellent material.

2. Deliver materials and equipment to Site to ensure uninterrupted progress of the Work. Deliver anchorage materials to be embedded in concrete in ample time to prevent delaying the Work. Upon deliver, check materials and equipment for evidence of water that may have entered equipment during transit.
3. Comply with Section 01 65 00, Product Delivery Requirements.

B. Storage and Protection:
1. Store panelboards in a clean, dry location with controls for uniform temperature and humidity. Protect equipment with coverings and maintain environmental controls.
2. Comply with Section 01 66 00, Product Storage and Handling Requirements.

PART 2 – PRODUCTS

2.1 MATERIALS

A. Panelboards:
1. Manufacturers: Provide products of one of the following:
a. General Electric Company.
b. Eaton/Cutler-Hammer.
c. Schneider Electric/Square D Company.
d. Or equal.
2. Rating: Voltage rating, current rating, number of phases, number of wires and number of poles as shown or indicated on the Drawings.
3. Circuit Breakers: Molded case, bolt-in thermal magnetic type with number of poles and trip ratings as shown or indicated. Where indicated on the Drawings, circuit breakers shall be ground fault circuit interrupting type equipped with solid state sensing and five-milliamp sensitivity.
4. Circuit breakers for 480-volt panelboards shall have minimum interrupting rating of 14,000 ampere RMS symmetrical, unless otherwise indicated on the Drawings. Circuit breakers for other panelboards shall have minimum interrupting rating of 10,000 ampere RMS symmetrical, unless otherwise indicated on the Drawings.
5. Bus Bars: Bus bars shall be 98 percent conductivity copper. Four-wire panelboards shall have solid neutral bar. Each panel shall have ground bus bar.
6. Main: Panelboards shall have main circuit breaker, unless the Drawings specifically indicate main lugs only.
7. Connect branch circuit breakers for sequence phasing.
8. .Enclosures: Panel enclosures shall be as required for the area classifications indicated in Section 26 05 05, General Provisions for Electrical Systems, unless otherwise indicated on the Drawings.

9. Construction: Code-grade steel, ample gutter space, flush door, flush snap latch and lock. Panelboards shall comply with NEMA PB 1 and UL 67.
10. Trim: Surface or flush as required.
11. Directory: Typed or computer-printed card, with transparent protective cover in frame on back of door giving circuit numbers and area or equipment served.
12. Identification: Identify panelboards in accordance with Section 26 05 53, Identification for Electrical Systems. Identification shall indicate panel number and voltage.
13. Directory of Existing Panelboards: When adding or removing breakers or loads from existing panelboards, provide a new typed or computer-generated directory card, indicating the circuit numbers and equipment served.
14. Provide surge protective device in accordance with Section 26 43 00, Surge Protective Devices, for each panelboard shown or indicated on the Drawings. Surge protective device shall be included and factory-mounted within panelboard by panelboard manufacturer. Surge protective device monitoring and display shall be visible from front of panelboard.

B. Integrated Panelboard and Transformer:
1. Products and Manufacturers: Provide products of one of the following:
   a. Mini-Power Zone by Schneider Electric/Square D Company.
   b. Mini-Power Center by Eaton/Cutler-Hammer.
   c. Panel Tran by Acme Electric Corporation.
   d. Or equal.
2. General: Unit shall consist of encapsulated dry-type transformer, primary and secondary main circuit breakers, and secondary panelboard all in one enclosure.
3. Transformer Rating: Transformer portion shall comply with Section 26 22 14, Dry-type Low-Voltage Distribution Transformers. KVA, primary voltage, secondary voltage, frequency and number of phases shall be as shown or indicated on the Drawings.
4. Branch Circuits: Molded case circuit breakers, plug-in thermal magnetic type with number of poles and trip ratings as shown or indicated on the Drawings.
5. Enclosure: Enclosures shall be as required for the area classifications indicated in Section 26 05 05, General Provisions for Electrical Systems, unless otherwise indicated on the Drawings.

PART 3 – EXECUTION

3.1 INSPECTION

A. Examine conditions under which the Work is to be installed and notify ENGINEER in writing of conditions detrimental to the proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions are corrected.

3.2 INSTALLATION

A. Mounting: Install panelboards at locations shown or indicated. Set cabinets so that top branch circuit breaker is not over six feet above the floor.

B. Directory: Complete typewritten or computer-printed directory indicating items controlled by each circuit breaker and the size of feeder serving the panel.

C. Arrange circuits to balance the loads on the panelboards.

D. Identify panelboards in accordance with Section 26 05 53, Identification for Electrical Systems.

E. Install in accordance with Laws and Regulations, manufacturer's recommendations, and the Contract Documents. Verify proper installation prior to energizing panelboards.

+ + END OF SECTION + +

SECTION 26 27 26.13

LOW-VOLTAGE RECEPTACLES

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install low-voltage receptacles.

B. Related Sections:
   1. Section 26 05 05, General Provisions for Electrical Systems.
   2. Section 26 05 53, Identification for Electrical Systems.
   3. Section 26 05 33.36, Outlet Boxes.

1.2 REFERENCES

A. Standards referenced in this Section are:
   1. UL 498, Standard for Attachment Plugs and Receptacles.
   2. UL 514D, Cover Plates for Flush-Mounted Wiring Devices.
   3. UL 943, Standard for Ground-Fault Circuit-Interrupters.
   4. UL 1010, Standard for Receptacle-Plug Combinations for Use in Hazardous (Classified) Locations.
   5. UL 1449, Standard for Surge Protective Devices.

1.3 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with the following:
   1. Americans with Disabilities Act.
   2. NEC Article 406, Receptacles, Cord Connectors, and Attachment Plugs (Caps).

1.4 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Product Data: Manufacturer's technical information for receptacles and cover plates proposed for use.

PART 2 – PRODUCTS

2.1 MATERIALS

A. Receptacles:
   1. Grounding receptacle, two-pole, three-wire, NEMA 5-20R configuration, ivory color.
      a. Single:
         1) Products and Manufacturers: Provide one of the following:
            a) HBL5361I by Hubbell, Inc.
            b) 5361-I by Pass & Seymour.
            c) Or equal.
      b. Duplex:
         1) Products and Manufacturers: Provide one of the following:
            a) HBL5362I by Hubbell, Inc.
            b) PS5362-I by Pass & Seymour.
            c) Or equal.
      c. Weather-resistant Duplex:
         1) UL-listed as weather-resistant.
         2) Products and Manufacturers: Provide one of the following:
            a) HBL5362IWR by Hubbell, Inc.
            b) WR5362-I by Pass & Seymour.
            c) Or equal.
   2. Corrosion-resistant grounding receptacle, two-pole, three-wire, yellow color.
      a. Single, 125-volt, 20 ampere, NEMA 5-20R configuration:
         1) Products and Manufacturers: Provide one of the following:
            a) HBL53CM61 by Hubbell, Inc.
            b) CR6301 by Pass & Seymour.
            c) Or equal.
      b. Duplex, 125-volt, 20 ampere, NEMA 5-20R configuration:
         1) Products and Manufacturers: Provide one of the following:
            a) HBL53CM62 by Hubbell, Inc.
            b) CR6300 by Pass & Seymour.
            c) Or equal.
      c. Single, 125-volt, 30 ampere, NEMA 5-30 configuration:
         1) Products and Manufacturers: Provide one of the following:
            a) HBL9308 by Hubbell, Inc.
            b) 3802 by Pass & Seymour.
            c) Or equal.
   3. Grounding receptacle, two-pole, three-wire, 250-volt, 20 ampere, NEMA 6-20 configuration, brown color.
      a. Single:
         1) Products and Manufacturers: Provide one of the following:
            a) HBL5461 by Hubbell, Inc.
            b) 5871 by Pass & Seymour.
            c) Or equal.
      b. Duplex:

1) Products and Manufacturers: Provide one of the following:
   a) HBL5462 by Hubbell, Inc.
   b) 5862 by Pass & Seymour.
   c) Or equal.

4. Provide Type 302 stainless steel cover-plate conforming to UL 514D. Provide weatherproof-while-in-use cover where shown on the Drawings as "WP" or "WPU" or "WPWIU", and provide where receptacles are located in wet or corrosive location.
5. Receptacles shall comply with UL 498.

B. Receptacles for Hazardous Locations:
1. Material: Factory-sealed receptacle suitable for installation in Class I, Group D hazardous locations. Copper-free aluminum receptacle and cover with cast gray iron alloy or cast malleable iron mounting box with zinc electroplate finish. Receptacle rated at 20 amperes, 125 to 250 volts AC, two-wire, and three-pole. Provide matching plug for each receptacle.
2. Receptacles for hazardous locations shall conform to UL 1010.
3. Products and Manufacturers: Provide one of the following:
   a. Series CPS by Crouse-Hinds Company.
   b. Type CPS by Appleton Electric Company.
   c. Or equal.

C. Ground Fault Interrupting Receptacles:
1. Duplex grounding receptacle, two-pole, three-wire, NEMA 5-20R configuration, 125-volt AC, 20 amperes, gray color with ground fault circuit interrupting (GFCI) protection.
2. Ground fault interrupting receptacles shall comply with UL 943.
3. Provide Type 302 stainless steel cover-plate conforming to UL 514D. Provide weatherproof-while-in-use cover where shown on the Drawings as "WP" or "WPU" or "WPWIU", and provide where located in wet or corrosive location.
4. Products and Manufacturers: Provide one of the following:
   a. GFR5362SGY by Hubbell, Inc.
   b. 2091-GRY by Pass & Seymour.
   c. Or equal.
5. Weather-resistant Ground Fault Interrupting Receptacles
   a. Products and Manufacturers: Provide one of the following:
      1) 2095TRWRGRY by Pass & Seymour.
      2) Or equal.

D. Surge Suppression Receptacles:
1. Duplex grounding, surge suppression receptacle, two-pole, three-wire, NEMA 5-20R configuration 125-volt AC, 20 amperes, blue color, capable of absorbing transient surge of 6,000 volts minimum. Receptacle shall include power-on indicator light.
2. Surge suppression receptacles shall comply with UL 1449.

3. Provide Type 302 stainless steel cover-plate conforming to UL 514D. Provide weatherproof-while-in-use cover when shown on the Drawings as "WP" or "WPU", and provide where located in a wet or corrosive location.
4. Products and Manufacturers: Provide one of the following:
   a. HBL5362SA by Hubbell, Inc.
   b. 5362BLSP by Pass & Seymour.
   c. 5380-GY by Leviton Manufacturing Company.
   d. Or equal.

E. Weatherproof Covers:
1. Where receptacles are installed in damp locations as defined in area classification portion of Section 26 05 05, General Provisions for Electrical Systems, provide receptacles as specified in Paragraphs 2.1.A through 2.1.D of this Section, as applicable, with weatherproof covers as specified below.
2. Provide covers that are UL-listed weatherproof and suitable for use in damp locations in accordance with NEC 406.
3. Material:
   a. Gasketed spring door type for wet and corrosive locations. Plates in corrosive locations shall have factory-applied 40-mil PVC coating.
   b. Stainless steel screws and hardware.
4. Products and Manufacturers: Provide one of the following:
   a. Hubbell, Inc.
   b. Crouse-Hinds Company.
   c. Appleton Electric Company.
   d. Or equal.

F. Weatherproof-While-in-Use Covers:
1. Where receptacles are shown on the Drawings as "WP" or "WPU", and where receptacles are installed in wet locations as defined in area classification portion of Section 26 05 05, General Provisions for Electrical Systems, provide receptacles as specified in Paragraphs 2.1.A through 2.1.D of this Section, as applicable, with weatherproof-while-in-use covers as specified below.
2. Provide covers that are UL-listed, weatherproof while receptacle is in use, and are of ultraviolet-resistant construction suitable for outdoor use in accordance with NEC 406.
3. Material:
   a. Non-metallic box with hinged, non-metallic cover.
   b. Sealing gaskets between box and cover.
   c. Stainless steel screws and hardware.
   d. Color: Gray finish
4. Products and Manufacturers: Provide one of the following:
   a. TayMac Corporation.
   b. Pass and Seymour Type WIU
   c. Or equal.

G. Power Receptacles: 480-volt interlocked receptacle with enclosed safety switch service outlet. Provide service outlets, quantity as shown or indicated, for portable equipment.
   1. Material: Copper-free aluminum enclosures with operating handle NEMA 4, with gasketed, hinged door.
   2. Switch: Heavy duty, three-pole, with visible blades, quick make-a-break mechanism with reinforced, positive-pressure-type blade and fuse clips. Switch shall be mechanically interlocked with receptacle. Switch cannot be closed until plug is fully inserted and plug cannot be withdrawn or inserted unless switch is open.

H. Power and Special Receptacles: Provide receptacles with number of poles and voltage and current rating as shown or indicated. Coordinate with equipment plugs. Provide matching plug for each receptacle.

PART 3 – EXECUTION

3.1 INSPECTION

A. Examine conditions under which the Work is to be installed and notify ENGINEER in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions are corrected.

3.2 INSTALLATION

A. Non-hazardous Locations: Install receptacles at locations shown, in outlet or device boxes in accordance with Section 26 05 33.36, Outlet Boxes.

B. Hazardous Locations: Install receptacles in rigid metallic conduit systems.

C. Install receptacles with ground pole in the down position.

D. Mount receptacles 18 inches above finished floor in non-hazardous locations and 4.5 feet above finished floor in hazardous locations, in accordance with the Americans with Disability Act, unless otherwise shown or indicated in the Contract Documents.

E. Install in conformance with Laws and Regulations.

F. Identification:
   1. Identify each conductor with circuit number and lighting panel number in accordance with Section 26 05 53, Identification for Electrical Systems.
   2. Identify each receptacle with permanent phenolic tag. Tags shall include circuit number and lighting panel number.

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SECTION 26 27 26.23

SNAP SWITCHES

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install snap switches for lighting and other systems.

B. Related Sections:
   1. Section 26 05 53, Identification for Electrical Systems
   2. Section 26 05 33.36, Outlet Boxes.

1.2 REFERENCES

A. Standards referenced in this Section are listed below:
   1. UL 20, General Use Snap Switches.
   2. UL 894, Switches for Use in Hazardous (Classified) Locations.

1.3 QUALITY ASSURANCE

A. Regulatory Requirements
   1. Americans with Disabilities Act

1.4 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Product Data: Manufacturer's technical information for switches proposed for use.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Switches for Non-Hazardous Locations:
   1. Single pole AC toggle switch, quiet type, 120/277-volt AC, 20 amperes, Ivory, specification grade.
      a. Products and Manufacturers: Provide one of the following:
         1) Catalog No. 1221-I, by Harvey Hubbel, Inc.
         2) Catalog No. 1991-I, by Arrow-Hart, Inc.
         3) Catalog No. 20AC1-I, by Pass & Seymour

4) Or equal.

2. Single pole, three-way AC toggle switch, quiet type, 120/277-volt AC, 20 amperes, Ivory, specification grade.
   a. Products and Manufacturers: Provide one of the following:
      1) Catalog No. 1223-I, by Harvey Hubbell, Inc.
      2) Catalog No. 1993-I, by Arrow-Hart, Inc.
      3) Catalog No. 20AC3-I, by Pass & Seymour
      4) Or equal.
3. Two-pole AC toggle switch, quiet type, 120/277-volt AC, 20 amperes, Ivory, specification grade.
   a. Products and Manufacturers: Provide one of the following:
      1) Catalog No. 1222-I, by Harvey Hubbel, Inc.
      2) Catalog No. 1992-I, by Arrow-Hart, Inc.
      3) Catalog No. 20AC2-I, by Pass & Seymour
      4) Or equal.
4. Switches in non-hazardous areas shall be UL-listed in accordance with UL 20.

B. Switches for Hazardous Locations:
   1. Material: Factory sealed tumbler switch suitable for installation in Class I, Group D hazardous locations. Cast gray iron alloy or cast malleable iron body and cover with zinc electroplate finish. Switch rated at 20 amperes, 120/277-volt AC.
   2. Switches in hazardous areas shall be UL-listed in accordance with UL 894.
   3. Products and Manufacturers: Provide one of the following:
      a. Series EDS by Crouse-Hinds Company.
      b. Type EDS by Appleton Electric Company.
      c. Or equal.

C. Switch Covers:
   1. Indoor covers shall be Type 304 stainless steel.
   2. Outdoor, wet, or corrosive location covers shall be weatherproof and corrosion resistant.

D. Key Operated On-Off Switches:
   1. Key operated switches shall be complete with legend plate and NEMA 4 enclosure and two keys for each switch.

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine conditions under which the Work is to be installed and notify ENGINEER in writing of conditions detrimental to the proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install switches at locations as shown or indicated in the Contract Documents in outlet or device boxes, in accordance with Section 26 05 33.36, Outlet Boxes.

B. Mount wall switches 4.0 feet above finished floor, in accordance with the Americans with Disability Act, unless otherwise noted.

C. Identify each conductor with circuit number and lighting panel number. Identification shall be in accordance with Section 26 05 53, Identification for Electrical Systems.

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SECTION 26 28 16.33

DISCONNECT SWITCHES

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install disconnect switches.

B. Related Sections:
   1. Section 26 05 05, General Provisions for Electrical Systems.
   2. Section 26 05 53, Identification for Electrical Systems.
   3. Section 26 27 26.23, Snap Switches.

1.2 REFERENCES

A. Standards referenced in this Section are:
   1. UL 98, Enclosed and Dead-Front Switches.
   2. NEMA KS 1, Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum).
   3. NEMA 250, Enclosures for Electrical Equipment (1000 Volts Maximum).

1.3 QUALITY ASSURANCE

A. Regulatory Requirements:
   1. NEC Article 404, Switches.
   2. Disconnect switches shall bear the UL label.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Shop Drawings:
      a. Listing of each switch to be furnished, including location, rating, and NEMA enclosure type for each.
   2. Product Data:
      a. Manufacturer's technical information for disconnect switches proposed for use.

B. Maintenance Material Submittals: Submit the following:
   1. Extra Stock Materials:
      a. Furnish one set of spare fuses for each fused disconnect switch to be installed.

PART 2 – PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Provide products of one of the following:
   1. Square-D Company.
   2. Cutler-Hammer.
   3. General Electric Company.
   4. Siemens.
   5. Or equal.

2.2 MATERIALS

A. Service Disconnect Switches:
   1. Type: Fused, heavy-duty, single throw, quick-make, quick-break mechanism, visible blades in “OFF” position and safety handle.
   2. Rating: Voltage, current and short circuit ratings and number of poles as shown or indicated on the Drawings. Switch shall bear UL label indicating suitability for use as service equipment and shall comply with UL 98, NEMA KS 1, and NEMA 250.
   3. Provide auxiliary dry contacts to indicate switch position where shown on the Drawings.

B. Single Throw, Circuit Disconnect Switches:
   1. Type: Fused or unfused, horsepower rated, heavy-duty, single throw, quick-make, quick-break mechanism, visible blades in the "OFF" position and safety handle.
   2. Rating: Voltage and current ratings and number of poles as required for motor or equipment circuits being disconnected. Switches shall bear a UL label and shall comply with the requirements of UL 98, NEMA KS 1 and NEMA 250.
   3. Provide auxiliary dry contacts to indicate switch position.

C. Double Throw Safety Switches:
   1. Type: Unfused, double throw with center “OFF” position, quick-make, quick-break mechanism, visible blades in the “OFF” position, and safety handle.
   2. Rating: Voltage and current ratings and number of poles as required for circuits being disconnected. Switches shall bear UL label and shall comply with UL 98, NEMA KS 1, and NEMA 250.
   3. Provide auxiliary dry contacts to indicate switch position where shown on the Drawings.

D. Disconnect Switches for 120-volt, Single-phase Circuits:
   1. Refer to Section 26 27 26.23, Snap Switches.

E. Enclosures: NEMA rating shall be as required for area classifications specified in Section 26 05 05, General Provisions for Electrical Systems.

F. Identification:
   1. Identify enclosures in accordance with Section 26 05 53, Identification for Electrical Systems.
   2. Provide nameplate to identify the equipment served by disconnect switch and associated source of power.

PART 3 – EXECUTION

3.1 INSPECTION

A. Examine conditions under which the Work will be installed and notify ENGINEER in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions are corrected.

3.2 INSTALLATION

A. Install equipment so that sufficient access and working space is provided for ready and safe operation and maintenance.

B. Securely fasten equipment to walls or other structural supports on which they are mounted. Provide independent stainless steel supports where no wall or other structural surface exists. Mount disconnect enclosures at a height not exceeding six feet.

C. Provide suitable 1/4-inch spacers to prevent mounting enclosure directly against walls.

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SECTION 26 28 17

ENCLOSED CIRCUIT BREAKERS

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment and incidentals required to furnish and install molded-case thermal magnetic circuit breakers each in NEMA-rated enclosure with size and trip rating as shown or specified.

B. Coordination:
   1. Review installation procedures under other Sections and coordinate installation of items to be installed with or before enclosed circuit breakers Work.

C. Related Sections:
   1. Section 26 05 05, General Provisions for Electrical Systems.
   2. Section 26 05 29, Hangers and Supports for Electrical Systems.
   3. Section 26 05 53, Identification for Electrical Systems.
   4. Section 26 05 73, Electrical Power Distribution System Studies.

1.2 REFERENCES

A. Standards referenced in this Section are:
   1. NFPA 70, National Electrical Code.
   2. NEMA AB 1, Molded-case Circuit Breakers
   3. UL 50, Enclosures for Electrical Equipment
   4. UL 50E, Enclosures for Electrical Equipment, Environmental Considerations
   5. UL 489, Molded-case Circuit Breakers

1.3 QUALITY ASSURANCE

A. Qualifications:
   1. Manufacturer:
      a. Manufacturer shall have not less than five years of experience producing substantially similar equipment to that required and, upon request, shall submit documentation of not less than five installations in satisfactory operation for not less than five years in the United States.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Shop Drawings:
      a. Outline drawings with dimensions, materials of construction, installation details, accessories, and equipment ratings for voltage, amperage and short-circuit.
   2. Product Data:
      a. Manufacturer's technical information for enclosed circuit breakers proposed for use.

B. Informational Submittals: Submit the following:
   1. Certifications:
      a. Manufacturer's certification of completed installation.
   2. Source Quality Control Submittals:
      a. Results of required source quality control tests and inspections.
   3. Site Quality Control Submittals:
      a. Results of required field quality control tests and inspections.
   4. Qualifications Statements:
      a. Submit manufacturer qualifications when requested by ENGINEER.

C. Closeout Submittals: Submit the following:
   1. Operation and Maintenance Data:
      a. Submit complete installation, operation and maintenance manuals including test reports, maintenance data and schedules, and description of operation.
      b. Recommended Spare Parts and Extra Stock Materials: Include list of additional spare parts or extra stock materials recommended for use with enclosed molded-case circuit breakers. Describe each recommended part, quantity recommended, current unit price, and ordering information.
      c. Comply with Section 01 78 23, Operations and Maintenance Data.

PART 2 – PRODUCTS

2.1 MANUFACTURERS

A. Manufacturer: Provide equipment by one of the following:
   1. Eaton Cutler Hammer
   2. General Electric
   3. Square-D
   4. Or equal

2.2 MATERIAL AND FABRICATION

A. Type:
   1. Breakers shall be molded-case with inverse time and instantaneous tripping characteristics.
   2. Circuit breakers shall be operated by toggle-type handle and shall have a quick-make, quick-break, over-center switching mechanism that is mechanically trip-free. Automatic tripping of circuit breaker shall be clearly indicated by the handle position. Contacts shall be non-welding silver alloy with arc-extinction chutes. Push-to-trip button shall provide local manual means to exercise the trip mechanism.
   3. For frame sizes 250-ampere and above, provide with interchangeable trip unit.
   4. For frame sizes 150-ampere and below, provide with non-interchangeable trip.
   5. Terminations: Provide terminals for accommodating two normal-range copper cables per phase.
   6. Provide auxiliary contact (Form C-10 amp at 240 volts) for remote indication of breaker status.
   7. Enclosed circuit breakers shall be UL-listed and bear the UL label, and shall comply with UL 489 and NEMA AB 1.

B. Interrupting Capacities:
   1. 400-ampere Frame and Above: Minimum 35,000 amperes RMS symmetrical at 480-volt, three-phase, 60 Hertz, or as shown.
   2. 100-ampere, 150-ampere, and 225-ampere Frame: Minimum 22,000 amperes RMS symmetrical at 480-volt, three-phase, 60 Hertz, or as shown.

C. Enclosure:
   1. NEMA type as required in Section 26 05 05 General Provisions for Electrical Systems.
   2. Access Door Interlock: Provide disconnect device to prevent unintentional opening of door while circuit breaker is energized and unintentional application of load power while door is open, with provisions for releasing interlock for intentional access or application of power by authorized personnel.
   3. External operating handle shall be integral part of the associated box, not the door. Operating handle shall have provisions for padlocking in the “OFF” position with door open or closed, and shall include prominent trip indication.
   4. Identification: Provide nameplate identification of circuit breaker in accordance with Section 26 05 53, Identification for Electrical Systems. Identify load side equipment controlled and line side source.
   5. Enclosures shall be UL-listed and comply with UL 50 and UL 50E.

2.3 SOURCE QUALITY CONTROL

A. Tests:
   1. Perform standard factory tests on equipment furnished under this Section. Tests shall be in accordance with applicable NEMA and UL standards.

PART 3 – EXECUTION

3.1 INSPECTION

A. Examine conditions under which the Work will be installed and notify ENGINEER in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions are corrected.

3.2 INSTALLATION

A. Install in accordance with NFPA 70, and Laws and Regulations.

B. Mounting and Installation:
   1. Install equipment to provide sufficient access and working space for ready and safe operation and maintenance. Equipment centerline shall not be less than four feet above finished floor.
   2. Securely fasten equipment to walls or other surfaces on which equipment is mounted. Provide independent supports complying with Section 26 05 29 Hangers and Supports for Electrical Systems, where there is no wall or other surface capable of supporting the equipment.
   3. Provide suitable 1/4-inch spacers to prevent mounting enclosure directly against walls.

C. Adjustments: Perform field adjustments of circuit breakers as required to place equipment in operating condition. Adjustable breaker settings shall be in accordance with the accepted power distribution coordination study prepared under Section 26 05 73, Electrical Power Distribution System Studies, or as directed by ENGINEER.

3.3 FIELD QUALITY CONTROL

A. Field Tests and Inspections:
   1. All test equipment and material shall be by CONTRACTOR.
   2. Perform visual and mechanical inspection including:
      a. Inspect for physical, electrical, and mechanical condition.
      b. Check for proper installation, required area clearances, physical damage and proper alignment.
      c. Check electrical and mechanical interlock systems for proper operation.

d. Clean and lubricate as required.
e. Other testing and inspections recommended by manufacturer.

B. Manufacturer's Services:
1. Provide services of qualified, factory-trained manufacturer's representative to advise CONTRACTOR on installation of the equipment and to check the installed equipment prior to start-up.
2. Qualified factory-trained manufacturer's representative shall certify in writing that equipment has been installed, adjusted, and tested in accordance with manufacturer's recommendations.
3. Furnish services of qualified trained specialist, with minimum of five years experience, from manufacturer to instruct CITY's operations and maintenance personnel in recommended operation and maintenance of the equipment. Training requirements, duration of instruction, and other requirements shall be in accordance with Section 01 79 23, Instruction of Operations and Maintenance Personnel.

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SECTION 26 29 23

LOW-VOLTAGE VARIABLE FREQUENCY DRIVES

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment, services, and incidentals as shown, specified, and required to furnish and install low-voltage variable frequency drives, complete and operational.
   2. Variable frequency drives required under this Section are low-voltage, voltage source inverter, pulse width modulated. Variable frequency drives shall be customized.
   3. Low-voltage variable frequency drives included in this Section are associated with equipment as indicated on the drawings

B. Related Sections:
   1. Section 26 05 29, Hangers and Supports for Electrical Systems.
   2. Section 26 05 53, Identification for Electrical Systems.
   3. Section 26 43 00, Surge Protective Devices.
   4. Section 43 21 13.12 Centrifugal End Suction Pumps Dry Pit (HLPs in PGTB).
   5. Section 43 21 13.23 Centrifugal Axial Split Case Pumps (GFPs in Head House).

1.2 REFERENCES

A. Standards referenced in this Section are:
   1. IEEE 519, Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems.
   2. ISO 9000, Quality Management Systems, Fundamentals and Vocabulary.
   3. ISO 9001, Quality Management Systems, Requirements.
   4. ISO 9002, Quality Systems, Model for Quality Assurance in Production, Installation and Servicing.
   5. NEMA ICS 2, Controllers, Contactors and Overload Relays Rated 600 Volts.
   6. NEMA ICS 7, Industrial Control and Systems Adjustable Speed Drives.
   7. NEMA MG 1, Motor and Generators.
   8. UL 489, Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures.
   9. UL 508, Industrial Control Equipment.

1.3 QUALITY ASSURANCE

A. Qualifications:
   1. Manufacturer:
      a. Low-voltage variable frequency drive manufacturer shall have not less than five years of experience designing and regularly manufacturing and servicing substantially similar equipment to that required, and upon ENGINEER's request shall submit documentation of not less than five installations in satisfactory operation for not less than five years each.
      b. Manufacturer shall be certified under ISO 9000, ISO 9001, or ISO 9002 for materials and equipment specified.
      c. For all required factory tests, low-voltage variable frequency drive manufacturer shall use a factory test facility that has calibrated its testing apparatus in the previous twelve months, and is staffed by qualified, experienced technicians.

B. Component Supply and Compatibility:
   1. Drives specified under this Section employ a low switching frequency or pattern to minimize instantaneous rate of voltage change over time (dv/dt), and the adverse effects of potential bearing currents. Where alternate manufacturers are proposed, obtain manufacturer recommendations regarding bearing currents and provide equipment required at no additional cost to DEPARTMENT.
   2. Each low-voltage variable frequency drive shall be fully compatible with associated driven equipment and motors. Variable frequency drives shall be matched to specific load requirements for each system. Operation of variable frequency drive shall not overstress motor insulation.
   3. To centralize responsibility and to ensure that all equipment is properly coordinated, variable drives specified under this Section shall be obtained from the Supplier of the associated driven equipment.
   4. Similar components of drives associated with each system shall be products of a single manufacturer.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Shop Drawings:
      a. Dimensional information and construction details of enclosures. Enclosure details shall consist of exterior and interior front door with nameplate legends, interior door front and rear views, and terminal block layout.
      b. Three-line power and control schematic diagrams.
      c. Wiring diagrams showing the interconnection of conductors to all devices with terminal assignments for remote devices.
      d. Functional description of system operation.
      e. VFD heat dissipation at full load, including heat rejection/cooling system.

2. Product Data:
    a. Manufacturer's technical specifications.
    b. Manufacturer's catalog cuts and product literature.
3. Testing Plans:
    a. Not less than thirty days prior to source quality control testing, submit descriptions of proposed shop testing methods, procedures, apparatus, and limitations.
    b. Not less than thirty days prior to field quality control testing, submit descriptions of proposed field testing methods, procedures, and apparatus.

B. Informational Submittals: Submit the following:
1. Certificates:
    a. Certification letters from low-voltage variable frequency drive manufacturer and motor manufacturer that the approved driven equipment has been reviewed and that variable frequency drive units and motors are compatible, and shall be provided in accordance with the Contract Documents and requirements of the driven equipment.
2. Source Quality Control Submittals:
    a. Within five days of completing source quality control tests and inspections, submit test results with indication of whether all criteria of the Contract Documents for the specified equipment were met.
3. Field Quality Control Submittals:
    a. Within five days of completing field quality control tests and inspections, submit test results with indication of whether all criteria of the Contract Documents for the specified equipment were met.
4. Manufacturer Reports:
    a. Within five days of each visit to the Site by manufacturer's representative, submit written report of reason for visit, problems encountered, solutions implemented, and remaining work.
5. Qualifications Statements:
    a. Manufacturer, when requested by ENGINEER.

C. Closeout Submittals: Submit the following:
1. Operation and Maintenance Data:
    a. Submit complete installation, operation and maintenance manuals including test reports, maintenance data and schedules, description of operation, list of recommended spare parts, and spare parts ordering information.
    b. Manuals shall include record drawings of control schematics, including point-to-point wiring diagrams.
    c. Include a listing of all programmable drive parameters and their settings at Substantial Completion. Submit parameters as both printed pages in the operations and maintenance manual and in electronic format on compact disc that can be directly uploaded to the drive in event of drive replacement or repair.
    d. Comply with Section 01 78 23, Operations and Maintenance Data.

D. Maintenance Materials Submittals: Submit the following:
   1. Spare Parts and Extra Stock Materials:
      a. Furnish, tag, and box for shipment and long-term storage spare parts and special tools for low-voltage variable frequency drives. Each set of spare parts and tools shall include manufacturer's recommended spare parts inventory for one year and include, at minimum, the following:

Item	**Quantity per Four VFDs per HP Rating**
1) Transistor and diode modules with accessories	One set
2) Power supply module	One
3) Fans	One set
4) Power fuses	One set of each size and type used
5) Control power fuses	Two sets of each size and type used
6) Pilot lights	Two per ten of each type used

      b. Furnish a list of recommended spare parts for an operating period of one year. Describe each part, the quantity recommended, and current unit price.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Packing, Shipping, Handling, and Unloading:
   1. Packing:
      a. Inspect prior to packing to ensure that assemblies and components are complete and undamaged.
      b. Protect mating connections.
      c. Cover all openings into enclosures with-vapor inhibiting, water-repellent material.
      d. Indoor containers shall be bolted to skids.
   2. Upon delivery, check materials and equipment for evidence of water that may have entered equipment during transit.
   3. Handling:
      a. Lift, roll or jack low-voltage variable frequency drive equipment into locations shown.
      b. Variable frequency drives shall be equipped for handling required for installation. Handle equipment in accordance with manufacturer’s requirements.

B. Storage and Protection:
   1. Store low-voltage variable frequency drive equipment in a clean, dry location with controls for uniform temperature and humidity. Protect equipment with coverings and maintain environmental controls.

PART 2 – PRODUCTS

2.1 EQUIPMENT PERFORMANCE

A. System Performance:
   1. Driven equipment to be controlled by a low-voltage variable frequency drive shall be provided with a customized variable frequency drive. Each drive unit shall include an adjustable frequency controller with associated controls for continuous speed adjustment and protection of the driven equipment. Output speed control of motor shall be continuous throughout speed range of two to 60 Hertz under variable torque load or constant torque as specified for the driven equipment.
   2. Low-voltage variable frequency drives associated with each set of driven equipment shall be similar to each other.
   3. Variable frequency drives shall be UL-listed or ETL-listed and designed, built, and tested in accordance with UL 489, NEMA ICS 2, NEMA ICS 7, and UL 508.

2.2 MANUFACTURERS

A. Provide low-voltage variable frequency drives by one of the following:
   1. Allen Bradley, Inc.
   2. Siemens-Robicon Corporation
   3. Danfoss Inc.
   4. Or equal.

2.3 ENCLOSURE

A. Provide each low-voltage variable frequency drive with freestanding, front-access, NEMA 12, filtered and gasketed enclosure. Enclosure shall house all components required for the associated variable frequency drive.

B. Enclosure shall provide adequate cooling for components within and include positive ventilation.

C. Enclosure door shall include an operator interface for access to controller's digital keypad and display.

D. Equip enclosure front with nameplates for identification of equipment and operating functions. Nameplates shall be in accordance with Section 26 05 53, Identification for Electrical Systems.

E. Equip enclosure with phenolic type terminal blocks suitably labeled for all internal and remote wiring requirements, plus twenty percent spare.

2.4 ADJUSTABLE FREQUENCY CONTROLLER

A. General:
   1. Adjustable frequency controller shall be microprocessor-based, pulse width modulated design, suitable for operation on a 480-volt, three-phase supply. Controller shall produce an adjustable AC voltage/frequency output to vary speed of driven equipment. Controller shall consist of the following sections:
      a. Six-pulse diode bridge converter input section.
      b. Fixed DC bus section.
      c. Six-pulse power transistor inverter output section.
   2. Controller switching frequency shall be adjustable and allow operation at 5,000 Hertz or less. Controller technology shall include a switching scheme that reduces the dv/dt of output supply.
   3. Equip controller with a three-percent DC bus reactor or input line reactor.
   4. Controller's solid state converter input section switching devices shall have 1600 volt PIV rating.
   5. Overload rating of 110 percent variable torque, 150 percent constant torque for one minute.
   6. RMS harmonic content of output current shall be less than five percent of fundamental current.
   7. Able to withstand output terminal line-to-line short circuits without component failure.

B. Operating Criteria:
   1. Operating criteria shall be in accordance with the following:
      a. Ambient temperature range of zero to 40 degrees C.
      b. Operational humidity of up to 90 percent non-condensing.
      c. Altitude up to 3,300 feet above sea level.
      d. Nominal voltage of 480-volts plus or minus ten percent, three-phase, three-wire. Include an under-voltage feature to allow trip-free operation down to 35 percent under-voltage.
      e. Nominal frequency of 60 Hertz plus or minus three Hertz.
      f. Input power factor of 95 percent displacement power factor at all operating speeds.
      g. Efficiency of 96 percent at full speed and full load.

C. Features:
   1. Controller shall have the following features:
      a. Digital keypad and display module shall provide parameter setting, adjustments, and monitoring of control functions and faults. Display messages shall be in English.
      b. Serial communication port shall allow connecting to programmable controller interface using manufacturer standard protocol.
      c. Independent acceleration/deceleration rates shall provide two to 600 seconds minimum. When called to stop, motor shall decelerate to minimum speed before stopping.

d. Power loss feature shall allow five cycle ride through capability for input supply interruptions.
e. Time delay automatic restart shall allow restart after controller fault conditions with programmable attempts.
f. Coasting motor restart shall allow controller to restart into a coasting motor without damage or tripping. Coasting motor restart feature shall allow switching from bypass mode to low-voltage variable frequency drive mode while operating, without shutdown.
g. Isolated control inputs and outputs.

D. Protection:
1. Controller shall have protective functions as follows:
a. Input line metal oxide varistor transient surge protective device in compliance with Section 26 43 00.
b. Electronic over-current trip instantaneous and inverse time overload protection with thermal memory retention.
c. Over-temperature trip temperature protection.
d. Current limit trip protection.
e. Input line over- and under-voltage trip protection.

2.7 CONTROLS

A. General:
1. Equip each low-voltage variable frequency drive control system with relays, switches, fuses, indicating lights, and components required for a complete, functional system.
2. Variable frequency drive control shall be powered from a suitably sized and protected control power transformer.
3. Variable frequency drive control shall include status indicators, controller, and system fault condition displays and operating controls. Provide status indicators and operating controls associated with drive control on front door of enclosure.
4. Control arrangement shall be such that variable frequency drive internal electronic supply voltage is isolated from field wiring.

B. Control and Pilot Devices:
1. Relays shall be standard, latching type, and pneumatic or solid state time delay type. Provide relays with contacts rated ten amps, quantity as required.
2. Pilot devices shall be heavy duty type, rated 10 amps continuous. Indicating lights shall be push-to-test transformer type with 12-volt secondaries.

C. Operation:
1. Controls for each low-voltage variable frequency drive shall consist of all devices necessary for the following:
a. Stop/Start and Speed Control: Stop/start and speed control shall respond to drive-mounted selector switch. With switch in “REMOTE” position, stop/start and speed control shall be based on a stop/start

contact and four- to 20-mADC speed signal from remote process control panel. With switch in "LOCAL" position, stop/start control shall be based on remote stop/start pushbuttons located adjacent to driven equipment, and speed control shall be based on drive-mounted speed potentiometer.

b. Emergency Stop Control: Emergency stop control shall respond to remote stop pushbutton located adjacent to driven equipment. When activated driven equipment shall stop immediately in all operating modes.

c. Motor Over-temperature Shutdown: Motor over-temperature control shall respond to remote contact that activates on motor over-temperature. When over-temperature is detected, driven equipment shall stop. Include provisions to remotely supply 120-volt power to thermistor control module located at motor.

d. Discharge Pressure Shutdown: Pressure control shall respond to a remote discharge pressure switch. When high pressure is detected, driven equipment shall stop after an adjustable time delay.

e. Seal water control (required for pumps and other equipment that require seal water): Seal water control shall include provisions to supply 120-volt power to remote seal water solenoid. Seal water solenoid shall energize when equipment requiring seal water is enabled. Equipment requiring seal water start shall be delayed until remote-located pressure switch verifies seal water flow. Upon loss of seal water, after an adjustable period of time, an alarm shall be initiated but equipment requiring seal water shall not shut down. When equipment requiring seal water is stopped, seal water solenoid shall remain energized for an adjustable period of time.

f. Motor Space Heater Control: Motor space heater control shall energize remote motor's internal heater when driven equipment is stopped. Include provisions to supply 120-volt power to heater.

D. Auxiliary Features:

1. Provide each low-voltage variable frequency drive with the following:

a. Status Indicators: Status indicators shall include separate pilot lights for indication of motor run (red), and bypass mode (blue).

b. Shutdown Indicators: Shutdown indicators shall include separate pilot lights (amber) for each shutdown condition. Arrange shutdown indication circuitry so that, when activated, indicator requires manual reset.

c. Contact Outputs: Contact outputs shall include separate dry contacts for remote indication of motor run, seal water alarm for equipment with seal water systems, each shutdown condition, and controller faults.

d. Speed Output: Speed output shall include four- to 20-mADC signal for remote indication of motor speed.

E. Wiring and Device Identification:
   1. Provide control wiring and device identification for each low-voltage variable frequency drive:
      a. Identify all control conductors with permanent type wire markers. Each wire shall be identified by a unique number and shall be attached to wire at each termination point.
      b. Identify each control device with permanent type marker. Each device shall be identified by a unique number and shall be attached to each device.
      c. Numbering system for each wire and control device shall be identified on wiring diagrams and shall reflect actual designations used in the Work.

2.8 SOURCE QUALITY CONTROL

A. Tests:
   1. Perform factory tests on each low-voltage variable frequency drive prior to shipping. Tests shall consist of simulating expected load to be driven by operating load through speed ranges specified for driven equipment, for minimum of two hours per drive unit.
   2. Provide factory control and alarm tests on each drive unit by simulating each control signal and each alarm function to verify proper and correct drive unit action.
   3. Perform specified tests in addition to standard factory tests typically performed.

PART 3 – EXECUTION

3.1 INSPECTION

A. Examine conditions under which the Work will be installed and notify ENGINEER in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions are corrected.

3.2 INSTALLATION

A. Install equipment in accordance with manufacturer's recommendations and instructions and in conformance with Laws and Regulations, and the Contract Documents.

B. Unless otherwise shown or indicated, install equipment on concrete bases Section 26 05 29 Hangers and Supports for Electrical Systems.

C. Install equipment with sufficient access and working space provided for ready and safe operation and maintenance.

D. For installations against masonry walls, provide an insulation board, 1/4-inch minimum thickness, between equipment and wall for corrosion protection. Trim board neatly within outline of equipment.

E. Install all terminations, lugs, and required appurtenances necessary to properly terminate power supplies.

F. Install control wiring terminations and appurtenances necessary to complete installing control and monitoring devices.

G. Immediately prior to Substantial Completion, replace all enclosure filters and frames provided under this Contract with new filters and frames, except expanded metal filter types. Immediately prior to Substantial Completion, clean expanded metal filters.

3.3 FIELD QUALITY CONTROL

A. Site Tests:
   1. After installation, inspect, adjust, and test each low-voltage variable frequency drive at the Site. Testing and inspection shall be in accordance with manufacturer's recommendations and be performed by manufacturer's factory-trained representative. Through CONTRACTOR, manufacturer's factory-trained representative shall inform DEPARTMENT and ENGINEER when equipment is correctly installed and ready to be energized. Do not energize equipment without permission of ENGINEER.
   2. Perform the following equipment inspection and testing and provide reports documenting procedures and results.
      a. Verify all device settings and drive adjustments.
      b. Inspect all mechanical and electrical interlocks and controls for proper operation.
      c. Test each drive through specified speed ranges and loads for a minimum of two hours per drive unit.
      d. Test each drive by using actual control signal for remote and local operation.
      e. Test each drive alarm function.
      f. Perform other tests recommended by equipment manufacturer.
B. Manufacturer Services:
   1. Unloading and Installation: Manufacturer's factory-trained representative shall be present during unloading of equipment and installation at equipment's final location. Representative shall train installing personnel in advance in the proper handling and rigging of equipment. Services by manufacturer's representative under this paragraph shall be at least 1 eight-hour day at the Site.
   2. Post-installation Check: Manufacturer's factory-trained representative shall check and approve the installed equipment before initial operation. Manufacturer shall calibrate, set and program low-voltage variable frequency drives provided. Services by manufacturer's representative under this paragraph shall be at least 1 eight-hour day at the Site.

3. Manufacturer's factory-trained representative shall adjust the system to final settings as specified in Article 3.5 of this Section.
4. Manufacturer's factory-trained representative shall test the system as specified in Paragraph 3.3.A of this Section. Representative shall operate and test the system in presence of ENGINEER and verify that equipment is in conformance with the Contract Documents. Services by manufacturer's representative under this paragraph shall be at least 1 eight-hour day at the Site.
5. Representative shall revisit the Site as often as necessary until all deficiencies are corrected, prior to readiness for final payment.
6. Provide services of manufacturer's factory-trained representatives to correct defective Work within 72 hours of notification by CITY during the correction period specified in the General Conditions as may be amended by the Supplementary Conditions.
7. Replacement parts or equipment provided during the correction period shall be equal to or better than original.
8. Training: Provide services of qualified factory trained specialists from manufacturer to instruct CITY's operations and maintenance personnel in recommended operation and maintenance of equipment. Training requirements, duration of instruction, and other qualifications shall be in accordance with Section 01 79 23, Instruction of Operations and Maintenance Personnel.

3.4 ADJUSTING

A. Immediately prior to Substantial Completion, when testing is acceptably completed and low-voltage variable frequency drives are operating, manufacturer's representative shall return to the Site and make final adjustments as required to each variable frequency drive furnished under this Section.

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SECTION 26 29 33

CONTROL STATIONS

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install control stations, including pushbuttons, selector switches, and other control stations elements.

B. Coordination:
   1. Review installation procedures under this and other Sections and coordinate installation of items to be installed with or before control stations Work.

C. Related Sections:
   1. Section 26 05 05, General Provisions for Electrical Systems.
   2. Section 26 05 29, Hangers and Supports for Electrical Systems.
   3. Section 26 05 53, Identification for Electrical Systems.

1.2 REFERENCES

A. Standards referenced in this Section are:
   1. NEMA ICS 2, Controllers, Contactors and Overload Relays Rated 600 Volts.
   2. NEMA ICS 5, Industrial Control and Systems: Control-Circuits and Pilot Devices.
   3. NEMA ICS 6, Industrial Control and Systems Enclosures.
   4. NEMA 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
   5. UL 508, Industrial Control Equipment.

1.3 QUALITY ASSURANCE

A. Component Supply and Compatibility:
   1. Obtain all control stations furnished under this Section from a single control station manufacturer.
   2. Components shall be suitable for the specified application and shall be integrated into the overall assembly by control station manufacturer.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Shop Drawings:

a. Listing of control stations to be furnished with their location, rating, and NEMA enclosure type for each.

2. Product Data:
   a. Manufacturer's technical information and specifications for control stations proposed for use.

PART 2 – PRODUCTS

2.1 MATERIALS

A. Control Stations:
   1. Manufacturers: Provide products of one of the following:
      a. Cutler-Hammer.
      b. General Electric Company.
      c. Allen Bradley Company.
      d. Square-D Company.
      e. Or equal.
   2. Type: 30.5 mm industrial, heavy duty, oil-tight construction with clearly-marked legend plates.
   3. Emergency Stop or Lockout Stop: Lockout stop pushbuttons shall be two-position, push-pull type with maintained contact and mushroom head. Provide control stations with padlocking attachment and legend plate reading "PUSH-TO-STOP, PULL-TO-START".
   4. Pushbuttons: Momentary or maintained types, NEMA A600 contact rating.
   5. Selector Switches: Rotary type with round or oval handles and positioning device to securely hold switch in selected position for maintained type and for spring return from left, right, or both left and right to maintained position.
   6. Control stations shall comply with NEMA ICS 2, NEMA ICS 5, and UL 508, and shall bear the UL label.
   7. Indicating Lights: 120 vac, push-to-test. Lens color shall be in accordance with Section 26 05 53, Identification for Electrical Systems.
   8. Enclosures: As required for area classifications specified in Section 26 05 05, General Provisions for Electrical Systems, and complying with NEMA 250 and NEMA ICS 6.
   9. Identification: Identify enclosures in accordance with Section 26 05 53, Identification for Electrical Systems. Devices shall include front-mounted nameplates identifying function and equipment controlled, if not readily apparent.

PART 3 – EXECUTION

3.1 INSPECTION

A. Examine conditions under which the Work will be installed and notify ENGINEER

in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions are corrected.

3.2 INSTALLATION

A. Install equipment as shown and indicated, and provide sufficient access and working space for ready and safe operation and maintenance.

B. Securely fasten equipment to walls or other surfaces on which equipment is mounted. Provide independent supports where no wall or other surface exists, in accordance with Section 26 05 29, Hangers and Supports for Electrical Systems.

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SECTION 26 29 36

LOW-VOLTAGE MANUAL MOTOR STARTERS

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install low-voltage manual motor starters.

B. Related Sections:
   1. Section 26 05 05, General Provisions for Electrical Systems.
   2. Section 26 05 53, Identification for Electrical Systems.

1.2 REFERENCES

A. Standards referenced in this Section are:
   1. NEMA ICS 2-110, General Standards for Manual and Magnetic Controllers.
   2. UL 508, Industrial Control Equipment.

1.3 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with the following:
   1. NEC Article 430, Motors, Motor Circuits, and Controllers.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Shop Drawings:
      a. Listing of low-voltage manual motor starters to be furnished, with identification of location of each, NEMA enclosure type, and equipment to be controlled.
   2. Product Data:
      a. Manufacturer's technical information for low-voltage manual motor starters proposed.

PART 2 – PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Provide products of one of the following:
   1. Cutler-Hammer.

2. General Electric Company.
3. Allen Bradley Company.
4. Square-D.
5. Or equal.

2.2 MATERIALS

A. Low-Voltage Manual Motor Starters:
   1. Type: Toggle-operated, horsepower-rated, with thermal overload protection.
      a. Where shown or indicated on the Drawings, provide manual motor starters rated 600-volt, three-pole, 20-amp without overload protection for use as disconnects.
   2. Provide starters rated for 600-volt, three-pole; 240-volt, two-pole; or 120-volt, single-pole with amperage and horsepower rating as required for load to be controlled.
   3. Enclosure: As required for area classifications specified in Section 26 05 05, General Provisions for Electrical Systems.
   4. Identification: Identify starters in accordance with Section 26 05 53, Identification for Electrical Systems. Identify per the equipment controlled.
   5. Starter shall comply with NEMA ICS 2-110 and UL 508.

PART 3 – EXECUTION

3.1 INSPECTION

A. Examine conditions under which Work will be installed and notify ENGINEER in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions are corrected.

3.2 INSTALLATION

A. Install equipment so that sufficient access and working space is provided for ready and safe operation and maintenance.

B. Securely fasten equipment to walls or other surfaces on which equipment is to be mounted. Provide suitable 1/4-inch spacers to so that enclosure is not installed directly against walls. Provide independent supports where no wall or surface capable of supporting equipment exists.

C. Install in conformance with Laws and Regulations, the Contract Documents, and manufacturer recommendations.

+ + END OF SECTION + +

SECTION 26 29 37

LOW-VOLTAGE COMBINATION MAGNETIC MOTOR STARTERS

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install low-voltage combination magnetic motor starters.

B. Related Sections:

   1. Section 26 05 05, General Provisions for Electrical Systems.
   2. Section 26 05 53, Identification for Electrical Systems.
   3. Section 26 29 33, Control Stations.

1.2 REFERENCES

A. Standards referenced in this Section are:
   1. NEMA ICS 2, Controllers, Contactors and Overload Relays Rated 600 Volts.
   2. NEMA 250, Enclosures for Electrical Equipment (1000 Volts Maximum).

1.3 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Shop Drawings:
      a. Listing of low-voltage combination magnetic motor starters to be furnished, listing for each the installation location, NEMA rating and enclosure size, and equipment to be controlled.
      b. Customized wiring diagrams for low-voltage combination magnetic motor starters.
   2. Product Data:
      a. Manufacturer's technical information, specifications, and standardized wiring diagrams for low-voltage combination magnetic motor starters proposed.

PART 2 – PRODUCTS

2.1 EQUIPMENT

A. Manufacturers: Provide products of one of the following:
   1. Square D Company.

2. Allen Bradley Company.
3. General Electric Company.
4. Cutler-Hammer.
5. Or equal.

B. Design, fabricate, and test low-voltage combination magnetic motor starters in accordance with NEMA ICS 2 and NEMA 250.

C. General:
1. Type: Combination type with magnetic-only motor circuit protector with interrupting rating of not less than 65,000 ampere RMS symmetrical, unless otherwise indicated on the Drawings. Magnetic coil operated, NEMA horsepower rated, with thermal overload protection. Coil shall be rated 120 vac.
2. Enclosures: Panel enclosures shall be as required for area classifications specified in Section 26 05 05, General Provisions for Electrical Systems, unless otherwise indicated on the Drawings.
3. Functional Type: Full-voltage, single speed, non-reversing, unless otherwise shown or indicated on the Drawings.
4. Control power transformer fused and grounded on low-voltage (120 vac) side for each starter.
5. Auxiliary contacts for motor space heaters, remote status signals, and interlocks as shown or indicated on the Drawings and as required.
6. Overload Relays: Provide an overload relay for each motor starter. Overload relays shall be in accordance with:
   a. Thermal Overload Relays: Relays shall be thermal, bimetallic type, direct or current sensing. Relays shall include ambient compensation and be equipped with separate heater elements sized for full load amperes and service factor of actual motors furnished.
   b. Each overload relay shall be manual-reset type and include provisions for resetting by an insulating button on front of starter unit door.
   c. Overload relay shall include normally-open auxiliary contact for remote alarm purposes.
   d. Size overload relay for full-load amperes and service factor of actual motors installed.
7. Pushbuttons, selector switches, pilot lights, and other devices shall be as shown on the Drawings and in accordance with Section 26 29 33, Control Stations.
8. Provide nameplate identifying equipment controlled in accordance with Section 26 05 53, Identification for Electrical Systems.

PART 3 – EXECUTION

3.1 INSPECTION

A. Examine conditions under which Work will be installed and notify ENGINEER in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions are corrected.

3.2 INSTALLATION

A. General:
   1. Install equipment in accordance with the Contract Documents, Laws and Regulations, and manufacturer's installation instructions.
   2. Install equipment so that sufficient access and working space is provided for ready and safe operation and maintenance.
   3. Securely fasten equipment to walls or other surfaces on which equipment is mounted. Provide suitable 1/4-inch spacers so that enclosure is not installed directly against walls. Provide supports to rigidly support equipment reasonably close to motor where no wall or surface capable of supporting equipment exists.

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SECTION 26 32 13

ENGINE GENERATORS

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Provide all labor, materials, equipment, and incidentals as shown specified and required to furnish and install 480-volt standby power generator system with appurtenances for complete and operational system.
   2. The following generator system(s) are included in this Section:
      a. As shown.

B. Coordination:
   1. Review installation procedures under other Sections and coordinate installation of items that must be installed with or before engine generator Work.

C. Related Sections:
   1. Section 05 05 33, Anchor Systems.

1.2 REFERENCES

A. Standards referenced in this section are:
   1. International Standards Organization (ISO), ISO 8528, Reciprocating Internal Combustion Engine Driven Alternating Current Generator Sets.
   2. ISO 9001, Quality Management Systems – Requirements.
   3. NEMA MG-1, Motors and Generators.
   4. NFPA 30, Flammable and Combustible Liquids Code.
   5. NFPA 37, Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines.
   6. NFPA 70E, Electrical Safety in the Workplace.
   7. NFPA 110, Standard for Emergency and Standby Power Systems.
   8. UL 142, Steel Aboveground Tanks for Flammable and Combustible Liquids.
   9. UL 508, Safety Standard for Industrial Control Equipment.
   10 UL 2200, Standard for Safety Stationary Engine Generator Assemblies (rated 600 volts or less)

1.3 QUALITY ASSURANCE

A. Qualifications:
   1. Manufacturer:
      a. Shall have minimum of five years of experience of producing substantially similar equipment to that specified and shall document at least five installations in satisfactory operation for at least five years.

b. Shall possess valid ISO 9001 certification.
c. Supplier shall have complete parts and service facilities, factory-trained service staff available for 24-hour emergency service, and be authorized to administer the warranty for all components of engine generator systems.

B. Component Supply and Compatibility:
1. Obtain all equipment included in this Section regardless of component manufacturer from a single generator set manufacturer. Materials, equipment, and parts shall be new, of current production of a firm that manufactures the generator set as a matched system. Manufacturer shall have full responsibility for engine generator performance. Generator set manufacturer shall prepare or approve all Shop Drawings and other submittals for all components furnished under this Section.
2. Engine generator shall be factory-assembled and factory-tested. Verify in the factory that system is free from electrical and mechanical defects and conforms to the Contract Documents.

C. Regulatory Requirements: Comply with applicable provisions of authorities having jurisdiction, including the following:
1. Code of Federal Regulations (CFR), Title 40, Part 89, Control of Emissions from New and In-Use Nonroad Compression Ignition Engines, Subpart D Emission Test Equipment Provisions
2. Local Ordinances: Systems shall conform to Laws and Regulations relative to noise control and emissions.
3. Local and State Building Codes: Installations shall conform to applicable codes including requirements of local fire marshals.
4. Permits: Obtain and pay for required permits, fees, and inspections by authorities having jurisdiction

1.4 SUBMITTALS

A. Action Submittals: Submit the following:
1. Shop Drawings:
a. Installation drawings specific to the Project.
b. Bill of material for all equipment and spare parts.
c. Electrical wiring and interconnection diagrams with all external connections identified.
d. Control panel data shall include:
1) Description of control features.
2) Operator panel control switches and functions.
3) Alarm and status displays.
4) Provisions for remote start signal and remote status and alarm.
5) Compliance with UL 508.
e. Enclosure data shall include the following:
1) Plan and elevation drawings showing overall dimensions, interior equipment arrangement, and working spaces.

2) Construction details and hardware specifications.
3) Exhaust piping and silencer mounting arrangement.
4) Sound attenuation provisions and decibel levels.

f. Fuel storage system data shall include:
1) Day tank and storage tank arrangements.
2) Storage capacity and hours of operation at rated load and 3/4 load.
3) Alarm devices.
4) Construction details including secondary containment provisions for fuel tank.
5) Piping arrangements and details.
6) Compliance with UL 142 and local codes.

g. Provide the following relative to installation:
1) Vibration isolators and anchor bolt requirements.
2) Seismic restraint requirements.
3) Provisions for fuel piping, electrical conduits, and other external connection requirements.

2. Product Data:

a. Manufacturer's literature, specifications, engineering data sheets, and standard drawings, necessary to fully describe the engine generator sets and appurtenances, and substantiate compliance with the Contract Documents. Information shall be annotated to clearly indicate ratings, features, and options specific to the Project.

b. Generator data shall include:
1) Listed to UL 2200.
2) Heat rejection to room
3) Combustion air requirements.
4) Factory painting specifications.

c. Engine data shall include:
1) Fuel flow at rated load.
2) Fuel consumption at 1/4, 1/2, 3/4, and full load.
3) Engine Type: Naturally aspirated or turbocharged and after-cooled.
4) Maximum exhaust backpressure.
5) Silencer attenuation rating.
6) Jacket water heater system.
7) Gaseous emissions data measurements for hydrocarbons, carbon monoxide, particulate matter, and NOx conforming to 40 CFR 89, Subpart D.

d. Alternator data shall include:
1) Winding insulation class and temperature rise in accordance with NEMA MG-1-1.65
2) Standby and continuous KW/KVA ratings.
3) Motor starting KVA at 90 percent sustained voltage.
4) Surge KW capacity.
5) Machine reactances and time constants.

e. Starting system data shall include:
1) Battery system.
2) Battery charger.

3) Cycle cranking configuration.

3. Testing Procedures:
   a. Source Quality Control Testing Procedures: For Units 501 kW and larger, provide factory testing procedures and dates at least thirty days prior to testing.
   b. Site Quality Control Testing Procedures: Testing procedures, provided at least thirty days prior to scheduled start of testing.

B. Informational Submittals: Submit the following:
   1. Manufacturer's Instructions:
      a. Manufacturer's unloading, rigging, installing, testing, and startup instructions. Information shall be specific to and indicate options for the Project
   2. Source Quality Control Submittals:
      a. For Units 500 kW and Smaller: Prototype testing certification.
      b. For Units 501 kW and Larger: Provide factory testing results within seven days of completing factory test.
   3. Site Quality Control Submittals:
      a. Services to be performed by Supplier's representative, provided at least thirty days prior to start of Site testing.
      b. Report on results of testing at the Site, provided within seven days of completion of testing.
   4. Manufacturer Reports: Reports of visits to Site by Supplier's representative, including purpose of visit, problems encountered, and resolutions.
   5. Qualifications Statements:
      a. Manufacturer: When requested by ENGINEER, submit data documenting compliance with qualifications requirements of the Contract Documents.

C. Closeout Submittals:
   1. Operation and Maintenance Manuals: Provide in accordance with Section 01 78 23, Operations and Maintenance Data. Include the following information:
      a. Operating Instructions: Instructions for starting, stopping, protection of circuits, automatic controls, battery charging and safety considerations. Methods for adjusting speed, output voltage, and control timers.
      b. Performance Parameters: Provide nominal values and acceptable limits for output voltage, frequency, load, engine temperature, and oil pressure Include circuit drawings with component identifications for reference.
      c. Maintenance Instructions: Procedures for daily, weekly, monthly, and annual basis, or on an hours-run basis. Include guidance for selecting fuel oil, lubricating oil, use of water treatment additives, and anti-freeze.
   2. Warranty Documentation.

D. Maintenance Materials:
   1. Provide the following spare parts for each generator set:
      a. Two sets of primary and secondary fuel filters.
      b. One set of air filters.

c. Two control circuit fuses of each size used.
d. Two sets of lube oil filters.
e. One set of fan belts.

1.5 WARRANTY

A. General Warranty: Special warranty specified in this Article shall not deprive CITY or DEPARTMENT of other rights or remedies CITY or DEPARTMENT may otherwise have under the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by CONTRACTOR under the Contract Documents. Obligations of CONTRACTOR under the Contract Documents shall not be limited by provisions of the specified special warranty.

B. Special Warranty:
1. Provide manufacturer's written warranty, running to the benefit of DEPARTMENT and CITY, agreeing to correct or, at option of CITY remove or replace materials or equipment specified in this Section found to be defective during a period of five years after date of Substantial Completion or 3,000 hours of operation.
2. Products supplied under this Section shall be covered by a single warranty for the coverage period. Warranty shall provide for free replacement or repair of parts for five years or 3,000 hours of operation, and free labor for the first two years.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Delivery:
1. Cover all generator air and exhaust openings with vapor inhibiting and water repellent material.
2. Deliver anchorage devices that are to be embedded in cast-in-place concrete in ample time to prevent delaying the Work.
3. Inspect equipment for shipping damage or loose parts upon delivery. Check for evidence of water that may have entered equipment during transit.
4. Notify ENGINEER of loss or damage to equipment or components. Replace loss and repair damage to new condition in accordance with manufacturer's instructions.

B. Handle equipment in accordance with manufacturer's instructions. Furnish at least one copy of instructions with equipment at time of shipment.

C. Storage:
1. Store equipment in a clean, dry location with controls for uniform temperature and humidity. Protect equipment with coverings and maintain environmental controls.
2. Store materials for easy access for inspection and identification. Keep all materials off the ground, using pallets, platforms or other supports. Protect equipment from corrosion and deterioration.

PART 2 – PRODUCTS

2.1 SYSTEM REQUIREMENTS

A. Quantity and ratings of the systems shall be as indicated in Paragraph 1.1.A.2 of this Section.

B. Generators shall be rated for standby operation for duration of normal utility outage as defined by ISO 8528 for limited time operation. Generators shall be capable of operating for up to 500 hours per year, of which maximum of 300 hours is continuous running, and no overload is allowed.

C. Generator assemblies shall be UL 2200-listed, control panels shall be UL 508-listed and above-ground fuel tanks shall be UL 142-listed.

D. Generators shall be rated for the specified KW, without overload, at the following Site conditions:
   1. Maximum Ambient Temperature: 40 degrees C.
   2. Altitude: 500 feet above mean sea level.

2.2 MANUFACTURERS

A. Provide generator systems of one of the following:
   1. Caterpillar
   2. Cummins/ONAN
   3. Or equal.

2.3 ENGINE

A. Engine Type: Four-cycle compression ignition, water cooled diesel 1800 RPM. Two-cycle engines are not acceptable.

B. Engine Construction:
   1. Steel-backed bearings.
   2. Crank Case: Reinforced cast iron.
   3. Crank Shaft: Forged alloy steel with hardened journals, finished and dynamically balanced.
   4. Cylinder Head: Cast iron.
   5. Pistons: Aluminum alloy with chrome faced rings.
   6. Replaceable cylinder liners and valve seat inserts for engines rated over 200 horsepower.
   7. Single-block construction. Bolted, multiple blocks are not acceptable.

C. Cooling System:
   1. Radiator: Engine-mounted with engine-driven blower fan capable of cooling the engine under full load conditions in an ambient temperature of 104 degrees F without de-rating.

2. Thermostatic valve in jacket water outlet between radiator and engine to maintain proper jacket water temperature. Engine-driven pump to circulate water through cooling system.
3. Coolant: Fill system with 50 percent solution of ethylene glycol.
4. Coolant water temperature gauge.
5. High engine temperature shutdown.
6. Loss of coolant shutdown.
7. Fan guard.
8. Radiator face duct connection.
9. Engine coolant heaters, thermostatically controlled, capable of keeping jacket water at temperature not less than 90 degrees F in compliance with NFPA 110. Coolant heaters shall operate at 208 volts, single phase. House contactor for controlling heater in NEMA 4X stainless steel enclosure mounted on unit.

D. Lubrication System: Positive displacement, mechanical, full pressure lube pump, full flow and bypass lubrication filters with replaceable spin-on canister elements, oil drain line with valves and dipstick oil level indicator.

E. Fuel System: Suitable for operation on No. 2 diesel fuel oil. System to include primary and secondary fuel filters, fuel/water separator, fuel priming pump, flexible fuel lines and fuel pressure gauge.

F. Governor: Electronic system to provide automatic isochronous frequency regulation. System dynamic capabilities to be controlled as function of engine temperature for fast stable operation at varying engine operating conditions. System to actively control fuel rate and excitation. Fuel rate to be regulated as function of starting, accelerating to start disconnect speed, accelerating to rated speed, and operating in various isochronous states.

G. Fuel Oil Sub-base Tank
1 Construction: Heavy-gage steel primary tank, gallon capacity as indicated on the drawings, and welded steel secondary containment sized to contain 110 percent of primary tank capacity. Rust inhibitor coating inside and prime- and finish-coated outside, color to match generator set exterior paint.
2. Comply with the following:
   a. UL142-listed and labeled.
   b. NFPA 30, NFPA 37, and NFPA 110.
3. Fittings: NPT for fuel supply and return; two-inch diameter NPT for normal vent, manual fill and level alarm; NPT for emergency vents, level gauge, basin drain, and leak detection alarm.
4. Fuel level gauge and leak detector switch with alarm lights and contacts for remote annunciation of low fuel level and leak detection.
5. Mushroom-type cap and screen for normal vent openings and pressure relief-type caps for emergency vent openings.
6. Manufacturers: Provide sub-base tank of one of the following:
   a. Pryco, Inc.
   b. Tramont Corp.

c. Or equal.

H. Air Supply/Exhaust Systems:
1. Heavy duty air cleaner with service indicator.
2. Flexible stainless steel exhaust connector.
3. Critical grade silencer with condensate drain ports.
4. Schedule 40 stainless steel piping. Insulate indoor piping to limit surface temperature to 50 degrees C.

I. Air Emissions:
1. Comply with United States Environmental Protection Agency (USEPA) standards for non-road engines and with state and local requirements.
2. Submit emissions data measurements for hydrocarbons (HC), carbon monoxide (CO), particulate matter (PM) and oxides of nitrogen (NOx) conforming to USEPA test procedures. Include USEPA not-to-exceed requirements for each pollutant.

J. Starting System: DC system complete with engine mounted batteries, locally mounted charger and connecting cables between batteries and engine and between charger and batteries.
1. Batteries: Lead-acid or calcium/lead antimony, engine cranking type, rated in accordance with engine manufacturer's requirements for minimum of three 15-second cranking cycles at firing speeds without recharging, and to accommodate DC power requirements of control panel and other accessories requiring DC power.
2. Battery racks, cables, connectors, and disconnect switch.
3. Engine-mounted battery charging alternator and solid state voltage regulator.
4. Battery Charger:
a. UL-listed, voltage regulated and equipped with float, taper and equalize charge settings.
b. Analog DC ammeter and voltmeter; 12-hour equalize timer; AC and DC fuses.
c. Loss of AC power, low battery voltage and high battery voltage alarm lights and contacts for remote annunciation; power on light.

2.4 ALTERNATOR

A. Construction: Synchronous generator, four-pole, 2/3 pitch, revolving field, self ventilated, drip-proof construction, single bearing, dynamically balanced rotor with amortisseur windings to minimize voltage deviations and heating effects under unbalanced load conditions. Rotor directly connected to engine flywheel housing to ensure permanent alignment.

B. Winding Insulation Systems: Class H in accordance with NEMA MG-1. Temperature rise not to exceed 130 degrees C over 40 degrees C ambient at rated load. Epoxy coating for fungus resistance and abrasion protection.

C. Excitation System: Brushless construction. Excitation support system, permanent magnet type, to sustain 300 percent rated current for up to 10 seconds under short circuit conditions. Provide surge suppressors to protect against voltage spikes.

D. Voltage Regulator: Automatic solid state system to maintain generator output voltage within plus or minus 0.5 percent from no load to full load. Control voltage buildup, provide volts per Hertz regulation, protect from over-excitation, limit voltage overshoot on startup, and be environmentally sealed.

E. Provide anti-condensation heater to maintain temperature approximately five degrees Fahrenheit above ambient when generator is idle.

2.5 CONTROL PANEL

A. Controls shall be in accordance with NFPA 110, Level 1, and control panel shall conform to the following:
   1. Install control panel on vibration isolators with controls, instruments, lights, and devices necessary to manually and automatically start, stop, monitor, and protect the generator.
   2. Controls shall be UL 508-listed and microprocessor-based with programmable adjustments. Control power from starting battery system. Panel shall include the following:
      a. Emergency stop pushbutton.
      b. Adjustable cycle cranking.
      c. KW, KVA, KVAR, and power factor meters.
      d. Engine coolant temperature readout.
      e. Engine oil pressure readout.
      f. Running time readout.
      g. RPM meter.
      h. Cool down timer.
   3. Readouts and dry contact outputs shall be provided as required by NFPA 110, Level 1.
   4. Provide output dry contacts for remote monitoring and control for the following:
      a. Generator running
      b. Generator common warning alarm.
      c. Generator common shutdown alarm.
      d. Low day tank fuel if day tank is used (warning alarm).
      e. Low main tank fuel (warning alarm).
      f. Liquid leak in containments areas, including tank, double walled piping, and other fuel supply components (warning alarm).
   5. Reset Control: Manual or remote restarts are not allowed and alarm lamps shall remain in alarm state until manual reset is accomplished even if alarm condition has been corrected.
   6. Provide control panel anti-condensation space heater.

2.6 CIRCUIT BREAKERS

A. General: Provide main and exciter circuit breakers, sized for protecting the engine-generator.

B. Type: UL-listed, molded case with interchangeable electromechanical trip unit for sizes 225-amp and larger. Provide NEMA 1 enclosed units and mount on engine generator.

2.7 ENCLOSURE

A. Provide engine-generator system with outdoor weatherproof enclosure.

B. Non-walk-in enclosure shall be constructed of minimum14-gauge, reinforced sheet steel and shall attach directly to engine-generator base or sub-base fuel tank. Enclosure shall be factory assembled structure with key-lockable access doors for performing normal maintenance operations. Hardware and fasteners shall be stainless steel. Lube oil and coolant drains shall be extended to exterior of enclosure and terminated with drain valves, capped with pipe nipples on flanged connections.

C. Sound Attenuation: Engine-generator enclosure shall be sound-attenuated to reduce noise level to 75 dBA at a point seven meters from engine-generator in free air environment, while operating at full load.

2.8 ACCESSORIES

A. Engine Generator Mounting:
   1. Vibration Isolators: Steel springs in combination with rubber pads.
   2. Vibration Isolation: Provide flexible connections between engine-generator set and fuel lines, exhaust system, electrical conduits, and other externally connected support systems.
   3. Anchor Bolts: Type 316 stainless steel, conforming to Section 05 05 33, Anchor Systems.
   4. Template shall be furnished by manufacturer for setting anchorages devices, pipe sleeves, and nuts for mounting spring-type isolators to concrete foundation. Provide bolts and nuts for bolting isolators to channel frame base of engine-generator set.

2.9 FINISHING

A. Engine generator ferrous metal surfaces shall be prime-coated for corrosion protection and finish-painted in accordance with manufacturer's standard painting system.

B. Color of finish paint to be selected by ENGINEER from manufacturer's standard colors.

2.10 SOURCE QUALITY CONTROL

A. Factory Tests
   1. Generators 500 Kw and Smaller: Provide results of tests and evaluations previously performed on prototype generator sets representative of the models to be provided, in accordance with NFPA 110.
   2. Generators 501 kW and Larger: Following assembly, perform at the factory standard production tests to verify proper operation and performance. Tests shall include two-hour load test.

PART 3 – EXECUTION

3.1 INSPECTION

A. Examine the conditions under which the Work is to be installed and notify ENGINEER in writing of conditions detrimental to the proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install engine generator system in accordance with the Contract Documents, approved Shop Drawings, and manufacturer's recommendations.

3.3 SITE QUALITY CONTROL

A. Site Testing: Test engine-generator set in accordance with NFPA 110. Provide all materials and equipment, including load banks, fuel, lubricants and material required for Site testing. Completely fill fuel tank at conclusion of testing.

B. Manufacturer's Services: Provide qualified, factory-trained serviceman to perform the following:
   1. Supervise unloading and installation of equipment.
   2. Instruct CONTRACTOR in the installation of equipment.
   3. Inspect and adjust equipment after installation and ensure that equipment operates properly.
   4. Instruct CITY's personnel in operating and maintaining the equipment.
   5. Service representative shall make a minimum of 1 visit, with a minimum of 8 hours at the Site for each visit. First visit shall be for unloading supervision and instruction of CONTRACTOR in installing equipment; second visit shall be for assistance in installation of equipment; third visit shall be for checking completed installation and start-up of system; fourth visit shall be to instruct operations and maintenance personnel. Representative shall revisit the Site as often as necessary until installation is acceptable.

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SECTION 26 36 23

AUTOMATIC TRANSFER SWITCHES

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install automatic transfer switches.
   2. Switches specified under this Section include enclosed types.

B. Related Sections:
   1. Section 26 05 53, Identification for Electrical Systems.

1.2 REFERENCES

A. Standards referenced in this Section are:
   1. IEEE 472, Guide for Surge Withstand Capability Tests.
   2. IEEE 446, Recommended Practice for Emergency and Standby Power Systems for Industrial and Commercial Applications.
   3. IEEE C62.41, Recommended Practice for Surge Voltages in Low Voltage AC Power Circuits.
   4. NEMA ICS1 109, Tests and Procedures.
   5. NEMA ICS10, AC Automatic Transfer Switches.
   6. UL 1008, Transfer Switch Equipment.
   7. UL 508, Industrial Control Equipment
   8. UL 61010B-1 (previously UL 3111-1), Electrical Measuring and Test Equipment; Part 1: General Requirements.
   9. ANSI C37.90a, Surge Withstand Capability Test (formerly IEEE Standard 472-1974) – Ring Wave Test.

1.3 QUALITY ASSURANCE

A. Regulatory Requirements:
   1. NEC Article 702, Optional Standby Systems.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Shop Drawings:
      a. Listing of transfer switches to be provided, including ratings and location of each.

b. Equipment dimensions, and construction details of enclosures with conduit entry locations.

2. Product Data:
   a. Manufacturer's technical information for products proposed, including catalog cut sheets.
3. Test Procedures:
   a. At least thirty days prior to actual factory and field testing, submit proposed testing procedures, methods and apparatus.

B. Informational Submittals:
   1. Source Quality Control Submittals:
      a. Submit reports of completed factory tests, including test results and procedures used for testing.
   2. Field Quality Control Submittals:
      a. Submit reports of completed field tests, including test results and procedures used for testing.
   3. Supplier Instructions:
      a. Manufacturer's written instructions for transporting, handling, storing, and installing the products.
   4. Supplier Reports:
      a. Written report of each visit to Site by supplier's service representative.

C. Closeout Submittals
   1. Operation and Maintenance Data:
      a. Submit complete installation, operation and maintenance manuals including test reports, maintenance data and schedules, description of operation, and spare parts information.
      b. Manuals shall include record drawings of control schematics, including point-to-point wiring diagrams.
      c. Furnish operation and maintenance manuals per Section 01 78 23, Operations and Maintenance Data.

D. Maintenance Material Submittals: Furnish the following:
   1. Spare Parts and Extra Stock Materials: Provide as specified in this Section.

1.5 DELIVERY, STORAGE AND HANDLING

A. Deliver products to the Site to ensure uninterrupted progress of the Work. Deliver anchor bolts and anchorage devices to be embedded in cast-in-place concrete in time to prevent delay of the Work.

B. Shipping sections shall be designed to be shipped by truck, rail, and ship. Indoor sections shall be bolted to skids.

C. Equipment shall be equipped to be handled by crane. Where cranes are not available equipment shall be suitable for skidding in place on rollers using jacks to raise and lower the sections.

D. Comply with Section 01 65 00, Product Delivery Requirements, and Section 01 66 00, Product Storage and Handling Requirements.

1.6 MAINTENANCE

A. Spare Parts and Extra Stock Materials:
   1. Furnish, tag, and box for shipment and long term storage the following spare parts for each switch:

Item	**Quantity per Switch**
a. Control relay	Two of each type used
b. Pilot light	Two per ten of each type used
c. Fuses	Two set of each type and size used

   2. Furnish a list of additional recommended spare parts for an operating period of one year. Describe each part, quantity recommended, and current unit price of each.
   3. Package spare parts in suitable containers bearing labels clearly indicating contents and equipment with which they are to be used. Deliver spare parts at same time as switchgear.

PART 2 - PRODUCTS

2.1 SYSTEM PERFORMANCE

A. Provide automatic transfer switches as specified for transferring loads from one power source to another.

2.2 MANUFACTURERS

A. Manufacturers: Provide products of one of the following:
   1. Russelectric, Inc.
   2. ASCO Power Technologies.
   3. Or equal.

2.3 SWITCH

A. Ratings:
   1. Switches shall be capable of switching all classes of loads and rated for continuous duty when installed in a non-ventilated enclosure.
   2. Switches shall be rated with continuous ampere rating, number of poles and voltage as shown on Drawings.
   3. Switches shall be rated to withstand the magnitude of fault current available without welding of contacts in compliance with ANSI C37.90a and IEEE C62.41.

B. Standards and Performance:

1. Switches shall comply with UL Standard 1008, NEMA Standard ICS10, and applicable requirements of NEC Article 700, IEEE 446, IEEE C62.41, UL 508, and UL 61010B-1. Switches shall be UL labeled with performance meeting or exceed the following:
   a. Temperature Rise: Measurements shall be made after overload and endurance tests.
   b. Withstand: UL listed to withstand magnitude of fault current available at switch terminals when coordinated with respective protective devices shown on Drawings at an X/R ratio of 6.6 or less. Main contacts shall not trip open or weld when subjected to fault currents.
      1) As a condition for approval, manufacturer of automatic transfer switches shall verify that switches are listed by Underwriters Laboratories, Inc., Standard UL-1008 with three-cycle short circuit closing and withstand as follows:

RMS Symmetrical Amperes at 480 VAC	
Amperes	**3 Cycle Closing & Withstand**
100 to 400	42,000
600 to 800	65,000
1000 to 1200	85,000
1600 to 4000	100,000

      2) During three-cycle closing and withstand tests, there shall be no contact welding or damage. Three-cycle tests shall be performed without using current limiting fuses, and oscillograph traces across main contacts shall be furnished to verify that contact separation has not occurred, and there is contact continuity across all phases after completion of testing. Test procedures shall be in accordance with UL-1008, and testing shall be certified by UL.
      3) When conducting temperature rise tests to UL-1008, Supplier shall include post-endurance temperature rise tests to verify ability of transfer switch to carry full rated current after completing overload and endurance tests.
   c. Dielectric: Measurements shall be made at 1960 VAC RMS minimum following the withstand current rating test.
   d. Transient Withstand: Control panel shall pass the voltage surge withstand test per IEEE Standard 472 and voltage impulse withstand test per NEMA ICS1 109.

C. Construction:

1. Switch shall be double throw actuated by non-fused, momentarily energized operating mechanism(s).
2. Accomplish mechanical locking of main contacts in each direction without aid of latching solenoids, toggle mechanisms, or gear arrangements.
3. An overload or short-circuit shall not cause switch to go to a neutral position.

4. All transfer switch sizes shall use only one type of main operator for ease of maintenance and commonality of parts.
5. Switch shall be positively locked and unaffected by momentary outages, so that contact pressure is maintained at a constant value and contact temperature rise is minimized for maximum reliability and operating life.
6. Main contacts shall be silver-tungsten composition. Switches shall have segmented, blow-on construction for high withstand and close-on capability and be protected by separate arcing contacts.
7. Inspection of contacts shall be possible from front of switch without disassembly of operating linkages and without disconnecting power conductors. Switches rated 600 amps and higher shall have front-removable and -replaceable contacts. All stationary and moveable contacts shall be replaceable without removing power conductors or bus bars.
8. Transfer switch shall be equipped with a safe manual operator designed to prevent injury to operating personnel. Manual operator shall provide same contact-to-contact transfer speed as electrical operator to prevent a flash-over from switching main contacts slowly. Manual operation shall be safe even if electrical operator becomes energized and shall not require prior disconnection of operators or control wiring. Safe manual transfer shall be possible under all load conditions, energized or non-energized. Manual operator shall be an external type, operable through door of transfer switch enclosure. Operating personnel shall not be required to open transfer switch door to facilitate manual transfer. Manual operator shall be functional at all times, regardless of switch position or status. Manually initiated electrical operation does not meet intent of this requirement. Manual operator is not required on closed transition type switches.
9. Neutral Connections:
   a. Switch shall include a solid neutral suitable for neutral conductors to be solidly connected. Provide neutral conductor plate with fully rated ALCU pressure connectors.

D. Enclosure: Enclosed switches shall be NEMA 1 at minimum.
   1. Standard and optional door-mounted switches and pilot lights shall be 30.5-mm industrial grade type or equivalent.
   2. Provide door controls on a separate, removable plate that can be supplied loose for open type units.

E. Identification: Identify switches per Section 26 05 53, Identification for Electrical Systems.

2.4 TRANSFER SWITCHING FEATURES

A. Delay Transition (Open): Provide automatic delayed open transition transfer for each switch. Switch shall transfer load in delayed transition (break-before-make) mode. Transfer shall be accomplished with a user-defined interruption period in both directions adjustable from one second to five minutes in at least 15 increments.

2.5 SEQUENCE OF OPERATION

A. When voltage on any phase of normal source is outside of specified parameters and after a programmable time delay period to allow for momentary dips, engine starting contacts shall close to start generating supply.

B. Transfer switch shall transfer to emergency source when generating supply has reached specified voltage and frequency on all phases.

C. After restoration of normal supply on all phases to within specified parameters, an adjustable time delay shall delay retransfer to normal to assure stabilization of normal supply. After expiration of the time delay period, transfer switch shall retransfer to normal. Should emergency supply source fail during the time delay period, switch shall bypass time delay and automatically return to normal source. Provide an adjustable time delay between opening of closed contacts and closing of open contacts during transfers to allow loads to be demagnetized.

D. After retransfer to normal, engine generator shall be allowed to operate at no load for a programmable period to cool down.

E. Should transfer to emergency source be initiated by test switch rather than an actual source failure, transfer from normal to emergency shall be as described above.

2.6 MICROPROCESSOR CONTROLLER

A. Each switch shall include a microprocessor controller for operation of the switch. Equip controller with the following:
   1. Provide controller's sensing and logic by a built-in microprocessor with ability to communicate serially through an optional serial communication module.
   2. Controller shall provide a minimum of five selectable nominal voltages. Voltage sensing shall be true RMS type and be accurate to plus/minus one percent of nominal voltage. Frequency sensing shall be accurate to plus/minus 0.2 percent. Controller shall be capable of operating over a temperature range of -20 to +60 degrees C and storage from -55 to +85 degrees C.
   3. Connect controller to transfer switch by an interconnecting wiring harness that shall include a keyed disconnect plug to enable controller to be disconnected from transfer switch for routine maintenance. Interfacing relays shall be industrial grade plug-in type with dust covers. Enclose controller with a protective cover. Mount controller internally but separately from transfer switch.
   4. Customer connections shall be wired to a common terminal block.

B. Controller Display and Keypad:
   1. Display and keypad shall be an integral part of controller for viewing available data and setting desired operational parameters. Operational parameters shall also be available for viewing and limited control through serial communications input port. The following parameters shall be adjustable:
      a. Nominal line voltage and frequency
      b. Single- or three-phase sensing
      c. Operating parameter protection
      d. Transfer operating mode configuration: Open transition, closed transition or delayed transition
   2. Instructions and controller settings shall be easily accessible, readable, and accomplished without using codes, calculations, or instruction manuals.

C. Controller Voltage, Frequency and Phase Rotation Sensing:
   1. Voltage and frequency on both the normal and emergency sources shall be continuously monitored, with the following pickup, dropout, and trip setting capabilities values shown as a percent nominal unless otherwise specified:

Parameter	Sources	Dropout/Trip	Pickup/Reset
Under-voltage	Normal and Emergency, three-phase	70 to 98%	85 to 100%
Over-voltage	Normal and Emergency, three-phase	102 to 115%	2% below trip
Under-frequency	Normal and Emergency	85 to 98%	90 to 100%
Over-frequency	Normal and Emergency	102 to 110%	2% below trip
Voltage Unbalance	Normal and Emergency	5 to 20%	1% below dropout

   2. Repetitive accuracy of all settings shall be within plus/minus 0.5 percent over an operating temperature range of -20 degrees C to +60 degrees C.
   3. Voltage and frequency settings shall be field adjustable in one percent increments, either locally with the display and keypad or remotely via serial communications port access.
   4. When activated by keypad or through serial port, controller shall be capable of sensing phase rotation of both normal and emergency sources. Source will be unacceptable if phase rotation is not preferred rotation selected (ABC or CBA).
   5. Source status screens shall be provided for both normal and emergency to provide digital readout of voltage on all three phases, frequency, and phase rotation.

D. Controller Time Delays:
   1. Provide controller with time delays below. Time delay settings shall be adjustable over a range of zero to 9999 seconds (factory set at three seconds) unless specified otherwise.
      a. Normal source failure, for engine starting.
      b. Transfer to emergency on availability of emergency source.
      c. Emergency source failure, retransfer on availability of normal source.

d. Engine cool down following retransfer to normal.
e. Time delay to control contact transition time during open transition transfer to either source.
f. All timers can be bypassed via operation on processor's keypad.

2. Provide adjustable time-delay on retransfer to normal. Time delay shall be automatically bypassed if emergency source fails and normal source is acceptable.
3. Provide a time delay activated output signal to drive external relays for selective load disconnect control. Controller shall have the ability to activate an adjustable zero to five-minute time delay for one of the following modes:
   a. Prior to transfer only.
   b. Prior to and after transfer.
4. Time delay and sensing functions shall be field adjustable and operate with drift that does not exceed plus/minus one percent of set frequency, plus/minus two percent of set voltage, and plus/minus ten percent of set time delay, over the temperature range of -20 degrees C to +70 degrees C.
5. Time delays shall be adjustable in one-second increments, except extended parallel time, that shall be adjustable in 0.01-second increments.
6. Time delays shall be adjustable by using display and keypad or with a remote device connected to serial communications port. Time delay value displayed shall be time remaining until next event occurs.
7. For (open) delay transition transfer switches controller shall include the following built-in time delays for delayed transition operation:
   a. Zero to five-minute time delay for load disconnect position for delayed transition operation.

2.7 ACCESSORY FEATURES:

A. Provide each switch with the following:
   1. A two-position maintained-type test switch for test/automatic/ modes. Test position shall simulate a normal source failure.
   2. A SPDT silver-tungsten contact, rated five amps at 30 VDC, for a low-voltage engine start signal. Start signal shall prevent dry cranking of engine by requiring generator set to reach proper output and run for duration of cool down setting regardless of whether normal source restores before load is transferred.
   3. Auxiliary contacts, rated ten amps at 250 VAC, consisting of one contact, closed when switch is connected to normal source and one contact closed when switch is connected to emergency source.
   4. LED indicating lights (30.5 mm, industrial heavy duty, oil-tight, NEMA rated to match automatic transfer switch enclosure). One shall indicate when switch is connected to normal source (green) and one to indicate when the switch is connected to emergency source (red).
   5. LED indicating lights (30.5 mm, industrial heavy duty, oil-tight, NEMA rated to match automatic transfer switch enclosure), energized by controller outputs. Lights shall provide true source availability of normal and

emergency sources as determined by voltage sensing trip and reset settings for each source.

6. Provide the following built-in to controller, capable of being activated through keypad programming or serial port only when required by user:
   a. Provide ability to select "commit/no commit to transfer" to determine whether load should be transferred to standby generator if normal source restores before generator is ready to accept load.
   b. Provide terminals for a remote contact that opens to signal switch to transfer to emergency, and for remote contacts that open to inhibit transfer to emergency or retransfer to normal. Provide ability to activate both inhibit signals through keypad or serial port.
   c. Controller shall be capable of accepting a normally open contact that will allow transfer switch to function in a non-automatic mode using an external control device.
   d. Engine Exerciser: Controller shall provide an internal engine exerciser that allows user to program up to seven different exercise routines. For each routine, user shall be able to:
      1) Enable or disable routine.
      2) Enable or disable transfer of load during routine.
      3) Set start time.
      4) Time of day
      5) Day of week
      6) Week of month (first, second, third, fourth, last, alternate, and every)
      7) Set duration of run.
      8) At end of specified duration, switch shall transfer load back to normal and run generator for specified cool down period. A ten-year life battery that supplies power to real time clock in event of a power loss shall maintain time and date information.
7. System Status: Controller display shall include a "System Status" screen that shall be readily accessible from all points in the menu by a maximum of two key strokes. System status screen shall display a clear description of active operating sequence and switch position.
8. Self-Diagnostics: Controller shall contain a diagnostic screen for detecting system errors. Screen shall provide information on status input signals to controller that may be preventing completion of load transfer commands.
9. Communications Interface: Controller shall be capable of interfacing, through an optional full-duplex RS 485 serial communication module, with a network of transfer switches, within 4,000 feet (locally) and remotely through modem serial communications. Standard software specific for transfer switch applications shall be available from transfer switch manufacturer. Software shall include monitoring, control, and setup of parameters.
10. Data Logging: Controller shall have ability to log data and to maintain last 99 events, even during total power loss. The following events shall be time and date stamped and maintained in a non-volatile memory:
    a. Event Logging

1) Date and time and reason for transfer normal to emergency.
2) Date and time and reason for transfer emergency to normal.
3) Date and time emergency source available.

b. Statistical Data
1) Total number of transfers.
2) Last ten numbers of transfers due to source failure.
3) Total number of hours both normal and emergency sources are available.

11. Terminate control wires with crimp lugs and identify with sleeve type markers. Provide suitable copper connector lugs for each service and load connections.

2.8 BYPASS-ISOLATION SWITCH

A. Provide separate bypass and isolation handles. Handles shall be permanently affixed and operable without opening enclosure door. Designs requiring insertion of loose operating handles or opening of enclosure door to operate are unacceptable.

B. Bypass handle shall have three operating modes: “Bypass to Normal”, “Automatic”, and “Bypass to Emergency”. Operating speed of bypass contacts shall be the same as associated transfer switch and be independent of speed at which manual handle is operated. In “Automatic” mode bypass contacts shall be out of power circuit so that they will not be subjected to fault currents to which system may be subject.

C. Isolation handle shall provide three operating modes: “Closed”, “Test”, and “Open”. “Test” mode shall allow testing of entire emergency power system, including automatic transfer switches with no interruption of power to load. “Open” mode shall completely isolate automatic transfer switch from source and load power conductors. In “Open” mode, it shall be possible to completely withdraw automatic transfer switch for inspection or maintenance to conform to code requirements without removing power conductors and without requiring tools.

D. When isolation switch is in “Test” or “Open” modes, bypass switch shall function as a manual transfer switch.

E. Break-before-make Design Bypass Isolation Switch:
1. Break-before-make bypassing shall be by means of a single, externally operated handle. Handle shall allow direct, one step bypass to either normal source or to emergency source, regardless of position or condition of transfer switch. Designs requiring multiple steps, bypassing to other than desired source, or that are dependent on electrical operation of transfer switch are not acceptable. Bypass operation shall not be dependent upon electrical device or interlocks for safety purposes or for proper sequencing.

2. Isolating shall be by a second externally operated handle. For safety purposes, operation of isolating handle shall disconnect all electrical power to transfer switch.
3. Necessary controls shall be provided to assure that "engine run" circuit shall remain closed if bypass switch is in bypass to emergency position, regardless of status of transfer switch signals.
4. Indicating lights shall be provided to show the following:
   a. Amber LED to indicate normal power available.
   b. Amber LED to indicate emergency power available.
   c. Green LED:
      1) Constant: Indicates load bypassed to normal source, isolating contacts closed, transfer switch energized.
      2) Flashing: Indicates load bypassed to normal source, isolating contacts open, transfer switch bypassed and isolated
   d. Red LED:
      1) Constant: Indicates load bypassed to emergency source, isolating contacts closed, transfer switch energized.
      2) Flashing: Indicates load bypassed to emergency source, isolating contacts open, transfer switch bypassed and isolated.
5. The automatic transfer switch and the bypass isolation switch shall be mounted in a common enclosure, and be separated by barrier from each other. Provide separate hinged doors with individual lockable handles for transfer switch section and bypass switch section.
6. Transfer switch shall be of draw-out design. Draw-out shall be via draw-out carriage that disconnects all power and control connections from transfer switch so that switch is completely isolated and electrically de-energized.
7. Interconnections between transfer switch and bypass isolation switch shall be made by manufacturer so that installer shall be required only to make external power and control connections to lugs or terminal strips at bypass/isolation switch to complete installation. Power interconnections shall be silver-plated copper bus bar.

2.9 SOURCE QUALITY CONTROL

A. Perform manufacturer's standard factory tests that shall include:
   1. Physical inspection and checking of components.
   2. Mechanical operation and device functional tests.
   3. Control operation and functionality tests.
   4. Primary, control, and secondary wiring hi-pot tests.

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine conditions under which Work is to be performed and notify ENGINEER in writing of conditions detrimental to proper and timely completion of the Work.

Do not proceed with the Work until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install equipment so that sufficient access and working space is provided for ready and safe operation and maintenance.

B. Install equipment in accordance with Contract Documents and manufacturer recommendations.

C. Securely fasten equipment to floors, walls, or other surfaces on which equipment will be mounted. Install freestanding switches on raised concrete pad at locations shown on Drawings. Install in accordance with manufacturer's recommendations.

3.3 FIELD QUALITY CONTROL

A. Perform field testing and inspection of each automatic transfer switch. Testing and inspection shall be in accordance with manufacturer's recommendations and be performed by manufacturer's factory-trained representative, who shall inform ENGINEER when equipment has been correctly installed. Do not energize equipment without permission of CITY and ENGINEER.

3.4 MANUFACTURER SERVICES

A. Manufacturer Services:
   1. Unloading and Installation: Manufacturer's factory-trained representative shall be present during unloading of equipment and installation at equipment's final location. In advance of installation, representative shall train installing personnel in proper handling and rigging of equipment, for at least 1 eight-hour days at the Site.
   2. Manufacturer's factory-trained representative shall test the system as specified in Article 3.3 of this Section. Representative shall operate and test system in the presence of ENGINEER and verify that equipment conforms to requirements. These services shall be at least 1 eight-hour days at the Site.
   3. Manufacturer's factory-trained representative shall adjust the system to initial settings specified in Article 2.6 of this Section.
   4. Representative shall revisit the Site as often as necessary until all deficiencies are corrected, prior to readiness for final payment.
   5. Provide services of manufacturer's factory-trained representatives to correct defective Work within 72 hours of notification by CITY during the Correction Period specified in the General Conditions as amended by the Supplementary Conditions.
   6. Replacement parts or equipment installed during the Correction Period shall be equal to or better than the original.

B. Training: Furnish services of qualified factory trained specialists from manufacturer to instruct CITY's operations and maintenance personnel in recommended operation and maintenance of the products. Training requirements, duration of instruction, and other qualifications shall be in accordance with Section 01 79 23, Instruction of Operations and Maintenance Personnel.

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SECTION 26 43 00

SURGE PROTECTIVE DEVICES

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install surge protective devices (SPD).
   2. SPDs furnished under this Section shall be ANSI/UL 1449 Type 2 integrating both surge suppression and high-frequency noise filtering suitable for use on low-voltage distribution systems.

B. Related Sections:
   1. Section 26 05 05, General Provisions for Electrical Systems.
   2. Section 26 24 13, Switchboards.
   3. Section 26 24 16, Panelboards.

1.2 REFERENCES

A. Standards referenced in this Section are:
   1. ANSI/UL 1449, Surge Protective Devices.
   2. IEEE C62.41, Recommended Practice on Surge Voltages in Low-voltage AC Power Circuits.
   3. IEEE C62.45, Recommended Practice on Surge Testing for Equipment Connected to Low-Voltage (1,000 V and Less) AC Power Circuits.
   4. UL 1283, Electromagnetic Interference Filters.

1.3 QUALITY ASSURANCE

A. Qualifications:
   1. Manufacturer: Shall have at least five years experience manufacturing and servicing products substantially similar to those required and shall be able to submit documentation of at least five installations in satisfactory operation for at least five years each.

B. Component Supply and Compatibility:
   1. Obtain all products included in this Section regardless of component manufacturer from a single SPD manufacturer.
   2. SPD manufacturer shall review and approve or prepare all Shop Drawings and other submittals for all components furnished under this Section.
   3. Components shall be suitable for the specified service conditions and shall be integrated into overall assembly by SPD manufacturer.

C. Regulatory Requirements: Comply with the following:
   1. NEC 110.9, Requirements for Electrical Installations, Interrupting Rating.
   2. NEC 240.21, Overcurrent Protection, Location in Circuit.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Shop Drawings:
      a. Electrical and mechanical drawings for each type of unit, showing electrical ratings, dimensions, mounting provisions, connection details, and layout diagrams.
      b. Components list and nameplate schedule.
      c. Summary sheets with schedules of equipment.
   2. Product Data:
      a. Manufacturer’s technical information, including catalog information.
      b. Manufacturer's technical specifications with assembly and component ratings.

B. Informational Submittals: Submit the following:
   1. Certifications:
      a. Certification that SPD devices comply with standards referenced in this Section.
   2. Source Quality Control Submittals:
      a. Report of results of testing and inspections performed at manufacturer’s shop.
   3. Supplier Reports:
      a. Submit written report of results of each visit to Site by Supplier’s service technician, including purpose and time of visit, tasks performed, and results obtained. Submit within two days of completion of visit to the Site.
   4. Qualifications Statements:
      a. Manufacture, when requested by ENGINEER.

C. Closeout Submittals: Submit the Following
   1. Operations and Maintenance Data:
      a. Submit in accordance with Section 01 78 23, Operations and Maintenance Data.
      b. Include acceptable test reports, maintenance data and schedules, description of operation, wiring diagrams, and list of spare parts recommended for one year of operation with current price list.
   2. Warranty Documentation: Submit example warranty at time of shipment of the equipment. Include final warranty accepted by ENGINEER in the operations and maintenance manual for the equipment.

1.5 DELIVERY, STORAGE, AND HANDLING.

A. Delivery:
   1. Upon delivery, check for evidence of water that may have entered equipment during transit.

B. Storage:
   1. Store SPD equipment in a clean, dry location with controls for uniform temperature and humidity. Protect equipment with coverings and maintain environmental controls.
   2. Protect equipment from corrosion and deterioration.

1.6 WARRANTY

A. General Warranty: The special warranty specified in this Article shall not deprive CITY or DEPARTMENT of other rights or remedies CITY or DEPARTMENT may otherwise have under the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by CONTRACTOR under the Contract Documents. The obligations of CONTRACTOR under the Contract Documents shall not be limited in any way by the provisions of the specified special warranty.

B. Special Warranty on Materials and Equipment:
   1. Provide manufacturer's written warranty, running to the benefit of DEPARTMENT and CITY, agreeing to correct, or at option of CITY, remove or replace materials or equipment specified in this Section found to be defective during a period of five years after the date of Substantial Completion.

PART 2 – PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Provide equipment of one of the following:
   1. General Electric.
   2. Schneider Electric/Square-D Company.
   3. Eaton/Cutler-Hammer.
   4. Or equal.

2.2 EQUIPMENT

A. General:
   1. SPD shall be modular, high-energy, parallel design with fast-acting transient voltage suppression using metal oxide varistors. Equipment shall provide noise attenuation with electromagnetic interference filter.
   2. SPD shall comply with requirements of the following:
      a. ANSI/UL 1449.
      b. UL 1283.

c. IEEE C62.11, IEEE C62.41 and IEEE C62.45.

3. SPD shall be suitable for operation under the following environmental conditions:
   a. Relative Humidity: Zero to 95 percent, non-condensing.
   b. Frequency: 47 to 63 Hertz.
   c. Temperature: Zero to 149 degrees F.
4. SPD operating voltage and IEEE C62.41 and IEEE C62.45 Category A, B, and C application environments shall be suitable for the associated SPD location(s) shown or indicated on the Drawings.
5. SPD shall be suitable for internal and external mounting. Where shown on the Drawings, SPD shall be factory-mounted and integrated into distribution equipment specified under the following Sections:
   a. Section 26 24 13, Switchboards.
   b. Section 26 24 16, Panelboards.

B. SPD shall include a surge suppression path for each mode as required for the system configuration shown on the Drawings. Each mode shall be individually fused and equipped with thermal cutouts. SPD short-circuit rating shall be 200 kA. Protection modes shall include, to the extent applicable, the following:
   1. Line-to-line.
   2. Line-to-neutral.
   3. Line-to-ground.
   4. Neutral-to-ground.

C. SPD shall include electromagnetic interference/radio frequency interference (EMI/RFI) noise rejection filter with attenuation up to 30 dB from 10 kHz to 100 MHz.

D. SPDs and components in the operating path shall have maximum continuous operating voltage greater than 115 percent of nominal system operating voltage.

E. ANSI/UL 1449 minimum withstand rating shall be 20 kA per pole, and ANSI/UL 1449 voltage protection rating for SPD shall not exceed the following:

Modes	208Y/120	480Y/277
L-N,L-G, N-G	800	1200
L-L	1200	2000

F. SPD surge capacity based upon IEEE C62.41 location category shall, as a minimum, be the following:

Category	Application	Per Phase	Per Mode
C	Service entrance	240 kA	120 kA
B	High exposure locations (distribution equipment)	160 kA	80 kA
A	Branch locations	120 kA	60 kA

2.3 ACCESSORIES

A. Provide SPD equipped with the following accessories:
   1. Surge counter with display for indicating the number of surges detected.
   2. LED indicators for monitoring device status.
   3. Audible alarm and silence switch for indicating an inoperative condition.
   4. Dry contacts, "Form C", for remote annunciation of unit status.
   5. Indicators, counter, alarm, and silence switch shall be visible and accessible from front of the SPD. When SPD is integral to switchgear, motor control center, panelboard, or other equipment, indicators, counter, alarm, and silence switch shall be visible and accessible from front of the equipment in which the SPD is installed.
   6. Enclosure for each externally-mounted SPD: NEMA rating shall be as required for area classifications specified in Section 26 05 05, General Provisions for Electrical Systems.

2.4 SOURCE QUALITY CONTROL

A. Perform manufacturer's standard factory tests on equipment. Tests shall be in accordance with IEEE C62.45 and ANSI/UL 1449.

PART 3 – EXECUTION

3.1 INSPECTION

A. Examine conditions under which materials and equipment will be installed and notify ENGINEER in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions are corrected.

3.2 INSTALLATION

A. Install SPD at locations shown on the Drawings in accordance with equipment manufacturer's recommendations, Laws, and Regulations, and the Contract Documents.

B. Conductor length between suppressor and connection point shall be as short and as straight as possible.

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SECTION 26 50 00

LIGHTING

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install lighting fixtures and associated controls.

B. Coordination:
   1. Coordinate location of fixtures with piping, ductwork, openings, and other systems and equipment and locate clear of interferences.
   2. Coordinate fixtures to be mounted in hung ceilings with the ceiling suspension system proposed.

C. Related Sections:
   1. Section 26 05 05, General Provisions for Electrical Systems.
   2. Section 26 05 53, Identification for Electrical Systems.

1.2 REFERENCES

A. Standards referenced in this Section are:
   1. UL 844, Luminaires for Use in Hazardous (Classified) Locations.
   2. UL 935, Safety of Fluorescent Lamp Ballasts.
   3. UL 1029, Safety of High-Intensity- Discharge Lamp Ballasts.
   4. UL 1598, Safety of Luminaires.

1.3 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with the following:
   1. NEC Article 410, Luminaires, Lampholders, and Lamps.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Shop Drawings:
      a. Schedule of light fixtures to be furnished, indicating fixture type and location for each.
      b. Customized wiring diagrams.
   2. Product Data:
      a. Manufacturer's technical information, specifications, standard wiring diagrams, and catalog cuts for lighting fixtures proposed.

b. Fixture construction details.
c. ETL photometric and isocandle curves for each fixture proposed.
d. Verification that recessed fixtures to be mounted in hung ceilings are compatible with ceiling suspension system proposed.

B. Informational Submittals: Submit the following:
1. Manufacturer's Instructions:
a. Instructions and recommendations for handling, storing, and protecting the equipment.
b. Installation instructions for for the equipment, including setting drawings, templates, and directions and tolerances for installing anchorage devices.

C. Maintenance Material Submittals: Submit the following:
1. Spare Parts and Extra Stock Materials: Furnish spare parts for each type of unit required as indicated in Part 2 of this Section.

1.5 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Delivery:
1. Upon delivery, inspect equipment for evidence of water that may have entered equipment during transit.

B. Storage:
1. Store lighting fixtures, controls, related materials and equipment in clean, dry location with controls for uniform temperature and humidity. Protect materials and equipment with coverings and maintain environmental controls.
2. Store materials and equipment for easy access for inspection and identification. Keep materials and equipment off ground, using pallets, platforms, or other supports. Protect materials and equipment from corrosion and deterioration.

PART 2 – PRODUCTS

2.1 MATERIALS

A. Type: Lighting fixtures required shall be in accordance with the Lighting Fixture Schedule on the Drawings. Fixtures shall be complete with supports, ballasts, lamps, and incidentals, as required.

B. Fixtures in hazardous locations shall be listed in accordance with UL 1598 and UL 844.

C. Lamps:
1. Fluorescent: Fluorescent lamps shall be toxic characteristic leaching procedure (TCLP) compliant for low mercury content. Linear fluorescent lamps shall be T8, energy-efficient, extended life type. Compact fluorescent lamps shall be long-life, energy-efficient type.

2. High Pressure Sodium: Shall be TCLP-compliant for low mercury content. Lamps shall be clear with high-efficacy and lumen maintenance.
3. Metal Halide: Shall be fabricated for low mercury content and be TCLP-compliant when available. Lamps shall be clear-pulse, start type with high-efficacy and lumen maintenance.
4. Incandescent: Inside-frosted.
5. Spare Parts and Extra Stock Materials: Ten percent spare lamps of each type and wattage.

D. Ballasts:
1. Fluorescent: UL 935 listed, high power factor, energy-efficient type, equipped with thermal protectors (Type "P" ballast), compatible with lamps installed. Indoor two-lamp fluorescent ballasts shall be electronic type with total harmonic distortion of less than 20 percent. Ballast factor shall be 0.85 minimum with total of less than 61 watts input. Provide cold weather type ballast where indicated in the Lighting Fixture Schedule.
2. High Intensity Discharge: UL 1029 listed, high power factor, constant wattage, stabilized autotransformer with line starting current the same or less than operating current.
3. Ballasts sound level shall be 30 decibels or less, sound rating "A".
4. Ballasts shall be Edison Testing Laboratories (ETL) listed and Certified Ballast Manufacturer Association, CMB-certified.
5. For fixtures utilizing double-ended lamps, provide fixture disconnecting means within the fixture.
6. Spare Parts and Extra Stock Materials: Ten percent spare ballasts of each type and quantity, but not less than one.

E. Fixtures located in area identified as hazardous in Section 26 05 05, General Provisions for Electrical Systems, shall each be approved as a complete assembly, shall be clearly marked to indicate maximum wattage of lamps for which they are approved, and be protected against physical damage by suitable guards.

F. Hardware: Provide necessary hangers, supports, conduit adaptors, reducers, hooks, brackets, and other hardware required for safe fixture mounting. Hardware shall have protective, non-corrosive finish.

G. Outdoor Fixtures: Provide each fixture to be installed outdoors with cut-off lens to reduce the fixture's light pollution emissions.

H. Time Switch:
1. Type: Astronomic dial time switch with day-omitting device.
2. Products and Manufacturers: Provide of one of the following:
   a. Z Series by Tork Time Controls, Inc.
   b. Or equal.
3. Timing Motor: Heavy-duty, synchronous, self-starting, high torque, 120-volt or 277-volt, 60 Hertz, as shown on the Drawings.
4. Capacity: 40 amps per pole at 277 volts.

5. Dial: 24-hour rotation, with gear to provide one revolution per year that automatically raises the "ON" and "OFF" settings each day according to seasonal changes of sunset and sunrise.
6. Reserve Power: Spring driven reserve sufficient to operate time switch contacts for not less than 30 hours after power failure. On restoration of power, time switch shall transfer to synchronous motor drive and automatically rewind reserve.

I. Lighting Contactor and Controls:
1. Provide a lighting contactor and control system for control of each area where shown on the Drawings.
2. Product and Manufacturer: Provide products of one of the following:
   a. Type SM03 by Square D Company.
   b. Or equal.
3. System shall include:
   a. Enclosure sized as required, complete with input control fuse and screw type terminal blocks rated 300-volt, 20-amp quantity for all circuits, unless indicated otherwise on the Drawings.
   b. Single coil, electrically-operated, mechanically-held contactor. Contactor shall be rated 30-amp, 600-volt, with 120-volt operating coil, unless indicated otherwise on the Drawings. Number of poles shall be as shown on the Drawings. Provide multiple contactors when necessary.
   c. Where lighting contactors are controlled by photocell, provide a 120-volt, two-pole control relay, enclosure mounted to convert the two-wire photocell control to three-wire control required by contactor. Control shall include a cover mounted on-off-auto selector switch for "manual" or "auto" selection of operation. In "auto" position, contactor shall respond to photocell.
   d. Enclosure: As required for area classification per Section 26 05 05, General Provisions for Electrical Systems.
   e. Identify panel in compliance with Section 26 0 53, Identification for Electrical Systems.

J. Photocell:
1. Products and Manufacturers: Provide one of the following:
   a. 2100 Series by Tork Time Controls, Inc.
   b. Or equal.
2. Cadmium sulfide hermetically-sealed cell, fully temperature compensated, with time delay of not less than 15 seconds to prevent false switching.
3. Built-in fail safe light level selector, adjustable within limits of two to 50 foot-candles and factory set at 25 foot-candles.

K. Fixture-Lowering Hanger System:
1. General:
   a. Provide corrosion-resistant system that lowers fixtures to ground level to allow maintenance on fixtures. Provide lowering hanger system for each fixture as shown on the Drawings.

2. Products and Manufacturers: Provide one of the following:
    a. Thompson Hangers, by Joslyn Hi-Voltage Corp.
    b. Or equal.
3. System:
    a. Upper or fixed housing of lowering devices shall contain:
        1) Attached pulley.
        2) Single point latching mechanism.
        3) Guide.
        4) Upper or socket electrical contacts.
    b. Lower or moveable housing of lowering devices shall contain:
        1) Operating line termination.
        2) Positioning stem and lower half of latch assembly.
        3) Lower electrical contacts.
        4) Fixture adapter.
    c. Fixtures shall be lowered on a guide line to allow operation of system in adverse weather and with structural clearance. Angles of the guide line to the structure shall be in accordance with to lowering device manufacturer's instructions.
    d. Operating line shall be high-strength/high-flexibility stainless steel and supplied by the lowering device manufacturer.
    e. Each operating line shall be encased in conduit where lower than eight feet above finished floor.
    f. Non-hanger termination shall be of enclosed and surface mounted design.
    g. Pulleys shall be supplied by hanger manufacturer as required to prevent excessive cable sag and allow lateral offsets between fixture location and cable termination.
    h. Provide portable manual winch.
4. Electrical:
    a. Contact material shall be silver-impregnated/silver-plated plate copper. Contacts shall use ball and socket design for ease of alignment and to allow for residual building vibration and movement.
    b. Contact pressure shall be supplied by springs remote from current conductors and shall not be part of current-carrying path.
    c. Termination of wiring shall be to crimp connectors.
    d. Provide electrical insulation of contacts by porcelain standoffs.
    e. Lowering device shall be make-and-break rated, UL-approved, as follows:
        1) 250 vac: 30 amps
        2) 600 vac: 15 amps
        3) 250 vdc: 10 amps
    f. Lowering device shall have eight contacts rated at 120 vac, 15 amps.
5. Mechanical:
    a. System loading capacity: 200 pounds.
    b. Manual or power winch operation.
    c. Housing manufactured with copper-free or low copper content cast aluminum.
    d. Operation shall be slow pull/quick release method.

e. Maintenance-free design.
f. Latching means shall be single point centered design to facilitate even wear over life of hangar.
g. Provide a tag line to facilitate lateral movement over inaccessible spaces. Tag line shall consist of the following parts by hanger manufacturer:
   1) Termination kit for wall.
   2) Manual winch.
   3) Operating cable.
   4) Pulley for upper mounting.

L. Motion/Occupancy Sensor:
   1. Products and Manufacturers: Provide one of the following:
      a. Leviton, Motion Sensor Field-of-View PR 150-1LW
      b. Or equal.
   2. Adjustable time delay interval of 15 seconds to 15 minutes.
   3. Equipped with passive infrared (PIR) sensing technology.

PART 3 – EXECUTION

3.1 INSPECTION

A. Examine conditions under which the Work will be installed and notify ENGINEER in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions are corrected.

3.2 INSTALLATION

A. General:
   1. Fixture mounting heights and locations indicated on the Drawings are approximate and are subject to revision in the field where necessary to clear conflicts and obstructions.
   2. Mounting Heights: Mounting heights or elevations are to bottom of fixture or to centerline of device.
   3. Install fixtures in accordance with Laws and Regulations, the Contract Documents, and manufacturer instructions and recommendations.
   4. Mount fixtures so that sufficient access is available for ready and safe maintenance.
   5. Securely fasten equipment to walls or other surfaces on which equipment is mounted.

B. Suspended Fixtures:
   1. Pendant-mount using 1/2-inch diameter conduit stems.
   2. Ground to outlet box.
   3. Attach mounting to building structure with expansion anchors.
   4. Fixtures shall not be dependent on the outlet box cover screws for support.

C. Surface Mounted Fixtures:
   1. Attach to appropriate outlet box.
   2. Attach to surface using fasteners and sealing washers when mounting fixture in damp or wet locations.

D. Boxes and Fixtures:
   1. For units mounted against masonry or concrete walls, provide suitable 1/4-inch spacers to prevent mounting back of box directly against wall.
   2. Bolt units rigidly to building with expansion anchors, toggle bolts, hangers, or Unistrut.
   3. Do not install boxes with open conduit holes.
   4. Cable each circuit and identify with tag.

E. Re-lamp all fluorescent fixtures provided under this Contract with new lamps following Substantial Completion.

F. Mount photocells as shown and adjust foot-candle setting for proper dusk and dawn photo-control. Provide wiring in conduit from photocell to controls.

G. Fixture Lowering System:
   1. Hangers shall be plumb.
   2. Provide adequate clearance between operating line and structural members, pipes, ducts, and other equipment and devices to avoid interference.
   3. Conduit runs enclosing operating lines shall be straight with no offset bends.

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SECTION 28 31 00

FIRE DETECTION AND ALARM SYSTEM

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope :
   1. CONTRACTOR shall provide all labor, materials, equipment and incidentals shown, specified and required to design, furnish, install, calibrate, test, adjust and place into satisfactory operation a fire detection and alarm system.
   2. CONTRACTOR shall retain the services of a designer/installer regularly engaged in the installation of fire alarm systems to design and install the fire alarm system in accordance with requirements of federal, state, and local codes and standards.
   3. Permits and Inspections: CONTRACTOR shall be responsible for the following:
      a. Preparation and submission of plans for permitting to the authority having jurisdiction (AHJ).
      b. Obtaining and paying associated fees of all permits required.
      c. Arranging and coordinating inspections of the installation at the times and stages of construction required by the AHJ.
      d. Arranging and coordinating the final inspection and acceptance testing of the system by the AHJ.
      e. Obtaining the final inspection permit.
   4. The fire alarm system shall be installed in the following buildings:
      a. GAC Treatment Building
         1) Smoke detectors.
         2) Manual Pull Stations.
         3) Horn/Strobe Annunciators.
         4) Beam detectors.

B. General:
   1. The basic design shall be that the building will have its own Fire Alarm Control Panel (FACP) that will monitor and control the detection system and the notification system for that building. The FACP shall also communicate with a master FACP located at the Head House. Suggested location for the FACP is shown on the Drawings. It shall be the responsibility of the designer/installer to verify the location of devices and provide an acceptable layout in terms of device coverage and location that conforms to code requirements.

C. Related Sections:
   1. Section 26 05 53, Identification for Electrical Systems.

1.2 QUALITY ASSURANCE

A. General:
   1. It is the intent of these Specifications to provide a complete fire alarm system that complies with the requirements of all applicable federal, state, and local codes and standards. Equipment, materials, software, installation practices, etc. that do not meet these requirements or do not meet the performance standards herein specified shall not be acceptable.
   2. All references to model numbers and other pertinent information herein is intended to establish the standards of performance, quality and appearance, and is based upon equipment already designed and manufactured.

B. Supplier:
   1. In order to insure standardization, proper interfacing and compatibility, it is required that all equipment offered under this Section shall be furnished by a single supplier. The supplier shall provide all equipment required for a proper installation and shall coordinate all design and shop drawings.
   2. All items of equipment, including wire and cable, shall be compatible.
   3. Supplier shall have and maintain an adequate service organization or service representatives located within 200 miles of the project site knowledgeable in the maintenance and installation of equipment required.

1.3 REFERENCES

A. Comply with applicable provisions and recommendations of the following except where otherwise shown or specified.
   1. National Fire Protection Association
   2. National Electrical Code.
   3. Underwriters' Laboratories.
   4. National Electrical Manufacturer Association.
   5. Factory Mutual.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Product Data:
      a. Manufacturer's literature, illustrations, specifications and engineering data including: general arrangement, outline drawings, dimensions, materials, size, and performance data.
   2. Shop Drawings:
      a. Fabrication, assembly, installation, and wiring diagrams.
      b. Design drawings and calculations prepared by designer/installer shall be submitted to ENGINEER for review and approval prior to submission to AHJ and prior to proceeding with work.
      c. The design calculations and design drawings for the fire alarm system shall be prepared under the direction of a Professional Engineer or Architect registered in the state where the work is located.
      d. All design drawings and the first sheet of calculations shall bear the professional's seal and signature.

e. The design drawings shall be prepared in sufficient detail that all fire alarm system components are clearly defined and located.
f. The design drawings shall show the following:
1) Complete point-to-point connection and riser diagrams clearly labeling all interconnected components, conduit, and wire.
2) Component locations superimposed on project plan drawings.

B. Closeout Submittals: Submit the following:
1. Operation and Maintenance Data:
a. Submit complete installation, operation, and maintenance manuals including test reports, maintenance data and schedules, description of operation and spare parts information.
b. Provide Operation and Maintenance manuals as specified in Section 01 78 23, Operations and Maintenance Data.
c. Spare parts and maintenance materials.
2. Inspection Reports:
a. Submit copies of the signed, approved permit forms following each inspection by the AHJ.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Manufacturers:
1. SimplexGrinnell.
2. Cerberus, Division of Siemens.
3. Or equal

B. Fire Alarm Control Panel (FACP):
1. General: The FACP shall provide power, annunciation, supervision, and control for initiating devices and notification devices. The FACP shall also provide alarm and trouble reporting and interlocks to other equipment.
2. All external circuits shall be listed as power limited circuits per Article 760 of The National Electric Code.
3. The FACP shall be modular in construction and contain all modules necessary to operate according to applicable codes and standards and the Contract Documents.
4. Where the protected area consists of multiple buildings or a building large enough that more than one panel is required, the panels shall be interconnected or networked. One panel shall be designated as the Master Fire Alarm Control Panel (MFACP). The MFACP shall echo the alarms and trouble reports of the other panels in the system. It shall also be possible to acknowledge or reset the remote alarms from the MFACP.
5. The FACP shall operate from a 120 VAC single phase power supply.
a. Provide internal standby power supply.
1) The standby power shall be capable of powering the system for 24 hours in a quiescent state and then providing at least 5 minutes of full scale alarming.

2) Provide charger and monitoring for the standby power system

6. The FACP shall provide supervision of system electronics, wiring, initiation devices, notification devices, and software.
   a. Failure of system hardware or wiring shall be indicated by a trouble indication on the FACP.
   b. Software and processor operation shall be monitored by an independent hardware watchdog, which will indicate their failure. Each processor in the system shall have its own hardware watchdog circuitry.
   c. Ground fault detection shall be provided for all system circuits.
7. The FACP shall support the following features:
   a. Support for addressable analog detectors and other addressable initiating devices.
   b. Support for addressable notification devices.
   c. Alarm verification programmable on a device-by-device basis.
   d. "Almost" dirty detector reporting.
   e. Peak value logging (by device).
   f. Automatic drift compensation of detectors.
   g. Event history: shall store alarm, supervisory and trouble information.
   h. Subsequent alarm and trouble annunciation with reminder of acknowledged or silenced conditions.
   i. One person test feature allowing one individual to test the devices in the system.
   j. The FACP shall have the ability to bypass a zone, an initiating device, or an output through programming. There shall be a separate indication to show that part of the system has been bypassed.
8. FACP user interface:
   a. Light emitting diodes (LED's) shall indicate system power, alarm, supervisory/trouble, part of system bypassed, and Test/Program mode.
   b. An LCD display shall display system messages and also allow for display of custom label information as it relates to system messages.
   c. Switches for Alarm acknowledge, Alarm silence, System reset, and a System drill function.
9. FACP Enclosure:
   a. FACP enclosure shall be designed to accommodate the control unit, input and output modules, power supplies, and all other components utilized in the system.
   b. Enclosure shall be surface mounted.
   c. Enclosure shall consist of a back box and door cover assembly fabricated of sheet steel.
   d. Door cover shall be mounted with a sag resistant, steel piano hinge and fitted with a key locking arrangement.
   e. Door cover shall contain viewing slots to permit viewing of the user interface.
10. Support modules: The following modules shall be available for use as required:
    a. Relay output modules: Form "C" relays for programmable outputs such as general alarm, trouble outputs, and interlocks to HVAC and other equipment or monitoring systems.

1) Contacts shall be rated at 120 VAC, 3 amp. The relay coil shall be supervised.
2) Assume two outputs of each type per panel.

b. Relay input module: The module shall accept dry contact inputs from remote sources. Action taken upon receipt of contact change of state shall be programmable.

c. Networking or communications module: The module shall allow communications between multiple fire alarm control panels installed in the same facility.

d. City Circuit Module: The module shall interface the main FACP to telephone lines. The module shall transmit alarms and trouble reports to a listed, manned remote monitoring facility.

C. Horn/Strobe:
1. Operates from 24 VDC power supply.
2. Die cast metal housing.
3. Textured red enamel finish.
4. Polarized.
5. Sound output 99 dB at 10 feet.
6. UL listed.
7. White polycarbonate lens, with red "FIRE" lettering, to protect strobe circuitry.
8. Strobe shall produce 8000 peak candlepower at approximately 1 flash per second.
9. Horn/strobes shall be of sufficient quantity and locations so that an alarm shall be clearly visible and audible to all occupants of the building(s) regardless of where occupants are at.

D. Manual Pull Station:
1. Molded polycarbonate with red matte finish. Raised molded lettering highlighted in white.
2. Alarm switch resetting requires opening front cover. Cover shall be hinged to back-plate assembly and locked by Allen head screw.
3. Normally open SPST switch.
4. Weather proof gasket, as required.
5. Manual Pull Stations shall be of sufficient quantity and locations to make the buildings be in conformance with applicable codes and standards.

E. Area Smoke Detectors
1. Surface Mounted.
2. Photoelectric type.
3. Listed per UL268A.
4. Contacts and Ratings: two Form C, 120 VAC, 1 ampere and 30 VAC/DC, 2 ampere; and one Form A, 30 VAC/DC, 2 ampere.
5. Provide with electrical outlet box and all mounting accessories, 120 VAC wiring kit.
6. Provide subbase and all other accessories required for a functioning detector.

7. Area Smoke Detectors shall be of sufficient quantity and locations so to make the buildings be in conformance with applicable codes and standards.

F. Duct Smoke Detectors:
   1. Duct smoke detectors shall be photoelectric. Each smoke detector and its air duct housing shall be self-compensating for the effects of air velocity (from 300 to 4,000 CFM), temperature, humidity and atmospheric pressure. It shall not be necessary to field adjust the sensitivity to compensate for the above effects. Each smoke detector shall utilize solid state components and be equipped with an alarm indicating LED which shall flash when the smoke detector is activated and shall be provided with a form "C" remote relay with contacts rated at 3 amps 120 VAC or 24 VDC. The smoke detectors address shall be set by electronic means only, no mechanical means such as dipswitches, rotary dials, or by inserting programmable pins shall be used. The smoke detector mounting base shall be of the twist/lock type.

G. Heat Detectors:
   1. Heat detectors shall be self-restoring and provide rate compensated, fixed temperature sensing of 135°F, with rate-of-rise temperature sensing. Unit shall be UL for a maximum coverage area of 2,500 sq. ft. Rate-of-rise alarm threshold rate shall be 15°F per minute. Activation of this rate-of-rise heat detector shall be self restoring. All detectors shall be addressable and have a white finish. The thermal detectors shall be individually annunciated on the control panel. Thermal detectors shall contain an integral alarm lamp. The detector's address shall be set by electronic means only, no mechanical means such as programming pins, dipswitches, or rotary dials shall be used.
   2. Units designated as high temperature heat detectors shall comply with the requirements above except for a fixed temperature of 155°F.

H. Remote Annunciator:
   1. A System remote annunciator shall be provided for the Head House and shall be located in the Control Room.

2.2 WIRE

A. System supplier shall provide all wire and cable to interconnect all devices and panels as needed.

2.3 SPARES

A. Spare Parts:
   1. Ten percent of each type of detector (Minimum of 1).
   2. Ten percent of each type of module in FACP (power supply, supplementary relay, input, dialer, output, etc.)(Minimum: one of each).

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install fire alarm system including conduit and cable in accordance with Contract Documents, the approved Shop Drawings, and manufacturer's recommendations.

B. Install all conduit and cable required for the complete system, including 120 volt power requirements from local lighting panels. Provide pull and junction boxes as required.

C. Bond metallic conduits entering non-metallic enclosures to a ground terminal within the enclosure.

D. Wire and cable shall be labeled per Section 26 05 53, Identification For Electrical Systems.

E. Conduit shall be labeled per Section 26 05 53, Identification For Electrical Systems.

3.2 FIELD QUALITY CONTROL SERVICES

A. CONTRACTOR shall retain a qualified factory-trained serviceman to perform the following services:
   1. Inspect and adjust the equipment after installation and verify that it operates properly.
   2. Be present during inspections by the AHJ.
   3. Instruct CITY's personnel in the operation and maintenance of the equipment.

B. Field Tests:
   1. Field testing to be supervised by a factory-trained serviceman.
   2. Verify that the entire installation has been made in accordance with the approved shop drawings and that the fire alarm system is ready for total operation.
   3. Adjust and leave equipment in proper working order.

C. CONTRACTOR shall make available to CITY a local service department of a duly authorized distributor of the equipment manufacturer that shall stock the manufacturer's standard parts.

D. CONTRACTOR shall provide a service and maintenance agreement. On-the-premises maintenance parts, and labor, shall be provided during normal working hours at no cost to the CITY or DEPARTMENT for a period of twelve months. Said period shall start upon DEPARTMENT's and CITY's acceptance of entire fire alarm system.

3.3 TRAINING

A. Training shall be conducted by a factory qualified representative.

Training requirements, duration of instruction, and other qualifications shall be in accordance with Section 01 78 23, Section 01 79 13 and Section 01 79 23, Instruction of Operations and Maintenance Personnel.

Equipment	Specification Section	Total Training Time (hours)	Training Sessions Required		
			Operations	Mechanic Maint.	Instrument Maint.
Fire Alarm System	28 31 00	12	2 sessions, 2 hours		2 sessions, 4 hours

++ END OF SECTION ++

SECTION 31 05 19

GEOSYNTHETICS FOR EARTHWORK

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment, and services required to provide and place geosynthetics as shown and specified.

B. Related Sections:
   1. Section 31 23 05, Excavation and Fill.

1.2 REFERENCES

A. Standards referenced in this Section are listed below:
   1. American Society for Testing and Materials, (ASTM).
      a. ASTM D 1117, Test Methods for Non-Woven Fabrics.
      b. ASTM D 3776, Test Methods for Mass per Unit Area (Weight) of Woven Fabric.
      c. ASTM D 5034, Test Method for Breaking Strength and Elongation of Textile Fabrics (Grab Test).

1.3 QUALITY ASSURANCE

A. Manufacturer's Qualifications:
   1. Geotextile manufacturer shall be a specialist in the manufacture of geotextile cushion fabric, and have produced and successfully installed a minimum of five million square feet.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Product Data:
      a. Submit geotextile manufacturer's data, specifications, installation instructions and dimensions.

B. Informational Submittals: Submit the following:
   1. Certificates:
      a. Submit an affidavit certifying that the filter fabric furnished complies with all requirements specified herein.
      b. No fabric shall be shipped until the affidavit is submitted to the ENGINEER.

1.5 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Each roll of geotextile delivered to the Site shall be labeled by the manufacturer identifying the manufacturer's name, product identification, lot number, roll number and roll dimensions.

B. All rolls and packages shall be inspected by CONTRACTOR upon delivery to the Site. CONTRACTOR shall notify ENGINEER if any loss or damage exists to geotextile filter fabric. Replace loss and repair damage to new condition, in accordance with manufacturer's instructions.

C. Geotextile shall be protected from ultraviolet light exposure, precipitation or other inundation, mud, dirt, dust, puncture, cutting or any other damaging or deleterious conditions. Geotextile rolls shall be shipped and stored in relatively opaque and watertight wrappings.

PART 2 - PRODUCTS

2.1 GEOTEXTILE FILTER FABRIC

A. Geotextile shall be a needle punched, nonwoven fabric composed of 100 percent polyester filaments, which are formed into a stable network such that the filaments retain their relative position. The fabric shall be inert to biological degradation and naturally encountered chemicals, alkalizes, and acids. Geotextile shall conform to the following:

Fabric Property	Unit	Test Method	Minimum Value
Weight	oz/yd^2	ASTM D 5261	10.0
Grab Tensile Strength	lb	ASTM D 4632	250
Grab Strength Elongation	%	ASTM D 4632	50
Trapezoid Tear Strength	lb	ASTM D 4632	40
Water Permeability, "k"	sec-1	ASTM D 4491	1.2
Water Flow Rate	gpm/ft2	ASTM D 4491	80

B. Product and Manufacturer: Provide one of the following:
   1. Geotex 250 by Propex.
   2. GSE Environmental.

2.2 GEOTEXTILE STABILIZATION FABRIC

A. Geotextile shall be a woven fabric composed of 100 percent polyester filaments, which are formed into a stable network such that the filaments retain their relative position. The fabric shall be inert to biological degradation and naturally

encountered chemicals, alkalizes, and acids. Geotextile shall conform to the following:

Fabric Property	Unit	Test Method	Minimum Value
Grab Tensile Strength	lb	ASTM D 4632	315
Grab Strength Elongation	%	ASTM D 4632	12
Trapezoid Tear Strength	lb	ASTM D 4533	120
Mullen Burst	psi	ASTM D 3786	600
CBR Puncture	lbs	ASTM D 6241	900
Flow Rate	gpm/ft2	ASTM D 4491	4

B. Product and Manufacturer: Provide one of the following:
   1. Woven 315ST by Propex.
   2. GSE Environmental.

PART 3 - EXECUTION

3.1 INSPECTION

A. CONTRACTOR shall examine the conditions under which the Work is to be installed and notify the ENGINEER, in writing, of conditions detrimental to the proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions have been corrected.

3.2 INSTALLATION - GENERAL

A. All geotextiles shall be weighted with sandbags or the equivalent when required. Such sandbags shall be installed during placement and shall remain until replaced with cover material or geomembrane.

B. CONTRACTOR shall take any necessary precautions to prevent damage to underlying layers during placement of the geotextile.

C. During placement of geotextiles, care shall be taken not to entrap in the geotextile stone, excessive dust, or moisture that could damage the geomembrane, generate clogging, or hamper subsequent seaming.

D. Geotextiles shall not be exposed to precipitation prior to being installed, and shall not be exposed to direct sunlight for more than 15 days.

E. Geotextiles shall be overlapped 12 inches.

3.3 GEOTEXTILE REPAIR

A. Any holes or tears in the fabric shall be repaired as follows:
   1. On slopes: A fabric patch shall be sewn into place using a double sewn lock stitch (1/4-inch to 3/4-inch apart and no closer than 1 inch from any edge). Should any tear exceed ten percent of the width of the roll, that roll shall be removed from the slope and replaced.
   2. Non-slopes: A fabric patch shall be spot-seamed in place with a minimum of 24 inches of overlap in all directions.

3.4 PLACEMENT OF COVER MATERIALS

A. CONTRACTOR shall place all cover materials in such a manner to ensure the geotextile is not damaged; minimal slippage of the geotextile on underlying layers; and no excess tensile stresses in the geotextile.

+ + END OF SECTION + +

SECTION 31 11 00

CLEARING AND GRUBBING

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals required to perform clearing and grubbing as shown and specified in the Contract Documents.
   2. The Work includes removing from the Site and disposing of trees, stumps, brush, roots, shrubs, vegetation, logs, rubbish, and other objectionable material.
   3. Pay all costs associated with transporting and disposing of debris resulting from clearing.
   4. Limits of Clearing and Grubbing: Clear and grub the areas shown or indicated on the Drawings.

B. Related Sections:
   1. Section 01 57 05, Temporary Controls.

1.2 SUBMITTALS

A. Action Submittals: Submit the following
   1. Shop Drawings:
      a. Plan for removing trees and other large vegetation not explicitly shown or indicated for removal in the Contract Documents.
      b. Plan showing proposed limits of clearing and grubbing, if different from clearing and grubbing limits shown or indicated in the Contract Documents.

1.3 WARRANTY

A. CONTRACTOR shall warrant that Work performed under this Section will not permanently damage trees, shrubs, turf, and plants designated to remain, or other adjacent work, facilities, or property. If damage resulting from CONTRACTOR's operations becomes evident during the correction period, CONTRACTOR shall replace damaged items and property at no additional cost to DEPARTMENT.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION

3.1 PREPARATION

A. Protection:
   1. Throughout the Project, protect existing site improvements, including streets, drives, and Underground Facilities to remain (if any), and adjacent property and structures. Repair damage caused by CONTRACTOR to original condition or replace in kind, to satisfaction of ENGINEER, at no additional cost to DEPARTMENT.
   2. Protect trees, shrubs, vegetation, and grassed areas to remain by providing temporary fencing, barricades, wrapping, or other methods shown, specified, or accepted by ENGINEER. Correct at CONTRACTOR's expense damage caused by CONTRACTOR outside the limits of clearing Work.
   3. Do not remove trees without approval of ENGINEER, unless shown or indicated for removal.
   4. Do not locate construction equipment, stored materials, or stockpiles within drip line of trees and vegetation to remain.

B. Site Preparation:
   1. Obtain, pay costs associated with, and comply with applicable permits required for clearing and grubbing Work.
   2. Delineation of Clearing and Grubbing Limits:
      a. Locate and clearly flag trees and vegetation to remain, and other materials to remain in the clearing and grubbing limits. Locate and clearly flag salvable vegetation to be relocated.
      b. Provide flagging to delineate limits of areas to be cleared or grubbed. Review at Site with ENGINEER before commencing removal of trees, vegetation, and other materials to be removed.
      c. Replace flagging that is lost, removed, or destroyed, until clearing and grubbing Work is complete and ENGINEER allows removal of flagging.
   3. Erosion and Sediment Controls:
      a. Provide applicable erosion and sediment controls before commencing clearing and grubbing Work.
      b. Comply with erosion and sediment control requirements of Section 01 57 05, Temporary Controls.
      c. Continue providing erosion and sediment controls as clearing and grubbing Work progresses to previously uncleared, ungrubbed areas of the Site.

3.2 CLEARING AND GRUBBING

A. Remove and dispose of all trees, shrubs, stumps, roots, brush, logs, rubbish, and debris within limits of clearing and grubbing shown or indicated in the Contract Documents, unless otherwise shown or indicated.

B. Disposal of Cleared and Grubbed Materials:
   1. Dispose at appropriate off-Site location trees, stumps, rubbish, debris, and other cleared and grubbed material. Cleared or grubbed materials may remain at the Site only when allowed in the Contract Documents or when approved by ENGINEER in writing. Do not use cleared or grubbed material as fill, backfill, or in embankments.
   2. Dispose of cleared and grubbed material in accordance with Laws and Regulations.
   3. Do not burn clearing debris at the Site, unless approved by CITY and ENGINEER and authorities having jurisdiction. If burning is permitted, comply with requirements of authorities having jurisdiction and Laws and Regulations. If burning is permitted at the Site, also comply with CITY's requirements.

C. Removal of Site Improvements: Comply with Section 02 41 00, Demolition.

3.3 TOPSOIL REMOVAL

A. Existing topsoil to be removed is defined as friable, clay loam, surface soil present in depth of at least four inches. Topsoil shall be free of subsoil, clay lumps, stones, and other objects over two-inch diameter and other objectionable material.

B. Stripping:
   1. Strip topsoil to depths encountered, in manner that prevents intermingling of topsoil with underlying subsoil or other objectionable material. Remove heavy growths of grass and vegetation from areas before stripping.
   2. Do not strip topsoil from within drip line of each tree to remain as part of the completed Project.

C. Properly dispose of excess topsoil at a location other than the Site.

+ + END OF SECTION + +

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SECTION 31 23 05

EXCAVATION AND FILL

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals required to perform all excavating, filling, and grading, and disposing of earth materials as shown, specified, and required for construction of structures, Underground Facilities, roads, and other facilities required to complete the Work.
   2. Preparation of subgrade for slabs and pavements is included under this Section.
   3. No classification of excavated materials will be made. Excavation includes all materials regardless of type, character, composition, moisture, or condition thereof, except rock requiring drilling or special equipment for removal which is under Section 31 23 16.26, Rock Removal.

B. Related Sections:
   1. Section 31 23 16.26, Rock Removal.
   2. Section 31 05 19, Geosynthetics for Earthwork

1.2 REFERENCES

A. Standards referenced in this Section are:
   1. ACI 522R, Pervious Concrete.
   2. ANSI/AISC 360, Specification for Structural Steel for Buildings.
   3. ASTM C29/C29M, Test Method for Bulk Density ("Unit Weight") and Voids in Aggregate.
   4. ASTM C33/C33M, Specification for Concrete Aggregates.
   5. ASTM C94/C94M, Specification for Ready-Mixed Concrete.
   6. ASTM C138/C138M, Test Method for Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete.
   7. ASTM C172, Practice for Sampling Freshly Mixed Concrete.
   8. ASTM C150/C150M, Specification for Portland Cement.
   9. ASTM C595/C595M, Specification for Blended Hydraulic Cements.
   10. ASTM C618, Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete.
   11. ASTM C989, Specification for Slag Cement for Use in Concrete and Mortars.
   12. ASTM D422, Test Method for Particle-Size Analysis of Soils.
   13. ASTM D448, Classification for Sizes of Aggregate for Road and Bridge Construction.

14. ASTM D698, Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12 400 ft-lbf/ft^3 (600 kN-m/m^3)).
15. ASTM D1556, Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method.
16. ASTM D1557, Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft^3 (2,700 kN-m/m^3)).
17. ASTM D2216, Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass.
18. ASTM D4253, Test Methods for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table.
19. ASTM D4254, Test Methods for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density.
20. ASTM D4318, Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
21. ASTM D4832, Test Method for Preparation and Testing of Controlled Low Strength Material (CLSM) Test Cylinders.
22. ASTM D6023, Test Method for Density (Unit Weight), Yield, Cement Content, and Air Content (Gravimetric) of Controlled Low-Strength Material (CLSM).
23. ASTM D6103, Test Method for Flow Consistency of Controlled Low Strength Material (CLSM).
24. ASTM D6938, Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).
25. ASTM E329, Specification for Agencies Engaged in Construction Inspection and/or Testing.

1.3 TERMINOLOGY

A. The following words or terms are not defined but, when used in this Section, have the following meaning:
   1. "Subgrade" is the uppermost surface of native soil material unmoved from cuts; the bottom of excavation.

1.4 QUALITY ASSURANCE

A. Qualifications:
   1. Professional Engineer:
      a. Engage a registered professional engineer legally qualified to practice in the same jurisdiction as the Site and experienced in providing engineering services of the kind indicated.
      b. Responsibilities include but are not necessarily limited to:
         1) Reviewing system performance and requirements shown or indicated in the Contract Documents.
         2) Preparing written requests for clarifications or interpretations of performance and requirements for submittal to ENGINEER by CONTRACTOR.

3) Preparing or supervising the preparation of design calculations and related submittals verifying compliance of the system with the requirements of the Contract Documents.
4) Signing and sealing all calculations, drawings, and submittals prepared by professional engineer.
5) Certifying that:
   a) it has performed the design of the system in accordance with the performance requirements stated in the Contract Documents, and
   b) the said design conforms to Laws and Regulations, and to the prevailing standards of practice.

2. CONTRACTOR's Testing Laboratory:
   a. Retain the services of independent testing laboratory to perform testing and determine compliance with the Contract Documents of the materials specified in this Section.
   b. Testing laboratory shall comply with ASTM E329 and requirements of Section 01 45 29.13, Testing Laboratory Services Furnished by Contractor.
   c. Testing laboratory shall be experienced in the types of testing required.
   d. Selection of testing laboratory is subject to ENGINEER's acceptance.

B. Quality Assurance Testing:
   1. Quality assurance testing is in addition to field quality control testing required under Part 3 of this Section.
   2. Materials used in the Work may require testing and retesting, as directed by ENGINEER, during the Project. Allow free access to material stockpiles and facilities at all times. Tests not specifically indicated to be performed at DEPARTMENT's expense, including retesting of rejected materials and installed Work, shall be performed at CONTRACTOR's expense.
   3. CONTRACTOR's Testing Laboratory Scope:
      a. Collect samples and perform testing of proposed fill materials in the laboratory and in the field to demonstrate compliance of the Work with the Contract Documents.
      b. Testing laboratory shall perform testing required to obtain data for selecting moisture content for placing and compacting fill materials.
      c. Submit to ENGINEER and CONTRACTOR written report results of each test.
   4. Required Quality Assurance Material Testing by CONTRACTOR's Testing Laboratory:
      a. Gradation in accordance with ASTM D422. Perform one test for every 1,000 cubic yards of each of the following types of material incorporated into the Work: select fill, general fill, subbase material, drainage fill, and pipe bedding material.
      b. Atterberg limits in accordance with ASTM D4318. Perform one test for every 1,000 cubic yards of the following types of materials incorporated into the Work: general fill, and pipe bedding material.
      c. Moisture/density relations in accordance with ASTM D698, ASTM D1557, ASTM D4253, or ASTM D4254, as applicable. Perform one

test for every 5,000 cubic yards of the following types of materials incorporated into the Work: select fill, general fill, subbase material, drainage fill, and pipe bedding material.

d. Moisture content of stockpiled or borrow material in accordance with ASTM D2216. Perform one test for every 1,000 cubic yards of the following types of material incorporated into the Work: select fill, general fill, subbase material, drainage fill, and pipe bedding material.

e. Requirement for trial batch may be waived by ENGINEER if sufficient field test data documenting compliance with specified material properties and performance properties is submitted to and accepted by ENGINEER. Tests shall have been made on concrete with identical mix design to mix design proposed for the Work, including sources of aggregate and manufacturers of cementitious materials and admixtures.

C. Regulatory Requirements:

1. Perform excavation work in compliance with requirements of authorities having jurisdiction and Laws and Regulations, including:

a. OSHA, 29 CFR Part 1926, Section .650 (Subpart P – Excavations).

2. Obtain required permits and approvals for excavation and fill Work, including work permits from right-of-way owners and permits from environmental authorities having jurisdiction over discharge of water from excavations.

1.5 SUBMITTALS

A. Action Submittals: Submit the following:

1. Shop Drawings:

a. Modifications to the Work proposed due to design of sheeting, shoring, bracing, cofferdams, and similar excavation supports.

2. Samples:

a. Submit Sample of each aggregate and soil material required under this Section. Deliver Samples to Resident Project Representative. Samples shall be of sufficient size to demonstrate the array of gradation and material types expected in the Work.

B. Informational Submittals: Submit the following:

1. Procedure Submittals:

a. Excavation Plan: Prior to starting excavation operations, submit written plan to demonstrate compliance with OSHA 29 CFR Part 1926.650. As a minimum, excavation plan shall include:

1) Name of CONTRACTOR's "competent person" in responsible charge of excavation and fill Work.

2) Excavation method(s) and additional items to be included in the Work, as listed in Paragraph 1.5.B.2.a of this Section.

3) Copies of "manufacturer's data" or other tabulated data if protective system(s) are designed on the basis of such data.

4) Copies of required permits and approvals, from authorities having jurisdiction and affected utility owners, for excavation methods proposed.

b. Proposed compaction procedure and compaction equipment proposed for use. Where different procedures or equipment will be used for compacting different types of material or at different locations at the Site, indicate where each procedure and equipment item will be used.

2. Excavation Support Plan and Related Information Prepared by CONTRACTOR's Professional Engineer:
   a. CONTRACTOR and CONTRACTOR's professional engineer shall prepare the following for submittal:
      1) Sheeting and bracing, or other protective system(s) required.
      2) Dewatering system.
   b. Drawings and calculations shall be prepared by professional engineer qualified in the specialty involved. ENGINEER's review and acceptance of submittal does not imply approval by ENGINEER of the associated Work. CONTRACTOR shall be solely responsible for designing, installing, operating and maintaining the system(s) required to satisfactorily perform all necessary sheeting, bracing, protection, underpinning, and dewatering.
3. Delivery Tickets:
   a. Copy of delivery ticket for each load of aggregate and borrow material delivered to the Site. Each delivery ticket shall indicate project and contract by name and number, date, material type, department of transportation item number when applicable, and quantity delivered.
4. Quality Assurance Test Results Submittals:
   a. Submit results of quality assurance testing performed by in accordance with Paragraph 1.4.B of this Section, unless included as part of another submittal under this Section. Submit results for the following quality assurance testing:
      1) Tests on borrow fill material.
      2) Optimum moisture – maximum dry density curve for each type of fill material.
5. Field Quality Control Submittals:
   a. Submit results of testing and inspection performed in accordance with the field quality control Article in Part 3 of this Section, including:
      1) Field density testing.
      2) Tests of actual unconfined compressive strength or bearing tests of each stratum.
6. Qualifications Statements:
   a. Professional engineer.
   b. Quality Assurance Testing laboratory. Submit name and qualifications of testing laboratory to be employed, and qualifications of testing laboratory's personnel that will perform quality assurance testing required in this Section.
   c. Field Quality Control Testing Laboratory: Names and qualifications of testing laboratory employed, and qualifications of testing laboratory's

personnel that will perform field quality control testing as required under this Section.

1.6 SITE CONDITIONS

A. Subsurface Information: The LIMITED SITE USE DATA indicate information available relative to subsurface conditions at the Site. Such information and data is not intended as a representation or warranty of continuity of conditions between soil borings or test pits, nor of groundwater levels at dates and times other than date and time when measured, nor that purpose of obtaining the information and data were appropriate for use by CONTRACTOR. DEPARTMENT will not be responsible for interpretations or conclusions drawn therefrom by CONTRACTOR.

B. Soil borings and other exploratory operations may be made by CONTRACTOR, at no additional cost to DEPARTMENT. Coordinate CONTRACTOR-performed test borings and other exploratory operations with CITY, ENGINEER and utility owners as appropriate. Perform such explorations without disrupting or otherwise adversely affecting operations of CITY or utility owners. Comply with Laws and Regulations relative to required notifications.

C. Existing Structures:
   1. The Contract Documents show or indicate certain structures and Underground Facilities adjacent to the Work. Such information was obtained from existing records and is not guaranteed to be correct or complete. CONTRACTOR shall explore ahead of the excavation to determine the exact location of all existing structures and Underground Facilities. Existing structures and Underground Facilities shall be supported and protected from damage by CONTRACTOR. Immediately repair and restore existing structures and Underground Facilities damaged by CONTRACTOR without additional cost to DEPARTMENT.
   2. Movement or operation of construction equipment over Underground Facilities shall be at CONTRACTOR's sole risk and only after CONTRACTOR has prepared and submitted to ENGINEER and utility owners (as applicable), and received acceptance therefrom, a plan describing CONTRACTOR's analysis of the loads to be imparted and CONTRACTOR's proposed measures to protect structures and Underground Facilities during the Project.
   3. Coordinate with utility owners for shut-off of services in active piping and conduits. When required by utility owner, CITY will assist CONTRACTOR with utility owner notifications. Completely remove buried piping and conduits indicated for removal and not otherwise indicated as being abandoned or to remain in place.
   4. Do not interrupt existing utilities serving facilities occupied and used by CITY or others, except when such interruption is indicated in the Contract Documents or when allowed in writing by ENGINEER after acceptable temporary utility services are provided by CONTRACTOR for the affected structure or property

PART 2 – PRODUCTS

2.1 MATERIALS

A. Select Fill:
   1. Material shall be well-graded, crushed aggregate, free of organic material. Material shall be Item Select Granular Fill, Item 203-2.02.C in accordance with NYSDOT.

B. General Fill:
   1. Material shall be free of: rock and gravel larger than three inches in any dimension, debris, waste, frozen materials, organic material, and other deleterious matter.
   2. Fill shall have a liquid limit not greater than 45, and plasticity index not greater than 25.
   3. Previously-excavated materials complying with the Contract Documents requirements for general fill may be used for general fill.
   4. When on-Site materials are found unsuitable for use as general fill, provide select fill or approved off-Site general fill materials. Prior to using off-Site material as general fill, furnish submittal for and obtain ENGINEER's approval of the material proposed for use.

C. Subbase Material:
   1. Material shall be naturally- or artificially-graded mixture of natural or crushed gravel, crushed stone, or natural or crushed sand. Crushed slag is unacceptable. Material shall be Item 403, Type 4 in accordance with NYSDOT.

D. Drainage Fill:
   1. Material shall be washed, uniformly-graded mixture of crushed stone, or crushed or uncrushed gravel, with 100 percent passing 1.5-inch sieve and not more than five percent passing a No. 4 sieve.

E. Pipe Bedding Material:
   1. Aggregate material shall be crushed stone and gravel, free of: rock or gravel larger than 1/2-inch in any dimension, debris, waste, frozen materials, organic material and other deleterious matter. Material shall be Item 703, Number 1 stone in accordance with NYSDOT.
   2. Sand material, where required, shall consist of natural or manufactured granular material and shall contain no organic material. Sand shall be non-plastic, when tested in accordance with ASTM D4318, 100 percent shall pass a 1/2-inch screen and not more than five percent shall pass a No. 200 screen.

2.2 SOURCE QUALITY CONTROL

A. Perform quality assurance testing, and submit results to ENGINEER, in accordance with the 'Quality Assurance" Article in Part 1 of this Section.

PART 3 – EXECUTION

3.1 INSPECTION

A. Provide ENGINEER with sufficient notice and with means to examine areas and conditions under which excavating, filling, and grading will be performed. ENGINEER will advise CONTRACTOR in writing when ENGINEER is aware of conditions that may be detrimental to proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions are corrected.

3.2 TEST PITS

A. General:
   1. In advance of the construction, excavate, make observations and measurements, and fill test pits to determine conditions or location of the existing Underground Facilities and structures. Perform all work required in connection with excavating, stockpiling, maintaining, sheeting, shoring, filling, and replacing pavement for test pits. CONTRACTOR shall be responsible for the definite location of each existing Underground Facility involved within the area of excavation for the Work. Exercise care during such location work to avoid damaging and disrupting the affected Underground Facility or structure. CONTRACTOR shall be responsible for repairing, at his expense, damage to Underground Facility or structure caused during the Work.

3.3 PREPARATION

A. Use of Explosives:
   1. Use of explosives is not allowed.

B. Dust Control:
   1. Control objectionable dust caused by CONTRACTOR's operation of vehicles and equipment, clearing, and other actions. To minimize airborne dust, apply water or use other methods subject to ENGINEER's acceptance and approval of authorities having jurisdiction.

3.4 DEWATERING

A. Dewatering – General:
   1. Provide and maintain adequate drainage and dewatering equipment to remove and dispose of all surface water and ground water entering excavations, or other parts of the Work and work areas. Keep each excavation dry during excavation, subgrade preparation, and continually thereafter until the structure to be built therein is acceptable to ENGINEER and backfilling operations are completed and acceptable to ENGINEER.
   2. Keep all working areas at the Site free of surface water at all times. Provide temporary drainage ditches and temporary dikes, and provide required

temporary pumping and other work necessary for diverting or removing rainfall and all other accumulations of surface water from excavations and fill areas. Perform diversion and removal of surface water in manner that prevents accumulation of water behind permanent or temporary structures and at any other locations in the construction area where such accumulations may be detrimental.

3. Water used for working or processing, resulting from dewatering operations, or containing oils or sediments that will reduce the quality of the surface water or groundwater downstream of the point of discharge, shall not be directly discharged. Divert such waters through temporary settling basin or filter before discharging to surface water, groundwater, or drainage routes.
4. CONTRACTOR shall be responsible for condition of piping, conduits, and channels used for drainage and such piping, conduits, and channels shall be clean and free of sediment.
5. Remove water from excavations as fast as water collects.

B. Temporary Dewatering System:
1. CONTRACTOR shall design, provide, and operate dewatering system to include sufficient trenches, sumps, pumps, hose, piping, well points, deep wells, and similar facilities, necessary to depress and maintain groundwater level greater than one foot below the base of each excavation during all stages of construction operations.
2. Design and operate dewatering system to avoid settlement and damage to existing structures and Underground Facilities.
3. Groundwater table shall be lowered in advance of excavation for a sufficient period of time to allow dewatering of fine grain soils.
4. Maintain groundwater level at excavations two feet below lowest subgrade excavation until the structure has sufficient strength and weight to withstand horizontal and vertical soil and water pressures from natural groundwater.
5. Operate dewatering system continuously, 24 hours per day, seven days per week. Provide standby pumping facilities and personnel to maintain the continued effectiveness of the system. Do not discontinue dewatering operations without first obtaining ENGINEER's acceptance for such discontinuation.
6. If, in ENGINEER's opinion, the water levels are not being lowered or maintained as required, provide additional or alternate temporary dewatering devices as necessary, at no additional cost to DEPARTMENT.
7. Locate elements of temporary dewatering system to allow continuous dewatering operation without interfering with the Work to the extent practicable.
8. Where portions of dewatering system are located in the area of permanent construction, submit to and obtain ENGINEER's acceptance of details of proposed methods of constructing the Work at such location. Control of ground water shall continue until the permanent construction provides sufficient dead load to withstand hydrostatic uplift of the normal groundwater, until concrete has attained sufficient strength to withstand earth and hydrostatic loads, and until waterproofing Work is completed.

9. Perform pumping of water from excavations in a manner that prevents carrying away of unsolidified concrete materials, and that avoids damaging the subgrade.
10. Before discontinuing dewatering operations or permanently allowing rise of groundwater level, prepare computations to demonstrate that structures affected by the water level rise are protected by fill or other means to sustain uplift. Use a safety factor of 1.25 when preparing such calculations.

C. Disposal of Water Removed by Dewatering System:
1. CONTRACTOR's dewatering system shall discharge to a suitable location acceptable to CITY and ENGINEER, in accordance with Laws and Regulations.
2. Convey water from excavations in closed conduits. Do not use trench excavations as temporary drainage ditches.
3. Dispose of water removed from excavations in a manner that does not endanger health and safety, property, the Work, and other portions of the Project.
4. Dispose of water in manner that causes no inconvenience to CITY, others involved in the Project, and adjacent and downstream properties.

3.5 EXCAVATION

A. Perform all excavation required to complete the Work as shown, specified, and required. Excavations shall include removing and handling of earth, sand, clay, gravel, hardpan, soft, weathered or decomposed rock, pavements, rubbish, and other materials within the excavation limits. Where the excavation includes rock that requires drilling or specialized equipment for removal, remove rock in accordance with Section 31 23 16.26, Rock Removal.

B. Excavation Protection:
1. Provide excavation protection system(s) in accordance with Laws and Regulations to prevent injury to persons and property, including Underground Facilities.
2. Excavation Less Than Five Feet Deep: Excavations in stable rock or in soil conditions where there is no potential for a cave-in may be made with vertical sides. Under all other conditions, excavations shall be sloped and benched, shielded, or shored and braced.
3. Excavations Greater Than Five Feet Deep: Excavations in stable rock may be made with vertical sides. Under all other conditions, excavations shall be sloped and benched, shielded, or shored and braced.
4. Provide and maintain excavation protection system(s) in accordance with submittals accepted by ENGINEER and required under Paragraph 1.5.B of this Section.

C. Maintain excavations in dry condition in accordance with "Dewatering" Article in Part 3 of this Section.

D. Elevation of bottom of footings shown is approximate. ENGINEER may direct such minor changes in dimensions and elevations as may be required to secure a satisfactory footing.

E. When excavations are made below required grades without written order of ENGINEER, fill such excavations with compacted select fill material, as directed by ENGINEER, at CONTRACTOR's expense.

F. Extend excavations sufficiently on each side of structures, footings, and similar construction to allow setting of forms, installation of shoring and bracing, and the safe sloping of banks, as necessary.

G. Subgrades – General:
   1. Subgrades shall be firm, dense, and thoroughly compacted and consolidated; shall be free from mud, muck, and other soft or unsuitable materials; and shall remain firm and intact under all construction operations. Subgrades that are otherwise solid but become soft or mucky on top due to construction operations shall be reinforced with Select Fill. Finished elevation of stabilized subgrades shall not be above subgrade elevations shown.
   2. If, in ENGINEER's opinion, subgrade becomes softened or mucky because of construction delays, failure to dewater properly, or other cause within CONTRACTOR's control, subgrade shall be excavated to firm material, trimmed, and backfilled with select fill material at CONTRACTOR's expense.

H. Proofrolling Subgrades:
   1. Prior to placing fill or constructing pavements or slabs, proofroll the subgrade surface with sufficient proofrolling apparatus. Before starting proofrolling, submit to and obtain acceptance from ENGINEER of proofrolling apparatus and procedure to be used.
   2. Proofrolling operations shall be made in the presence of ENGINEER. Notify ENGINEER at least 24 hours in advance of start of proofrolling operations.
   3. Subgrades displaying pronounced elasticity or deformation, deflection, cracking, or rutting shall be stabilized as directed by ENGINEER. Unsuitable materials shall be undercut to the depth directed by ENGINEER and replaced with select fill material. Other suitable stabilization methods may be directed by ENGINEER.

I. Pipe Trench Preparation:
   1. Not more than 150 feet of trench may be opened in advance of installing pipe in trench.
   2. Trench width shall be minimized to greatest extent practical, and shall comply with the following:
      a. Trench width shall be sufficient to provide space for installing, jointing and inspecting piping. Refer to Drawings for trench requirements. In no case should trench be wider at top of pipe than pipe barrel OD plus two feet, unless otherwise shown or indicated.

b. Enlargement of trench width at pipe joints may be made when required and approved by ENGINEER.
c. Trench width shall be sufficient for shoring and bracing, or shielding and dewatering.
d. Trench width shall be sufficient to allow thorough compaction of fill adjacent to bottom half of pipe.
e. Do not use excavating equipment that requires the trench to be excavated to excessive width.

3. Depth of trench shall be as shown or indicated. If required and approved by ENGINEER in writing, depths may be revised.
4. Where ENGINEER considers existing material beneath bedding material unsuitable, remove and replace such unsuitable material with select fill material.

J. Excavated Materials to be Used as Fill:
1. Stockpile excavated materials that are acceptable for use as fill.
2. As excavation proceeds, keep stockpiles of excavated materials suitable for use as fill separate from unsuitable materials and waste materials.
3. Place, grade, and shape stockpiles for proper drainage.
4. Locate and retain soil materials away from edge of excavations.
5. Dispose of excess soil material and waste materials as specified in this Section.
6. Stockpiled excavated soils for use as select fill or general fill shall be tested and classified by laboratory as on-Site select fill or on-Site general fill. Perform required quality assurance testing for material verification on stockpiled materials as soon as possible to demonstrate compliance of excavated materials with the Contract Documents.

3.6 UNAUTHORIZED EXCAVATION

A. All excavations outside lines and grades shown or indicated and that are not approved by ENGINEER, together with removing and disposing of the associated material, shall be at CONTRACTOR's expense. Fill unauthorized excavations with properly-compacted select fill material at CONTRACTOR’s expense.

3.7 EROSION AND SEDIMENT CONTROLS

A. Provide temporary erosion and sediment controls in accordance with Section 01 57 05, Temporary Controls. When applicable, also comply with requirements of the erosion and sediment control plan approved by authorities having jurisdiction.

3.8 SHEETING, SHORING, AND BRACING

A. General:
1. Design and provide sheeting, shoring, bracing, cofferdams, and similar excavation supports as shown, specified, and required for the Work.

2. Clearances and types of temporary sheeting, shoring, bracing, and similar excavation supports, insofar as they may affect the finished character of the Work and the design of sheeting to be left in place, will be subject to the ENGINEER's approval; but CONTRACTOR is responsible for adequacy of all sheeting, shoring, bracing, cofferdams, and similar excavation supports.
3. Materials:
   a. Previously-used materials shall be in good condition, and shall not be damaged or excessively pitted. All steel or wood sheeting designated to remain in place shall be new. New or used sheeting may be used for temporary sheeting, shoring, and bracing.
   b. All steel work for sheeting, shoring, bracing, cofferdams and other excavation supports, shall be in accordance with ANSI/AISC 360, except that field welding will be allowed.
4. As excavation progresses, carry down shoring, bracing, cofferdams, and similar excavation supports to required elevation at bottom of excavation.
5. Comply with Laws and Regulations regarding sheeting, shoring, bracing, cofferdams, and similar excavation supports.
6. Maintain sheeting, shoring, bracing, bracing, and other excavation supports in excavations regardless of time period excavations will be open.
7. Unless otherwise shown, specified, or directed, remove materials used for temporary construction when the Work is completed. Perform such removal in manner not injurious to the structures and Underground Facility, their appearance, and adjacent construction.

B. Removal of Sheeting and Bracing:
   1. Remove sheeting and bracing from excavations, unless otherwise directed by ENGINEER in writing. Perform removal to avoid damaging the Work and adjacent construction. Removal shall be equal on both sides of excavation to ensure no unequal loads on structures and Underground Facilities.
   2. Defer removal of sheeting and bracing, where removal may cause soil to come into contact with concrete, until the following conditions are satisfied:
      a. Concrete has cured for not less than seven days.
      b. Wall and floor framing, up to and including grade level floors, is in place.

3.9 TRENCH SHIELDS

A. Excavation of earth material below bottom of trench shield shall not exceed the limits established in Laws and Regulations.

B. When using a shield for installing piping:
   1. Portions of trench shield extending below the mid-diameter of an installed, rigid pipe, such as prestressed concrete pipe and other types of rigid pipe, shall be raised above the pipe's mid-diameter elevation prior to moving the shield along the trench for further construction.

2. Bottom of shield shall not at any time extend below mid-diameter of installed pipe that is flexible or has flexing capability, such as steel, ductile iron, PVC, CPVC, polyethylene, and other pipe that has flexing capability.

C. When using a shield for installing structures, bottom of the shield shall not extend below the top of the bedding for the structures.

D. When removing the shield or moving the shield ahead, exercise extreme care to prevent moving piping, structures, and other Underground Facilities, and prevent disturbance of bedding material for piping, structures, and other Underground Facilities. When piping, structures, or Underground Facilities are disturbed, remove and reinstall the disturbed items in accordance with the Contract Documents.

3.10 FILL AND COMPACTION – GENERAL PROVISIONS

A. Provide and compact all fill required for the finished grades as shown and as specified in this Section.

B. Place fill in excavations as promptly as progress of the Work allows, but not until completing the following:
   1. ENGINEER's authorization after observation of construction below finish grade, including dampproofing, waterproofing, perimeter insulation, and similar Work.
   2. Inspection, testing, approval, and recording of locations of Underground Facilities.
   3. Removal of concrete formwork.
   4. Removal of shoring and bracing, and filling of voids with satisfactory materials.
   5. Removal of trash and debris.
   6. Permanent or temporary horizontal bracing is in place on horizontally-supported walls.
   7. Field testing of tanks, Underground Facilities including piping and conduits, and water-retaining structures.
   8. Placing of settlement plates.

C. Fill that includes organic materials or other unacceptable material shall be removed and replaced with approved fill material in accordance with the Contract Documents.

D. Placement – General:
   1. Place fill to the grades shown or indicated. Bring up evenly on all sides fill around structures and Underground Facilities.
   2. Fill areas shall be undercut and proof-rolled as directed by ENGINEER.
   3. Place fill materials at moisture content and density as specified in Table 31 23 05-A of this Section and this Article's requirements on compaction density. Furnish and use equipment capable of adding measured amounts of water to the fill materials to bring fill materials to a condition within

required moisture content range. Furnish and use equipment capable of discing, aerating, and mixing the fill materials to ensure reasonable uniformity of moisture content throughout the fill materials, and to reduce moisture content of borrow materials by air drying, when necessary. When subgrade or lift of fill materials requires moisture-conditioning before compaction, fill material shall be sufficiently mixed or worked on the subgrade to ensure uniform moisture content throughout the lift of material to be compacted. Materials at moisture content in excess of specified limit shall be dried by aeration or stockpiled for drying.

4. Perform compaction with equipment suitable for the type of fill material placed. Select and use equipment capable of providing the minimum density required in the Contract Documents. Use light compaction equipment, with equipment gross weight not exceeding 7,000 pounds within horizontal distance of ten feet from the wall of completed, below-grade structures. Furnish and use equipment capable of compacting in restricted areas next to structures and around piping and Underground Facilities. Effectiveness of the equipment selected by CONTRACTOR shall be tested at start of compacted fill Work by constructing a small section of fill within the area where fill will be placed. If tests on the test section of fill indicate that required compaction is not obtained, do one or more of the following: increase the amount of coverages, decrease the lift thicknesses, or use different compactor equipment.
5. Place fill materials in horizontal, loose lifts, not exceeding specified uncompacted thickness. Place fill in a manner ensuring uniform lift thickness after placing. Mechanically compact each lift, by not less than two complete coverages of the compactor. One coverage is defined as the conditions reached when all portions of the fill lift have been subjected to the direct contact of compactor's compacting surface. Compaction of fill materials by inundation with water is unacceptable.
6. Do not place fill materials when standing water is present on surface of the area where fill will be placed. Do not compact fill when standing water is present on the fill to be compacted. Do not place or compact fill in a frozen condition or on top of frozen material. Fill containing organic materials or other unacceptable material previously described shall be removed and replaced prior to compaction.
7. If required densities are not obtained because of improper control of placement or compaction procedures, or because of inadequate or improperly-functioning compaction equipment, CONTRACTOR shall perform all work required to provide the required densities. Such work shall include, at no additional cost to DEPARTMENT, complete removal of unacceptable fill areas and replacement and re-compaction until acceptable fill is provided.
8. Repair, at CONTRACTOR's expense, observed or measured settlement. Make repairs and replacements as required within 30 days after being so advised by ENGINEER.

E. Fill Against Concrete:
   1. Placing fill against concrete below finished grade is not allowed until the concrete has attained its specified strength, as determined by duration of concrete curing and testing of field-cured concrete cylinders. Requirements for strength and curing time are in Section 03 30 00, Cast-in-Place Concrete.
   2. Elevation of fill placed against concrete walls shall not differ by more than two feet on each side of walls, unless walls are adequately braced or all floor framing is in place up to and including grade level slabs.
   3. Backfill structural foundation units as soon as practicable, in accordance with this Section, after concrete has gained sufficient strength to avoid damage, to avoid ponding of surface water and accumulation of debris.
   4. Where fill is placed against waterproofed surface, exercise care that waterproofing material is not damaged.

F. Fill in Electrical Ductbank Trenches:
   1. Provide general fill for full depth of electrical ductbank trench, below and above electrical ductbank. Where one ductbank passes beneath another pipe or ductbank, provide select fill to the elevation of the bottom of upper ductbank or pipe, as applicable.
   2. Placing and compacting fill in electrical ductbank trenches shall comply with requirements of Paragraph "G. Fill in Pipe Trenches", of this Article.

G. Fill in Pipe Trenches:
   1. Place pipe bedding material in pipe trenches in horizontal layers, and thoroughly compact each layer before the next layer is placed.
   2. Piping Installed in Fills Above Pre-construction Grade:
      a. Prior to installing piping, place the fill in accordance with the Contract Documents until the fill reaches a minimum elevation two feet higher than the top of piping to be installed. Excavate the trench; install the piping, and backfill. Subsequently provide the remainder of the fill required for the Work.
   3. Piping trenches may be backfilled prior to testing of piping, unless nature of the test requires observation of pipe during testing. Do not construct building or structure over piping until piping has been successfully tested and passed.
   4. Pipe Bedding: Pipe bettering material shall be as follows:
      a. Install PVC, CPVC, HDPE, and FRP piping on a layer of sand. Sand shall extend to 12 inches above top of pipe and to the trenchwalls on each side of the pipe.
      b. Unless otherwise shown, install other types of piping on not less than six-inch layer of aggregate pipe bedding material. Aggregate pipe bedding material shall extend 12 inches above top of the pipe.
   5. Placing and Compacting Pipe Trench Fill: Unless otherwise shown, placement and compaction of pipe trench fill materials shall comply with the following:
      a. Pipe bedding material shall be spread and the surface graded to provide a uniform and continuous support beneath piping at all points between bell holes or pipe joints. Slight disturbance of installed pipe

bedding material surface during withdrawal of pipe slings or other lifting tackle is acceptable.

b. After each pipe's bedding material has been graded, and the piping has been aligned, joined in accordance with the Contract Documents, and placed in final position on bedding material, provide and compact sufficient pipe trench fill material under and around each side of the pipe and back of the bell or end thereof to hold piping in proper position and maintain alignment during subsequent pipe jointing and embedment operations. Deposit and compact pipe trench fill material uniformly and simultaneously on each side of piping to prevent lateral displacement of piping. Place and compact pipe trench fill material to an elevation 12 inches above top of pipe, unless otherwise shown or specified.

c. Each layer of pipe trench fill material shall be compacted by at least two complete coverages of all portions of surface of each lift using appropriate compaction equipment.

d. Method of compaction and compaction equipment used shall be appropriate for material to be compacted and shall not transmit damaging shocks to the piping.

H. Drainage Fill Placement:

1. Provide drainage fill material where shown to the limits shown or indicated.
2. Place drainage fill material in compacted layers of uniform thickness not exceeding depth of six inches each. Compact lifts of drainage fill using suitable compaction equipment.

I. Compaction Density Requirements:

1. Compaction and lift thickness required for all types of fills shall be as specified in Table 31 23 05 below. Moisten material or aerate the material as necessary to provide the moisture content that will facilitate obtaining the required compaction.

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TABLE 31 23 05-A
REQUIRED MINIMUM DENSITY

Material	Percent Compaction (ASTM D698)	Uncompacted Lift (inches)
General Fill		
More than five feet below final grade	100	8
Less than five feet below final grade	95	8
Select Fill		
Below concrete slabs or mats	100	8
Below pavement and sidewalks	100	12
Behind concrete walls	95	8
Subbase Material		
Below pavement and sidewalks	100	12
All other locations	100	8
Pipe Bedding Material		
Below structures or pavement	100	8
All other locations	95	6
Drainage Fill	N/A	6

2. Fill shall be wetted and thoroughly mixed to achieve optimum moisture content plus-or-minus three percent, with the following exceptions:
   a. On-site clayey soils: Optimum to plus three percent.
3. Replace natural, undisturbed soils or compacted soil subsequently disturbed or removed by construction operations with materials compacted as indicated in Table 31 23 05-A of this Section.
4. Field quality control testing for density; to verify that specified density was obtained, will be performed during each day of compaction Work. Responsibility for field quality control testing is specified in the "Field Quality Control" Article in Part 3 of this Section.
5. When field quality control testing indicates unsatisfactory compaction, provide additional compaction necessary to obtain the specified compaction. Perform additional compaction Work at no additional cost to DEPARTMENT until specified compaction is obtained. Such work includes complete removal of unacceptable (as determined by ENGINEER) fill areas and replacement and re-compaction until acceptable fill is provided in accordance with the Contract Documents.

J. Replacement of Unacceptable Excavated Materials: In cases where over-excavation to replace unacceptable soil materials is required, backfill the excavation to required subgrade with select fill material and thoroughly compact in accordance with Table 31 23 05-A and the associated "Compaction Density Requirements" in this Article. Slope the sides of excavation in accordance with the maximum inclinations specified for each structure location.

3.11 GRADING

A. General:
   1. Uniformly grade areas within limits of grading under this Section, including adjacent transition areas.
   2. Smooth subgrade surfaces within specified tolerances, compact with uniform levels or slopes between points where elevations are shown, or between such points and existing grades.

B. Grading Outside Building and Structure Lines: Grade areas adjacent to building and structure lines to drain away from structures and to prevent ponding. Finish surfaces free of irregular surface changes, and shall comply with the following:
   1. Grassed Areas or Areas Covered with Gravel, Stone, Wood Chips, or Other Special Cover: Finish areas to receive topsoil or special cover to within not more than one inch above or below the required subgrade elevations.
   2. Sidewalks: Shape surface of areas under sidewalks to line, grade, and cross section, with finish surface not more than one inch above or below the required subgrade elevation.
   3. Pavements: Shape surface of areas under pavement to line, grade, and cross section, with finish surface not more than 1/2-inch above or below the required subgrade elevation.

C. Grading Surface of Fill Under Concrete Slabs: Grade smooth and even, free of voids, compacted as specified, and to required elevation. Provide final grades within a tolerance of 1/2-inch when tested with a ten foot straight edge.

D. Compaction:
   1. After grading, compact subgrade surfaces to the depth and percentage of maximum density for each area classification.

3.12 DISPOSAL OF EXCAVATED MATERIALS

A. General:
   1. CONTRACTOR shall haul away material removed from excavations that does not comply with requirements for fill, or is in excess of the quantity required for fill.
   2. Disposal of materials shall be in compliance with Laws and Regulations, at no additional cost to DEPARTMENT.

3.13 TEMPORARY BARRIERS

A. Provide temporary barrier surrounding excavations and excavation work areas to provide temporary protection to persons and property. Barrier shall have openings only at vehicular, equipment, and worker access points.

B. Minimum Material Requirements for Temporary Barriers:
   1. Temporary barrier shall not be less snow fence-type fencing, four feet high.

2. Fence shall be constructed of vertical hardwood slats measuring not less than 1.5 inches by 1/4-inch interwoven with strands of horizontal wire, or shall be of equivalent plastic construction.
3. Posts:
    a. Posts shall be steel, either “U”-, “Y”-, “T”-shaped, or channel section.
    b. Posts shall have a nominal weight of not less than 1/3-pound per linear foot, exclusive of the anchor.
    c. Posts shall have tapered anchors weighing not less than 0.67 pounds, each firmly attached by means of welding, riveting or clamping.
    d. Posts shall have corrugations, knobs, notches, or studs placed and constructed to engage a substantial number of fence line wire in the proper position.
    e. Provide each post with sufficient quantity of galvanized wire fasteners or clamps, of not less than 0.120-inch diameter, for attaching fence wire to post.

3.14 FIELD QUALITY CONTROL

A. Site Tests: Employ a testing laboratory to perform field quality control testing.
1. Testing Laboratory Scope:
    a. Perform field moisture content and density tests to ensure that the specified compaction of fill materials has been obtained.
    b. Tests of actual unconfined compressive strength or bearing tests on each stratum.
    c. Report results of each test to ENGINEER and CONTRACTOR.
2. Required Material Tests:
    a. Compaction: Comply with ASTM D1556 and ASTM D6938, as applicable.
3. Authority and Duties of Testing Laboratory:
    a. Technicians representing the testing laboratory shall inspect the materials in the field, perform testing, and report findings to ENGINEER and CONTRACTOR. When materials furnished or the Work performed does not comply with the Contract Documents, technician will direct attention of ENGINEER and CONTRACTOR to such failure.
    b. Technician will not act as foreman or perform other duties for CONTRACTOR. Work will be checked as it progresses, but failure to detect defective Work or non-complying materials shall not in any way prevent later rejection when defect is discovered, nor shall it obligate ENGINEER for Substantial Completion or final acceptance. Technicians are not authorized to revoke, alter, relax, enlarge, or release requirements of the Contract Documents, or to approve or accept any portion of the Work.
4. Responsibilities and Duties of CONTRACTOR:
    a. Use of testing laboratory shall in no way relieve CONTRACTOR of the responsibility to provide materials and Work in full compliance with the Contract Documents.

b. To facilitate testing laboratory, CONTRACTOR shall advise testing laboratory at least two days in advance of filling operations to allow for completion of field quality control testing and for assignment of personnel.

c. It shall be CONTRACTOR's responsibility to accomplish the specified compaction for fill and other earthwork. CONTRACTOR shall control construction operations by confirmation tests to verify and confirm that CONTRACTOR has complied, and is complying at all times, with the Contract Documents relative to compaction, control.

d. CONTRACTOR shall demonstrate adequacy of compaction equipment and procedures before exceeding one or more of the following quantities of earthwork. Each test location shall include tests for each layer, type, or class of fill to finish grade.

1) 200 linear feet of trench fill.
2) 10 cubic yards of select fill.
3) 100 cubic yards of general fill.
4) 50 cubic yards of subbase material.

5. Testing laboratory will inspect and indicate acceptable subgrades and fill layers before construction work is performed thereon. Testing of subgrades and fill layers shall be taken as follows:

a. Trenches for Structures, and Underground Facilities (including buried ductbanks):

1) In Open Fields: Two locations every 1,000 linear feet.
2 Along Dirt or Gravel Roads or Off Traveled Right-of-Way: Two locations every 500 linear feet.
3) Crossing Paved Roads: Two locations along each crossing.
4) Under Pavement Cuts or Within Two Feet of Pavement Edges: One location every 400 linear feet.

b. Footing Subgrade: For each stratum of soil on which footings will be placed, perform not less than one test to verify required design bearing capacities. Subsequent verification and approval of each footing subgrade may be based on a visual comparison of each subgrade with related tested strata, when acceptable to ENGINEER.

c. For Select Fill: On 30-foot intervals on all sides of the structure for every compacted lift, but not less than one per lift on each side of the structure for structures less than 60 feet long on a side.

d. For General Fill: One per 1,000 square feet on every compacted lift.

e. Subbase Material: One per 1,000 square feet on every compacted lift.

6. Periodic compliance tests will be made by ENGINEER to verify that compaction is complying with the requirements specified, at no cost to CONTRACTOR. CONTRACTOR shall remove the overburden above the level at which ENGINEER wishes to test and shall fill and re-compact the excavation after testing is complete.

7. If testing laboratory reports or inspections indicate subgrade, fills, or bedding compaction below specified density, CONTRACTOR shall remove unacceptable materials as necessary and replace with specified materials and provide additional compaction at CONTRACTOR's expense until subgrades, bedding, and fill are acceptable. Costs for retesting of subgrade,

fills, or bedding materials that did not originally comply with specified density shall be paid by CONTRACTOR.

+ + END OF SECTION + +

SECTION 31 23 16.26

ROCK REMOVAL

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to perform rock removal required for the Work, including disposing of excavated rock material.
   2. Perform rock removal Work in compliance with Laws and Regulations applicable permits, and requirements of authorities having jurisdiction.

B. Coordination:
   1. Review procedures under this and other Sections and coordinate the Work that must be performed with or before rock removal.

C. Related Sections:
   1. Section 31 23 05, Excavation and Fill.

D. Measurement: Limits of rock removal shall be as follows:
   1. Structures: Limit for all structures shall be bounded by the following:
      a. Bottom of footing, drainage course material, or compacted backfill.
      b. Pre-construction rock surface.
      c. Vertical planes located 12 inches outside footing.
   2. Trenches: Limit for trenches shall be bounded by the following:
      a. Width of trenches shall be the outside diameter or outside edge (as applicable) of the Underground Facility plus two feet, exclusive of pipe bells, branches, hubs, spurs, or cradles. Sides of trench shall be considered vertical.
      b. Depth of trench shall be six inches below the outside of the Underground Facility in the trench unless indicated otherwise on the Drawings.
      c. Length shall be equal to installed length of the Underground Facility, measured horizontally.
   3. No payment will be made for additional quantity outside the limits described in this Section.

1.2 REFERENCES

A. Standards referenced in this Section are:
   1. United States Bureau of Mines (USBM), Report of Investigations (RI) 8507.

1.3 TERMINOLOGY

A. The following words or terms are not defined but, when used in this Section, have the following meaning:
   1. "Rock removal" is removal of igneous, metamorphic, or sedimentary rock or stone; boulders over two cubic yards in volume in open areas and boulders over one cubic yard in volume in trenches; and mass concrete; that cannot be removed using rippers or other mechanical methods and therefore requires drilling or use of large excavator-mounted pneumatic breakers. The following material will not be measured nor allowed for payment as rock removal:
      a. Soft, weathered or disintegrated rock that can be removed by normal excavating equipment, including bulldozers with rippers and large trackhoes with rock teeth or rock buckets.
      b. Loose rock.
      c. Broken stone in rock fills.
      d. Rock or stone that falls into the excavation from outside limits of excavation shown or indicated in the Contract Documents.
      e. Boulders that can be removed without drilling or pneumatic breakers.
      f. Pavements, sidewalks, and gutters of concrete, asphalt, or masonry.
   2. "Trenches" means excavations having vertical sides whose depth exceeds its width, made for Underground Facilities and drainage beds.

1.4 SUBMITTALS

A. Informational Submittals: Submit the following:
   1. Test and Evaluation Reports:
      a. Rock surface survey information, in accordance with Article 3.1 of this Section.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION

3.1 EXAMINATION

A. Top-of-Rock Survey:
   1. Prior to rock removal, CONTRACTOR shall survey and measure the elevation of the top of rock to determine the in-place quantity of rock to be excavated.
   2. Uncover rock to be excavated in sections or areas acceptable to ENGINEER for surveying.
   3. Conform to Section 01 71 23, Field Engineering.
   4. Submit to ENGINEER field notes, site plan showing rock elevations measured, cross-sections of rock surface when necessary or required by ENGINEER, and detailed estimation of quantity of rock to be excavated.

3.2 PRE-REMOVAL SURVEY

A. General:
   1. Pre-removal survey shall be performed or supervised by CONTRACTOR's or Subcontractor's professional engineer qualified in accordance with Section 31 23 05, Article 1.4.
   2. Complete survey before starting rock removal.
   3. Survey Limits:
      a. Survey shall document the pre-removal condition, defects, and other physical factors that could reasonably be affected by rock removal, of all existing residences; commercial, industrial, and institutional buildings; water supply wells; Underground Facilities and above-ground utilities; and other structures within the greater of the following distances from the limits of rock removal Work to be performed: 500 feet, or limit required in Laws and Regulations.
      b. Survey shall include structures such as dams, ponds and reservoirs, cisterns, structures of historical significance, and structures with unusually costly or vulnerable contents.
   4. If, during the Work, CONTRACTOR is requested by a property owner or tenant to view alleged damage to property, CONTRACTOR shall give written notice to DEPARTMENT prior to visiting to the property.

B. Preparation for Survey:
   1. Contact all owners and tenants, or their legal representative, of properties within limits of survey to obtain permission to conduct survey of the associated property. If property owner and tenant (if any) does not grant permission to conduct survey, contact property owner and tenant (if any) a second time by registered mail (return receipt requested). Second request for permission to conduct survey shall include description of survey to be performed and purpose of survey. At least 72 hours prior to starting rock removal activities, provide to authority having jurisdiction, in writing, names and addresses of property owners and tenants (if any) who refuse access for survey.
   2. Notify property owners and tenants at least 48 hours prior to conducting survey.
   3. Not less than 48 hours before conducting rock removal, submit survey report as specified in Paragraph 3.2.D of this Section.

C. Method:
   1. Buildings, Structures, Underground Facilities, and Above-ground Utilities:
      a. Include in survey detailed examination of interior and exterior of structures, Underground Facilities, and above-ground utilities located within specified limits of survey.
      b. Underground Facilities: With owner of Underground Facility, document condition of access points such as chambers, manholes, and vaults.
      c. Obtain color photographs, video, and prepare sketches and written descriptions to document the condition of areas within specified limits of

survey. Photographs and video shall conform to Section 01 32 33, Photographic Documentation.

d. Document evident structural faults or deficiencies and recent repairs.

D. Survey Report:

1. General:

a. Prepare written report summarizing results of survey.

b. Not less than 48 hours before start of rock removal, submit two copies of completed survey report to each authority having jurisdiction for their reference, if required. Submit one copy of survey to DEPARTMENT, two copies to ENGINEER, and retain one copy at the Site.

c. CONTRACTOR's or Subcontractor's professional engineer shall sign and seal final survey report.

2. Contents: survey report shall contain the following:

a. Location and description of each property within or partially within the specified survey limits.

b. Descriptions of conditions of buildings, structures, Underground Facilities, above-ground utilities, wells, and other elements included in the survey.

c. Summary of visual observations and inspections.

d. Color photographs, sketches, and video as appropriate.

e. All data, results, and yield estimates developed from water supply well assessments.

3. Photographic Documentation: Provide video to present supplemental information, as required. Photographic documentation shall conform to Section 01 32 33, Photographic Documentation. Include in photographs and video (where appropriate) a scale to indicate dimensions. In addition to information required in Section 01 32 33, Photographic Documentation, label photographs with name of the professional engineer responsible for survey, name of property owner, and sufficient information to determine the location of the image. Include in survey report one print of each photograph and include discs with video and electronic copies of photographs.

4. CONTRACTOR's or Subcontractor's professional engineer shall report all findings that, in professional engineer's opinion, indicate that building, structure, Underground Facility, above-ground utility, or well will be adversely affected by the rock removal Work.

3.3 ROCK REMOVAL

A. Removal by Methods Other than Blasting:

1. Perform rock removal by means other than blasting.

2. Blasting will not be permitted.

B. Removal and Disposal of Rock:

1. Remove broken rock from excavations with suitable equipment in accordance with Section 31 23 05, Excavation and Fill.

2. Do not use excavated rock as backfill. Dispose of excavated rock off the Site at CONTRACTOR's expense in compliance with Laws and Regulations.

3.4 UNAUTHORIZED ROCK REMOVAL

A. Rock removal outside the limits shown or indicated in the Contract Documents or that is not approved by ENGINEER, including removal, disposal, and backfill, will be at CONTRACTOR's expense.

B. Fill unauthorized excavation below pipe or foundation with compacted select backfill as directed by ENGINEER in writing, at no additional cost to DEPARTMENT. Backfill other unauthorized excavation as specified in Section 31 23 05, Excavation and Fill.

+ + END OF SECTION + +

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SECTION 31 37 00

RIPRAP

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals required to furnish and install riprap at locations shown or indicated in the Contract Documents.

B. Coordination:
   1. Review procedures under this and other Sections and coordinate the Work that must be performed with or before riprap.

C. Related Sections:
   1. Section 31 05 19, Geosynthetics for Earthwork.
   2. Section 31 11 00, Clearing and Grubbing.
   3. Section 31 23 05, Excavation and Fill.

1.2 REFERENCES

A. Standards referenced in this Section are:
   1. ASTM C127, Test Method for Density, Relative Density (Specific Gravity), and Absorption of Coarse Aggregate.
   2. NSSGA-293, Aggregate Handbook.
   3. New York State Department of Transportation Standard Specifications.

1.3 QUALITY ASSURANCE

A. Qualifications:
   1. Riprap Supplier:
      a. Supplier of riprap and other materials furnished under this Section shall be certified by the New York State Department of Transportation for furnishing such materials for New York State highways.

B. Regulatory Requirements:
   1. Reference Specifications and Details:
      a. Comply with applicable requirements of New York State Department of Transportation.

1.4 SUBMITTALS

A. Acton Submittals: Submit the following:

1. Product Data:
    a. Source or quarry name, gradation, and other information required by ENGINEER. Submit for each source of material proposed.

B. Informational Submittals: Submit the following:
1. Certificates:
    a. Where material is specified according to reference specification item number, submit copy of Supplier's valid certification from entity issuing the reference specification, and associated certification of material conformance with the reference specifications.

PART 2 – PRODUCTS

2.1 MATERIAL

A. Riprap: Material shall be in accordance with the reference specifications indicated in Article 1.3 of this Section.

PART 3 – EXECUTION

3.1 PREPARATION

A. Clear ground surface of brush, trees, stumps, and other objectionable material, and dress to a smooth surface. Clearing and grubbing, where required, shall comply with Section 33 11 00, Clearing and Grubbing.

B. Remove all soft or spongy material to depth shown or indicated on the Drawings or as directed by ENGINEER, and replace with acceptable material. Excavation, removal of unsuitable material if any, and backfilling shall comply with Section 31 23 05, Excavation and Fill.

C. Placing of geosynthetics, where required, shall comply with Section 31 05 19, Geosynthetics for Earthwork.

3.2 INSTALLATION

A. Riprap Placing:
1. Minimum total thickness of riprap shall be as shown on the Drawings.
2. Place riprap stones so that weight of stone is carried by underlying material and not by adjacent stones. Carefully place the stones on geosynthetics, where required, to produce an even distribution of pieces, with minimum of voids and without damaging the geosynthetic. Place the full-course thickness in one operation while preventing segregation and avoiding displacing of underlying material. Do not place stones in layers, by dumping into chutes, or by other

methods that cause segregation or damage to geosynthetic, if any. When necessary, rearrange individual stones for uniform distribution.

3. Riprap may be placed using equipment, and placing shall produce an installation of firm and solid riprap. Level the top surface of riprap to required alignment and slope by hand-placing stones to fill large voids and to make surface even.
4. On slopes, place the largest stones at the bottom. Riprap shall be properly sized to form compact, solid blanket to protect the slope or channel, as applicable. On slopes steeper than one foot vertical to 1.5 feet horizontal, do not use rounded boulders or cobbles without grouting stones in place.
5. Grouting: Where grouting of riprap is required, comply with the following:
    a. When stones are in place, completely fill spaces between stones with "grout fill" material in accordance with Section 03 60 00, Grouting.
    b. ENGINEER may direct that occasional spaces be left ungrouted for relief of hydrostatic pressure. Chink ungrouted spaces with spalls of suitable size.
    c. Do not grout riprap in freezing weather.
    d. Clean exposed surface of stones to remove accumulation of grout.
    e. Keep grouted riprap moist for seven days after grouting. Suitable grout curing compound may be employed when approved by ENGINEER.
6. When existing riprap is in proximity to riprap provided under this Section, place riprap to conform as closely as practicable in size and character to existing riprap.

+ + END OF SECTION + +

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SECTION 32 12 00

FLEXIBLE PAVING

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install flexible, hot-mix, hot-laid, asphalt concrete pavement.
   2. The Work includes:
      a. Preparation such as sawcutting, milling where shown or indicated, cleaning, and other preparation for installing flexible pavements.
      b. Providing asphalt concrete paving materials.
      c. Providing tack coat material.
      d. Providing pavement markings where shown or indicated.
      e. Providing quality controls and testing.

B. Coordination:
   1. Review installation procedures under this and other Sections and coordinate installation of items to be installed with or before flexible paving Work.
   2. Notify other contractors in advance of installing flexible paving to provide other contractors with sufficient time for installing items included in their contracts to be installed with or before flexible paving Work.

C. Related Sections:
   1. Section 31 05 19, Geosynthetics for Earthwork.
   2. Section 31 23 05, Excavation and Fill.
   3. Section 32 16 13, Concrete Curbs, Gutters and Sidewalks.

1.2 REFERENCES

A. Standards referenced in this Section are:
   1. AASHTO M320, Specification for Performance-Graded Asphalt Binder.
   2. AASHTO MP1a, Specification for Performance-Graded Asphalt Binder.
   3. AI MS-2, Mix Design Methods for Asphalt Concrete and Other Hot-Mix Types.
   4. ASTM C1371, Test Method for Determination of Emittance of Materials Near Room Temperature Using Portable Emissometers.
   5. ASTM C1549, Test Method for Determination of Solar Reflectance Near Ambient Temperature Using a Portable Solar Reflectometer.
   6. ASTM D242/D242M, Specification for Mineral Filler For Bituminous Paving Mixtures.

7. ASTM D692/D692M, Standard Specification for Coarse Aggregate for Bituminous Paving Mixtures.
8. ASTM D946/D946M, Specification for Penetration-Graded Asphalt Cement for Use in Pavement Construction.
9. ASTM D977, Specification for Emulsified Asphalt.
10. ASTM D1073, Specification for Fine Aggregate for Bituminous Paving Mixtures.
11. ASTM D1188, Test Method for Bulk Specific Gravity and Density of Compacted Bituminous Mixtures Using Coated Samples.
12. ASTM D2726, Test Method for Bulk Specific Gravity and Density of Non-Absorptive Compacted Bituminous Mixtures.
13. ASTM D2950, Test Method for Density of Bituminous Concrete in Place by Nuclear Methods.
14. ASTM D3549, Test Method for Thickness or Height of Compacted Bituminous Paving Mixture Specimens.
15. ASTM D6690, Specification for Joint and Crack Sealants, Hot Applied, for Concrete and Asphalt Pavements.
16. ASTM E329, Specification for Agencies Engaged in Construction Inspection and/or Testing.
17. ASTM E408, Test Methods for Total Normal Emittance of Surfaces Using Inspection-Meter Techniques.
18. ASTM E1918, Test Method for Measuring Solar Reflectance of Horizontal and Low-Sloped Surfaces in the Field.
19. ASTM E1980, Practice for Calculating Solar Reflectance Index of Horizontal and Low-Sloped Opaque Surfaces
20. FS TT-P-115, Paint, Traffic, Highway, White and Yellow.
21. USGBC LEED-NC, Reference Guide, For New Construction and Major Renovation.

1.3 QUALITY ASSURANCE

A. Qualifications:
   1. Asphalt Concrete Production Facility:
      a. Production facility for asphalt concrete, tack coat materials, and other bitumastic materials shall be certified by the New York State Department of Transportation for furnishing such materials for New York State highways.
   2. CONTRACTOR's Testing Laboratory:
      a. Retain the services of independent testing laboratory to perform testing and determine compliance with the Contract Documents of the materials provided under this Section.
      b. Do not employ the same laboratory hired by OWNER for field quality control testing under the "Field Quality Control" Article of this Section.
      c. Testing laboratory shall comply with ASTM E329 and requirements of Section 01 45 29.13, Testing Laboratory Services Furnished by Contractor.
      d. Testing laboratory shall be experienced in the types of testing required.

e. Selection of testing laboratory is subject to ENGINEER's acceptance.

B. Regulatory Requirements:
1. Reference Specifications and Details:
a. Comply with applicable requirements of New York State Department of Transportation Standard Specifications and Standard Details.
2. Obtain required highway and street rights-of-way work permits.
3. Jurisdiction:
a. Paved areas to be constructed are jurisdiction of CITY.

C. Quality Assurance Testing:
1. Quality assurance testing is in addition to source quality control testing, when required, and field quality control testing required under Article 3.4 of this Section.
2. Materials used in the Work may require testing and retesting, as directed by ENGINEER, during the Project. Allow free access to material stockpiles and facilities at all times. Tests not specifically indicated to be performed at DEPARTMENT's expense, including retesting of rejected materials and installed Work, shall be performed at CONTRACTOR's expense.
3. CONTRACTOR's Quality Assurance Testing Laboratory Scope:
a. Use of testing laboratory shall not relieve CONTRACTOR of responsibility for providing materials and the Work in compliance with the Contract Documents.
b. Quality assurance testing laboratory shall perform the following, unless evidence of material compliance with reference specifications indicated in Paragraph 1.3.B of this Section, is submitted to ENGINEER by CONTRACTOR and asphalt concrete production facility:
1) Test in accordance with reference specifications indicated in Article 1.3 of this Section. In lieu of quality assurance testing, submit evidence and certification of material compliance with reference specifications. When evidence of conformance submitted is not acceptable to ENGINEER, perform quality assurance testing.
c. To facilitate testing services, CONTRACTOR shall:
1) Secure and deliver to testing laboratory and ENGINEER (when requested by ENGINEER) representative Samples of materials that CONTRACTOR proposes to furnish and that are required to be tested.
2) Furnish such labor as is necessary to obtain and handle Samples at the Site or at asphalt concrete production facility and other material sources.
3) Advise testing laboratory and ENGINEER sufficiently in advance of operations to allow for completion of quality assurance tests and for the assignment of personnel.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:
1. Shop Drawings:

a. Submit the proposed asphalt concrete mix design for each asphalt concrete material, and other bituminous materials, required under this Section, providing complete data on materials, including location in the Work, source, material content and percentages, temperatures and all other pertinent data. Indicate proportion of bituminous material from reclaimed asphalt pavement.

b. Proposed gradation for each aggregate to be used in flexible paving. Submit gradation test results for the same material furnished on a previous project. Indicate the proportion of reclaimed asphalt pavement.

c. In lieu of the information required under Paragraphs 1.4.A.1.a and 1.4.A.1.b, above, submit certificates of compliance with the reference specifications indicated in Article 1.3 of this Section, for each for the following:

1) Each mix design required.
2) Bituminous materials required.
3) Aggregates to be used in flexible paving, from each material source and each required gradation.
4) Density of uncompacted asphalt concrete material.
5) Density of previously-compacted, previously-tested asphalt concrete material.
6) Density and voids analysis for each asphalt concrete material test specimen.
7) Evidence of asphalt concrete plant inspection and compliance with the reference specifications indicated in Article 1.3 of this Section.
8) Proportion of reclaimed asphalt pavement in bituminous materials and aggregate.

2. Product Data:

a. Manufacturer's complete product data on all pavement marking materials proposed for use, including product literature, specifications, and recommended application techniques and other installation data.

B. Informational Submittals: Submit the following:

1. Quality Assurance Test Data Submittals and Source Quality Control Submittals:

a. Submit for quality assurance tests and source quality control tests required.

2. Delivery Tickets:

a. Submit copy of delivery ticket for each load of asphalt concrete, tack coat materials, and other materials obtained from asphalt concrete production facility, signed by CONTRACTOR

3. Field Quality Control Submittals:

a. Submit results of required field quality control testing.

4. Qualifications:

a. Asphalt concrete production facility, when required by ENGINEER.

b. CONTRACTOR's testing laboratory, when required by ENGINEER.

1.5 SITE CONDITIONS

A. Weather Limitations:
   1. Temperature:
      a. For base course and binder course paving lifts equal to or greater than two inches thickness, atmospheric temperature shall be 40 degrees F and rising.
      b. For surface course paving or other pavement courses in lifts less than two inches thick, temperature of surface on which pavement is to be placed shall be 50 degrees F or greater.
   2. Prohibitions:
      a. Do not place flexible paving materials when weather is foggy or during precipitation.
      b. Do not place flexible paving materials when the base on which the material will be placed contains moisture in excess of optimum.
      c. Place flexible paving materials only when ENGINEER concurs that weather conditions are suitable.

PART 2 – PRODUCTS

2.1 SYSTEM PERFORMANCE

A. System Description:
   1. Provide subbase course of the thickness shown or indicated, in accordance with Section 31 23 05, Excavation and Fill.
   2. Flexible Pavement Courses:
      a. Provide the flexible pavement courses indicated below.
      b. Site Pavement:
         1) Binder Course: 4 inches compacted thickness.
         2) Surface Course (Wearing Course or Top Course): 1 inch compacted thickness.

2.2 ASPHALT CONCRETE MIXES

A. Asphalt Concrete Mixtures: Provide the following materials designed and manufactured in accordance with reference specifications indicated in Article 1.3 of this Section:
   1. Binder Course: NYSDOT Item No. 403.138902, Asphalt Concrete – Type 3 Binder Course.
   2. Surface Course (Wearing Course, Top Course): NYSDOT Item No. 403.198202, Asphalt Concrete – Type 7 F2 Top Course."

2.3 BITUMINOUS MATERIALS

A. Bituminous Materials for Asphalt Concrete:
   1. Bituminous materials for asphalt concrete shall comply with the reference specifications indicated in Article 1.3 of this Section, for the asphalt concrete mixes specified.

B. Tack Coat:
   1. Tack coat shall be emulsified asphalt.
   2. Provide Item NYSDOT Item. No. 407.0101, Tack Coat, in accordance with reference specifications indicated in Article 1.3 of this Section.

C. Crack Sealant:
   1. Provide sealant complying with ASTM D6690, Type III, hot-applied type.

2.4 AGGREGATES IN FLEXIBLE PAVEMENTS

A. Aggregates for Asphalt Concrete – General:
   1. Aggregate materials used in flexible pavement shall be in accordance with the reference specifications indicated in Article 1.3 of this Section, for the asphalt concrete mix designs indicated.

2.5 PAVEMENT MARKING MATERIALS

A. Material:
   1. Pavement marking paint shall have chlorinated rubber base.
   2. Factory-mixed, quick-drying and non-bleeding, complying with FS TT-P-115, Type III.

B. Colors:
   1. Roadway Center Markings Between Opposing Traffic Lanes: Yellow.
   2. Roadway Side Striping: White, unless otherwise shown or specified. On roads with divided median, right-side striping of each direction shall be white, and left-side striping shall be yellow.
   3. Roadway Miscellaneous Lane Markings (turn lane arrows and text): White.
   4. No-Parking Areas: Yellow.
   5. Handicap Parking Spaces: Unless otherwise indicated with signs, provide handicap symbol on pavement with white paint on blue background.

PART 3 – EXECUTION

3.1 INSPECTION

A. Examine the subbase and base on which flexible paving will be installed. Notify ENGINEER in writing of conditions detrimental to the proper and timely completion

of the Work. Do not proceed with the Work until unsatisfactory conditions are corrected.

B. Do not place materials on subgrades, or subbase that is muddy or has water thereon.

3.2 PREPARATION

A. Preparation: Before starting installation of flexible paving, perform the following:
   1 Grade Control: Establish and maintain throughout flexible paving installation the required lines and grades, including crown and cross-slope for each asphalt concrete course during construction operations.
   2. Prepare subgrade and provide subbase for flexible pavement in accordance with Section 31 23 05, Excavation and Fill. Before installing flexible pavement, obtain ENGINEER's concurrence that subgrade and subbase are suitable for installing flexible pavement.
   3. Provide appropriate maintenance and protection of traffic measures during placement of pavement.

B. Milling:
   1 Perform milling of existing pavement where shown or indicated.
   2. "Milling" consists of the milling, shaping, and removing portions of existing surfaces by cold milling process and subsequent cleaning.
   3. Milling Equipment:
      a. Milling machines shall be power-operated, self-propelled machines capable of removing the desired thickness of existing surfaces. Machines shall have sufficient power, traction, and stability to accurately maintain depth of cut and slope. Machines shall produce a finished profile and cross slope to within 1/4 inch of that required and shall produce uniform surface texture free of gouges and ridges greater than 3/8-inch deep.
      b. Machines shall be equipped with a means to control dust and other particulate matter created by the cutting action.
      c. Provide equipment that removes milled material as quickly as the rate of milling.
      d. Use vacuum trucks, street sweepers or power brooms to clean milled surfaces.
   4. Milling Operations:
      a. Perform milling to so that, when final course of pavement is placed, required elevations and grades are provided. Where required, establish a taut reference string line to control line and grade of milling.
      b. Minimize the time between milling and placement of pavement over milled surface.
      c. Areas not accessible to the milling machine, such as around or adjacent to drainage structures, manholes, curbs, and transverse joints on structures, may be removed by a small milling machine, handwork or other method acceptable to ENGINEER.
      d. Remove milled material as soon as it is milled. Remove fines and other material prior to opening milled area to traffic. Control objectionable

dust emissions. When traffic has been allowed into milled area or when more than 48 hours have elapsed since milling, clean the milled area again prior to applying tack coat.

e. Maintain drainage to drainage inlets and other drainage structures in a manner acceptable to ENGINEER.

f. Properly dispose of milled material at a location away from the Site.

C. Surface Preparation:

1. Repair surface defects in existing pavement to provide uniform surface to receive new pavement.
2. Provide crack sealant to completely fill cracks more than 1/16-inch wide in areas shown or indicated on the Drawings.
3. Clean existing surfaces over which asphalt concrete pavement will be installed, by removing from the surface foreign material, excess asphalt concrete, excess joint sealant, and crack filler, and other undesirable matter.
4. Provide tack coat as indicated in Article 3.3 of this Section.

3.3 INSTALLATION OF FLEXIBLE PAVING

A. General:

1. Provide final pavement surfaces of uniform texture, at required grades and cross-sections.
2. Construct roadways to the lines, grades, and typical sections shown or indicated.

B. Installation of Asphalt Concrete:

1. Asphalt concrete mixture shall be transported to the site of paving and placed as soon as possible after mixing.
2. Placement of each asphalt concrete course shall be completed over the full width of the section under construction during each day's paving operations.
3. Spread and finish asphalt concrete courses by means of self-propelled mechanical spreading and finishing equipment. Compacted thickness of layers placed shall not exceed 150 percent of specified thickness unless approved in writing by ENGINEER.
4. Compaction:

a. Rollers:

1) Use sufficient rolling equipment to satisfactorily compact and finish the quantity of asphalt concrete placed. There shall be not less than two rollers on the Project at all times. When acceptable to ENGINEER, one of the rollers may be a pneumatic-tire roller.
2) During rolling operations, roller speed shall not exceed three miles per hour. When sufficient number of rollers is not available, reduce the quantity of asphalt concrete placed to accommodate the available rollers' speed.
3) Required rollers shall be at the Site, in acceptable operating condition, prior to placing of asphalt concrete.

4) Use of vibratory rollers in lieu of steel-wheeled rollers is acceptable, however when thickness of asphalt concrete is one-inch or less, rolling shall be in the static mode.

b. Rolling of initially-placed asphalt concrete material, or breakdown rolling, shall begin as soon as the asphalt concrete mixture will bear the roller without undue displacement.

c. Rolling shall be longitudinal, overlapping on successive trips by not less than one-half roller rear wheel width, and not more than three-quarters of roller rear wheel width. Alternate trips of the roller shall be of slightly different lengths.

d. At all times, roller motion shall be slow enough to avoid displacing the asphalt concrete.

e. Operate rollers continuously from breakdown of laid asphalt concrete through finish rolling.

f. Perform finish rolling using a steel-wheeled roller or a vibratory steel-wheel roller operating in the static mode.

g. Perform rolling with consecutive passes to achieve even and smooth finish without roller marks.

h. At each location not accessible to roller, thoroughly compact asphalt concrete with tampers and finish, where necessary, with a hot smoothing iron to provide uniform, smooth layer over the entire area so compacted.

5. Each compacted asphalt concrete course shall be within plus or minus 1/4-inch of the indicated thickness.

6. Placement of Adjacent Strips of New Asphalt Concrete:

a. When more than one width of asphalt concrete material will be placed, a six-inch wide strip of asphalt concrete adjacent to the area on which the future material is to be placed shall not be rolled until such future material is placed.

b. Do not leave the unrolled strip unrolled for more than two hours after placement, unless the six-inch unrolled strip is first heated with a joint heater.

c. After the first strip or width of asphalt concrete is compacted, place, finish, and compact the second width or strip as required for the first width, except that rolling shall be extended to include the six-inch strip of the first width not previously compacted.

C. Construction Joints:

1. Construction joints shall be made in such a manner as to ensure a neat junction, thorough compaction, and bond throughout.

2. Provide a transverse joint extending over the full width of the strip being laid and at right angles to its centerline at end of each workday and at other times when the placement of hot-mix asphalt concrete will be suspended for a period of time that will allow asphalt concrete mixture to chill.

3. Thoroughly compact by rolling the forward end of a freshly laid strip of asphalt concrete before the asphalt concrete mixture becomes chilled. When the Work is resumed, the end shall be cut vertically for the full depth of the layer.

D. Joining of Pavements:
   1. When pavement is to join existing or previously-laid pavement, the existing or previously-laid pavement shall be neatly and carefully edged to allow for overlapping and feathering of the subsequent course of asphalt concrete material.
   2. Where new pavement is to meet existing pavement, the existing pavement shall be sawcut and notched.
   3. Where new pavement will meet existing asphalt pavement, remove existing pavement 12 inches onto undisturbed existing pavement course at edges where new pavement will meet existing pavement.
   4. Tack Coat:
      a. Provide tack coat material at the following locations:
         1) At edges where new pavement will connect to existing or previously-installed pavement.
         2) On surface of existing or previously-installed pavement course over which new pavement will be installed, prior to placement of the subsequent pavement course. Tack coat may be deleted when a succeeding layer of asphalt pavement is being applied over a freshly-placed asphalt pavement course that has been subjected to very little or no traffic, with approval of ENGINEER
         3) Where new pavement will abut curbing, concrete gutters, drainage structures and frames, manhole cover frames, valve boxes, and similar items.
      b. Tack Coat Installation: Install tack coat immediately prior to installing pavement. Place pavement while tack coat is wet. Apply tack coat in accordance with reference specification indicated in Article 1.3 of this Section.

E. Curing:
   1. Do not allow traffic onto pavement until directed by ENGINEER. Traffic will not be allowed on new asphalt concrete pavement until surface temperature is less than 140 degrees F.
   2. Hold construction traffic on new pavement to a minimum as acceptable to ENGINEER.

F. Asphalt Concrete Curbs: Provide extruded asphalt curbs of the height and profile indicated on the Drawings.

G. Defective Pavement Work:
   1. When directed by ENGINEER, remove and replace defective flexible paving Work. Cut out such areas of defective pavement and fill with fresh asphalt concrete materials, compacted to required density.

3.4 FIELD QUALITY CONTROL

A. Site Tests:
   1. Responsibility:

a. CONTRACTOR's field quality control testing laboratory will:
   1) Perform field density tests to verify that required compaction of asphalt materials has been obtained.
   2) Test the proposed materials for compliance with the Contract Documents, as directed by ENGINEER.
   3) Submit reports of all test results to ENGINEER and CONTRACTOR.
b. Authority Field Quality Control Testing Laboratory:
   1) Technicians representing the testing laboratory will inspect materials at the Site and perform required testing. When the materials furnished or Work performed do not comply with the Contract Documents, field quality control testing laboratory technician shall direct the attention of ENGINEER and CONTRACTOR to such non-compliance.
   2) Testing laboratory personnel shall not act as foreman or perform other duties for CONTRACTOR. The Work will be checked as it progresses, but failure to detect defective Work shall not in any way prevent the later rejection of such defective Work when defect is discovered. Failure to detect defective Work as it occurs does not obligate ENGINEER to final acceptance. Testing laboratory personnel are not authorized to revoke, alter, relax, enlarge, or release requirements of the Contract Documents, nor to approve or accept any portion of the Work.

2. Asphalt Concrete Mix Temperature: Measure temperature at time of placement, record, and submit to ENGINEER.
3. Surface Smoothness:
   a. Test finished surface of each flexible paving course for smoothness, using a ten-foot straightedge applied parallel to and at right angles to centerline of paved areas.
   b. Check surfaced areas at intervals as directed by ENGINEER.
   c. Surfaces will be acceptable relative to smoothness when measurements are equal to or less than the following:
      1) Base Course: 3/8-inch vertical in ten feet horizontal.
      2) Binder Course: 3/8-inch vertical in ten feet horizontal.
      3) Surface Course (Wearing Course): 1/4-inch vertical in ten feet horizontal.
      4) Crowned Surfaces:
      5) Test crowned surfaces with a crown template, centered and at right angles to the crown.
      6) Surfaces will be acceptable when variance is equal to or less than 1/4-inch from the template.
   d. Elevation: Finished surface of pavement shall be within plus or minus 1/2-inch of elevations shown or indicated.
4. Density:
   a. Test Method: ASTM D2950 nuclear method; test one sample every 1,000 square yards of pavement. Test for each asphalt concrete course installed.
   b. In addition, when directed by ENGINEER, compare density of in-place flexible paving materials against laboratory specimen or certificates on same asphalt pavement mixture, using nuclear density device.

c. Criteria for Acceptance: Density of in-place asphalt pavement material shall be not less than 90 percent of the recorded laboratory specimen or certificate density. Density shall be not greater than 98 percent.

5. Thickness of Asphalt Concrete Pavement Thickness: Measure in accordance with ASTM D3549; obtain and test one core sample from every 1,000 square yards compacted pavement. Comply with thickness tolerance specified in Article 3.3 of this Section.
6. Repair holes from test specimens in accordance with this Section's requirements for repairing defective Work.

3.5 ADJUSTING

A. Frames and Covers:
1. Set frames of drainage structures, manholes, valve boxes, and similar items to final grade. Adjust frames of existing structures and frames furnished under other Sections. Frames shall be substantially similar elevation to finished surface course of pavement.
2. Replace covers and gratings of existing structures immediately following adjusting associated frames. Install covers and gratings of structures provided under the Project as quickly as possible.
3. Where there is a delay between adjusting of frames and installation of surface course, provide temporary bituminous material around perimeter of each frame to smooth vehicle access over the frame. Maintain and repair temporary bituminous material as required until placement of surface course. Remove temporary bituminous material before installing surface course.

B. Pavement Adjustment:
1. Repair or replace in manner acceptable to ENGINEER areas of pavement that are observed to pond or collect water.

3.6 CLEANING

A. Cleaning: After completing the paving operations, clean surfaces of excess or spilled bituminous materials, excess asphalt concrete, and foreign matter.

3.7 PROTECTION

A. Protect finished pavement until pavement has become properly hardened and cool.

B. Cover openings of drainage structures, manholes, valve boxes, and similar items in the paved area until permanent coverings are provided.

3.8 PAVEMENT MARKINGS

A. Pavement Markings: Provide pavement markings where shown or indicated.
1. Preparation:

a. Sweep surface with power broom supplemented by hand brooms to remove loose material and dirt.
b. Do not begin marking bituminous concrete pavement until approved by ENGINEER.
c. When reflective glass beads are required, mix with paint prior to paint application.

2. Application:
   a. Using mechanical equipment, provide uniform, straight edges in two separate coats. Apply in accordance with paint manufacturer's recommendations.

+ + END OF SECTION + +

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SECTION 32 16 13

CONCRETE CURBS, GUTTERS, AND SIDEWALKS

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install concrete curbs, gutters, and sidewalks.
   2. Types of Work required under this Section include:
      a. Conventionally-formed or machine-formed curb and sidewalk.
   3. Width, thickness, geometry, and extent of curb, gutter, and sidewalk shall be as shown or indicated on the Drawings.
   4. Requirements for concrete sidewalks apply to concrete driveways, unless otherwise shown or specified, or unless concrete pavement requirements are included in the Contract Documents.

B. Related Sections:
   1. Section 03 11 00, Concrete Forming.
   2. Section 03 15 00, Concrete Accessories.
   3. Section 03 20 00, Concrete Reinforcing.
   4. Section 03 30 00, Cast-In-Place Concrete.
   5. Section 07 92 00, Joint Sealants.

1.2 REFERENCES

A. Standards referenced in this Section are:
   1. AASHTO M252, Specification for Corrugated Polyethylene Drainage Pipe.
   2. ASTM D1248, Specification for Polyethylene Plastics Extrusion Materials For Wire and Cable.

1.3 QUALITY ASSURANCE

A. Qualifications:
   1. Installer:
      a. Installer shall have not less than two years experience installing concrete curbs, gutters, and sidewalks similar to those required for the Work.
      b. When required by ENGINEER, submit record of experience documenting not less than three successful, completed projects. For each project, submit name the following information: project name, location of project, approximate quantity of concrete curb, gutter, and sidewalk constructed by installer, contract price of concrete curb, gutter, and sidewalk

construction, and name and contact information for project owner and the project's construction-phase engineer.

B. Regulatory Requirements:
   1. Reference Specifications and Details:
      a. Comply with applicable requirements of New York State Department of Transportation Standard Specifications and Standard Details.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Shop Drawings:
      a. Submit concrete mix design when mix design is different from that submitted under Division 03 Sections on concrete. Submit in accordance with Division 03 Sections on concrete.
      b. Proposed reinforcing materials.
      c. Schedule of proposed underdrain piping sizes and materials by location in the Project.
   2. Product Data:
      a. Concrete Materials: Submit Supplier's technical information for materials proposed for use, when concrete materials are different from those submitted under Division 03 Sections on concrete.
      b. Reinforcing Steel: Submit fabricator's technical information, including catalog information and specifications, for materials proposed for use, sufficient for ENGINEER to verify compliance with the Contract Documents.
      c. Expansion Joint Filler: Submit Supplier's technical information, including manufacturer's product data, brochure, and specifications, for materials proposed for use, when materials are different from those submitted under Division 03 Sections on concrete.
      d. Underdrain Piping: Manufacturer's product data, brochure, and specifications for underdrain piping proposed for use.

B. Informational Submittals: Submit the following:
   1. Certifications:
      a. When concrete materials are different from those approved under Division 03 Sections on concrete, submit certifications as required in concrete Specifications Sections referred to in this Section.
   2. Site Quality Control Submittals:
      a. Concrete test results for the Work included under this Section.
   3. Qualifications Statements:
      a. Installer, when requested by ENGINEER.

1.5 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Comply with Division 03 Sections on concrete referenced in this Section.

1.6 SITE CONDITIONS

A. Weather and Temperature Limitations:
   1. When temperature and environmental conditions warrant, comply with requirements for cold weather placing and hot weather placing under Division 03 Sections referenced in this Section, unless otherwise required under this Section.
   2. Temperature of aggregate base material under concrete shall be 39 degrees F or higher. Aggregate base material shall not have snow, ice, frost, or standing water on its surface at the time of concrete placing. Use of insulating materials and heating equipment may be required before concrete placing begins.
   3. Discontinue concrete placing when the air temperature falls below 39 degrees F. Do not place concrete in the rain.

PART 2 – PRODUCTS

2.1 MATERIALS

A. Aggregate Bedding Material for Curbs, Sidewalks, and Gutters: Select Fill in accordance with Section 31 23 05, Excavation and Fill, unless otherwise shown or indicated.

B. Concrete Materials:
   1. Comply with applicable requirements of: Section 03 11 00, Concrete Forming; Section 03 15 00, Concrete Accessories; Section 03 20 00, Concrete Reinforcing; and Section 03 30 00, Cast-in-Place Concrete; including requirements for formwork, concrete materials, admixtures, bonding materials, curing materials, and others as required.
   2. Concrete Mix, Design, and Testing:
      a. Comply with applicable requirements of Section 03 30 00, Cast-in-Place Concrete, for concrete mix design, sampling, and testing, and quality control.
      b. Design the mix to produce concrete of properties of compressive strength, slump range, and air content as specified in Section 03 30 00, Cast-in-Place Concrete.
      c. When machine-formed equipment is used for constructing concrete curbs, sidewalks, or gutters, concrete so placed shall have properties in accordance with Section 03 30 00, Cast-in-Place Concrete, except that maximum slump shall be 2.5 inches and air content shall be two percent of design.

C. Reinforcing Materials:
   1. Provide deformed steel bars and smooth wire fabric complying with Section 03 20 00, Concrete Reinforcing.
   2. Provide wire fabric in flat sheets. Do not furnish wire fabric in rolls.

D. Expansion Joint Material:
   1. Preformed Expansion Joint Filler: Comply with Section 03 15 00, Concrete Accessories, for preformed expansion joint fillers.
   2. Joint Sealant: For joint sealants and accessories used on expansion joints, comply with Section 07 92 00, Joint Sealants.

PART 3 – EXECUTION

3.1 INSPECTION

A. Examine subgrade, subbase, and conditions under which the Work is will be performed and notify ENGINEER in writing of unsatisfactory conditions. Do not proceed with the Work until unsatisfactory conditions are been corrected.

B. Subgrade:
   1. Verify that earthwork is completed to correct line and grade.
   2. Verify that subgrade is smooth, properly compacted, and free of frost and excessive moisture in accordance with Division 31 Section on excavation and fill.
   3. Do not commence the Work under this Section until conditions are satisfactory.

3.2 AGGREGATE BASE FOR CURBS, SIDEWALKS, AND GUTTERS

A. Aggregate Base under Curb, Gutter, or Sidewalk:
   1. Install aggregate fill in accordance with Section 31 23 05, Excavation and Fill. Properly compact aggregate fill to thickness shown or indicated in the Contract Documents.
   2. When thickness of aggregate base is not shown or indicated, provide six-inch thick aggregate base under curbs, sidewalks, and gutters.

3.3 PERFORATED UNDERDRAIN PIPING

A. Preparation for Underdrain Piping:
   1. Provide leveled and compacted bed of the required underdrain bedding material just prior to installing the underdrain piping. Slope bedding as shown and as required for drainage of underdrain piping.

B. Installation of Underdrain Piping:
   1. Install underdrain piping in accordance with pipe manufacturer's recommended installation procedures.
   2. Upgrade end of corrugated polyethylene underdrain pipe shall be closed with a solid plastic cap.
   3. Unless otherwise shown or required by ENGINEER, install underdrain pipe with perforations down.
   4. Install piping to drain to suitable discharge location.

5. When polyethylene underdrains are daylighted through the side slope protect end of pipe from sunlight by providing section of corrugated steel or aluminum pipe, not less than three feet long, at the outlet. Extend the metal pipe not less than six inches into the ground and shall overlap the perforated underdrain piping by not less than the diameter of the underdrain pipe.

C. Acceptability of Underdrain Piping:
   1. With ENGINEER, visually inspect installed underdrain piping after installation and prior to filling and placing additional construction over underdrain piping. Piping will be acceptable when it is verified as installed on acceptable grade for drainage, is installed in accordance with the Contract Documents, and is free of damage and defects.

3.4 CONSTRUCTION OF FORMS

A. Conventional Forms:
   1. Set forms to line and grade. Forms shall be free from warp.
   2. Install forms along full length of curb, gutter, and sidewalk.
   3. Forms shall extend to the full depth of the curb, sidewalk, and gutter (as applicable) and be secured so no displacement occurs during concrete placing.

B. At CONTRACTOR's option, machine-formed concrete curbs, sidewalks, and gutters are acceptable.

3.5 REINFORCING

A. General:
   1. Locate, place, and support reinforcing in accordance with Section 03 20 00, Concrete Reinforcing, unless otherwise shown on the Drawings.
   2. Size of reinforcing shall be as shown or indicated in the Contract Documents.
   3. Unless otherwise shown or indicated, locate reinforcing for sidewalks at the mid-depth point in the concrete slab.

B. When machine-formed concrete curbs, sidewalks, and gutters are provided, reinforcing shall be suitable for the forming/placing method, at no additional cost to DEPARTMENT. Obtain ENGINEER's approval of alternate reinforcing prior to placing concrete.

3.6 CONCRETE PLACING

A. General:
   1. Comply with Section 03 30 00, Cast-in-Place Concrete, and this Section relative to mixing and placing concrete.

B. Placing:
   1. Curbs and Gutters: Place concrete using methods that prevent segregation of the mix. Consolidate concrete along face of forms with an internal vibrator.

2. Sidewalks: Place concrete in one-course, monolithic construction, for full width and depth of sidewalk.
3. Machine-Formed:
   a. At CONTRACTOR's option, automatic curb, gutter, and sidewalk machine may be used for installing concrete.
   b. Machine forming shall produce curbs, gutters, and sidewalks of required cross-section, lines, grades, finish, and jointing, as specified for conventionally-formed concrete.
   c. At curb cuts and driveway entrances, cut-out concrete and hand-finish the curbing to provide the required curb cut or driveway entrance, as applicable.
   d. If results do not comply with the Contract Documents, remove and replace at no additional cost to DEPARTMENT.

C. Curbs:
1. Provide curb-cuts and driveway entrances for vehicle passage and pedestrian passage where shown, and when not shown but where existing sidewalks and curbs are being replaced, provide curb-cut or driveway entrance (as applicable) at location of existing driveways and pedestrian access ramps in sidewalks.
2. Neatly form transitions from curb to curb-cut or driveway entrance.
3. Unless otherwise shown or indicated, top of curb at curb-cut or driveway entrance shall be not greater than 1/4 inch above elevation of finished pavement surface.

D. Gutters:
1. Unless otherwise shown or indicated, top of gutter shall be not greater than 1/4 inch above elevation of finished pavement surface.

3.7 JOINTS

A. General:
1. Provide expansion joints, contraction joints, and construction joints in concrete curbs, gutters, and sidewalks.
2. Provide expansion, contraction, and construction joints perpendicular to formed faces of curb, gutter, or sidewalk.
3. Construct transverse joints at right angles to the Work centerline and as shown.

B. Contraction Joints: Provide joints as indicated below:
1. Curbs and Gutters: Provide at intervals of ten feet on centers. Joint shall be not less than 1/8- inch and not more than 1/4 inch in width, and have a depth of 1.5 inches.
2. Sidewalks: Provide at intervals of five feet on centers. Joint shall be not less than 1/8- inch and not more than 1/4 inch in width, and have a depth of not less than one-third the total thickness of concrete sidewalk.
3. Joints may be formed or sawcut.

C. Construction Joints: Place construction joints at locations where concrete placing operations are stopped for more than 30 minutes, except where such pours terminate at expansion joints.

D. Expansion Joints:
   1. General: Provide preformed expansion joint filler at locations indicated. When curb, gutter, or sidewalk is not poured monolithically, provide expansion joints where each abuts the other.
   2. Curbs and Gutters: Provide 11/16-inch wide preformed expansion joint filter at the intervals of 30 feet along curb and gutter; at expansion joints in pavement; at movable structures (such as bridges); and between curb or gutter and: structures, returns, and at 30-foot intervals along length of curb or gutter.
   3. Sidewalks: Provide 1/2-inch wide preformed expansion joint filler at 30-foot intervals along length of sidewalk and at all joints between sidewalk and: curb, gutters, pavement, buildings, drainage structures, utility metal appurtenances such as manhole cover frames and valve boxes, and similar construction.
   4. Place top of expansion joint material not less than 1/2 inch or more than one-inch below concrete surface. Apply joint sealer on top of expansion joint material flush with concrete surface, and in accordance with sealant manufacturer's instructions and Section 07 92 00, Joint Sealants.

3.8 CONCRETE FINISHING

A. Smooth exposed surface by screeding and floating. Perform hand-screeding when conventionally-formed concrete is provided.

B. Work edges of gutter and sidewalks, back top edge of curb, and transverse joints; and round to 1/4-inch radius.

C. Complete surface finishing by drawing a fine-hair broom across surface, perpendicular to line of traffic.

3.9 CURING

A. General:
   1. Protect and cure finished concrete curbs, gutters, and sidewalks, in accordance with Section 03 30 00, Cast-in-Place Concrete.
   2. Cure driveways and sidewalks at driveways for not less than three days prior to opening to vehicle traffic. In colder weather, as indicated in Article 1.6 of this Section, curing period shall be not less than six days prior to opening to vehicle traffic unless other provisions to determine strength are provided and approved by ENGINEER.

3.10 REPAIR AND CLEANING

A. Repair or replace broken or defective curbs, gutters, and sidewalk as directed by ENGINEER.

B. Sweep the concrete curb, sidewalk, and gutter Work and wash free of stains, discolorations, dirt, and other foreign material.

+ + END OF SECTION + +

SECTION 32 31 00

FENCING

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, tools, equipment and incidentals as shown, specified, and required to furnish and install fencing.
   2. Extent of fencing is shown or indicated.
   3. Types of materials required under this Section include:
      a. Aluminum-coated, steel chain link fabric.
      b. Galvanized steel framework.
      c. Barbed wire.
      d. Grounding and bonding.
      e. Auxiliary system components, gates, accessories, fasteners, and fittings.
   4. Substitutions: Structural shapes of satisfactory sections and equal strengths may be substituted upon ENGINEER's approval of CONTRACTOR's substitution request.

B. Related Sections:
   1. Section 03 30 00, Cast-In-Place Concrete.

1.2 REFERENCES

A. Standards referenced in this Section are:
   1. ASTM A53, Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
   2. ASTM A90/A90M, Test Method for Weight [Mass] of Coating on Iron and Steel Articles with Zinc or Zinc-Alloy Coatings.
   3. ASTM A123, Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
   4. ASTM A153/A153M, Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
   5. ASTM A428/A428M, Test Method for Weight [Mass] of Coating on Aluminum-Coated Iron or Steel Articles.
   6. ASTM A491, Specification for Aluminum-Coated Steel Chain-Link Fence Fabric.
   7. ASTM A780, Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings.
   8. ASTM A817, Specification for Metallic-Coated Steel Wire for Chain-Link Fence Fabric.

9. ASTM A1011/A1011M, Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength.
10. ASTM B6, Specification for Zinc.
11. ASTM D412, Test Methods for Vulcanized Rubber and Thermoplastic Rubbers and Thermoplastic Elastomers—Tension.
12. ASTM D746, Test Method for Brittleness Temperature of Plastics and Elastomers by Impact.
13. ASTM D792, Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement.
14. ASTM D1499, Practice for Filtered Open-Flame Carbon-Arc Exposures of Plastics.
15. ASTM D2240, Test Method for Rubber Property—Durometer Hardness.
16. ASTM F552, Terminology Relating to Chain Link Fencing.
17. ASTM F567, Practice for Installation of Chain-Link Fence.
18. ASTM F626, Specification for Fence Fittings.
19. ASTM A653, Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
20. ASTM F668, Specification for Polyvinyl Chloride (PVC) and Other Organic Polymer-Coated Steel Chain-Link Fence Fabric.
21. ASTM F900, Specification for Industrial and Commercial Swing Gates.
22. ASTM F1043, Specification for Strength and Protective Coatings on Metal Industrial Chain Link Fence Framework.
23. ASTM F1083, Specification for Pipe, Steel, Hot-Dipped Zinc-Coated (Galvanized) Welded, for Fence Structures.
24. ASTM F1184, Specification for Industrial and Commercial Horizontal Slide Gates.
25. CLFMI CLF 2445, Product Manual.
26. CLFMI, Step-by-Step Installation Guide.
27. IEEE C2, National Electrical Safety Code.
28. IEEE 81, Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System Part 1: Normal Measurements.

1.3 TERMINOLOGY

A. The following words or terms are not defined but, when used in this Section, have the following meaning.
   1. "Knuckling" describes the type of selvage obtained by interlocking adjacent pairs of wire ends and then bending the wire ends back into a closed loop.
   2. "Gate operating cycle" is one gate opening plus one gate closing.
   3. "Fencing" describes an assembly of metal components, including wire chain-link fabric fastened to top, bottom and intermediate horizontal rails and to vertical line posts, corner posts and terminal posts. This assembly includes all auxiliary components, gates, fittings, fasteners, and other accessories, all with specified protective coatings.

B. Terminology used in this Section and not defined in this Article will be construed in accordance with the terminology used in CLF 2445 and ASTM F552.

1.4 QUALITY ASSURANCE

A. Qualifications:
   1. Erector/Installer:
      a. Engage a single erector that is skilled and trained, and possesses successful and documented experience installing fencing, and employs only workers with specific skill and successful experience in the type of Work required.
      b. Erector shall be acceptable to fencing manufacturer,
      c. Submit name and qualifications of erector with the following information for a minimum of three successful projects:
         1) Names and telephone numbers of owner and architect or engineer responsible for project.
         2) Approximate fencing contract amount.
         3) Quantity of fencing installed.

B. Component Supply and Compatibility:
   1. Provide fencing as complete system with all gates, hardware, appurtenances and other components produced by a single manufacturer, including custom erection accessories, fittings, clamps, and fastenings as required for complete system.
   2. Provide electrical components, devices and accessories from a single manufacturer regularly engaged in manufacturing such items, acceptable to, and coordinated by, fencing manufacturer.

C. Regulatory Requirements:
   1. Comply with Laws and Regulations, including:
      a. Americans with Disabilities Act of 1990 (Public Law 101-336), Appendix A of 28 CFR 36, Americans with Disabilities Act Accessibility Guidelines for Buildings and Facilities (ADAAG).
   2. Electrical Components, Devices, and Accessories:
      a. Shall be listed and labeled by testing agency acceptable to authority having jurisdiction at the Site, and marked for intended use.
      b. Comply with requirements of authorities having jurisdiction at the Site for automatic gate operators serving as required means of access.

1.5 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Shop Drawings:
      a. Drawings at scale of 1/4-inch equal to one foot of typical fence assembly, identifying all materials, dimensions, sizes, weights, and finishes of rails, posts, braces, supports and other fencing components. Show fence heights, and locations of gates. Show gate swing, or other

operation, hardware, and accessories. Include plans, elevations, and sections, with required installation and operating clearances, and details of post anchorage, attachments, and bracing.

b. List of all hardware, fasteners, and accessories.

2. Product Data:

a. Copies of manufacturer's technical product information, and specifications for all fencing components, including auxiliary system components such as gate operators and motors.

b. Data substantiating that materials proposed comply with the following:

1) Weight of aluminum coating on wire fabrications, in compliance with ASTM A428.

2). Weight of zinc coating on pipe fabrications, in compliance with ASTM A90.

3. Samples: ENGINEER's review will be for color and texture only. Compliance with other requirements is CONTRACTOR's responsibility. Submit the following:

a. Each fencing component, fastener, post, rail, support, chain-link fabric type, and other auxiliary and miscellaneous items labeled with identification of proposed use and location.

b. Sample of each chain-link fabric material, six inches square; and framework members, and typical accessories, each approximately six inches long.

c. Full range of manufacturer's standard and custom color Samples.

B. Informational Submittals: Submit the following:

1. Certifications:

a. Submit shipping list for materials used, endorsed with manufacturer's voucher, signed by authorized employee of manufacturer, certifying that material used in fencing complies with the Contract Documents and with the approved submittals.

2. Design Data: Submit with the Shop Drawings:

a. All structural calculations verifying that all system components comply with requirements of authorities having jurisdiction at the Site.

b. When proposing fencing framework or other structural components that varies from the Contract Documents, submit fabricator's structural calculations for design of proposed fencing. Structural analysis shall verify that all system components including supports, gates, fasteners, fittings, and connections comply with the Contract Documents and requirements of authorities having jurisdiction at the Site.

3. Manufacturer's Instructions:

a. Manufacturer's installation instructions.

4. Qualifications Statements:

a. Erector.

C. Maintenance Material Submittals: Submit the following:

1. Extra Stock Materials:

a. Furnish extra stock materials from same manufactured lot as materials installed.
b. Provide minimum of five percent excess over required amount of fencing components. Pack in cartons and store at the Site where directed by ENGINEER.
c. Do not provide partial containers or packages of materials. Round-up quantities to furnish only complete, unopened, and undamaged containers and packages.
d. Submit quantities of each system component required for the Work, based on actual purchase order to manufacturer for materials to be used for this Project, with calculations substantiating quantity of extra stock materials furnished.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Delivery of Materials:
1. Packaging and Marking: Comply with CLFMI CLF 2445.
2. Deliver materials in manufacturer's original, unopened packaging with all factory-applied tags, labels and other identifying information intact, legible and accurately representing material on approved submittals.

B. Storage of Materials:
1. Store all materials under weatherproof cover, off the ground and away from other construction activities.
2. Do not store material in a manner that would create a humidity chamber. Provide for free movement of air under protective cover and between components of the fencing.

C. Handling of Materials:
1. Handle material in manner that is in compliance with manufacturer's recommendations and that avoids damaging coatings.

1.7 PROJECT CONDITIONS

A. Existing Utilities: Do not interrupt utilities unless allowed:
1. in Section 01 14 16, Coordination with CITY's Operations; or
2. under the following conditions, only after providing temporary utility services according to requirements indicated.
a. Notify ENGINEER and CITY not less than three days in advance of proposed utility interruptions.
b. Do not proceed with utility interruptions without ENGINEER's written permission.

B. Obtain measurements at the Site to verify layout information and dimensions for fencing and gates in relation to reference points provided by CITY or indicated in the Contract Documents.

PART 2 – PRODUCTS

2.1 SYSTEM PERFORMANCE

A. Design Considerations:
   1. Verify size of framing members shown or indicated in the Contract Documents. Where structural analysis indicates the need, provide additional members, or increased member size, thickness or weight.
   2. Modifications may be made only as necessary to meet Site conditions to ensure proper fitting and support of the Work and only upon submittal of Shop Drawings and receipt of approval by ENGINEER.

2.2 MATERIALS

A. General:
   1. Tube sizes specified are nominal outside dimension.
   2. Roll-formed section sizes are nominal outside dimensions.
   3. Wire gages shall conform to American Steel and Wire Company gage.
   4. Heat-form arcs and chords before applying protective coatings to metal.
   5. Sizes specified are given for uncoated metal. Protective coatings are in addition to specified metal dimensions, gages, and sizes.
   6. Provide weights of zinc and aluminum coatings on wire and pipe fabrications in accordance with CLFMI CLF 2445.

B. Chain-Link Fence Fabric:
   1. One-piece fabric widths, for fencing 12 feet and less in height, complying with CLFMI CLF 2445.
   2. Wire mesh shall be woven throughout in form of approximately-uniform square mesh with parallel sides and horizontal and vertical diagonals of approximately-uniform dimensions, of size and gage specified and in compliance with ASTM A817, Type 1, cold-drawn carbon steel wire with minimum breaking strength of 2,170 pounds and coated with aluminized finish, as specified. Fabric shall be as recommended by CLFMI for heavy industrial usage.
   3. Provide fence fabric imprinted with manufacturer's trade name, country of origin, core wire gage, and finished outside diameter gage.
   4. Provide fabric knuckled to eliminate exposure of sharp edges.
   5. Fabric Gage: Provide the following:
      a. No. 9-gage wires.
   6. Mesh Size: Provide the following:
      a. Two-inch mesh.

2.3 FRAMEWORK

A. General: The following table presents actual OD and equivalent nominal NPS size and trade size of round members:

Actual OD (inches)	NPS Size (inches)	Trade Size (inches)
1.315	1.0	1-3/8
1.660	1.25	1-5/8
1.900	1.5	2
2.375	2.0	2.5
2.875	2.5	3
3.500	3.0	3.5
4.000	3.5	4
6.625	6.0	6-5/8
8.625	8.0	8-5/8

B. Pipe shall be commercial grade, plain-end steel pipe with standard-weight walls. Steel strip used for manufacture of pipe shall comply with ASTM F1083, Schedule 40 pipe with minimum yield strength of 25,000 psi and protected with zinc, as specified.

C. Fittings: Comply with ASTM F626.

D. End, Corner, and Pull Posts: Provide end, corner, and pull posts of following minimum sizes:
   1. Up to six feet fabric height:
      a. 2.375 inches OD pipe weighing 3.65 pounds per linear foot.
   2. Over six feet fabric height and less than eight feet fabric height:
      a. 2.875 inches OD pipe weighing 5.79 pounds per linear foot.
   3. Over eight feet fabric height:
      a. 3.50 inches OD pipe weighing 7.58 pounds per linear foot.

E. Line Posts: Provide line posts of following minimum sizes and weights:
   1. Up to six feet fabric height:
      a. 1.90 inches OD pipe weighing 2.72 pounds per linear foot.
   2. Over six feet fabric height and less than eight feet fabric height:
      a. 2.375 inches OD pipe weighing 3.65 pounds per linear foot.
   3. Over eight feet fabric height:
      a. 3.50 inches OD pipe; weight of 7.58 pounds per linear foot.

F. Gate Posts: Provide gate posts for supporting single gate leaf, or one leaf of a double gate installation, for nominal gate widths as follows:
   1. Up to six feet wide:
      a. 2.875 inches OD pipe weighing 5.79 pounds per linear foot.
   2. Over six feet wide and up to 13 feet wide:
      a. Four inches OD pipe weighing 9.11 pounds per linear foot.
   3. Over 13 feet wide and up to 18 feet wide:
      a. 6.625 inches OD pipe weighing 18.97 pounds per linear foot.
   4. Over 18 feet wide:
      a. 8.625 inches OD pipe weighing 28.55 pounds per linear foot.

G. Top Rail: Provide top rails, unless otherwise shown or indicated, conforming to the following:
   1. 1.900 inch OD pipe weighing 2.72 pounds per linear foot.
   2. Provide in manufacturer's longest lengths, with expansion-type coupling 0.051-inch thick rail sleeves, approximately seven inches long, for each joint.
   3. Provide means for attaching top rail securely to each gate, corner, pull, and end post.

H. Center Rails Between Line Posts: Provide center rails between line posts, where shown, consisting of 1.660-inch OD pipe weighing 2.27 pounds per linear foot.

I. Roll-Formed Steel: Provide rolled steel shapes produced from structural-quality steel conforming to ASTM A1011, Grade 45, with minimum yield strength of 45,000 psi. Protective coating system shall conform to ASTM F1043, as specified.

J. Post Brace Assembly: Provide bracing assemblies at end and gate posts, and at both sides of corner and pull posts, with horizontal brace located at mid-height of fabric.
   1. Use 1.900-inch OD pipe weighing 2.72 pounds per linear foot for horizontal brace and 3/8-inch diameter rod with turnbuckle for diagonal truss.

2.4 GATES

A. Swing gates shall comply with ASTM F900.

B. Sliding gates shall comply with ASTM F1184.

C. Gate hinges shall be double clamping offset type. To hold gate in the open or closed positions, provide each gate frame with a keeper that automatically engages gate shoe set in concrete. Gates shall have drop latch with provision for padlock.
   1. Gate Hinges: Pressed or forged steel or malleable iron to suit gate size, non-lift-off type, 180-degree offset heavy-industrial hinges, 1.5 pair per leaf.
   2. Latch: Forked-type or plunger bar type to permit operation from either side of gate, with padlock eye as integral part of latch.
   3. Keeper: Provide a gate keeper for vehicle gates that automatically engages gate leaf and holds gate leaf in open position until manually released.

D. Padlocks: Provide each gate with heavy-duty bronze padlock and shackle chain as follows:
   1. Product and Manufacturer: Provide one of the following:
      a. No. 160DHM with 11/32-inch marine brass shackle by Master Lock Company.
      b. Or equal.
   2. Provide three keys for each padlock. Where more than one gate is required for same enclosure, padlocks shall be keyed identically.

E. Provide gate frames with intermediate horizontal rails. Gate frames shall be welded construction and shall be galvanized after fabrication. Provide single gates six feet or greater in width, and double gates 12 feet or greater in width, with diagonal bracing in one direction, extending from top to bottom rail.

F. Gate Stops: Provide gate stops for double gates consisting of mushroom-type flush plate with anchors, set in concrete and designed to engage a center drop rod or plunger bar. Include locking device and padlock eyes as integral part of latch, using one padlock for locking both gate leaves.

G. Fabricate gate perimeter frames of tubular members. Provide additional horizontal and vertical members to ensure proper gate operation and for attachment of fabric, hardware, and accessories. Space so that frame members are not more than eight feet apart. Fabricate as follows:
   1. Up to six feet high, or leaf width of eight feet or less:
      a. 1.660-inch OD pipe weighing 2.27 pounds per linear foot.
   2. Over six feet high, or leaf width exceeding eight feet:
      a. 1.900-inch OD pipe weighing 2.72 pounds per linear foot.

H. Assemble gate frames by welding or with special malleable or pressed steel fittings and rivets for rigid connections. Use same fabric as provided for fence. Install fabric with stretcher bars at vertical edges. Bars may also be used at top and bottom edges. Attach stretchers to gate frame at not more than 15 inches on centers. Attach hardware with rivets or by other means that will provide security against removal and breakage.

I. Install diagonal cross-bracing on gates consisting of 1/2-inch diameter adjustable length truss rods provided with turnbuckles to ensure frame rigidity without sag or twist.

J. Where barbed wire is shown or indicated above gates, extend end-members of gate frames one foot above top member and prepare to receive three strands of wire. Provide necessary clips for securing wire to extensions.

2.5 AUXILIARY FENCING MATERIALS AND ACCESSORIES

A. Wire Ties:
   1. For tying fabric to line posts, use nine-gage, aluminum alloy 1100-H4, PVC-coated wire ties to match fence fabric, spaced 12 inches on centers.
   2. For tying fabric to rails and braces, use nine-gage, aluminum alloy 1100-H4, PVC-coated wire ties to match fence fabric, spaced two feet on centers.
   3. For tying fabric to tension wire, use 11-gage, aluminum alloy 1100-H4, PVC-coated wire hog ring ties to match fence fabric, spaced two feet on centers.

B. Tension Wire: Provide tension wire consisting of aluminized, seven-gage, coiled spring steel wire coated with 0.40-ounces of aluminum per square foot of wire surface, minimum, in compliance with ASTM F1664.
   1. Locate at bottom of fabric only.

C. Barbed Wire Supporting Arms: Pressed steel for three rows of barbed wire attached to each arm, complete with provisions for anchorage to posts. Supporting arms shall be integral with post-top weather cap. Provide following type:
   1. Single 45-degree arm, one for each post.

D. Barbed Wire: Commercial quality steel, two-strand, 11-gage line wire with 14-gage, four-point twisted aluminum alloy barbs spaced five inches on centers, as follows:
   1. PVC-coated, complying with ASTM F1665.

E. Post Caps: Pressed steel, wrought iron, or cast aluminum alloy, designed as weather-tight closure cap, for tubular posts. Provide one cap for each post unless equal protection is afforded by combination post-top cap and barbed wire supporting arm, where barbed wire is required.
   1. Provide caps with openings to allow through-passage of top rail.
   2. Provide cone-type caps for terminal posts and loop-type caps for line posts.

F. Stretcher Bars: One-piece lengths equal to full height of fabric, with minimum cross-section of 3/16-inch by 3/4-inch. Provide one stretcher bar for each gate and end-post, and two for each corner- and pull-post, except where fabric is integrally woven into the post.

G. Stretcher Bar Bands: Pressed steel, galvanized, 0.078-inch to 0.108-inch thick depending on post diameter, spaced not greater than 15 inches on centers to secure stretcher bars to end-, corner-, pull-, and gate-posts.
   1. Bands may also be used with special fittings for securing rails to end-, corner-, pull-, and gate-posts.

H. Truss Rods: Steel rods, 3/8-inch diameter, merchant quality with turnbuckle.

I. Concrete: In accordance with Section 03 30 00, Cast-In-Place Concrete.

2.6 FENCE GROUNDING

A. Conductors: Bare, solid wire for No. 6-gage and smaller, stranded wire for No. 4-gage and larger.
   1. Material Above Finished Grade: Copper.
   2. Material On or Below Finished Grade: Copper.
   3. Bonding Jumpers: Braided copper tape, one inch wide, woven of No. 30-gage bare copper wire, terminated with copper ferrules.

B. Connectors and Ground Rods: As listed in UL 467.
   1. Connectors for Below-Grade Use: Exothermic welded type.
   2. Ground Rods: Copper-clad steel.
      a. Size: 5/8-inch by eight feet.

2.7 FINISHING

A. Chain-Link Fence Fabric:
   1. Aluminized finish with not less than 0.40 ounces aluminum per square foot, complying with ASTM A491, Class II.

B. Framework and Appurtenances: Provide the following finishes for steel framework, auxiliary system components, and miscellaneous accessories:
   1. Galvanizing: Zinc for galvanizing shall be of High Grade or Special High Grade conforming to ASTM B6 with maximum aluminum content of 0.01 percent. Galvanize metal using hot-dip process in accordance with the following:
      a. Structural Iron and Steel Shapes: ASTM A123
      b. Rolled-Form Sheet Steel: ASTM A653
      c. Hardware and Accessories: ASTM A153
      d. Fittings: ASTM F626
      e. Pipe: ASTM A53
   2. Provide minimum weights of zinc as follows:
      a. Pipe: 1.8 ounces of zinc per square foot. Apply Type A coating both inside and outside according to ASTM F1043, as determined by ASTM A90.
      b. Rolled-Form Sheet Steel: 4.0 ounces of zinc per square foot of surface area.
      c. Hardware and Accessories: Zinc weights in compliance with Table 1 of ASTM A153.

C. Welded Joints:
   1. Repair zinc coatings at welded joints by applying zinc-rich paint, as specified in Section 09 91 00, Painting, and ASTM A780.
   2. Repair polymer-coated steel by applying an epoxy primer, intermediate coat and urethane topcoat, as specified in Section 09 91 00, Painting, matching color and reflectivity of adjacent PVC finish.

2.8 SOURCE QUALITY CONTROL

A. Fabrication Tolerances:
   1. Fabric, posts, rails, and other supports shall be straight or uniformly curved to provide the profiles shown, to dimensional tolerance of 1/16 inch in 10 feet without warp or rack in the finished Work.

PART 3 – EXECUTION

3.1 INSPECTION

A. Examine conditions under which the Work will be erected and notify ENGINEER in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions are corrected.

3.2 ERECTION

A. Comply with CLFMI Step-by-Step Installation Guide and ASTM F567. Do not begin installation and erection of fencing until final grading is completed.

B. Excavation: Drill holes of diameters specified, for post footings in firm, undisturbed or compacted soil.
   1. For posts set in cast-in-place concrete, provide hole diameters dug or drilled a minimum of four times the largest cross section of post.
      a. Unless otherwise shown or indicated, excavate hole depths approximately three inches lower than bottom of post, with bottom of posts set not less than two feet below the surface of finished grade when in firm, undisturbed soil, plus an additional three inches for each foot increase in the fence height over four feet.
   2. Spread soil from excavations uniformly adjacent to fence line, or on adjacent areas of the Site, as directed by ENGINEER.
   3. When solid rock is encountered at ground surface, drill into rock at least 12 inches for line-posts and at least 1.5 feet for end-, pull-, corner-, and gate-posts. Drill hole at least one inch greater diameter than largest dimension of post to be placed.
      a. If solid rock is below soil overburden, drill to full depth required, except penetration into rock need not exceed the minimum depths specified above for rock encountered at ground surface.

C. Setting Posts: Remove loose and foreign materials from sides and bottoms of holes, and moisten soil prior to placing concrete.
   1. Center and align posts in holes 3 inches above bottom of excavation.
   2. Posts shall be set in concrete footings, except as otherwise shown or specified. Place concrete around posts in continuous pour, and vibrate or tamp for consolidation. Check each post for vertical and top alignment, and hold in position during placement and finishing operations.
   3. Extend concrete to two inches above ground surface, or to two inches below ground surface if cover of sod, bituminous asphalt paving, or other material is shown or indicated to conceal concrete. Crown to shed water away from posts.
   4. Extend footings for gate posts to underside of bottom hinge. Set keeps, stops, sleeves, and other accessories into concrete as required.

5. Keep exposed concrete surfaces moist for at least seven days after placement, or cure with membrane curing materials, or other acceptable curing method.

D. Concrete Strength: Allow concrete to attain at least 75 percent of its minimum 28-day compressive strength, but in no case sooner than seven days after placement, before installing rails, tension wires, barbed wire, or chain-link fabric.
   1. Do not stretch and tension fabric and wires, and do not hang gates, until concrete has attained its full design strength.

E. Posts and Rails:
   1. Line Posts: Set posts in cast-in-place concrete footings as specified, spaced not more than ten feet on centers. Provide caps on top of each post to exclude moisture and to receive top rail, unless equal protection is afforded by combination post-top cap and barbed wire supporting arm, where barbed wire is required.
   2. Top Rails: Run rail continuously through post caps or extension arms, bending to radius for curved runs. Provide expansion couplings as recommended by fencing manufacturer to form continuous rail between terminal posts.
   3. Center Rails: Provide center rails, where shown or specified, erected in one piece between posts and flush with post on fabric side, using special offset fittings where necessary.
   4. Brace Assemblies: Install braces so posts are plumb when diagonal rod are under proper tension. Install brace assemblies at end-posts and at both sides of corner- and pull-post panels. Panels adjacent to gates shall have intermediate horizontal rails and diagonal bracing. Diagonal bracing shall run from center of first line-post to bottom of terminal-post.

F. Chain-Link Fabric:
   1. Install fabric on security side of fence, and anchor to framework so that fabric remains in tension after pulling force is released. Fasten to terminal posts and gate posts with tension bars threaded through mesh and secured with tension bands at maximum intervals of 14 inches.
   2. Tie to line-posts, gate frames and top and bottom rails with tie wires spaced at maximum 12 inches on posts and two feet on rails.
   3. Connect tension bars to posts and frames by means of adjustable bolts and bands spaced not more than 14 inches apart.
   4. Leave approximately two inches between finish ground surface and bottom selvage, except where bottom of fabric extends into concrete.
   5. Join roll of chain-link fabric by weaving a single picket into the ends of roll to form continuous mesh.

G. Tension Wire:
   1. Stretch tension wire taut and free of sag, from end to end of each stretch of fence and position at a height that will enable the wire to be fastened to chain-link fabric by securing within the top 12 inches of chain-link fabric.

2. Fasten bottom tension wire within bottom six inches of chain-link fabric.
3. Tie tension wire to each post with not less than six-gage galvanized wire.

H. Barbed Wire:
1. Install three parallel wires on each extension arm; on security side of fence, unless otherwise shown or indicated
2. Pull wire taut to remove sag and firmly install in slots of extension arms to prevent movement or displacement.
3. Secure wire to terminal posts utilizing terminal post band arms or brace bands.
4. Extend vertical members of gates to receive barbed wire.

I. Stretcher Bars: Thread through or clamp to fabric four inches on centers, and secure to posts with metal bands spaced 15 inches on centers.

J. Gates: Install gates plumb, level, and secure for full opening without interference. Install ground-set items in concrete for anchorage, as shown on approved Shop Drawings. Adjust hardware for smooth operation and lubricate where necessary.

K. Tie Wires: Use U-shaped wires conforming to diameter of pipe. Clasp pipe and fabric firmly with ends twisted at least two full turns. Bend ends of wire to minimize hazard to persons and clothing.

L. Fasteners: Install nuts for tension band and hardware bolts on side of fence opposite fabric side. Peen ends of bolts or score threads to prevent removal of nuts.

3.3 GROUNDING AND BONDING

A. Fence Grounding: Provide at maximum intervals of 1,500 feet, except as follows:
1. Ground fencing within 100 feet of buildings, structures, walkways, and roadways at maximum intervals of 750 feet.
a. Gates and Other Fence Openings: Ground fence on each side of opening.
1) Bond metal gates to gate-posts.
2) Bond across openings, with and without gates, except openings indicated as intentional fence discontinuities. Use No. 2-gage wire and bury wire at least 1.5 feet below finished ground surface.

B. Protection at Crossings of Overhead Electrical Power Lines: Ground fencing at location of crossing and at maximum distance of 150 feet on each side of crossing.

C. Fences Enclosing Electrical Power Distribution Equipment: Ground as required by IEEE C2, unless otherwise shown or indicated.

D. Grounding Method: At each grounding location, drive ground rod vertically until the top is six inches below finished ground surface. Connect rod to fence with No. 6-gage conductor. Connect conductor to each fence component at grounding location, including the following:
   1. Each Barbed Wire Strand: Make grounding connections to barbed wire with wire-to-wire connectors designed for this purpose.

E. Bonding Method for Gates: Connect bonding jumper between gate post and gate frame.

F. Connections: Make connections so possibility of galvanic action or electrolysis is minimized. Provide connectors, connection hardware, conductors, and connection methods so metals in direct contact will be galvanically compatible.
   1. Use electroplated or hot-tin-coated materials to ensure high conductivity and to make contact points closer in order of galvanic series.
   2. Make connections with clean, bare metal at points of contact.
   3. Make aluminum-to-steel connections with stainless-steel separators and mechanical clamps.
   4. Make aluminum-to-galvanized-steel connections with tin-plated copper jumpers and mechanical clamps.
   5. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.

G. Bonding to Lightning Protection System: If fence terminates at lightning-protected building or structure, ground the fence and bond the fence grounding conductor to lightning protection down conductor or lightning protection grounding conductor.

3.4 FIELD QUALITY CONTROL

A. Site Tests:
   1. Ground-Resistance Testing Agency: Engage a qualified independent testing agency to perform field quality-control testing.
   2. Ground-Resistance Tests: Subject completed grounding system to a megger test at each grounding location. Measure ground resistance not less than two full days after last trace of precipitation, without soil having been moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance. Perform tests by two-point method in accordance with IEEE 81.
   3. Desired Maximum Grounding Resistance Value: 25 ohms.
   4. Excessive Ground Resistance: If resistance to ground exceeds desired value, notify ENGINEER promptly. Include recommendations to reduce ground resistance and proposal to accomplish the recommendations.
   5. Report: Prepare and submit test reports, certified by testing agency, of ground resistance at each test location. Include observations of weather and other phenomena that may affect test results.
B. Manufacturer's Services:

1. Engage a factory-authorized service representative to train CITY's personnel to adjust, operate, and maintain gates.
2. Train CITY's personnel on procedures and schedules for starting and stopping, troubleshooting, servicing, and maintaining equipment and schedules.
3. Review data in maintenance manuals.
4. Schedule and provide training in accordance with Section 01 79 23, Instruction of Operations and Maintenance Personnel.
5. Training times and duration shall be in accordance with Section 01 79 23, Instruction of Operations and Maintenance Personnel.

3.5 ADJUSTMENT AND CLEANING

A. Repair coatings damaged in the shop or at the Site by recoating with manufacturer's recommended repair compound, applied in accordance with manufacturer's directions. Repair hot-dip galvanized coatings in accordance with ASTM A780.

B. Gate: Adjust gate to operate smoothly, easily, and quietly, free of binding, warp, excessive deflection, distortion, nonalignment, misplacement, disruption, and malfunction throughout entire operational range. Confirm that latches and locks engage accurately and securely without forcing or binding.

C. Lubricate operating equipment and clean exposed surfaces.

D. Repair and replace broken or bent components.

+ + END OF SECTION + +

SECTION 32 32 23

SEGMENTAL RETAINING WALL SYSTEM

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Provide all engineering design, labor, materials, equipment and incidentals as shown, specified and required to furnish and install the segmental retaining wall system.
   2. This specification covers mortarless, segmental retaining wall systems.

B. Coordination:
   1. Review installation requirements and procedures as stated by the manufacturer and under other Sections of this contract and coordinate them with the Work specified herein.

C. Related Sections:
   1. Section 31 05 19, Geotextile Filter Fabric.
   2. Section 31 23 05, Excavation and Backfill.
   3. Section 03 30 00, Cast-in-Place Concrete.
   4. Section 33 40 00, Site Drainage.

1.2 QUALITY ASSURANCE

A. Reference Standards: Comply with applicable provisions and recommendations of the
   1. ASTM C-140, Methods of Sampling and Testing Concrete Masonry Units.
   2. ASTM C-920, Specification for Elastomeric Joint Sealants.
   3. ASTM C-1262, Standard Test Method for Evaluating the Freeze-Thaw durability of Manufactured Concrete Masonry Units and Related Concrete Units.
   4. ASTM C-1372, Specification for Dry-Cast Segmental Retaining Wall Units.
   5. ASTM D-448, Standard Classification for Sizes of Aggregate for Road and Bridge Construction.
   6. ASTM D-4595, Standard Test Method for Tensile Properties of Geotextiles by the Wide-Width Strip Method.
   7. ASTM D-5321, Standard Test Method for Determining the Coefficient of Soil and Geosynthetic or Geosynthetic and Geosynthetic Friction by the Direct Shear Method.
   8. ASTM D-5818, Standard Practice for Obtaining Samples of Geosynthetics from a Test Section for Assessment of Installation Damage.
   9. ASTM D-6637, Standard Test Method for Tensile Properties of Geogrids by the Single or Multi-Rib Tensile Method.
   10. ASTM D-6638, Standard Test Method for Determining Connection Strength Between Geosynthetic Reinforcement and Segmental Concrete Units.

11. ASTM D-6706, Standard Test Method for Measuring Geosynthetic Pullout Resistance in Soil.
12. Federal Highway Administration (FHWA), Mechanically Stabilized Earth Walls and Reinforced Soils slopes Design and Construction Guidelines, Report No. FHWA NHI-00-043.
13. Federal Highway Administration (FHWA), Corrosion/Degradation of Soil Reinforcements for mechanically stabilized earth walls and reinforced soil slopes, Report No. FHWA NHI-00-044.
14. National Concrete Masonry Association (NCMA), Design Manual for Segmental Retaining Walls, Third Edition.
15. National Concrete Masonry Association (NCMA), Seismic Design Manual for Segmental Retaining Walls, Third Edition.

1.3 DEFINITIONS

A. Geogrid reinforcement is a structural element formed by a regular network of integrally connected tensile elements with apertures of sufficient size to allow interlocking with surrounding soil, rock, or earth and is designed and functions primarily to reinforce the soil mass.

B. Segmental retaining wall units are dry stacked masonry units manufactured as stand alone retaining walls or as facing elements in reinforced soil retaining walls.

C. Drainage fill is a free draining granular material used (if applicable) within, between and directly behind the concrete segmental retaining wall units to collect and dispose of the water within the system.

D. Select fill is compacted soil, which is placed within the reinforced soil mass.

E. Subgrade is the soil mass supporting the leveling pad and reinforced soil mass of the retaining wall system.

F. Geotextile Filter Fabric: Material used for separation and filtration of dissimilar soil types.

G. General fill is impervious fill placed and compacted above the select fill and drainage fill.

1.4 QUALITY ASSURANCE

A. Qualifications
   1. CONTRACTOR:
      a. CONTRACTOR shall be experienced in the installation and construction of retaining walls of this type and magnitude. CONTRACTOR shall be able to provide a listing of a minimum of six (6) similar projects, of which he was directly involved, where this type of retaining wall was successfully completed. Contact names and telephone numbers shall be listed for each

project. CONTRACTOR shall have equipment and manpower suitable for the work and available for the entire operation of the work.

2. Professional Engineer:
   a. CONTRACTOR shall retain registered professional engineer legally qualified to practice in the same state as the Site. Professional engineer shall have at least five years experience in designing segmental retaining wall systems.
   b. Responsibilities include:
      1) Reviewing segmental retaining wall systems performance and design criteria stated in the Contract Documents.
      2) Preparing written requests for clarifications or interpretations of performance or design criteria for submittal to ENGINEER by CONTRACTOR.
      3) Preparing or supervising preparation of design calculations, segmental retaining wall system design drawings, and related Shop Drawings.
      4) Signing and sealing all calculations, segmental retaining wall system design drawings, and Shop Drawings.
      5) Certifying that:
         a) Design of the segmental retaining wall system has been performed in accordance with performance and design criteria stated in the Contract Documents, and
         b) Design conforms to all applicable local, state, and federal Laws and Regulations, and to prevailing standards of practice.
3. Manufacturer's Qualifications:
   a. Manufacturer shall be skilled and experienced in designing and fabricating segmental retaining wall systems similar to type required. Segmental retaining wall units shall be manufactured in permanent, properly equipped facility by experienced workers.

B. Component Supply and Compatibility
   1. CONTRACTOR shall furnish components that are standard products of a manufacturer regularly engaged in the manufacturing of products that are of similar material, design and workmanship.

C. Certifications
   1. CONTRACTOR shall provide affidavit certifying that the geogrid reinforcement meets the project specifications. The affidavit shall be signed by an official authorized to certify on behalf of the manufacturer and shall be accompanied by a mill certificate that verifies physical properties were tested during manufacturing and lists the manufacturer's quality control testing. The documents shall include a statement confirming that all purchased resin used to produce reinforcement is virgin resin. The mill certificate shall include the tensile strength tested in accordance with ASTM D 4595.

D. Sampling and Testing:
   1. The purchaser or authorized representative shall be accorded proper facilities to inspect and sample units from lots ready for delivery. The CONTRACTOR shall

notify the authorized representative in writing a minimum of 5 calendar days prior to shipment of materials.

2. Sample and test units for compressive strength and absorption in accordance with ASTM C-140. Compressive strength test specimens shall conform to the saw-cut coupon provisions of Section 5.2.4 of ASTM C-140 with the following exceptions:
   a. Coupon shall be taken from the least dimension of the unit of a size and shape representing the geometry of the unit in whole.

E. Rejection: If the shipment fails to conform to the specified requirements, new specimens shall be selected by the purchaser from the retained lot at the expense of the manufacturer. If the second set of specimens fails to conform to the test requirements, the entire lot shall be rejected.

1.5 SUBMITTALS

A. Action Submittals: Submit for approval, the following:
   1. Shop drawings:
      a. The plans shall include all details, dimensions, quantities and cross-sections necessary to construct the wall and shall include but shall not be limited to the following:
         1) An elevation sheet or sheets for each wall.
         2) An elevation view of the wall which shall include the elevation at the top of the wall at all horizontal and vertical break points and at least every 50 feet along the face of the wall, all steps in the leveling pads, the designation as to the type of panel, the length of soil reinforcing elements, the distance along the face of the wall to where changes in length of the soil reinforcing elements occur; and an indication of the final ground line and maximum calculated bearing pressures.
         3) A typical cross section or cross sections showing the elevation relationship between ground conditions and proposed grades.
         4) General notes pertaining to design criteria and wall construction.
         5) A listing of the summary of quantities on the elevation sheet for each wall.
      b. All unit details shall show all dimensions necessary to construct the element, all details of the geogrid reinforcement, and the location of soil reinforcing connection pins embedded in the unit.
      c. Clearly indicated details for construction of walls around drainage facilities and utilities.
      d. Details of the architectural treatment, if any.
   2. Product Data:
      a. Material description and installation instructions for each manufactured product specified included segmental retaining wall units and geogrid reinforcement.
      b. Name and address of the production facility where the proposed segmental retaining wall units will be manufactured. All units shall be manufactured in the same facility.

c. Notarized letter stating that the units supplied for this project are manufactured in complete compliance with this specification. The letter shall state that the segmental retaining wall units shown in the attached test reports are representative samples of the plants normal mix design and regular production runs.

3. Samples:
   a. Furnish one segmental retaining wall unit sample 16-inch wide by 6-inch high by 12-inch deep, demonstrating the color, face pattern, and texture of the segmental retaining wall unit, if requested by ENGINEER.
   b. Furnish 12-inch square or larger piece of the geogrid reinforcement specified.
   c. Sample of nylon/fiberglass pin and other attachments and accessories as required.

B. Informational Submittals:
   1. Certificates:
      a. Certification by professional engineer that segmental retaining wall system design is in accordance with performance and design criteria stated in the Contract Documents, and that design conforms to applicable local, state, and federal Laws and Regulations, and to prevailing standards of practice.
   2. Design Data: Submit the following:
      a. Design Calculations:
         1) Submit copies of segmental retaining wall system design calculations prepared in accordance with the NCMA Design Manual for Segmental Retaining Walls, showing that segmental retaining wall system meets the minimum design requirements outlined in these specifications.
         2) Design Calculations shall be signed, sealed, and dated by CONTRACTOR's professional engineer. State of professional engineer's registration, registration number, and name on seal shall be clearly legible.
   3. Manufacturer Instructions: Provide the following:
      a. Installation instructions for segmental retaining wall units.
   4. Test Reports:
      a. Independent laboratory reports indicating compressive strength, moisture absorption, and freeze-thaw durability of the segmental retaining wall units from the proposed production facility. Only tests performed within the past 12 months will be considered current and valid.
      b. Independent test reports verifying the long-term design strength properties (creep, installation damage, and durability) and soil interaction properties of the geogrid reinforcement.
      c. Independent tests reports verifying the connection capacity between the geogrid reinforcement and the segmental retaining wall units.
   5. Source Quality Control Submittals:
      a. Submit source quality control testing and in-place testing reports of all granular backfill materials. Refer to specification section 02315 for tests required on backfill materials.

6. Qualification Statements: Submit qualifications for the following:
    a. CONTRACTOR.
    b. Manufacturer and manufacturer's representative.
    c. CONTRACTOR's professional engineer.

1.6 DELIVERY, STORAGE AND HANDLING

A. Packing, Shipping, Handling, and Unloading:
    1. Deliver products to Site to ensure uninterrupted progress of the Work.
    2. Inspect all products upon delivery to Site and notify ENGINEER in writing of loss or damage to products. Promptly replace or remedy damage to new condition in accordance with manufacturer's instructions prior to installation. Contractor shall check all materials to assure that the proper type, grade, color, and certifications have been received.
    3. Conform to Section 01651, Transportation and Handling of Products.

B. Storage and Protection:
    1. Keep materials dry during delivery and storage. Store materials off ground and on firm surfaces to avoid warping and cracking. Protect units from discoloration.
    2. CONTRACTOR shall protect all materials from damage due to jobsite conditions and in accordance with manufacturer's recommendations.
    3. Exposed faces of segmental retaining wall units shall be free of chips, cracks, stains, and other imperfections detracting from their appearance, when viewed from a distance of 10 feet.
    4. Prevent mud, wet cement, adhesives and similar materials that may harm the appearance of units, from coming in contact with system components.
    5. Geogrid reinforcement shall be stored per the manufacturer's instructions.
    6. Conform to Section 01661, Storage and Protection of Products.

PART 2 - PRODUCTS

2.1 SYSTEM PERFORMANCE

A. Design Criteria
    1. CONTRACTOR shall complete the stability analysis in accordance with NCMA Design Manual for Segmental Retaining Walls. Only one method shall be followed for the complete design, including reinforcement design strength, layout, stability calculations, hydrostatic loading, rapid drawdown, surcharge, backslopes, and seismic effects. The segmental retaining wall system shall be designed by the CONTRACTOR's professional engineer.
    2. Design Parameters:
        a. Unit weight of soil is 110 pcf.
        b. Lateral earth pressure coefficient at-rest is 0.30.
        c. Design groundwater elevation shall be taken at the drainage pipe elevation.

d. Any surcharge at the top of the wall due to backslopes shall be determined per the grades and conditions outlined in the Contract Drawings. Minimum surcharge shall be 250 psf uniform loading or H20 traffic loading from two vehicles on the driveway above the retaining wall at any point along the wall.
e. Factor of safety for sliding shall be 1.5.
f. Factor of safety for overturning shall be 2.0.
g. Factor of safety for Global Stability shall be 1.3.
h. Factor of safety for Bearing Capacity shall be 2.0.

3. Seismic Design Requirements:
   a. The CONTRACTOR shall complete the seismic stability analysis in accordance with NCMA Seismic Design Manual for segmental retaining walls.
4. Minimum reinforcement length shall be 60 percent of the wall height. Reinforcement coverage at each layer shall be 100 percent (no gaps).
5. The maximum vertical distance between layers of soil reinforcement shall be limited to a maximum of 25 inches for systems that derive their connection capacity from friction and 31 inches for systems using a mechanical connection to derive their connection capacity (per FHEA-NHI 00-043).

2.2 MANUFACTURERS

A. Product and Manufacturer: Provide one of the following:
   1. Versa-Lok Segmental Retaining Wall Systems.
   2. Keystone Standard Unit Retaining Wall System.
   3. Or equal.

2.3 MATERIALS

A. Segmental Retaining Wall Units shall meet the following requirements:
   1. Structural Requirements:
      a. Compressive Strength and Absorption: Concrete retaining wall units shall be tested in accordance with ASTM C140, Sections 6, 8, and 9. Concrete retaining wall units shall meet the requirements of ASTM C1372, except the compressive strength will be increased to a minimum of 3500 psi and the maximum water absorption shall be limited to 8 percent. Test shall be performed within the past 6 months to be considered current and valid.
      b. Freeze-thaw durability: Shall be tested in accordance with ASTM C1262. Test shall be performed within the past 12 months to be considered current and valid.
      c. Inter-unit shear strength: 1500 pounds per linear foot minimum at 2 psi normal pressure.
      d. Geogrid reinforcement/unit peak connection strength: 1000 pounds per linear foot minimum at 2 psi normal force.
      e. Wall Caps:
         1) Segmental concrete block units shall be placed as caps on top of all segmental retaining wall units. The cap blocks shall have a color and

texture on exposed faces to match that of the other segmental retaining wall units and meet the requirements for the other blocks except that the minimum height shall be 3 inches. Each cap block shall have abutting edges saw cut or formed to provide tight, flush abutting joints with no gaps in the joints when placed end to end in the alignment shown on the Drawings.

2. Architectural Requirements:
   a. Face color shall be chosen by the CITY from manufacturer's standard colors.
   b. Face texture: Split rock face that exposes the natural aggregates.
   c. Face Appearance: Sculptured rock face in angular tri-planer configuration.
   d. Batter: Segmental retaining wall units shall be engaged to the unit below by use of keys, pins, clips or other reliable mechanism to provide a consistent wall batter. Units, when placed in the final wall configuration shall provide a minimum setback from vertical of 7 degrees and a maximum setback from vertical of 12 degrees.
   e. Permissible variations in Dimensions: Overall dimensions, as defined by the manufacturer, shall not vary more than 1/8 inch in the depth or length of the units, and not more than 1/16 inch in height from that specified in the ASTM reference, not including the textured face.

B. Shear Connectors:
   1. Shear connectors shall be 1/2-inch (12 mm) diameter thermoset isopthalic polyester resin pultruded fiberglass reinforcement rods or equivalent to provide connection between vertically and horizontally adjacent units. Strength of shear connectors between vertical adjacent units shall be applicable over a design temperature of 10 degrees F to + 100 degrees F (-10 to 40 degrees C).
   2. Shear connectors shall be capable of holding the geogrid reinforcement in the proper design position during grid pre-tensioning and backfilling.

C. Geogrid Reinforcement: Geogrid reinforcement shall be manufactured with high-tenacity polyester or HDPE in a grid or textile structure. The geogrid reinforcement shall meet the long term design strength, soil interaction, and connection capacity requirements as required by the design of the retaining wall.
   1. Long term design strength: As determined in accordance with method A of the NCMA Design Manual for segmental retaining walls.
      a. Ultimate Tensile Strength: The ultimate tensile strength of the geogrid reinforcement shall be determined in accordance with ASMT D-4595 or ASTM D-6637.
      b. Creep: Creep testing of the geogrid reinforcement shall be performed in accordance with ASTM D-5262. The creep reduction factor shall be determined in accordance with FHWA NHI-00-044.
      c. Installation Damage: The installation damage reduction factor shall be determined in accordance with ASTM D-5818 and FHWA-NHI-00-043.
      d. Durability: The durability reduction factor shall be determined in accordance with FHWA NHI-00-044.

2. Soil Interaction: The soil interaction properties include the coefficient of direct sliding and coefficient of interaction as determined through direct shear and pullout testing, respectively:
   a. Pullout: Shall be determined in accordance with ASTM D-6706.
   b. Direct Sliding: Shall be determined in accordance with ASTM D-5321.
3. Connection Capacity: As determined in accordance with ASTM D-6638.

D. Leveling Pad:
1. Concrete Base: Non-reinforced concrete mudmat base as specified in Section 03300, cast in place concrete.
   a. Base Thickness: At least 2 inches, as determined by the wall design Engineer.

E. Drainage Fill:
1. Drainage fill material as specified in Section 02315, Excavation and Backfill.
2. A minimum of twelve (12) inches of drainage fill must extend behind the wall to within one (1) foot of final grade. Cap drainage fill with one (1) foot of compacted general fill, as specified in Section 31 23 05, Excavation and Backfill.

F. Drainage Pipe:
1. As specified in Section 15067, Thermoplastic Pipe.

G. Select Fill:
1. As specified in Section 02315, Excavation and Backfill.

H. Masonry Adhesive:
1. The masonry adhesive shall meet the following requirements:
   a. ASTM C 920, Type S, Grade NS, Class 25.
   b. Expected 30 year life.
   c. Meet the recommendations of the block manufacturer.

I. Geotextile Filter Fabric:
1. Filter Geotextile as specified in section 31 05 19, Geotextile Filter Fabric.

PART 3 - EXECUTION

3.1 INSPECTION

A. CONTRACTOR and his installer shall examine the substrate and the conditions under which Work is to be performed and notify ENGINEER of unsatisfactory conditions. Do not proceed with the Work until unsatisfactory conditions have been corrected in a manner acceptable to ENGINEER.

3.2 CONSTRUCTION REQUIREMENTS

A. Wall Excavation: Unclassified excavation shall be in accordance with the requirements of the general specifications and in reasonably close conformity with the limits shown on the plans.

B. Subgrade Preparation:
   1. Subgrade shall be excavated as required for footing dimensions shown on the wall design drawings, or as directed by the ENGINEER.
   2. Subgrade shall be examined by the ENGINEER to ensure that the actual subgrade material strength meets or exceeds the assumed design strength. Subgrade materials not meeting the required strength shall be removed and replaced with acceptable material.
   3. Over excavated areas shall be filled with compacted select fill material.

C. Leveling Pad:
   1. Leveling pad shall be placed as shown on wall design drawings.
   2. Leveling pad materials shall be installed upon undisturbed subgrade, or compacted general fill material.
   3. Material shall be compacted so as to provide a hard, level surface on which to place the first course of units. Compaction will be with mechanical plate compactor to 95% of Standard Proctor Density.
   4. Leveling pad shall be prepared to insure complete contact of retaining wall units with the base. Gaps between the unit and base shall not be allowed.
   5. Leveling pad materials shall be to the depths and widths shown. The CONTRACTOR shall provide evidence that the bearing area of the unit proposed is sufficient for established loading. Evidence shall be verified by a Registered Engineer. Leveling pad shall be of consistent material throughout the length of the wall to eliminate differential movement of the base.

D. Segmental Retaining Wall Unit Installation:
   1. The first course of segmental retaining wall units shall be placed on the prepared base. The units shall be checked for level and alignment. The first course is the most important to ensure accurate and acceptable results.
   2. Ensure that the units are in full contact with the base.
   3. Units shall be placed tight side by side for the full length of the wall alignment (do not gap). Alignment shall be done by using a string line or offset from a base line. The CONTRACTOR shall follow manufacturer's installation instructions when making tight radius curves.
   4. Place drainage fill a minimum of twelve (12) inches thick directly behind the back of and between the units. Place select fill against drainage fill and compact. Where fine grain soils or water seepage is encountered in backfill, place geotextile fabric between the drainage fill and select fill to keep the drainage fill clean of fines. Fill should be placed in six (6) inch lifts and compacted to achieve 95% Standard Proctor Density compaction.
   5. Sweep all excess material from the top of the units and install the next course of wall units, drainage fill and select fill. Lay up each course, ensuring a positive

connection between adjacent courses is achieved, by installing pins through the holes in the top of the unit and interlocking with slots in the previous course. Follow the manufacturer's specific instructions for installation of curves or corners. Backfill and compact. Repeat procedure to the extent of the wall height. Where geogrid reinforcement is required, follow the procedures outlined in the section on geogrid installation.

6. Cap units and the top two course of blocks shall be joined using masonry adhesive. Care shall be taken to keep adhesive from coming into contact with the face of wall units.

E. Geogrid Reinforcement Installation:

1. The geogrid reinforcement shall be laid horizontally on compacted select fill, connected to the concrete wall units, and embedded a minimum of six (6) inch within the modular units. Place grid on masonry units, place the succeeding course of units, install pins, place the drainage fill, pull grid taut and anchor the geogrid with stakes or fill prior to placing the select fill.
2. Slack in the geogrid reinforcement at the wall unit connections shall be removed in a manner, and to such a degree, as approved by the ENGINEER.
3. Select fill material shall be placed and compacted in six-inch lifts, or as directed to achieve 95% Standard Proctor Density compaction.
4. Select fill shall be placed from the wall back towards the fill area to insure that the geogrid remains taut. Select fill shall be placed, spread and compacted in such a manner that minimizes the development of wrinkles in or movement of the geogrid.
5. Only hand-operated compaction equipment shall be allowed within three feet of the wall face.
6. Tracked construction equipment shall not be operated directly on the geogrid. A minimum select fill thickness of six (6) inches is required prior to operation of tracked vehicles over the geogrid. Turning of tracked vehicles should be kept to a minimum to prevent tracks from displacing the fill and damaging the geogrid.
7. Rubber-tired equipment may pass over the geogrid reinforcement at slow speeds (less than 10 mph). Sudden braking and sharp turning shall be avoided.
8. Location and placement of geogrid shall be as submitted under design calculations. The relative position of geogrid layers to the wall height above finished grade must be maintained, regardless of the number or types of units which are used. Deviation from the elevation of grid layer(s) shall require resubmitting the design calculations.
9. Manufacturer’s representative:
    a. CONTRACTOR shall have a qualified representative from the segmental retaining wall system manufacturer available on an as-needed basis during the wall construction. The representative shall visit the site for consultation at least once during construction and as requested by ENGINEER. Representative shall have at least five years experience in similar projects.

F. Completion:

1. Within twelve (12) inches of the top of the wall, place general fill over the drainage fill and throughout the excavated area. Impervious general fill cap shall be graded to drain runoff laterally along the wall alignment.
2. Install cap units on the finished wall. Cap units shall be adhered to the top units using manufacturer-supplied adhesive, by placing two 1/4 inch beads of adhesive along the full length of the wall. Care shall be taken to keep adhesive from coming into contact with the face of wall units. Press the caps firmly into adhesive and allow to cure.
3. Complete wall construction by installing concrete flume, turf, etc. For extreme grades, or in areas where erosion control could be a problem, install proper surface treatment measures as soon as possible.

++ END OF SECTION ++

SECTION 32 92 00

LAWNS AND MEADOWS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, tools, equipment and incidentals as shown, specified and required to furnish and install all lawns and meadows.
   2. Extent of lawns and meadows is shown.
   3. Types of products required include the following.
      a. Topsoil.
      b. Lawn grass seed.
      c. Inorganic soil amendments.
      d. Organic soil amendments.
      e. Fertilizers.
      f. Mulches.
      g. Erosion-control materials.
      h. Accessories.

B. Coordination:
   1. Review installation procedures under other Sections and coordinate the installation of items that must be installed with, or before, lawns and meadows.
   2. Notify other contractors in advance of the planting of lawns and meadows to provide them with sufficient time for the installation of items that must be installed with, or before, lawns and meadows.

C. Related Sections:
   1. Section 33 11 00, Clearing and Grubbing.
   2. Section 32 31 00, Fences.
   3. Section 32 93 00, Plants.

1.2 REFERENCES

A. Standards referenced in this Section are listed below:
   1. Association of Official Analytic Chemists, (AOAC).
      a. Official Methods of Analysis of AOAC International.
   2. Association of Official Seed Analysts, (AOSA).
      a. Journal of Seed Technology; Rules for Testing Seeds.
   3. American Society of Agronomy, (ASA).
      a. Reference No. 1 - Methods of Soils Analysis, Soil Science Society of America, Incorporated.

4. American Society for Testing and Materials, (ASTM).
   a. ASTM B 221, Specification for Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles and Tubes.
   b. ASTM C 602, Specification for Agricultural Liming Materials.
   c. ASTM D 75, Practice for Sampling Aggregates.
   d. ASTM D 422, Test Method for Particle Size Analysis of Soil.
   e. ASTM D 977, Specification for Emulsified Asphalt.
   f. ASTM D 2487, Practice for Classification of Soils for Engineering Purposes (United Soil Classification System).
   g. ASTM D 5268, Specification for Topsoil Used for Landscape Purposes.
   h. ASTM E 329, Specification for Agencies Engaged in the Testing and/or Inspection of Materials Used in Construction.
   i. ASTM E 548, Guide for General Criteria Used for Evaluating Laboratory Competence.

1.3 DEFINITIONS

A. The term "finish grade" shall be used to describe the finished surface elevation of planting soil.

B. The term "manufactured topsoil" shall be used to describe soil produced off-Site by homogeneously blending mineral soils or sand with stabilized organic soil amendments to produce topsoil acceptable as a component of loam.

C. The term "loam" shall be used to describe topsoil that has been mixed with additional organic and inorganic additives, as specified.

D. The term "percentage pure live seed" shall be defined as the percent (%) purity multiplied by percent (%) germination divided by 100 to equal the percent pure live seed (PLS) and shall be calculated for all seed lots using each seed lots own unique purity and germination test results. A PLS pound shall be defined as the bulk weight of seed required to equal one pound of 100 percent pure, germinated seed.

E. The term "subgrade" shall be used to describe the surface of subsoil remaining after completing excavation; or the top surface of a fill or backfill immediately beneath topsoil and which has not been tested for acceptable use as topsoil.

1.4 QUALITY ASSURANCE

A. Installer Qualifications:
   1. Engage a single landscape installer skilled, trained and with successful and documented experience in the planting of lawns and meadows and with specific skill and successful experience in the installation of the types of materials required; and who agrees to employ only tradesmen with specific skill and successful experience in this type of Work. Submit names and

qualifications to ENGINEER along with the following information on a minimum of three successful projects:

a. Names and telephone numbers of owner, architects or engineers responsible for projects.
b. Approximate contract cost of the lawns and meadows.
c. Amount of area installed.

2. Installer's Site Supervisor: Require installer to maintain an experienced full-time landscape supervisor on-Site during the time of preparation for, and planting of, lawns and meadows. Supervisor shall have achieved landscape or horticultural certification acceptable to governing authorities having jurisdiction at the Site.
3. Ratio of laborers to certified landscape supervisors shall not exceed 12 to one. Certified landscape supervisor shall be on-Site throughout the day-to-day performance of the Work of this Section.
4. Application of herbicides, chemicals and insecticides shall be done by personnel licensed to perform such applications by governing authorities having jurisdiction at the Site and in accordance with each manufacturer's instructions provided on each product label.

B. Soil-Testing Laboratory Qualifications:

1. An independent laboratory, recognized by governing authorities having jurisdiction at the Site, with the experience and capability to conduct testing indicated and that specializes in types of soil tests to be performed.
2. To qualify for approval, an independent testing agency shall demonstrate to ENGINEER's satisfaction, based on evaluation of criteria submitted by testing agency, that it has the experience and capability to satisfactorily conduct the testing indicated without delaying the Work, in accordance with ASTM E 329 and as documented according to ASTM E 548.

C. References: Comply with the applicable requirements referenced in Section 01 42 00, References.

D. Soil Analysis: Furnish report of soil analysis to ENGINEER, prepared by a qualified soil-testing laboratory, stating percentages of organic matter; mechanical gradation of sand, silt, and clay content in compliance with ASTM D 422; cation exchange capacity; sodium absorption ratio; deleterious materials content; pH; and mineral and plant-nutrient content of soil. Chemical analysis shall include tests for percentages of nitrate nitrogen, ammonium nitrogen, phosphorus, potassium, calcium, iron, manganese, copper, zinc, extractable aluminum, and total soluble salts.

1. Existing On-Site Soil:

a. Separate soil stockpiled and proposed for use as topsoil for lawns and meadows into 1000 cubic yard piles and label with a numbering system used to reference all soil samples and test results.
b. Obtain a one cubic foot representative sample for each 1000 cubic yards of soil stockpiled on-Site proposed for use as topsoil for lawns

and meadows, in compliance with ASTM D 75 and Appendixes, for securing samples from stockpiles.

c. Place samples taken from each stockpile, into separate clean, new and previously unused, containers and mix thoroughly. Maintain separation and legible labeling of each sample taken from each stockpile, throughout the process of mixing, drying and delivering to soil analysis laboratory. Label samples on outside of container.

d. Take one cup of soil from each container and allow to dry at room temperature. Once dry, place each one-cup sample in a separate, accurately labeled, new and previously unused one-cup sized plastic container, seal tightly and deliver to soil testing laboratory.

e. Report suitability of soil as a topsoil component for lawn plant growth. State recommended quantities of nitrogen, phosphorus, secondary and micronutrients, potash and soil amendments to be added to produce satisfactory topsoils. Include calculations, types of fertilizer and recommendations for application rates in either gallons or pounds per cubic foot of soil.

f. In addition, all on-Site soil that will be used as topsoil shall be provided with additional compost and peat moss amendments specified, whether or not testing indicates positive need for such amendments, for such material to be used as loam.

2. Manufactured Imported Topsoil:

a. Test each 1000 cubic yards of manufactured topsoil at the proposed source. In addition, after ENGINEER's approval of manufactured topsoil based on results and recommendations of soil testing reports, test each 1000 cubic yards of manufactured topsoil that is delivered to the Site for conformance to results and recommended modifications of approved soil test reports. Manufactured topsoil that differs from proposed source material, after modification according to recommendations of soil test reports, shall be rejected for use in the Work.

b. Obtain a one cubic foot representative sample for each 1000 cubic yards of manufactured topsoil proposed for lawn and meadow Work, in compliance with ASTM D 75 and Appendixes, for securing samples from stockpiles.

c. Place samples taken from each stockpile into separate clean, new and previously unused, containers and mix thoroughly. Maintain separation and legible labeling of each sample, taken from each stockpile, throughout the process of mixing, drying and delivering to soil analysis laboratory. Label samples on outside of container.

d. Take one cup of topsoil from each container and allow to dry at room temperature. Once dry, place each one-cup sample in a separate, accurately labeled, new and previously unused one-cup sized plastic container, seal tightly and deliver to soil testing laboratory.

e. Report suitability of manufactured topsoil as a component for lawn plant growth. State recommended quantities of nitrogen, phosphorus, secondary and micronutrients, potash and soil amendments to be added

to produce satisfactory manufactured topsoil. Include calculations, types of fertilizer and recommendations for application rates in either gallons or pounds per cubic foot of manufactured topsoil.

f. Organic component of manufactured topsoil shall be obtained from compost and peat moss amendments specified, for such material to be used as loam.

E. Source Quality Control:

1. Analysis and Standards: Package all products with manufacturer's certified analysis performed in accordance with methods established by AOAC, wherever applicable, or as specified.
2. Provide manufactured imported topsoil from a commercial processing facility specializing in the manufacture of topsoil.
3. Seed that has been stored at temperatures, or under conditions not recommended by the seed supplier, or has become wet, moldy, or otherwise damaged, shall not be acceptable. The PLS for each seed lot shall be 75 percent, minimum.
4. Certify that all seed has been stored under conditions recommended by the seed supplier and has not been subjected to conditions damaging to PLS percentages.
5. Seed may be mixed by an approved method on-Site or at the seed supplier's facilities. If the seed is mixed on-Site, each variety shall be delivered in the original containers and shall bear the supplier's certified analysis. Where seed is mixed by the seed supplier, provide ENGINEER with the seed supplier's certified statement as to the composition of the mixture.

1.5 SUBMITTALS

A. Action Submittals: Submit the following:

1. Shop Drawings:
   a. Schedule for lawn planting showing anticipated planting dates for each type of Work.
2. Product Data:
   a. Manufacturer's product data, specifications and installation instructions for all required materials.
   b. Composition and analysis of commercial fertilizers and all purchase receipts showing the total quantity actually purchased for this Project.
   c. Proportions of each component contained in hydro seed mixture. Identify number of pounds of each component required for each 100 gallons of water. Include the number of square feet of lawn, grass meadow or wildflower meadow mixture that can be installed with each full tank of hydro seed mixture.
   d. PLS for each type of seed and each seed lot. Include bulk weight of seed required to equal one pound of 100 percent pure, germinated seed.
3. Samples:

a. Submit 12-inch by 12-inch sheet of erosion control fabric with manufacturer's selections of standard biodegradable filler papers, and yarns.

B. Informational Submittals: Submit the following:
1. Certificates:
a. Certification of Grass Seed: For each grass-seed monostand and seed mixture, furnish seed supplier's certification stating the botanical and common name, and percentage by weight of each species and variety, and percentage of purity, germination and weed seed. Include the year of production and date of packaging. Certify that seed has been stored in compliance with all recommendations of the seed supplier.
b. Certificates of inspection as may be required by governmental authorities to accompany shipments, and manufacturer's certified analysis for soil amendments and fertilizer materials. For standard products submit other data substantiating that materials comply with specified requirements.
2. Test Reports: Submit the following:
a. Soil analysis reports for existing soil and imported manufactured topsoil, as specified. Include recommendations for remediating existing soil into acceptable topsoil.
3. Qualifications Data: Submit qualifications data for the following:
a. Landscape installer.
b. Landscape supervisor.
c. Testing agency.
4. Source Quality Control Submittals
a. Written statement providing the location from which manufactured topsoil is to be obtained and the names and addresses of the suppliers.

C. Closeout Submittals: Submit the following:
1. Operations and Maintenance Data:
a. Submit recommended procedures to be established for the maintenance of lawns and meadows for one full year. Submit prior to expiration of required maintenance period.
2. Warranty Documentation:
a. Submit written warranty, signed by CONTRACTOR and landscape installer, as specified.

1.6 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Delivery of Materials:
1. Do not deliver seed, sprigs, plugs or sod until Site conditions are ready for installation.
2. Deliver packaged materials in containers showing weight, analysis and name of manufacturer. Protect materials from deterioration during delivery.
3. Deliver seed in undamaged, original containers, sealed by the supplier and indicating compliance with approved Shop Drawings.

4. Inspect lawn materials upon arrival at Site. Immediately and permanently remove unacceptable materials from Site.

B. Storage of Materials:
1. Store and cover materials to prevent deterioration. Remove packaged materials that become wet or show deterioration or water marks from the Site.
2. Seed that becomes wet, moldy or damaged during the time of storage on-Site or that has been damaged during transit is not acceptable.

1.7 PROJECT CONDITIONS

A. Environmental Requirements:
1. Proceed with and complete lawn and meadow planting as rapidly as portions of the Site become available, working within the seasonal limitations for each type of lawn, grass and wildflower planting required.
2. Proceed with planting only when current and forecasted weather conditions are favorable to successful planting and establishment of lawns and meadows.
   a. Do not spread seed when wind velocity exceeds five miles per hour.
   b. Do not plant when drought, or excessive moisture, or other unsatisfactory conditions prevail.
3. Herbicides, chemicals and insecticides shall not be used on areas bordering wetlands.

B. Scheduling:
1. Coordinate planting with specified extended service periods to provide required service from date of Substantial Completion. Plant during one of the following periods:
   a. Spring Planting: March 15 to June 1.
   b. Fall Planting: September 1 to October 30.
2. Do not begin lawn planting until water, acceptable for use and adequate in supply, is available on-Site and can be successfully transported to the areas of Work. Coordinate provision of adequate and acceptable water supply with Project Schedule.
3. Do not proceed with installation of loam until all subgrade utility services have been installed, are operating successfully and have been approved by ENGINEER.

C. Pre-installation Conference:
1. Prior to commencement of lawn and meadow planting and associated Work, CONTRACTOR shall schedule and meet at the Site with the landscape installer, the installers of other Work in and around lawn and meadow areas that follows the lawn and meadow Work, including fencing Work specified in Section 32 31 00, Fences; and ENGINEER and other representatives directly concerned with performance of the Work. Review foreseeable

methods and procedures related to the lawn and meadow Work, including the following:

a. Review Project requirements and the Contract Documents.
b. Review required submittals, both completed and yet to be completed.
c. Review availability of water and methods of delivery.
d. Review status of below-grade work and required access during lawn and meadow planting and establishment.
e. Review Project Schedule and availability of materials, tradesmen, equipment and facilities needed to make progress and avoid delays.
f. Review environmental conditions, other Project conditions, and procedures for coping with unfavorable conditions.
g. Review procedures required for protection of lawns and meadows during the remainder of the construction period.
h. Review required inspection, testing, and certifying procedures.

2. Record the discussions of the Pre-installation Conference and the decisions and agreements or disagreements reached, and furnish a copy of the record to each party attending.
3. Record all revisions or changes agreed upon, reasons therefor, and parties agreeing or disagreeing with them.
4. Reconvene the meeting at the earliest opportunity if additional information must be developed in order to conclude the subjects under consideration.

1.8 WARRANTY

A. General Warranty: The special warranties specified in this Article shall not deprive DEPARTMENT or CITY of other rights or remedies DEPARTMENT or CITY may otherwise have under the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by CONTRACTOR under the Contract Documents.

B. Special Warranties: Warranty lawns and meadows through the specified extended service period.

1.9 EXTENDED SERVICE

A. Extended Lawn Service:
1. Begin extended service immediately after each lawn area is acceptably established. Provide extended service for not less than the following periods:
2. Seeded Lawns: Sixty days from date after lawn areas are acceptably established.
   a. When full service period has not elapsed before end of planting season, or if lawn is not acceptably established, continue service during next planting season.
3. Service lawn by watering, fertilizing, weeding, mowing, trimming, replanting, and other operations. Roll, regrade, and replant bare or eroded areas and remulch to produce a uniformly smooth lawn.

a. In areas where mulch has been disturbed by wind or extended service operations, add new mulch. Anchor as required to prevent displacement.

4. Watering: Provide and maintain temporary piping, hoses, and lawn-watering equipment to convey water from sources. Keep newly germinated plants uniformly moist to a depth of 4 inches, applied at a minimum rate of 1 inch per week, or greater as required to maintain minimum moisture depth specified. Provide and maintain watering gages and soil moisture probes until end of maintenance period.
   a. Schedule watering to prevent wilting, puddling, erosion, and displacement of seed or mulch. Lay out temporary watering system to avoid walking over muddy or newly planted areas.
   b. After plants have their first true leaves and grasses show mature blades, watering shall be performed to provide moisture to a depth of 6-inches, and not performed again until top 1 inch of loam has dried.
5. Mow lawn as soon as top growth is tall enough to cut. Repeat mowing to maintain specified height without cutting more than 40 percent of grass-leaf height. Remove no more than 40 percent of grass-leaf growth in initial or subsequent mowing. Do not delay mowing until grass blades bend over and become matted. Do not mow when grass is wet. Schedule initial and subsequent mowing to maintain the following grass height:
   a. Mow grass 1-1/2 to 2 inches high.
6. Lawn Fertilization: Apply fertilizer after initial mowing and when grass is dry.
   a. Use fertilizer that will provide actual nitrogen of at least one pound for each 1000 square feet of lawn area.
7. After seed has passed its expected germination period, reseed all areas and parts of areas that fail to show a uniform stand of grass. Reseed repeatedly until all areas are covered with grass.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Topsoil:
   1. All soil accepted as topsoil, whether obtained from on-Site or off-Site sources, shall comply with specified topsoil analysis.
   2. Provide fertile, friable, natural loam, surface soil, capable of sustaining vigorous plant growth; free of any admixture of subsoil, clods of hard earth, plants or roots, sticks, stones larger than 1 inch in diameter, or other extraneous material harmful to plant growth, in compliance with ASTM D 5268. Provide topsoil with the following analysis:
      a. 3/4-inch mesh: 100 percent passing.
      b. No. 4-sieve: 90 to 100 percent passing.
      c. No. 200-sieve: 0 to 10 percent passing.

d. Clay content of material passing No. 200-sieve not greater than 60 percent, as determined by hydrometer tests.
e. pH-adjusted with ferrous sulphate or ground limestone to provide pH 5.5 to pH 7.0 at time of installation of lawns, grass and meadow areas, unless particular species of grass or wildflower stand requires a different pH to meet its growing needs.
f. Electrical conductivity of a 1:2 soil-water suspension shall not exceed 1.0 milliohm per centimeter and with less than 200 parts per million of extractable aluminum.
g. Cation Exchange Capacity: 5, minimum.
h. Organic content not less than five percent, as determined by ignition loss of oven-dried samples passing No. 10-sieve (Muffle Furnace Temperature: 110 plus or minus five degrees C for eight hours).
i. Free of pests and pest larvae.

3. Topsoil Source: Reuse surface soil stockpiled on-Site, where possible. Verify suitability of stockpiled surface soil to produce topsoil, as specified. Clean surface soil of roots, plants, sod, stones, clay lumps, and other extraneous materials harmful to plant growth.
   a. Supplement acceptable on-Site soil with manufactured topsoil from off-Site sources, when quantities available on-Site are insufficient to complete the Work.

B. Lawn Grass Seed:
1. Lawn Grass Seed Mixture: Provide fresh, clean, new-crop seed complying with the tolerance for purity and germination established by AOSA. Provide seed of the grass species, proportions and minimum percentages of purity, germination, and maximum percentage of weed seed, specified.
2. Seed Species: Seed of grass species as follows, with not less than 95 percent germination, not less than 80 percent pure seed, and not more than 0.25 percent weed seed by weight:
   a. Full Sun: Kentucky Bluegrass (Poa pratensis), a minimum of three cultivars.
   b. Sun and Partial Shade: Proportioned by weight as follows:
      1) 50 percent Kentucky Bluegrass (Poa pratensis).
      2) 30 percent Chewings Red Fescue (Festuca rubra variety).
      3) 10 percent Perennial Ryegrass (Lolium perenne).
      4) 10 percent Redtop (Agrostis alba).

C. Inorganic Soil Amendments:
1. Ground Oolitic Limestone: ASTM C 602, agricultural limestone containing a minimum 80 percent calcium carbonate equivalent and as follows:
   a. Class: Class O, with a minimum 95 percent passing through No. 8-sieve and a minimum 55 percent passing through No. 60-sieve.
2. Iron Sulfate: Commercial-grade acidulant, recommended for use on acid-loving plants. Provide granulated ferrous sulfate containing a minimum of 20 percent iron and 10 percent sulfur.
3. Perlite: Agricultural-grade, expanded pumice.

4. Agricultural Gypsum: Commercial-grade and finely ground, containing a minimum of 90 percent calcium sulfate.
5. Grit Aggregate: Commercial-grade filter sand consisting of hard, durable rounded grains of quartz or other rock that do not compact to a solid mass when wet, with a pH in the range required for topsoil. Provide clean, washed, natural or manufactured aggregate, free of toxic materials, salt and other chemical contamination.

D. Organic Soil Amendments:
1. Compost: Well-composted, stable, weed-free organic matter, produced by the aerobic decomposition of organic residues; pH range of 5.5 to 8; moisture content 35 to 55 percent by weight; 100 percent passing through a 1-inch screen; soluble salt content of 5 to 10 decisiemens/meter; not exceeding 0.5 percent inert contaminants and free of substances toxic to plantings; and as follows:
   a. Organic Matter Content: 50 to 60 percent of dry weight.
   b. Feedstock: Agricultural, food, or industrial residuals; biosolids; yard trimmings; or source-separated or compostable mixed solid waste.
2. Peat: Partially decomposed stems and leaves of several species of sphagnum moss; finely divided or granular texture. Supply shredded material, free from lumps, wood, roots, stones, decomposed collodial residue and other extraneous foreign matter, capable of passing through a 1/2-inch screen, which can easily be incorporated with the soil. Supply material, which has been conditioned in storage piles after excavation for at least six months, including one freezing and thawing period. Supply peat humus with the following analysis:
   a. Not less than 90 percent organic matter by weight on an ovendry basis.
   b. pH range of 3.4 to 4.8.
   c. Moisture content 35 percent at time of incorporation into soil.
   d. Water absorbing ability 150 percent to 350 percent by weight.
3. Wood Derivatives: Decomposed, nitrogen-treated sawdust, ground bark, or wood waste; of uniform texture, free of chips, stones, sticks, soil, or toxic materials.
4. Manure: Well-rotted, unleached, stable or cattle manure containing not more than 25 percent by volume of straw, sawdust, or other bedding materials; free of toxic substances, stones, sticks, soil, weed seed, and material harmful to plant growth.

E. Fertilizers:
1. Bonemeal: Commercial, raw or steamed, finely ground; a minimum of four percent nitrogen and 20 percent phosphoric acid.
2. Superphosphate: Commercial, phosphate mixture, soluble; a minimum of 20 percent available phosphoric acid.
3. Commercial Fertilizer: Commercial-grade complete fertilizer of neutral character, consisting of fast- and slow-release nitrogen, 50 percent derived from natural organic sources of urea formaldehyde, phosphorous, and potassium in the following composition:

a. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports.

4. Slow-Release Fertilizer: Granular or pelleted fertilizer consisting of 50 percent water-insoluble nitrogen, phosphorus, and potassium in the following composition:
   a. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified soil-testing agency.

F. Mulches:
1. Straw Mulch: Provide air-dry, clean, mildew- and certified seed-free, salt hay or threshed straw of wheat, rye, oats, or barley.
2. Peat Mulch: Sphagnum peat moss, partially decomposed, finely divided or granular texture, with a pH range of 3.4 to 4.8.
3. Compost Mulch: Well-composted, stable, and weed-free organic matter, pH range of 5.5 to 8; moisture content 35 to 55 percent by weight; 100 percent passing through 1-inch screen; soluble salt content of 5 to 10 decisiemens/meter; not exceeding 0.5 percent inert contaminants and free of substances toxic to plantings; and as follows:
   a. Organic Matter Content: 50 to 60 percent of dry weight.
   b. Feedstock: Agricultural, food, or industrial residuals; biosolids; yard trimmings; or source-separated or compostable mixed solid waste.
4. Fiber Mulch: Biodegradable, dyed-wood, cellulose-fiber mulch; nontoxic; free of plant-growth or germination inhibitors; with maximum moisture content of 15 percent and a pH range of 4.5 to 6.5.
5. Nonasphaltic Tackifier: Colloidal tackifier recommended by fiber-mulch manufacturer for slurry application; nontoxic and free of plant-growth or germination inhibitors.
6. Asphalt Emulsion: ASTM D 977, Grade SS-1; nontoxic and free of plant-growth or germination inhibitors.

G. Erosion-Control Materials:
1. Erosion-Control Blankets: 100 percent biodegradable wood excelsior, straw, or coconut-fiber mat enclosed in a photodegradable plastic mesh. Include manufacturer's recommended 6-inches long steel wire staples.

H. Accessories:
1. Provide herbicides, chemicals and insecticides as needed for disease, fungus or pest control. All herbicides, chemicals and insecticides shall be bear approval labels indicating they are approved by the United States Department of Agriculture for the intended uses and application rates.

I. Water: Acceptable for lawn and meadow application and containing no material harmful to plant growth and establishment.

2.2 LOAM MIXES

A. Follow recommendations of soil-testing laboratory for modifying on-Site soil and manufactured soil, for use as topsoil.

B. On-Site soil and manufactured soil that has been provided with all inorganic soil amendments and fertilizers recommended by soil-testing laboratory, and acceptable for use as topsoil, shall be mixed with an additional organic soil amendment mix in a ratio of two parts topsoil to one part organic soil amendment mix, by volume.
   1. Prepare soil amendment mix by combining 40 percent compost, 40 percent peat moss, ten percent wood derivatives, five percent well-rotted manure and five percent grit aggregate, by volume.

C. Loam: Thoroughly blend topsoil with organic soil amendment mix and use as planting media for all lawn and meadow Work.

PART 3 - EXECUTION

3.1 INSPECTION

A. CONTRACTOR shall examine the areas and conditions under which lawn and meadow Work is to be performed, and notify ENGINEER, in writing, of conditions detrimental to the proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions have been corrected in a manner acceptable to ENGINEER.

3.2 PREPARATION

A. Thoroughly blend and mix loam before spreading. Incorporate fertilizers, and ground limestone or acidulant, after spreading, as specified, and at rates recommended by soil-testing laboratory.

B. Protect structures, utilities, sidewalks, pavements, and other facilities, trees, shrubs, and plantings from damage caused by planting operations.
   1. Protect adjacent and adjoining areas from hydroseeding overspray.

C. Provide erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.

D. Perform percolation tests on existing subgrade and placed fills prior to fine grading.
   1. Perform percolation testing of subgrades and placed fills to determine whether or not the subgrade will drain properly. Perform percolation tests in accordance with the following procedure:

a. Dig a hole in the subgrade that is 4 inches in diameter and 12 inches deep.
b. Fill the hole with water and wait for the water to completely drain from the hole.
c. Immediately refill the hole with water and measure the rate of fall in the water level.

2. In the event that water drains at a rate less than 1-inch in one hour, excavate soil to a minimum depth of 24 inches, and deeper, as necessary to break the compaction. Backfill, recompact and retest each area so prepared to confirm drainage rates exceed one inch in one hour.
3. Perform minimum of one soil percolation test for every 10,000 square feet of lawn and meadow area.

E. Excavate or fill subgrade, as required, to bring subgrade to elevations shown. Maintain all angles of repose. Confirm that subgrade is at proper elevations and that no further earthwork is required to bring the subgrade to proper elevations. Provide subgrade elevations that slope parallel to finished grade and towards subsurface drains shown.

F. Remove all construction debris, trash, rubble and all extraneous materials from subgrade. In the event that fuels, oils, concrete washout or other material harmful to plant growth or germination have been spilled into the subgrade, excavate the subgrade sufficiently to remove all such harmful materials and fill with approved fill, compacted to the required subgrade compaction level.

3.3 FINE GRADING

A. Immediately prior to dumping and spreading loam, clean subgrade of all stones greater than 2 inches and all other extraneous matter. Remove all such material from Site. Notify ENGINEER that subgrade has been cleaned, and obtain approval prior to spreading loam.

B. Do not attempt to spread excessively wet, muddy or frozen loam. Do not spread loam more than five days before seeding or planting.

C. Spread loam to a depth of 6-inches but not less than required to meet finish grades after light rolling and natural settlement.
1. Spread approximately one-half the thickness of required loam depth. After spreading loam, rototill, disk or harrow loam and subgrade to bring top 2 inches of subgrade upward into loam layer, so that there is a transitional layer between loam and subgrade.
2. Spread remainder of loam to required finish grades.
3. Compact each lift sufficiently to reduce settling, but not enough to prevent the movement of water and feeder roots through loam. After compaction spread loam should offer firm, even resistance when a soil sampling tube is inserted.

4. Phase the placement of the final lift so that wheeled vehicles do not have to travel over areas where final lifts are already in-place.
5. Spread and compact to a smooth, uniform surface plane, to within plus or minus 1/2 inch of finish elevations. Roll and rake and remove all ridges, and fill depressions, as required. Remove all stones larger than 1 inch in any dimension and all sticks, roots, trash and other extraneous matter.
6. Perform percolation tests as for subgrades, except limit depth of holes to 2/3 the depth of loam layer.

D. Spread ground limestone or acidulant and fertilizer, as specified. Mix ground limestone with dry loam before spreading fertilizer and work lightly into the top 4 inches of loam by harrowing or tilling at least three days before applying commercial fertilizers.

E. Grade planting areas to smooth, even surface with loose, uniformly fine texture. Remove all stones and extraneous material in excess of 1-inch diameter. Roll, rake and remove ridges and fill depressions, as required to meet finish grades.

F. Moisten prepared areas before seeding, sodding, sprigging or plugging. Water thoroughly and allow surface moisture to dry before planting. Do not create a muddy loam condition.

G. Prior to seeding or planting, restore loam to specified condition, if eroded or otherwise disturbed.

3.4 CONVENTIONAL SEEDING

A. General: Maintain grade stakes until removal is mutually agreed upon by all parties concerned.

B. Rake or harrow all seedbeds immediately prior to seeding to produce a rough, grooved surface, no deeper than 1 inch. Seed only when seedbed is in a friable condition and not muddy or hard.

C. Sow seed using a spreader or seeding machine.

D. Distribute seed evenly over entire area by sowing equal quantity in two directions at right angles to each other.

E. Cultipacker, or approved similar equipment, may be used to cover the seed and to firm the seedbed in one operation. In areas inaccessible to cultipacker:
1. Rake the seed lightly into top 1/8 inch of loam, roll in two directions with a water ballast roller, weighing not less than 100 pounds per linear foot.
2. Take care during raking that seed is not raked from one spot to another.
3. Protect seeded areas against erosion by spreading specified mulch after completion of seeding operations.

a. Protect seeded areas against hot, dry weather or drying winds by applying peat moss mulch not more than 24 hours after completion of seeding operations. Presoak and scatter evenly to a depth of from 1/8 inch to 3/16 inches thick and roll to a smooth surface. Do not mound.

b. Spread straw mulch to form a continuous loose blanket not less than 1-1/2 inch deep over seeded areas at the approximately rate of two tons per acre.

1) Anchor mulch by spraying with asphalt emulsion at the rate of ten to 13 gallons per 1000 square feet.

2) Place mulch with equipment that will blow or eject, by means of a constant air stream, controlled quantities of the mulch and asphalt in a uniform pattern over the specified area. If the mulch is excessively cut or broken, take measures to reduce the cutting or breakage. Introduce the asphalt into the air stream by means of a spray arranged so that it will partially coat the mulch with a spotty asphalt tack prior to the depositing of the mulch covering. Rate of application not less than 75 gallons per ton of mulch.

c. Protect seeded areas, with slopes exceeding one on six, by providing erosion-control fiber mesh and where slopes exceed one on four, by providing erosion-control blankets. Install erosion-control materials according to manufacturer's written instructions and as follows:

1) Vertically down slope without stretching fabric.

2) Install hold down staples three per square yard minimum in center of fabric or as required to hold and shape the fabric to the contours of the slope. Install hold down staples along edges and overlaps of fabric at 9 inches on centers minimum, or as required to hold and shape the fabric to the contours of the slope.

3) Lap fabric 4 inches minimum and turn edges of fabric into 8-inch deep by 16-inch wide earth trench and fill trench with earth.

F. Using a uniform fine spray, thoroughly and evenly water seeded areas. Provide adequate water to moisten seedbed to a depth of 2 inches.

1. Repeat this process when peat mulch color lightens. Maintain all seedbeds in a uniformly moist condition, conducive to seed germination and plant establishment, as specified.

G. Reseed areas that remain without mulch for longer than three days.

H. Take precautions to prevent damage or staining of construction or other plantings adjacent to mulched areas. Immediately clean damaged or stained areas.

I. Prevent foot or vehicular traffic, or the movement of equipment, over the mulched areas. Reseed areas damaged as a result of such activity.

3.5 HYDROSEEDING

A. Hydroseeding: Mix specified seed, fertilizer, and fiber mulch in water, using equipment specifically designed for hydroseed application. Continue mixing until uniformly blended into homogeneous slurry suitable for hydraulic application.

B. Mix slurry with asphalt-emulsion tackifier.

C. Apply slurry uniformly to all areas to be seeded in a two-step process. Apply first slurry application at a minimum rate of 500 pounds per acre dry weight, but not less than the rate required to obtain specified seed-sowing rate so that the seed comes into direct contact with loam.

D. Apply slurry cover coat of fiber mulch at a rate of 1000 pounds per acre.

3.6 RECONDITIONING EXISTING LAWNS AND MEADOWS

A. Recondition existing lawn damaged by CONTRACTOR's operations, including areas used for storage of materials or equipment and areas damaged by movement of vehicles. Recondition existing lawns and meadow areas where minor regrading is required.

B. Recondition other existing lawn and meadow areas shown.

C. Provide fertilizer, seed or sod and soil amendments, as specified for new lawn and meadow, and as required to provide satisfactorily reconditioned lawns and meadows. Provide new loam as required to fill low spots and meet new finish grades.

D. Till stripped, bare, and compacted areas thoroughly to a depth of 12 inches.

E. Remove diseased or unsatisfactory lawn and meadow areas; do not bury into soil. Remove topsoil containing extraneous materials resulting from CONTRACTOR's operations including oil drippings, stone, gravel and other construction materials.

F. In areas approved by ENGINEER, where substantial lawns remain (but are thin), mow, dethatch, core aerate and rake. Fill low spots, remove humps, cultivate soil, fertilize, and seed. Remove weeds before seeding or if extensive, apply selective chemical weed killers, as required. Apply a seedbed mulch, if required, to maintain moist condition.

G. Water newly planted areas and keep moist until new lawns and meadows are established, as specified.

3.7 ACCEPTANCE CRITERIA FOR LAWNS AND MEADOWS

A. Lawn Work will be considered acceptable when:
   1. Seeded Lawn: When a healthy, uniform, close stand of grass has been established, free of weeds and surface irregularities, with coverage exceeding 90 percent over any 10 square feet and bare spots not exceeding 5-inches by 5-inches.
   2. Seeded Meadow: When a healthy, uniform, close stand of meadow grass and forbs has been established, free of weeds and surface irregularities, with coverage exceeding 90 percent over any 20 square feet and bare spots not exceeding 12 inches by 12 inches.
   3. Sodded Lawn: When a healthy, well-rooted, even-colored, viable lawn has been established, free of weeds, open joints, bare areas, and surface irregularities.
   4. Plugged Lawn: When the required number of plugs has been established as well-rooted, viable patches of grass; and areas between plugs are free of weeds and other undesirable vegetation.
   5. Sprigged Lawn: When the required number of sprigs has been established as well-rooted, viable plants and areas between sprigs are free of weeds and other undesirable vegetation.

3.8 CLEANUP AND PROTECTION

A. Promptly remove soil and debris, created by lawn and meadow Work, from paved areas. Clean wheels of vehicles before leaving Site to avoid tracking soil and loam onto roads, walks, or other paved areas.

B. Erect barricades and warning signs as required to protect newly planted areas from traffic. Maintain barricades throughout extended service period and remove when service period ends. Treat, repair or replace damaged lawns and meadows.

C. Remove erosion-control measures after lawn and meadow extended service period ends.

D. Take all precautions to ensure that hydroseed slurry is only placed on the areas designated. Completely clean any overspray, on areas not designated to receive slurry.

3.9 INSPECTION AND ACCEPTANCE

A. Where lawns and meadows do not comply with specified acceptance criteria, reestablish lawns and meadows and continue extended service period until lawns and meadows comply with criteria for acceptance.

3.10 DEMONSTRATION

A. Engage installer's Site supervisor to train and instruct CITY's personnel in the proper maintenance of lawns and meadows and procedures to be performed throughout the year for proper care and maintenance of lawn and meadows.
   1. Include instructions and training on reconditioning established lawns and meadow and sources of lawn and meadow materials.
   2. Schedule training with CITY, through ENGINEER, with at least seven days' advance notice.

B. Review Operation and Maintenance information and be sure all instructions are clearly understood by CITY's personnel and are supplemented with additional information, clarifications and instructions, as required.

C. Provide minimum of two, nonconsecutive, full days on-Site training time during day shift normal working hours.

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SECTION 32 93 00

PLANTS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, tools, equipment and incidentals as shown, specified and required to furnish and install plants.
   2. Extent of plants is shown.
   3. Types of products required include the following.
      a. Coniferous evergreen trees and shrubs.
      b. Securement and protection accessories.
      c. Topsoil.
      d. Organic and inorganic topsoil amendments.
      e. Fertilizers.
      f. Mulches and weed-control barriers.
      g. Erosion-control material.
      h. Accessories.

B. Coordination:
   1. Review installation procedures under other Sections and coordinate the installation of items that must be installed with, or before, the plants.
   2. Notify other contractors in advance of the installation of plants to provide them with sufficient time for the installation of items included in their contracts that must be installed with, or before, the plants.

C. Related Sections:
   1. Section 33 11 00, Clearing and Grubbing.
   2. Section 32 31 00, Fences.
   3. Section 32 92 00, Lawns and Meadows.

1.2 REFERENCES

A. Standards referenced in this Section are listed below:
   1. American National Standards Institute, (ANSI).
      a. ANSI Z60.1, American Standard for Nursery Stock.
   2. Association of Official Analytic Chemists, (AOAC).
      a. Official Methods of Analysis of AOAC International.
   3. American Society of Agronomy, (ASA).
      a. Reference No. 1 - Methods of Soils Analysis, Soil Science Society of America, Incorporated.
   4. American Society for Testing and Materials, (ASTM).
      a. ASTM A 36, Specification for Carbon Structural Steel.

b. ASTM A 641, Specification for Zinc-Coated (Galvanized) Carbon Steel Wire.
c. ASTM D 75, Practice for Sampling Aggregates.
d. ASTM D 422, Test Method for Particle Size Analysis of Soil.
e. ASTM D 977, Specification for Emulsified Asphalt.
f. ASTM D 2487, Practice for Classification of Soils for Engineering Purposes (United Soil Classification System).
g. ASTM D 4397, Specification for Polyethylene Sheeting for Construction, Industrial and Agricultural Applications.
h. ASTM D 5268, Specification for Topsoil Used for Landscape Purposes.
i. ASTM E 329, Specification for Agencies Engaged in the Testing and/or Inspection of Materials Used in Construction.
j. ASTM E 548, Guide for General Criteria Used for Evaluating Laboratory Competence.

5. Hortus III, Liberty Hyde Bailey Hortorium.
6. The Rainforest Alliance, SmartWood Certified Forestry Program.
7. United States Department of Agriculture, (USDA).
   a. Description of the Eco-regions of the United States.
   b. Plant Hardiness Zone Maps.

1.3 DEFINITIONS

A. The term "balled and burlapped stock" describes plants dug with firm, natural balls of earth in which they are grown, with ball size not less than diameter and depth recommended by ANSI Z60.1 for type and size of tree or shrub required; wrapped, tied, rigidly supported, and drum-laced as recommended by ANSI Z60.1.

B. The term "balled and potted stock" describes plants dug with firm, natural balls of earth in which they are grown and placed, unbroken, in a container. Ball size is not less than diameter and depth recommended by ANSI Z60.1 for type and size of plant required.

C. The term "bare-root stock" describes plants with a well-branched, fibrous-root system developed by transplanting or root pruning, with soil or growing medium removed, and with not less than minimum root spread according to ANSI Z60.1 for kind and size of plant required.

D. The term "container-grown stock" describes healthy, vigorous, well-rooted plants, grown in a container with well-established root system reaching sides of container and maintaining a firm ball when removed from container. Container shall be rigid enough to hold ball shape and protect root mass during shipping and be sized according to ANSI Z60.1 for kind, type, and size of plant required.

E. The term "fabric bag-grown stock" describes healthy, vigorous, well-rooted plants established and grown in-ground in a porous fabric bag with well-established root

system reaching sides of fabric bag. Fabric bag size is not less than diameter, depth, and volume required by ANSI Z60.1 for type and size of plant.

F. The term "finish grade" describes elevation of finished surface of planting soil mix.

G. The term "manufactured topsoil" describes soil produced off-Site by homogeneously blending mineral soils or sand with stabilized organic soil amendments to produce topsoil for planting soil mix.

H. The term "planting soil mix" describes native or imported topsoil, manufactured topsoil, or surface soil modified to become topsoil; mixed with topsoil amendments.

I. The term "subgrade" describes surface or elevation of subsoil remaining after completing excavation, or top surface of a fill or backfill, before placing planting soil mix.

1.4 QUALITY ASSURANCE

A. Installer Qualifications:
   1. Engage a single landscape installer skilled, trained and with successful and documented experience in the planting of plants and in the installation of the types of materials required; and who agrees to employ only tradesmen with specific skill and successful experience in this type of Work. Submit names and qualifications to ENGINEER along with the following information on a minimum of three successful projects:
      a. Names and telephone numbers of owner, architects or engineers responsible for projects.
      b. Approximate contract cost of the plants.
      c. Amount and kinds of plants installed.
   2. Installer's Site Supervisor: Require installer to maintain an experienced full-time landscape supervisor on-Site during the time of preparation for, and planting of, plants. Supervisor shall have achieved landscape or horticultural certification acceptable to governing authorities having jurisdiction at the Site.
   3. Ratio of laborers to certified landscape supervisors shall not exceed 12 to one. Certified landscape supervisor shall be on-Site throughout the day-to-day performance of the Work of this Section.
   4. Application of herbicides, chemicals and insecticides shall be done by personnel licensed to perform such applications by governing authorities having jurisdiction at the Site and in accordance with each manufacturer's instructions provided on each product label.

B. Soil-Testing Laboratory Qualifications:
   1. An independent laboratory, recognized by governing authorities having jurisdiction at the Site, with the experience and capability to conduct testing indicated and that specializes in types of soil tests to be performed.
   2. To qualify for approval, an independent testing agency shall demonstrate to ENGINEER'S satisfaction, based on evaluation of criteria submitted by testing agency, that it has the experience and capability to satisfactorily conduct the testing indicated, in accordance with ASTM E 329 and as documented according to ASTM E 548, without delaying the Work.

C. References: As specified in Section 01 42 00, References.

D. Soil Analysis: Furnish report of soil analysis to ENGINEER, prepared by a qualified soil-testing laboratory, stating percentages of organic matter; mechanical gradation of sand, silt, and clay content in compliance with ASTM D 422; cation exchange capacity; sodium absorption ratio; deleterious materials content; pH; and mineral and plant-nutrient content of soil. Chemical analysis shall include tests for percentages of nitrate nitrogen, ammonium nitrogen, phosphorus, potassium, calcium, iron, manganese, copper, zinc, extractable aluminum, and total soluble salts.
   1. Existing On-Site Soil:
      a. Separate soil stockpiled and proposed for use as topsoil for planting soil. Mix into 1000 cubic yard piles and label with a numbering system used to reference all soil samples and test results.
      b. Obtain a one cubic foot representative sample for each 1000 cubic yards of soil stockpiled on-Site proposed for use as topsoil for planting soil mix, in compliance with ASTM D 75 and Appendixes, for securing samples from stockpiles.
      c. Place samples taken from each stockpile, into separate clean, new and previously unused, containers and mix thoroughly. Maintain separation and legible labeling of each sample taken from each stockpile, throughout the process of mixing, drying and delivering to soil analysis laboratory. Label samples on outside of container.
      d. Take one cup of soil from each container and allow to dry at room temperature. Once dry, place each one-cup sample in a separate, accurately labeled, new and previously unused one-cup sized plastic container, seal tightly and deliver to soil testing laboratory.
      e. Report suitability of soil as a topsoil component for plant growth. State recommended quantities of nitrogen, phosphorus, secondary and micronutrients, potash and soil amendments to be added to produce satisfactory topsoils. Include calculations, types of fertilizer and recommendations for application rates in either gallons or pounds per cubic foot of soil.
      f. In addition, all on-Site soil that will be used as topsoil shall be provided with additional compost and peat moss amendments specified, whether or not testing indicates positive need for such amendments, for such material to be used as planting soil mix.

2. Manufactured Imported Topsoil:
    a. Test each 1000 cubic yards of manufactured topsoil at the proposed source. In addition, after ENGINEER's approval of manufactured topsoil based on results and recommendations of soil testing reports, test each 1000 cubic yards of manufactured topsoil that is delivered to the Site for conformance to results and recommended modifications of approved soil test reports. Manufactured topsoil that differs from proposed source material, after modification according to recommendations of soil test reports, shall be rejected for use in the Work.
    b. For samples from stockpiles, obtain a one cubic foot representative sample for each 1000 cubic yards of manufactured topsoil proposed for plant Work, in compliance with ASTM D 75 and Appendixes.
    c. Place samples taken from each stockpile into separate clean, new and previously unused, containers and mix thoroughly. Maintain separation and legible labeling of each sample, taken from each stockpile, throughout the process of mixing, drying and delivering to soil analysis laboratory. Label samples on outside of container.
    d. Take one cup of topsoil from each container and allow to dry at room temperature. Once dry, place each one-cup sample in a separate, accurately labeled, new and previously unused one-cup sized plastic container, seal tightly and deliver to soil testing laboratory.
    e. Report suitability of manufactured topsoil, as a component of planting soil mix, for use in growing plants. State recommended quantities of nitrogen, phosphorus, secondary and micronutrients, potash and soil amendments to be added to produce satisfactory manufactured topsoil. Include calculations, types of fertilizer and recommendations for application rates in either gallons or pounds per cubic foot of manufactured topsoil.
    f. Organic component of manufactured topsoil shall be obtained from compost and peat moss amendments specified, for such material to be used as planting soil mix.

E. Source Quality Control:
1. General:
    a. Provide quality, size, genus, species, and variety of plants indicated, complying with applicable requirements of ANSI Z60.1.
    b. Ship plants with certificates of inspection as required by governing authorities having jurisdiction at the Site.
2. Analysis and Standards: Package standard products with manufacturer's certified analysis. For other materials, provide analysis by recognized laboratory made in accordance with methods established by the AOAC, wherever applicable or specified.
3. Provide plants grown in a recognized nursery in accordance with good horticultural practice, with healthy root systems developed by transplanting or root pruning. Provide healthy, vigorous plants grown for at least two years under climatic conditions similar to conditions in the locality of the

Project and free of disease, insects, eggs, larvae, and defects such as knots, sun-scald, injuries, abrasions or disfigurement.

a. Provide plants of the sizes shown. Plants of larger size may be used if acceptable to ENGINEER, and if sizes of roots or balls are increased proportionately.
b. Measure according to ANSI Z60.1 with branches and trunks or canes in their normal position. Do not prune to obtain required sizes. Take caliper measurements 6 inches above ground for trees up to 4-inch caliper size, and 12 inches above ground for larger sizes.
c. Measure main body of tree or shrub for height and spread; do not measure branches, or roots, tip-to-tip.

4. Plants showing signs of graft incompatibility shall be removed from the Site. Visual indication of graft incompatibility shall include:
   a. Development of over-growths by rootstock or scion resulting in the development of shoulders or inverted shoulders.
   b. Suckering of the rootstock combined with poor growth or dieback of the scion.
   c. Any mechanical weakness between scion and rootstock.
   d. Any marked difference in bark pattern and structure between scion and rootstock.
5. Inspection: ENGINEER may inspect plants either at place of growth or at Site, before planting, for compliance with requirements for genus, species, variety, size, and quality. ENGINEER retains right to inspect plants further for size and condition of ball and root systems, insects, injuries, and latent defects and to reject unsatisfactory or defective material at any time during progress of Work. Immediately remove rejected plants from Site.
   a. Notify ENGINEER of sources of planting materials, minimum of 14 days in advance of delivery to Site.
6. Do not prune plants before delivery, except as approved by ENGINEER, in writing. Protect bark, branches, and root systems from sun scald, drying, sweating, whipping, and other handling and tying damage. Do not bend or bind-tie trees or shrubs in such a manner as to destroy their natural shape.
7. Requirements for Balled and Burlapped Plants:
   a. Where shown to be balled and burlapped, provide plants dug with a firm, natural ball of earth in which they are grown.
   b. Provide ball size of not less than the diameter and depth recommended by ANSI Z60.1 for the type and size of plants required. Increase ball size or modify ratio of depth to diameter as required to encompass the fibrous and feeding root system necessary for full recovery of plants subject to unusual or atypical conditions of growth, soil conditions or horticultural practice.
   c. Wrap and tie earth ball as recommended by ANSI Z60.1 for the size of balls required. Drum-lace balls with a diameter of 30 inches or greater.

F. Pre-installation Conference:
   1. Prior to commencement of planting and associated Work, CONTRACTOR shall schedule and meet at the Site with the landscape installer, the installers of other work in and around planting areas that follows the planting Work, including fencing Work specified in Section 32 31 00, Fences, and ENGINEER and other representatives directly concerned with performance of the Work. Review foreseeable methods and procedures related to the planting Work, including the following:
      a. Review Project requirements and the Contract Documents.
      b. Review required submittals, both completed and yet to be completed.
      c. Review availability of water and methods of delivery.
      d. Review status of below-grade work and required access during planting and extended service periods.
      e. Review Project Schedule and availability of materials, tradesmen, equipment and facilities needed to make progress and avoid delays.
      f. Review environmental conditions, other Project conditions, and procedures for coping with unfavorable conditions.
      g. Review procedures needed for protection of plantings during the remainder of the construction period.
      h. Review required inspection, testing, and certifying procedures.
   2. Record the discussions of the conference and the decisions and agreements or disagreements reached, and furnish a copy of the record to each party attending.
   3. Record all revisions or changes agreed upon, reasons therefor, and parties agreeing or disagreeing with them.
   4. Reconvene the meeting at the earliest opportunity if additional information must be developed in order to conclude the subjects under consideration.

1.5 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Shop Drawings:
      a. Planting schedule showing scheduled start and finish dates for each type of planting in each area of Site.
   2. Product Data:
      a. Manufacturer's specifications and installation instructions for all materials required.
      b. Composition and analysis of commercial fertilizers and all purchase receipts showing the total quantity actually purchased for this Project.
   3. Samples:
      a. Five pounds of washed mineral mulch for each color, size and texture of stone required, in labeled plastic bags.

B. Informational Submittals: Submit the following:
   1. Certificates:
      a. Certificates of inspection as may be required by governing authorities having jurisdiction at the Site to accompany shipments, and

manufacturer's certified analysis for soil amendments and fertilizer materials.

b. For standard products, submit other data certifying that materials comply with specified requirements.

c. For wood products, submit data certifying that wood has been obtained from sustainable managed forests in compliance with Rainforest Alliance SmartWood Program.

2. Test and Evaluation Reports:

a. An analysis made by an approved laboratory stating the mechanical and chemical analysis of the peat humus proposed for use.

b. Soil analysis reports for existing soil and imported manufactured topsoil, as specified. Include recommendations for remediating existing soil into acceptable topsoil as a component of planting soil mix.

3. Qualifications Data:

a. Landscape installer.

b. Landscape supervisor.

c. Testing agency.

4. Source Quality Control Submittals:

a. Written statement providing the location from which manufactured topsoil is to be obtained and the names and addresses of the suppliers.

C. Closeout Submittals: Submit the following:

1. Care and Maintenance Data:

a. Report with instructions recommending procedures to be established by CITY for full care, vigorous growth and maintenance of each type of plant specified, with specific recommendations for type of care, insect and disease prevention and special winter protection measures to be performed for each type of plant, for each month of the year. Include color pictures of each type of plant used in the Project, showing full plant form and close-ups of leaf and flower forms, along with botanical and common names adjacent to written full care and maintenance recommendations.

b. Submit report prepared in Microsoft Word or Adobe portable document format, with scanned pictures as specified, and provide DEPARTMENT with two copies on compact disc.

c. Submit prior to expiration of specified extended service periods.

2. Warranty Documentation:

a. Submit written warranty, signed by CONTRACTOR and landscape installer, as specified.

1.6 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Delivery of Materials:

1. Deliver each type of plant as the Work progresses, after preparations for planting that specific type of plant is completed, and when plants will be

planted immediately upon arrival at the Site. Do not stockpile plants on-Site.

2. Deliver packaged materials in original, unopened containers, legibly showing weight, analysis and name of manufacturer. Protect materials from deterioration during delivery. Provide protective covering.
3. Do not drop plants during delivery.
4. Immediately remove unacceptable material from Site.

B. Storage of Materials:
1. If planting is delayed more than six hours after delivery, set plants in shade, protect from weather and mechanical damage, and keep roots moist.
2. Set balled stock on ground and cover ball with soil, moistened peat moss or other acceptable material.
3. Heel-in bare root plants in a bed containing adequate peat moss to keep roots in a moist condition. Soak roots in water for two hours before planting.
4. Store and cover materials to prevent deterioration. Remove packaged materials that have become wet, or show deterioration or water marks, from Site.

C. Handling of Materials:
1. Handle balled and burlapped plants so that the ball will not be loosened or broken. Immediately remove split, broken or loosened balled and burlapped material from Site and replace with new material.
2. Do not remove container-grown plants from containers until planting time.
3. Do not lift or drag plants by stems or trunks. Handle plants by lifting root ball or container.
4. Water as necessary to maintain plant root systems in a moist condition.

1.7 PROJECT CONDITIONS

A. Existing Conditions:
1. Obstructions Below Ground and Utilities: Exercise extreme caution in all planting operations, as there are underground electric and telephone cables, sewer lines and water lines throughout the entire Site. Study and be familiar with the location of these obstructions and underground utilities. Place plantings, where shown in the proximity of these obstructions and underground utilities, clear of any interference. Repair all damages to obstructions and underground utilities caused by the Work of this Section.

B. Environmental Requirements:
1. Proceed with and complete the Work as rapidly as portions of the Site become available, working within the seasonal limitations for each kind of plant shown.
2. Herbicides, chemicals and insecticides shall not be used on areas bordering wetlands.

3. Do not resort to chemical control measures at the first sign of insect or disease attack. Make an attempt to determine the environmental cause of the attack and take corrective measures.
4. Apply chemical insect and disease measures locally and specifically to the area and type of planting in need of such insect and disease control, so as not to damage plantings, or endanger the environment. Select natural chemical controls specific to the type of insect or disease encountered, or provide naturally controlling insect predators and bacterial controls for release at the Site.
5. Plantings exhibiting a broad and heavy infestation of insects or diseases, or where insects or diseases have disfigured plantings such that they no longer provide their intended aesthetic effect, shall be replaced with new plantings.

C. Scheduling:
1. Coordinate planting with specified extended service periods to provide required service from date of acceptable completion of each type of planting. Plant during one of the following periods:
   a. Spring Planting: March 15 to June 15.
   b. Fall Planting: September 1 to October 30.
2. Do not begin planting until water, acceptable for use and adequate in supply, is available on-Site and can be successfully transported to the areas of Work. Coordinate provision of adequate and acceptable water supply with Project schedule.
3. Do not proceed with installation of plants until all subgrade utility services have been installed, are operating successfully and have been approved by ENGINEER.
4. Plant only after final grades are established and prior to planting of lawns and meadows, unless otherwise acceptable to ENGINEER. If planting occurs after lawn and meadow Work, protect lawn and meadow areas and promptly repair damage to lawns and meadows resulting from planting operations.
5. Apply anti-desiccant to trees and shrubs using power spray to provide an adequate film over trunks, branches, stems, twigs and foliage to protect during digging, handling, and transportation.
   a. One week before evergreen trees and deciduous trees and shrubs in full leaf are to be dug, spray with anti-desiccant at nursery before moving and again two weeks after planting.
   b. Apply anti-desiccant to evergreens, again, immediately after the first frost.

1.8 ALTERNATIVES

A. Do not select plant material differing from that shown, without consulting ENGINEER for approval.

B. Plant material differing from that shown may be allowed by ENGINEER, at the varietal level only. Submit proof of non-availability and proposal for types of equivalent material.

C. Bring to the attention of ENGINEER plant selections believed to be unsuitable for the microclimate or ecoregion of the Project, based on USDA information specified, or other authoritative sources.

1.9 WARRANTY

A. General Warranty: The special warranties specified in this Article shall not deprive DEPARTMENT of other rights or remedies DEPARTMENT may otherwise have under the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by CONTRACTOR under the Contract Documents.

B. Special Warranty: Warrant the following plants, for the warranty period indicated, against defects including death and unsatisfactory growth, except for defects resulting from lack of adequate care and maintenance, or abuse by CITY, or incidents that are beyond CONTRACTOR's control.
   1. Warranty Period for Trees and Shrubs: One year from date of end of extended service period.
   2. Replace plants that are more than 25 percent dead or in an unhealthy condition at end of warranty period.
   3. A limit of one replacement of each plant will be required, except where losses or replacement failures are due to CONTRACTOR’s failure to comply with specified requirements.

1.10 EXTENDED SERVICE

A. Extended Landscape Service:
   1. Begin extended service immediately after each planted area is acceptably completed. Provide extended service for not less than the following periods:
      a. Trees and Shrubs: 90 days after trees and shrub plantings are acceptably completed.
   2. Prune, cultivate, water, weed, fertilize, shade, mist, restore planting saucers, tighten and repair stakes and guy supports, and reset plantings to proper grades or vertical position, as required to establish healthy, viable plantings.
      a. Do not allow plantings to wilt or show other signs of environmental stress. Visit the Site twice a week during the extended service periods, to inspect the condition of the plantings and immediately provide required care.
      b. CONTRACTOR shall provide landscape installer who shall be available on-call if notified between regular visits that plants require critical care or maintenance, throughout the time of extended service periods.

3. Check and observe plantings for signs of insect and disease attack. Take corrective measures immediately upon notice of such attack. Control damaging insects and diseases, as specified.
4. Restore or replace damaged tree wrappings.
5. Remove dead plants immediately. Replace immediately, unless required to plant in the succeeding planting season.

B. Provide sufficient water to ensure that the top six inches of the planting bed mix remains moist at all times.
   1. Apply water using a 1-inch diameter hose with an attached metering gauge.
   2. For trees in seeded areas or mulched beds, apply water to the ground surface directly under the canopy. Apply water at a sufficiently slow rate to prevent water run-off from the soil surface but great enough to provide 0.2 inches of water per square foot of canopy area per hour for five hours each week.

C. Any decline in the condition of plants shall require CONTRACTOR to take immediate action to identify potential problems and undertake corrective measures. If required, engage professional arborists or horticulturists to inspect plants, identify problems and recommend correctives procedures. Advise ENGINEER of all such actions and submit inspection and recommendation reports.

PART 2 - PRODUCTS

2.1 MATERIALS

A. General Landscape Design Criteria:
   1. Provide plant materials true to name and variety, established in Hortus III.
   2. Provide nursery-grown plants complying with ANSI Z60.1, typical of their species or variety and with a normal habit of growth for type of plant required, with healthy root systems developed by transplanting or root pruning. Provide well-shaped, fully branched, healthy, vigorous plants free of disease, insects, eggs, larvae, and defects such as knots, sun scald, injuries, abrasions, and disfigurement.
   3. Label at least one tree and one shrub and one bundle or flat of plants of each variety and caliper with a securely attached, waterproof tag bearing legible designation of botanical and common name.
   4. Where formal arrangements or consecutive order of trees or shrubs are shown, select plants for uniform height and spread, and label with number to assure symmetry in planting.

2.2 CONIFEROUS EVERGREENS

A. Form and Size: Normal-quality, well-balanced, coniferous evergreens, of type, height, spread, and shape required, complying with ANSI Z60.1.

2.3 TOPSOIL

A. All soil accepted as topsoil, whether obtained from on-Site or off-Site sources, shall comply with specified topsoil analysis.

B. Provide fertile, friable, natural loam, surface soil, capable of sustaining vigorous plant growth; free of any admixture of subsoil, clods of hard earth, plants or roots, sticks, stones larger than 1-inch in diameter, or other extraneous material harmful to plant growth, in compliance with ASTM D 5268. Provide topsoil with the following analysis:
   1. 3/4-inch mesh: 100 percent passing.
   2. No. 4-sieve: 90 to 100 percent passing.
   3. No. 200-sieve: 0 to 10 percent passing.
   4. Clay content of material passing No. 200-sieve not greater than 60 percent, as determined by hydrometer tests.
   5. pH-adjusted with ferrous sulphate or ground limestone to provide pH 5.5 to pH 7.0 at time of installation of lawns, grass and meadow areas, unless particular species of grass or wildflower stand requires a different pH to meet its growing needs.
   6. Electrical conductivity of a 1:2 soil-water suspension shall not exceed 1.0 milliohm per centimeter and with less than 200 parts per million of extractable aluminum.
   7. Cation Exchange Capacity: 5, minimum.
   8. Organic content not less than five percent, as determined by ignition loss of oven-dried samples passing No. 10-sieve (Muffle Furnace Temperature: 110 plus or minus five degrees C for eight hours).
   9. Free of pests and pest larvae.

C. Topsoil Source: Reuse surface soil stockpiled on-Site, where possible. Verify suitability of stockpiled surface soil to produce topsoil, as specified. Clean surface soil of roots, plants, sod, stones, clay lumps, and other extraneous materials harmful to plant growth.
   1. Supplement acceptable on-Site soil with manufactured topsoil from off-Site sources, when quantities available on-Site are insufficient to complete the Work.

2.4 INORGANIC SOIL AMENDMENTS

A. Ground Oolitic Limestone: ASTM C 602, agricultural limestone containing a minimum 80 percent calcium carbonate equivalent and as follows:
   1. Class: Class O, with a minimum 95 percent passing through No. 8-sieve and a minimum 55 percent passing through No. 60-sieve.

B. Iron Sulfate: Commercial-grade acidulant, recommended for use on acid-loving plants. Provide granulated ferrous sulfate containing a minimum of 20 percent iron and 10 percent sulfur.

C. Perlite: Agricultural-grade, expanded pumice.

D. Agricultural Gypsum: Commercial-grade and finely ground, containing a minimum of 90 percent calcium sulfate.

E. Grit Aggregate: Commercial-grade filter sand consisting of hard, durable rounded grains of quartz or other rock that do not compact to a solid mass when wet, with a pH in the range required for topsoil. Provide clean, washed, natural or manufactured aggregate, free of toxic materials, salt and other chemical contamination.

F. Zeolites: Mineral clinoptilolite with at least 60 percent water absorption by weight.

2.5 ORGANIC SOIL AMENDMENTS

A. Compost: Well-composted, stable, weed-free organic matter, produced by the aerobic decomposition of organic residues; pH range of 5.5 to 8; moisture content 35 to 55 percent by weight; 100 percent passing through a 1-inch screen; soluble salt content of 5 to 10 decisiemens/meter; not exceeding 0.5 percent inert contaminants and free of substances toxic to plantings; and as follows:
   1. Organic Matter Content: 50 to 60 percent of dry weight.
   2. Feedstock: Agricultural, food, or industrial residuals; biosolids; yard trimmings; or source-separated or compostable mixed solid waste.

B. Peat: Partially decomposed stems and leaves of several species of sphagnum moss; finely divided or granular texture. Supply shredded material, free from lumps, wood, roots, stones, decomposed collodial residue and other extraneous foreign matter, capable of passing through a 1/2-inch screen, which can easily be incorporated with the soil. Supply material that has been conditioned in storage piles after excavation for at least six months, including one freezing and thawing period. Supply peat humus with the following analysis:
   1. Not less than 90 percent organic matter by weight on an ovendry basis.
   2. pH range of 3.4 to 4.8.
   3. Moisture content 35 percent at time of incorporation into soil.
   4. Water absorbing ability 150 percent to 350 percent by weight.

C. Wood Derivatives: Decomposed, nitrogen-treated sawdust, ground bark, or wood waste; of uniform texture, free of chips, stones, sticks, soil, or toxic materials.
   1. In lieu of decomposed wood derivatives, mix partially decomposed wood derivatives with at least 0.15 pounds of ammonium nitrate or 0.25 pounds of ammonium sulfate per cubic foot of loose sawdust or ground bark.

D. Manure: Well-rotted, unleached, stable or cattle manure containing not more than 25 percent by volume of straw, sawdust, or other bedding materials; free of toxic substances, stones, sticks, soil, weed seed, and material harmful to plant growth.

2.6 FERTILIZERS

A. Bonemeal: Commercial, raw or steamed, finely ground; a minimum of four percent nitrogen and 20 percent phosphoric acid.

B. Superphosphate: Commercial, phosphate mixture, soluble; a minimum of 20 percent available phosphoric acid.

C. Commercial Fertilizer: Commercial-grade complete fertilizer of neutral character, consisting of fast- and slow-release nitrogen, 50 percent derived from natural organic sources of urea formaldehyde, phosphorous, and potassium in the following composition:
   1. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports.

D. Slow-Release Fertilizer: Granular or pelleted fertilizer consisting of 50 percent water-insoluble nitrogen, phosphorus, and potassium in the following composition:
   1. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified soil-testing agency.

2.7 MULCHES

A. Compost Mulch: Well-composted, stable, and weed-free organic matter, pH range of 5.5 to 8; moisture content 35 to 55 percent by weight; 100 percent passing through 1-inch screen; soluble salt content of 5 to 10 decisiemens/meter; not exceeding 0.5 percent inert contaminants and free of substances toxic to plantings; and as follows:
   1. Organic Matter Content: 50 to 60 percent of dry weight.
   2. Feedstock: Agricultural, food, or industrial residuals; biosolids; yard trimmings; or source-separated or compostable mixed solid waste.

B. Wood Chip Mulch: Provide either hardwood or softwood chips as produced by any standard chipping machine containing no wood shavings, sawdust or foreign material such as stones. Chip sizes larger than 3-inches in greatest dimension are not acceptable.

2.8 WEED-CONTROL BARRIERS

A. Nonwoven Fabric: Polypropylene or polyester fabric, 3 ounces per square yard, minimum.

B. Composite Fabric: Woven, needle-punched polypropylene substrate bonded to a nonwoven polypropylene fabric, 4.8 ounces per square yard, minimum.

2.9 STAKES AND GUYS

A. Upright and Guy Stakes: Rough-sawn, sound, hardwood or softwood obtained from certified sustainable managed forests, free of knots, holes, cross grain, and other defects, 2 inches by 2 inches by length indicated, pointed at one end.

B. Guy and Tie Wire: ASTM A 641, Class 1, galvanized-steel wire, 2-strand, twisted, 0.106-inch in diameter.

C. Guy Cable: Five-strand, 3/16-inch diameter, galvanized-steel cable, with zinc-coated turnbuckles, a minimum of 3 inches long, with two 3/8-inch galvanized eyebolts.

D. Hose Chafing Guard: Reinforced rubber or plastic hose at least 1/2-inch in diameter, black, cut to lengths required to protect tree trunks from damage.

E. Flags: Standard surveyor's plastic flagging tape, white, 6 inches long.

2.10 MISCELLANEOUS PRODUCTS

A. Antidesiccant: Water-insoluble emulsion, permeable moisture retarder, film forming, for trees and shrubs. Deliver in original, sealed, and fully labeled containers and mix according to manufacturer's written instructions.

B. Trunk-Wrap Tape: Two layers of crinkled paper cemented together with bituminous material, 4-inch wide minimum, with stretch factor of 33 percent.

C. Provide herbicides, chemicals and insecticides as needed for disease, fungus or pest control. All herbicides, chemicals and insecticides shall be bear approval labels indicating they are approved by the USDA for the intended uses and application rates.

PART 3 - EXECUTION

3.1 INSPECTION

A. CONTRACTOR shall examine the subgrade, verify the elevations, observe the conditions under which planting Work is to be performed, and notify ENGINEER, in writing, of unsatisfactory conditions. Do no proceed with the Work until unsatisfactory conditions have been corrected in a manner acceptable to ENGINEER.

B. Inspect plants for injury, insect infestation, and improper pruning.

C. Do not begin planting or wrapping of trees until deficiencies are corrected, or plants, replaced.

3.2 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities, and lawns and existing plants from damage caused by planting operations.

B. Provide erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.

C. Lay out plants at locations directed by ENGINEER. Stake locations of individual trees and shrubs and outline areas for multiple plantings.

3.3 TREE AND SHRUB EXCAVATION

A. Pits and Trenches: Excavate circular pits with sides sloped inward. Trim base leaving center area raised slightly to support root ball and assist in drainage. Do not further disturb base. Scarify sides of plant pit smeared or smoothed during excavation. Dispose of subsoil removed from pits and trenches in a legal manner, off-Site.
   1. Excavate approximately three times as wide as ball diameter for balled and burlapped stock.
   2. Excavate at least 12-inches wider than root spread and deep enough to accommodate vertical roots for bare-root stock.

B. Obstructions: Notify ENGINEER if unexpected rock or obstructions detrimental to trees or shrubs are encountered in excavations.

C. Drainage: Notify ENGINEER if subsoil conditions evidence unexpected water seepage or retention in tree or shrub pits.

3.4 TREE AND SHRUB PLANTING

A. Set plants plumb and in center of pit or trench with top of root ball set such that it will be 1-inch above adjacent finish grades, at plant stem, after planting soil mix has settled.
   1. Remove burlap and wire baskets from tops of root balls and partially from sides, but do not remove from under root balls. Remove pallets, if any, before setting. Do not use plant if root ball is cracked or broken before or during planting operation.
   2. Place planting soil mix around root ball in layers. Each layer shall not be more than 6-inch deep. Tamp to settle mix and eliminate voids and air pockets. When pit is approximately one-half backfilled, water thoroughly before placing remainder of backfill. Repeat watering until no more water is absorbed. Water again after placing and tamping final layer of planting soil mix.

3. Remove all soil from around the root flare of the stem of each plant and from the top of the root ball to determine the true depth of the root flare. Plant with root flare at surface of finish planting soil mix.

B. Carefully remove root ball from container without damaging root ball or plant.
   1. After removal of plant from container, or sides from box, tease out feeder roots to assure positive contact and embedment into planting soil.

C. Set fabric bag-grown plants plumb and in center of pit or trench with top of root ball 1-inch above adjacent finish grades.
   1. Carefully remove root ball from fabric bag without damaging root ball or plant. Do not use plant if root ball is cracked or broken before or during planting operation.

D. Set and support bare-root plants in center of pit or trench with root collar or trunk flare 1 inch below adjacent finish grade. Spread roots without tangling or turning toward surface, and carefully work backfill around roots by hand. Puddle with water until backfill layers are completely saturated. Plumb before backfilling, and maintain plumb while working backfill around roots and placing layers above roots. Tamp final layer of backfill. Remove injured roots by cutting cleanly; do not break.

E. Organic Mulching: Apply 2-inch average thickness of organic mulch extending 12-inches beyond edge of planting pit or trench. Do not place mulch within 3-inches of trunks or stems.

F. Wrap trees of 2-inch caliper and larger with trunk-wrap tape. Start at base of trunk and spiral cover trunk to height of first branches. Overlap wrap, exposing half the width, and securely attach without causing girdling. Inspect tree trunks for injury, improper pruning, and insect infestation; take corrective measures required before wrapping.

G. Perform complete sequence of planting steps for each plant within the same day.

H. Dish top of backfill to allow for mulching. Provide dish four feet in diameter approximately 4 inches deep around each tree, with planting soil berm around edge of excavations to form shallow saucer to collect water.

I. After watering, any settlement within basins shall be refilled to required grade with planting soil mix.

3.5 TREE AND SHRUB PRUNING

A. Prune, thin out and shape trees in accordance with standard horticultural practice. Prune trees to retain required height and spread. Unless otherwise directed by the ENGINEER, do not cut tree leaders. Remove only injured or dead branches from ornamental flowering trees, if any. Prune to retain natural character and

accomplish their use in the landscape design. Required tree sizes are the size after pruning.

1. Remove all dead wood and suckers, and all broken and badly bruised branches.

B. Remove and replace excessively pruned or misformed stock resulting from improper pruning.

C. Paint cuts over 1/2-inch in size with standard tree wound compound, covering exposed, living tissue.

D. All pruning wounds shall show vigorous bark on all edges at the time of harvest.

3.6 GUYING AND STAKING

A. Guy and stake trees immediately after planting.

B. Upright Staking and Tying: Stake trees of 2 inches through 5-inch caliper. Stake trees of less than 2-inch caliper only as required to prevent wind tip-out. Use a minimum of two stakes of length required to penetrate at least 18 inches below bottom of backfilled excavation and to extend at least 72 inches above grade. Set vertical stakes and space to avoid penetrating root balls or root masses. Support trees with two strands of tie wire encased in hose sections at contact points with tree trunk. Allow enough slack to avoid rigid restraint of tree. Use the number of stakes as follows:

1. Use two stakes for trees up to 12 feet high and 2-1/2 inches or less in caliper.
2. Use three stakes for trees greater than 12 feet, but less than 14 feet high, and up to 4 inches in caliper. Space stakes equally around trees.

C. Guying and Staking: Guy and stake trees exceeding 14 feet in height and more than 3 inches in caliper, unless otherwise indicated. Securely attach no fewer than three guys to stakes 30 inches long, driven to grade.

1. For trees more than 6 inches in caliper, anchor guys to pressure-preservative-treated deadmen 8 inches in diameter and 48 inches long buried at least 36 inches below grade. Provide turnbuckles for each guy wire and tighten securely.
2. Attach flags to each guy wire, 30 inches above finish grade.

3.7 ACCEPTANCE CRITERIA FOR PLANTS

A. Planting Work will be considered acceptable when:

1. Coniferous Evergreen Trees and Shrubs: When firmly planted, properly located and vertically upright, with all securement devices and accessories, mulches and saucers formed and in-place; with plant showing no signs of environmental stress, disease, insect infestations, growth below the graft

union, damage, disfigurement or areas of missing or dead foliage, and with expanding candles or other indications of vigorous, healthy growth.

3.8 CLEANUP AND PROTECTION

A. Protect plants from damage due to landscape operations, operations by other contractors and trades, and others. Maintain protection during installation and extended service periods. Treat, repair, or replace damaged planting.

B. Protection includes all temporary fences, barriers and signs and other Work incidental to proper maintenance.

3.9 INSPECTION AND ACCEPTANCE

A. Where plants do not comply with specified acceptance criteria, replace plants and continue extended service period until plants comply with criteria for acceptance.

++ END OF SECTION ++

SECTION 33 05 05

BURIED PIPING INSTALLATION

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to install and test all buried piping, fittings, and specials. The Work includes the following:
      a. All types and sizes of buried piping, except where buried piping installations are specified under other Sections or other contracts.
      b. Unless otherwise shown or specified, this Section includes all buried piping Work required, beginning at the outside face of structures or structure foundations, including piping beneath structures, and extending away from structures.
      c. Work on or affecting existing buried piping.
      d. Installation of all jointing and gasket materials, specials, flexible couplings, mechanical couplings, harnessed and flanged adapters, sleeves, tie rods, cathodic protection, and other Work required for a complete, buried piping installation.
      e. Supports, restraints, and thrust blocks.
      f. Pipe encasements, with the exception of piping embedded in concrete within a structure or foundation specified under Section 40 05 05, Exposed Piping Installation.
      g. Field quality control, including testing.
      h. Cleaning and disinfecting.
      i. Incorporation of valves, meters, and special items shown or specified into piping systems in accordance with the Contract Documents and as required.

B. Coordination:
   1. Review installation procedures under this and other Sections and coordinate installation of items to be installed with or before buried piping Work.
   2. Coordinate with appropriate piping Sections of Division 40, Process Integration.
   3. Notify other contractors in advance of installing buried piping to provide them with sufficient time for installing items included in their contracts to be installed with or before buried piping installation Work.

C. Related Sections:
   1. Section 31 23 05, Excavation and Fill.
   2. Section 03 30 00, Cast-In-Place Concrete.

1.2 REFERENCES

A. Standards referenced in this Section are:
   1. ASME B31.3, Process Piping.
   2. American Society for Non-Destructive Testing (ASNT), ASNT-TC-1A, Recommended Practice, Personnel Qualification, and Certification in Non-destructive Testing.
   3. ASTM D2321, Practice for Underground Installation of Thermoplastic Pipe for Sewers and other Gravity-Flow Applications.
   4. ASTM D2774, Practice for Underground Installation of Thermoplastic Pressure Piping.
   5. ASTM F1417, Test Method for Installation Acceptance of Plastic Gravity Sewer Lines using Low-Pressure Air.
   6. ANSI/AWWA C105, Polyethylene Encasement for Ductile-Iron Pipe Systems.
   7. ANSI/AWWA C111, Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
   8. ANSI/AWWA C600, Installation of Ductile-Iron Water Mains and Their Appurtenances.
   9. ANSI/AWWA C651, Disinfecting Water Mains.
   10. AWWA M23, PVC Pipe - Design and Installation.
   11. AWWA M41, Ductile-Iron Pipe and Fittings.
   12. ASCE 37, Design and Construction of Sanitary and Storm Sewers.
   13. Chlorine Institute, Inc., Piping Systems for Dry Chlorine, Pamphlet No. 6.

1.3 QUALITY ASSURANCE

A. Regulatory Requirements:
   1. Comply with requirements and recommendations of authorities having jurisdiction over the Work.
   2. Obtain required permits for Work in roads, rights-of-way, railroads, and other areas of the Work.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Shop Drawings:
      a. Details of piping, specials, joints, harnessing and thrust blocks, and connections to piping, structures, equipment, and appurtenances.
   2. Product Data:
      a. Manufacturer's literature and specifications, as applicable, for products specified in this Section.
   3. Testing Procedures:
      a. Submit proposed testing procedures, methods, apparatus, and sequencing. Obtain ENGINEER's approval prior to commencing testing.

B. Informational Submittals: Submit the following:
   1. Certificates:
      a. Certificate signed by manufacturer of each product certifying that product conforms to applicable referenced standards.
   2. Field Quality Control Submittals:
      a. Results of each specified field quality control test.

C. Closeout Submittals: Submit the following:
   1. Record Documentation:
      a. Maintain accurate and up-to-date record documents showing modifications made in the field, in accordance with approved submittals, and other Contract modifications relative to buried piping Work. Submittal shall show actual location of all piping Work and appurtenances at same scale as the Drawings.
      b. Show piping with elevations referenced to Project datum and dimensions from permanent structures. For each horizontal bend in piping, include dimensions to at least three permanent structures, when possible. For straight runs of piping provide offset dimensions as required to document piping location.
      c. Include profile drawings with buried piping record documents when the Contract Documents include piping profile drawings.
      d. Conform to Section 01 78 39, Project Record Documents.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Delivery:
   1. Deliver materials to the Site to ensure uninterrupted progress of the Work.
   2. Upon delivery inspect pipe and appurtenances for cracking, gouging, chipping, denting, and other damage and immediately remove from Site and replace with acceptable material.

B. Storage:
   1. Store materials to allow convenient access for inspection and identification. Store material off ground using pallets, platforms, or other supports. Protect packaged materials from corrosion and deterioration.
   2. Pipe and fittings other than PVC may be stored outdoors without cover. Cover PVC pipe and fittings stored outdoors.

C. Handling:
   1. Handle pipe, fittings, specials, and accessories carefully in accordance with pipe manufacturer's recommendations. Do not drop or roll material off trucks. Do not drop, roll or skid piping.
   2. Avoid unnecessary handling of pipe.
   3. Keep pipe interiors free from dirt and foreign matter.
   4. Protect interior linings and exterior coatings of pipe and fittings from damage. Replace pipe and fittings with damaged lining regardless of cause of damage.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Piping materials are specified in the Buried Piping Schedule at end of this Section. Piping materials shall conform to Specifications for each type of pipe and piping appurtenances in applicable Sections of Division 40, Process Integration.

B. General:
   1. Pipe Markings:
      a. Factory-mark each length of pipe and each fitting with designation conforming to those on approved laying schedules.
      b. Manufacturer shall cast or paint on each length of pipe and each fitting pipe material, diameter, and pressure or thickness class.

C. Polyethylene Encasement:
   1. Polyethylene may be supplied in tubes or sheets.
   2. Polyethylene encasement materials shall be in accordance with ANSI/AWWA C105.

2.2 BURIED PIPING IDENTIFICATION

A. Polyethylene Underground Warning Tape for Metallic Pipelines:
   1. Tracer tape shall be of inert, acid- and alkali-resistant, polyethylene, four mils thick, six inches wide, suitable for direct burial. Tape shall be capable of stretching to twice its original length.
   2. Message shall read, "CAUTION [insert customized name of pipe service, i.e., "POTABLE WATER", "SANITARY SEWER", "CHLORINE GAS", or other service as appropriate, as indicated in the Buried Pipe Schedule at the end of this Section] PIPE BURIED BELOW", with bold letters approximately two inches high. Messages shall be printed at maximum intervals of two feet. Tape shall be custom colored the same as pipeline colors specified for associated pipe service in Section 09 91 00, Painting.
   3. Manufacturer: Provide products of one of the following:
      a. Brady Corporation
      b. Seton Identification Products
      c. Marking Services, Inc.
      d. Or equal.

B. Detectable Underground Warning Tape for Non-Metallic Pipelines:
   1. Tape shall be of inert, acid- and alkali-resistant, polyethylene, five mils thick, six inches wide, with aluminum backing, and have 15,000 psi tensile strength and 80 percent elongation capability. Tape shall be suitable for direct burial.
   2. Message shall read, "CAUTION [insert customized name of pipe service, i.e., "POTABLE WATER", "SANITARY SEWER", "CHLORINE GAS", or other appropriate service, as indicated in the Buried Pipe Schedule at the end of this

Section] PIPE BURIED BELOW" with bold letters approximately two inches high. Messages shall be printed at maximum intervals of two feet. Tape shall be custom colored the same as the pipeline colors as specified for the associated pipe service in Section 09 91 00, Painting.

3. Manufacturer: Provide products of one of the following:
   a. Brady Corporation
   b. Seton Identification Products
   c. Marking Services, Inc.
   d. Or equal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General:
   1. Install piping as shown, specified, and as recommended by pipe and fittings manufacturer.
   2. In event of conflict between manufacturer's recommendations and the Contract Documents, request interpretation from ENGINEER before proceeding.
   3. ENGINEER will observe excavations and bedding prior to laying pipe by CONTRACTOR. Notify ENGINEER in advance of excavating, bedding, pipe laying, and backfilling operations.
   4. Minimum cover over buried piping shall be four feet, unless otherwise shown or approved by ENGINEER.
   5. Earthwork is specified in Section 31 23 05, Excavation and Fill.
   6. Excavation in excess of that required or shown, and that is not authorized by ENGINEER shall be filled at CONTRACTOR's expense with granular material furnished, placed, and compacted in accordance with Section 31 05 16, Aggregates for Earthwork.
   7. Comply with NFPA 24 for "Outside Protection", where applicable to water piping systems used for fire protection.

B. Separation of Sewers and Potable Water Piping:
   1. Horizontal Separation:
      a. Where possible, existing and proposed potable water mains and service lines, and sanitary, combined, and storm sewers shall be separated horizontally by clear distance of at least ten feet.
      b. If local conditions preclude the specified clear horizontal separation, installation will be allowed if potable water main is in separate trench or on undistributed earth shelf on one side of sewer and with bottom of potable water main at least 18 inches above top of sewer.
      c. Exception:
         1) Where it is not possible to provide minimum horizontal separation described above, construct potable water main of cement-lined ductile iron pipe with restrained push-on joint or restrained mechanical joint

pipe complying with public water supply design standards of authority having jurisdiction. Hydrostatically test water main and sewer as specified in this Section prior to backfilling. Hydrostatic test pressure at crossing shall be at least 150 psi.

2. Vertical Separation:
   a. Provide minimum vertical distance of 18 inches between outside of potable water main and outside of sewer when sewer crosses over potable water main.
   b. Center a section of potable water main pipe at least 17.5 feet long over sewer so that sewer joints are equidistant from potable water main joints.
   c. Provide adequate structural support where potable water main crosses under sewer. At minimum, provide compacted select backfill for ten feet on each side of crossing.
   d. Exceptions:
      1) Where it is not possible to provide minimum vertical separation described above, construct potable water main of cement-lined ductile iron pipe with restrained push-on joint or restrained mechanical joint pipe. Hydrostatically test water main and sewer as specified in this Section, prior to backfilling. Hydrostatic test pressure at crossing shall be at least 150 psi.
      2) Encase either potable water main or sewer in watertight carrier pipe extending ten feet on each side of crossing, measured perpendicular to potable water main.

C. Plugs:
   1. Temporarily plug installed pipe at end of each day of work or other interruption of pipe installation to prevent entry of animals, liquids, and persons into pipe, and entrance or insertion of deleterious materials into pipe.
   2. Install standard plugs in bells at dead ends, tees, and crosses. Cap spigot and plain ends.
   3. Fully secure and block plugs, caps, and bulkheads installed for testing to withstand specified test pressure.
   4. Where plugging is required for phasing of the Work or subsequent connection of piping, install watertight, permanent type plugs, caps, or bulkhead acceptable to ENGINEER.

D. Bedding Pipe: Bed pipe as specified and in accordance with details on the Drawings.
   1. Trench excavation and backfill, and bedding materials shall conform to Section 31 23 05, Excavation and Fill, as applicable.
   2. Where ENGINEER deems existing bedding material unsuitable, remove and replace existing bedding with approved granular material furnished, placed, and compacted in accordance with Section 31 05 16, Aggregates for Earthwork. Payment for additional excavation and providing granular material will be made under the unit price payment items in the Contract.
   3. Where pipe is installed in rock excavation, provide minimum of three inches of granular bedding material underneath pipe smaller than four-inch nominal

diameter, and minimum of six inches of granular bedding material underneath pipes four-inch nominal diameter and larger.

4. Excavate trenches below bottom of pipe by amount shown and indicated in the Contract Documents. Remove loose and unsuitable material from bottom of trench.
5. Carefully and thoroughly compact pipe bedding with hand held pneumatic compactors.
6. Do not lay pipe until ENGINEER approves bedding condition.
7. Do not bring pipe into position until preceding length of pipe has been bedded and secured in its final position.

E. Laying Pipe:

1. Conform to manufacturer's instructions and requirements of standards and manuals listed below, as applicable:
   a. Ductile Iron Pipe: ANSI/AWWA C600, ANSI/AWWA C105, AWWA M41.
   b. Thermoplastic Pipe: ASTM D2321, ASTM D2774, ANSI/AWWA C605, AWWA M23, AWWA M45, AWWA, M55.
   c. Sanitary and Storm Sewers: ASCE 37.
2. Install pipe accurately to line and grade shown and indicated in the Contract Documents, unless otherwise approved by ENGINEER. Remove and reinstall pipes that are not installed correctly.
3. Slope piping uniformly between elevations shown.
4. Keep groundwater level in trench at least 12 inches below bottom of pipe before laying pipe. Do not lay pipe in water. Maintain dry trench conditions until jointing and backfilling are complete. Keep clean and protect interiors of pipe, fittings, valves, and appurtenances.
5. Start laying pipe at lowest point and proceed towards higher elevations, unless otherwise approved by ENGINEER.
6. Place bell and spigot-type pipe so that bells face the direction of laying, unless otherwise approved by ENGINEER.
7. Place concrete pipe containing elliptical reinforcement with minor axis of reinforcement in vertical position.
8. Excavate around joints in bedding and lay pipe so that pipe barrel bears uniformly on trench bottom.
9. Deflections at joints shall not exceed 75 percent of amount allowed by pipe manufacturer, unless otherwise approved by ENGINEER.
10. For PVC and CPVC piping with solvent welded joints, 2.5-nch diameter and smaller, and copper tubing, snake piping in trench to compensate for thermal expansion and contraction.
11. Carefully examine pipe, fittings, valves, and specials for cracks, damage, and other defects while suspended above trench before installation. Immediately remove defective materials from the Site and replace with acceptable products.
12. Inspect interior of all pipe, fittings, valves, and specials and completely remove all dirt, gravel, sand, debris, and other foreign material from pipe interior and joint recesses before pipe and appurtenances are moved into excavation. Bell

and spigot-type mating surfaces shall be thoroughly wire brushed, and wiped clean and dry immediately before pipe is laid.

13. Field cut pipe, where required, with machine specially designed for cutting the type of pipe being installed. Make cuts carefully, without damage to pipe, coating or lining, and with smooth end at right angles to axis of pipe. Cut ends on push-on joint type pipe shall be tapered and sharp edges filed off smooth. Do not flame-cut pipe.
14. Do not place blocking under pipe, unless specifically approved by ENGINEER for special conditions.
15. Touch up protective coatings in manner satisfactory to ENGINEER prior to backfilling.
16. Notify ENGINEER in advance of backfilling operations.
17. On steep slopes, take measures acceptable to ENGINEER to prevent movement of pipe during installation.
18. Thrust Restraint: Where required, provide thrust restraint conforming to Article 3.3 of this Section.
19. Exercise care to avoid flotation when installing pipe in cast-in-place concrete, and in locations with high groundwater.

F. Polyethylene Encasement:
   1. Provide polyethylene encasement for ductile iron piping to prevent contact between pipe and surrounding bedding material and backfill.
   2. Polyethylene encasement installation shall be in accordance with ANSI/AWWA C105.

G. Jointing Pipe:
   1. Ductile Iron Mechanical Joint Pipe:
      a. Immediately before making joint, wipe clean the socket, plain end, and adjacent areas. Taper cut ends and file off sharp edges to provide smooth surface.
      b. Lubricate plain ends and gasket with soapy water or manufacturer's recommended pipe lubricant, in accordance with ANSI/AWWA C111, just prior to slipping gasket onto plain end of the joint assembly.
      c. Place gland on plain end with lip extension toward the plain end, followed by gasket with narrow edge of gasket toward plain end.
      d. Insert plain end of pipe into socket and press gasket firmly and evenly into gasket recess. Keep joint straight during assembly.
      e. Push gland toward socket and center gland around pipe with gland lip against gasket.
      f. Insert bolts and hand-tighten nuts.
      g. If deflection is required, make deflection after joint assembly and prior to tightening bolts. Alternately tighten bolts approximately 180 degrees apart to seat gasket evenly. Bolt torque shall be as follows:

Pipe Diameter (inches)	Bolt Diameter (inches)	Range of Torque (ft-lbs)
3	5/8	45 to 60
4 to 24	3/4	75 to 90
30 to 36	1	100 to 120

h. Bolts and nuts, except those of stainless steel, shall be coated with two coats, minimum dry film thickness of eight mils each, of high build solids epoxy or bituminous coating manufactured by Tnemec, or equal.

i. Restrained mechanical joints shall be in accordance with Section 40 05 19, Ductile Iron Process Pipe.

2. Ductile Iron Proprietary Joints:

a. Install pipe that utilizes proprietary joints for restraint specified in Section 40 05 19, Ductile Iron Process Pipe, or other such joints, in accordance with manufacturer's instructions.

3. Thermoplastic Pipe Joints:

a. Solvent Cement Welded Joints:

1) Bevel pipe ends and remove all burrs before making joints. Clean pipe and fittings thoroughly. Do not attempt to make solvent cement joints if temperature is below 40 degrees F. Do not make solvent cement welded joints in wet conditions.

2) Use solvent cement supplied or recommended by pipe manufacturer.

3) Apply joint primer and solvent cement and assemble joints in accordance with recommendations and instructions of manufacturer of joint materials and pipe manufacturer.

4) Take appropriate safety precautions when using joint primers and solvent cements. Allow air to circulate freely through pipelines to allow solvent vapors to escape. Slowly admit water when flushing or filling pipelines to prevent compression of gases within pipes.

b. Bell and Spigot Joints:

1) Bevel pipe ends, remove all burrs, and provide a reference mark at correct distance from pipe end before making joints.

2) Clean spigot end and bell thoroughly before making the joint. Insert O-ring gasket while ensuring that gasket is properly oriented. Lubricate spigot with manufacturer's recommended lubricant. Do not lubricate bell and O-ring. Insert spigot end of pipe carefully into bell until reference mark on spigot is flush with bell.

4. Mechanical Coupling Joints:

a. Mechanical couplings include: sleeve-type flexible couplings, split flexible couplings, ANSI/AWWA C606 grooved or shouldered end couplings, plasticized PVC couplings, and other mechanical couplings specified in Section 40 05 06, Couplers, Adapters, and Specials for Process Piping.

b. Prior to installing and assembling mechanical couplings, thoroughly clean joint ends with wire brush to remove foreign matter.

c. For mechanical couplings that incorporate gaskets, after cleaning apply lubricant to rubber gasket or inside of coupling housing and to joint ends. After lubrication, install gasket around joint end of previously installed piece and mate joint end of subsequent piece to installed piece. Position gasket and place coupling housing around gasket and over grooved or shouldered joint ends. Insert bolts and install nuts tightly by hand. Tighten bolts uniformly to produce an equal pressure on all parts of housing. When housing clamps meet metal to metal, joint is complete and further tightening is not required.

d. For plasticized PVC couplings, loosen the stainless steel clamping bands and remove clamps from coupling. Slide coupling over plain ends of pipes to be joined without using lubricants. Place clamps over each end of coupling at grooved section and tighten with torque wrench to torque recommended by manufacturer.

5. HDPE Pipe Joints:

a. Bell and Spigot Joints:

1) Remove all burrs and provide reference mark at correct distance from pipe end. Place mark such that no more than 1/2-inch of machined spigot surface will be visible outside of bell after pipe has been joined.

2) Clean spigot end and bell thoroughly with soap and water before positioning gasket.

3) Lubricate spigot groove with manufacturer's recommended lubricant. Thoroughly clean gasket and place in spigot groove starting at bottom, ensuring that gasket fins face backwards toward pipe.

4) Thoroughly lubricate gasket with pipe manufacturer's recommended lubricant and equalize stretch in gasket by running screwdriver under gasket around its entire circumference three times. Reposition gasket in groove after stretching.

5) Thoroughly clean and lubricate receiving bell. Align pipe as straight as possible and insert spigot end of pipe carefully into bell until reference mark on spigot is flush with bell.

6) If mechanical means are used to insert spigot end, protect with wood the end of pipe being pushed, to ensure even distribution of pressure.

b. Butt Fusion Welded Joints:

1) Install joints in accordance with manufacturer's instructions using hydraulic butt fusion machine or manual machine equipped with torque wrench. Equipment shall be able to achieve and maintain heating tool temperature range of 400 to 450 degrees F and an interface pressure of 60 to 90 psi.

2) Clean interior and exterior of pipe and fitting ends with clean, dry, lint-free cloth.

3) Align ends to be joined in the fusion machine without forcing ends into alignment. Adjust alignment as necessary and tighten clamps to prevent slippage.

4) Place facing tool between ends to be joined and face them to provide clean, smooth, parallel mating surface. If stops are present, face ends

down to the stops. Remove all shavings after facing without touching ends.

5) Re-check alignment of ends and check for slippage against fusion pressure. There shall be no detectable gaps between ends. Align outside diameters.
6) Heating tool shall maintain pipe manufacture's recommended temperature range. Place the tool between ends to be joined. Move ends against heating tool to achieve full contact. Hold ends against heating tool without force until the manufacturer's recommended melt bead size is formed.
7) Upon forming proper melt bead size, quickly separate ends and remove heating tool. Quickly inspect melted ends and bring ends together applying joining force recommended by manufacturer, using 60 to 90 psi interfacial pressure to form double bead rolled over surface of pipe on both ends.
8) Hold joining force against ends until joint is cool to the touch. Cooling period shall be 30 to 90 seconds per inch of pipe diameter. Heavier wall thicknesses may require longer cooling times as recommended by pipe manufacturer.
9) Upon completing joint, inspect to verify double bead has been formed on both sides, uniformly rounded and consistent in size all around joint. Remove faulty joints and re-joint.

H. Backfilling:
   1. Conform to applicable requirements of Section 31 23 05, Excavation and Fill.
   2. Place backfill as Work progresses. Backfill by hand and use power tampers until pipe is covered by at least one foot of backfill.

I. Connections to Valves and Hydrants:
   1. Install valves and hydrants as shown and indicated in the Contract Documents.
   2. Provide suitable adapters when valves or hydrants and piping have different joint types.
   3. Provide thrust restraint at all hydrants and at valves located at pipeline terminations.

J. Transitions from One Type of Pipe to Another:
   1. Provide necessary adapters, specials, and connection pieces required when connecting different types and sizes of pipe or connecting pipe made by different manufacturers.

K. Closures:
   1. Provide closure pieces shown or required to complete the Work.

3.2 TRACER TAPE INSTALLATION

A. Polyethylene Underground Warning Tape for Metallic Pipelines:

1. Provide polyethylene tracer tape for buried metallic piping, which includes pipe that is steel, ductile iron, cast iron, concrete, copper, and corrugated metal.
2. Provide tracer tape 12 to 18 inches below finished grade, above and parallel to buried pipe.
3. For pipelines buried eight feet or greater below finished grade, provide second line of magnetic tracer tape 2.5 feet above crown of buried pipe, aligned along pipe centerline.
4. Tape shall be spread flat with message side up before backfilling.

B. Detectable Underground Warning Tape for Non-Metallic Pipelines:
1. Provide polyethylene tracer tape with aluminum backing for buried, non-metallic piping, which includes pipe that is PVC, CPVC, polyethylene, HDPE, FRP, ABS, and vitrified clay.
2. Provide magnetic tracer tape 12 to 18 inches below finished grade, above and parallel to buried pipe.
3. For pipelines buried eight feet or greater below finished grade, provide second line of magnetic tracer tape 2.5 feet above crown of buried pipe, aligned along the pipe centerline.
4. Tape shall be spread flat with message side up before backfilling.

3.3 THRUST RESTRAINT

A. Provide thrust restraint on pressure piping systems where shown or indicated in the Contract Documents.

B. Thrust restraint may be accomplished by using restrained pipe joints, concrete thrust blocks, or harnessing buried pipe. Thrust restraints shall be designed for axial thrust exerted by test pressure specified in the Buried Piping Schedule at the end of this Section.

C. Place concrete thrust blocks against undisturbed soil. Where undisturbed soil does not exist, or for projects where the Site consists of backfill material, thrust restraint shall be provided by restrained pipe joints.

D. Restrained Pipe Joints:
1. Pipe joints shall be restrained by means suitable for the type of pipe being installed.
   a. Ductile Iron, Push-on Joints and Mechanical Joints: Restrain with proprietary restrained joint system as specified in Section 40 05 19, Ductile Iron Process Pipe; lugs and tie rods; or other joint restraint systems approved by ENGINEER.
   b. Steel Pipe Joints: Provide butt-welded joints, lap welded joints, flanged joints, or mechanical coupling connections as shown and specified in Buried Piping Schedule in this Section. Provide tie rods connected to lugs welded to the steel pipe for restraint at mechanical couplings.

c. Thermoplastic and HDPE Joints: Where bell and spigot-type or other non-restrained joints are utilized, provide tie rods across joint or other suitable joint restraint system, subject to the approval of ENGINEER.

E. Concrete Thrust Blocks:
1. Provide concrete thrust blocks on pressure piping at changes in alignment of 15 degrees or more, at tees, plugs and caps, and where shown or indicated in the Contract Documents. Construct thrust blocks of Class B concrete, conforming to 03 30 00, Cast-In-Place Concrete.
2. Install thrust blocks against undisturbed soil. Place concrete so that pipe and fitting joints are accessible for repair.
3. Concrete thrust block size shall be as shown on the Drawings or as approved by ENGINEER.

F. Harnessed lengths of buried pipe shall be as shown on the Drawings.

3.4 WORK AFFECTING EXISTING PIPING

A. Location of Existing Underground Facilities:
1. Locations of existing Underground Facilities shown on the Drawings should be considered approximate.
2. Determine the true location of existing Underground Facilities to which connections are to be made, crossed, and that could be disturbed, and determine location of Underground Facilities that could be disturbed during excavation and backfilling operations, or that may be affected by the Work.

B. Taking Existing Pipelines and Underground Facilities Out of Service:
1. Conform to Section 01 14 16, Coordination with CITY's Operations.
2. Do not take pipelines or Underground Facilities out of service unless specifically listed in Section 01 14 16, Coordination with CITY's Operations, or approved by ENGINEER.
3. Notify ENGINEER in writing prior to taking pipeline or Underground Facilities out of service. Shutdown notification shall be provided in advance of the shutdown in accordance with the General Conditions and Section 01 14 16, Coordination with CITY's Operations.

C. Work on Existing Pipelines or Underground Facilities:
1. Cut or tap piping or Underground Facilities as shown or required with machines specifically designed for cutting or tapping pipelines or Underground Facilities, as applicable.
2. Install temporary plugs to prevent entry of mud, dirt, water, and debris into pipe.
3. Provide necessary adapters, sleeves, fittings, pipe, and appurtenances required to complete the Work.

4. Conform to applicable requirements of Section 01 14 16, Coordination with CITY's Operations, Section 01 73 29, Cutting and Patching, and Section 01 73 24, Connections to Existing Facilities.

3.5 FIELD QUALITY CONTROL

A. General:
   1. Test all piping, except as exempted in the Buried Piping Schedule in this Section.
   2. When authorities having jurisdiction are to witness tests, notify ENGINEER and authorities having jurisdiction in writing at least 48 hours in advance of testing.
   3. Conduct all tests in presence of ENGINEER.
   4. Remove or protect pipeline-mounted devices that could be damaged by testing.
   5. Provide all apparatus and services required for testing, including:
      a. Test pumps, compressors, hoses, calibrated gages, meters, test containers, valves, fittings, and temporary pumping systems required to maintain CITY's operations.
      b. Temporary bulkheads, bracing, blocking, and thrust restraints.
   6. Provide air if an air test is required, power if pumping is required, and gases if gases are required.
   7. Unless otherwise specified, CITY will provide fluid required for hydrostatic testing. CONTRACTOR shall provide means to convey fluid for hydrostatic testing into piping being tested. CONTRACTOR shall provide fluid for other types of testing required.
   8. Repair observed leaks and repair pipe that fails to meet acceptance criteria. Retest after repair.
   9. Unless otherwise specified, testing shall include existing piping systems that connect with new piping system. Test existing pipe to nearest valve. Piping not installed by CONTRACTOR and that fails the test shall be repaired upon authorization of DEPARTMENT unless otherwise included in the Work, repair of existing piping or Underground Facilities will be paid as extra Work.

B. Test Schedule:
   1. Refer to the Buried Piping Schedule in this Section for type of test required and required test pressure.
   2. Unless otherwise specified, required test pressures are at lowest elevation of pipeline segment being tested.
   3. For piping not listed in Buried Piping Schedule in this Section:
      a. Hydrostatically test pipe that will convey liquid at a pressure greater than five psig. Provide process air pipe test for pipe that will convey air or gas under pressure or vacuum.
      b. Use exfiltration testing, low-pressure air testing, or vacuum testing for other piping.
      c. Disinfect for bacteriological testing piping that conveys potable water.
   4. Test Pressure:

a. Use test pressures listed in Buried Piping Schedule in this Section.
b. If test pressure is not listed in Buried Piping Schedule, or if test is required for piping not listed in the Buried Piping Schedule, test pressure will be determined by ENGINEER based on maximum anticipated sustained operating pressure and methods described in applicable ANSI/AWWA manual or standard that applies to the piping system.

C. Hydrostatic Testing:
1. Preparation for Testing:
a. For thermoplastic pipe and fiberglass pipe, follow procedures described in Section 7 of ANSI/AWWA Standard C605.
b. For HDPE pipe, follow procedures described in ASTM F2164. Test duration, including time to pressurize, time for initial expansion, time at test pressure, and time to depressurize, shall not exceed eight hours. If re-testing of a test section or pipeline is required, at least eight hours shall elapse between tests.
c. For steel pipe, follow procedures described in ANSI/AWWA Manual M11. Wetting period is not required for pipe that is not cement-lined.
d. For other piping follow procedures described in ANSI/AWWA Manual M9. Wetting period is not required for pipe that is not cement mortar-lined.
e. Prior to testing, ensure that adequate thrust protection is in place and joints are properly installed.
2. Test Procedure:
a. Fill pipeline slowly to minimize air entrapment and surge pressures. Fill rate shall not exceed one foot of pipe length per second in pipe being tested.
b. Expel air from pipe as required. Obtain approval of ENGINEER prior to tapping pipe for expelling air.
c. Examine exposed joints and valves and make repairs to eliminate visible leakage.
d. After specified wetting period, add fluid as required to pressurize line to required test pressure. Maintain test pressure for a stabilization period of ten minutes before beginning test.
e. HDPE Pipe: After filling pipeline, gradually pressurize pipe to test pressure and maintain required test pressure for three hours for pipe to expand. During expansion, add fluid to maintain required test pressure. Begin timed test period after expansion period and other requirements are met.
f. Timed test period shall not begin until after pipe has been filled, exposed to required wetting period, air has been expelled, and pressure stabilized.
g. Timed Test Period: After stabilization period, maintain test pressure for at least two hours. During timed testing period, add fluid as required to maintain pressure within five psig of required test pressure. For HDPE pipe, after three-hour expansion phase, reduce test pressure by ten psig

and do not add liquid. Test pressure shall then remain steady for one hour, indicating no leakage.

h. Pump from test container to maintain test pressure. Measure volume of fluid pumped from test container and record on test report. Record pressure at test pump at 15 minute intervals for duration of test.

3. Allowable Leakage Rates: Leakage is defined as the quantity of fluid supplied to pipe segment being tested to maintain pressure within five psi of test pressure during timed test period. Allowable leakage rates for piping are:
   a. No Leakage: Pipe with flanged, welded, fused, threaded, soldered, or brazed joints.
   b. Rates based on formula or table in ANSI/AWWA Manual M41:
      1) Metal pipe joined with rubber gaskets as sealing members, including the following joint types:
         a) Bell and spigot and push-on joints.
         b) Mechanical joints.
         c) Bolted sleeve type couplings.
         d) Grooved and shouldered couplings.

D. Sewer Testing with Low Pressure Air:
   1. Plug and bulkhead ends and lateral connections of pipe segment to be tested.
   2. Required test pressure shall be increased by an amount equal to the elevation of groundwater above invert of lowest point of pipe segment being tested.
   3. Test in accordance with requirements of authority having jurisdiction.
   4. If there are no Laws and Regulations covering the test, use test procedures described in the following standards:
      a. Thermoplastic Pipe: ASTM F1417.

E. Vertical Deflection Test for Thermoplastic, and HDPE Pipe:
   1. Conduct vertical deflection test at least thirty days after backfill has been placed.
   2. Manually pull pin-type vertical gauge mounted on sled through pipe. Gauge shall be manufactured by Quality Test Products, or equal. Set gauge so that sled will stop if vertical deflection of pipe exceeds five percent. Excavate and re-install piping that fails deflection test, and retest.
   3. Use rigid ball or mandrel for deflection test, which shall have diameter of at least 95 percent of base inside diameter or average inside diameter of piping, depending on which is specified in applicable ASTM standard, including appendix, to which pipe is manufactured. Perform test without mechanical pulling devices. Re-install and retest pipe segments that exceed deflection of five percent.

F. Bacteriological Testing:
   1. Bacteriological testing for potable water lines, finished water lines, and other piping in accordance with the Buried Piping Schedule, is specified in Article 3.6 of this Section.

3.6 CLEANING AND DISINFECTION

A. Cleaning, General: Clean pipe systems as follows:
   1. Thoroughly clean all piping, including flushing with water, dry air, or inert gas as required, in manner approved by ENGINEER, prior to placing in service. Flush chlorine solution and sodium hypochlorite piping with water.
   2. Piping 24-inch diameter and larger shall be inspected from inside and debris, dirt and foreign matter removed.
   3. For piping that requires disinfection and has not been kept clean during storage or installation, swab each section individually before installation with five percent sodium hypochlorite solution.

B. Disinfection:
   1. Disinfect all potable and finished water piping.
   2. Suggested procedure for accomplishing complete and satisfactory disinfection is specified below. Other procedures may be considered for acceptance by ENGINEER.
      a. Prior to disinfection, clean piping as specified and flush thoroughly.
      b. Conform to procedures described in ANSI/AWWA C651. Use continuous feed method of disinfecting, unless alternative method is acceptable to ENGINEER.
   3. Water for initial flushing, testing, and disinfection will be furnished by CITY. CONTRACTOR shall provide all temporary piping, hose, valves, appurtenances, and services required. Cost of water required for redisinfection will be paid by CONTRACTOR to CITY at water utility's standard rates.
   4. Chlorine shall be provided by CONTRACTOR.
   5. Bacteriologic tests will be performed by CONTRACTOR. Certified test laboratory report will be provided to ENGINEER.
   6. Chlorine concentration in water entering the piping shall be between 50 and 100 ppm, such that minimum residual concentration of 25 mg/L remains after 24-hour retention period. Disinfect piping and all related components. Repeat as necessary to provide complete disinfection.
   7. After required retention period, flush chlorinated water to closed drain line, unless otherwise acceptable to ENGINEER. Properly dispose of chlorinated water in accordance with Laws and Regulations. Do not discharge chlorinated water to storm sewers, ditches, or overland.

3.7 SCHEDULES

A. Schedules listed below, following the "End of Section" designation, are part of this Specification section.
   1. Table 33 05 05-A, Buried Piping Schedule.

+ + END OF SECTION + +

TABLE 33 05 05-A, BURIED PIPING SCHEDULE

Service	Diameter (inch)	Material	Interior Lining	Exterior Coating	Pressure Class/ Thickness	Joint	Test	Remarks
Chemicals	1	HDPE	--	--	DR 11	BFW	HYD (150), DBT	Phosphate, Hypochlorite, Fluoride (and 2 spare)– transition from buried HDPE that penetrates wall in Chemical Building and GAC Treatment Building
HSW	6 to 36	DI	CL	AC	150	RMJ	HYD (150), DBT	
FW	20	DI	CL	AC	150	RMJ	HYD (100), DBT	
BD	8	DI	CL	AC	150	MJ/RMJ	HYD (150)	
Foundation Drain	4	PVC	--	--	Sch. 40	SW	NR	
Roof Drain Header	8	PVC	--	--	Sch. 40	SW	AIR	
Drainage Pipe	12	PE	--	--	Double wall	BS	AIR	
Floor Drains	6	PVC	--	--	Sch. 40	SW	AIR	
TW	24	DI	CL	AC	150	RMJ	HYD (100), DBT	
LSW	20 to 24	DI	CL	AC	100	RMJ	HYD (100), DBT	

The following abbreviations are used in the Buried Piping Schedule.

A. Service Abbreviations

Service	Abbrev.
Filtered Water	FW
Treated Water	TW
Backwash Drain	BD
High Service Water	HSW
Low Service Water	LSW

B. Material Abbreviations

Material	Abbrev
Ductile Iron	DI
Polyvinyl Chloride	PVC
Polyethylene	PE
High Density Polyethylene	HDPE

C. Lining/Coating Abbreviations

Lining	Abbrev		Coating	Abbrev.
Cement Mortar Lined	CL		Asphaltic Coated	AC

D. Joint Abbreviations

Joint Type	Abbrev
Bell and Spigot	BS
Restrained Mech. Joint	RMJ
Solvent Weld	SW
Mechanical Joint	MJ
Butt Fusion Weld	BFW

E. Test Abbreviations

Test	Abbrev
Hydrostatic Test (test pressure in psig)	HYD ( )
Disinfection and Bacteriological Testing	DBT
No Test Required	NR

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SECTION 33 05 61

CONCRETE MANHOLES

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish and install all precast concrete manholes and structures.

B. General:
   1. Manholes and structures shall conform in shape, size, dimensions, material, and other respects to the details shown or as directed by ENGINEER.
   2. Cast-iron frames, grates and covers shall be the standard frame and grate or cover unless otherwise shown and shall be as specified in Section 05 56 00, Metal Castings.
   3. Concrete for cast-in-place manholes and structures and for inverts in precast and masonry manholes and structures shall be Class "A" and shall conform to the requirements specified under Section 03 30 00, Cast-In-Place Concrete.
   4. All manholes and structures shall be precast construction, unless otherwise shown.

C. Related Sections:
   1. Section 03 30 00, Cast-In-Place Concrete.
   2. Section 05 56 00, Metal Castings.

1.2 REFERENCES

A. Standards referenced in this Section are listed below:
   1. American Society for Testing and Materials, (ASTM).
      a. ASTM C 139, Specification for Concrete Masonry Units for Construction of Catch Basins and Manholes.
      b. ASTM C 140, Test Methods for Sampling and Testing Concrete Masonry Units and Related Units.
      c. ASTM C 207, Specification for Hydrated Lime for Masonry Purposes.
      d. ASTM C 478, Specification for Precast Reinforced Concrete Manhole Sections.
   2. American Water Works Association, (AWWA).
      a. AWWA C302, Reinforced Concrete Pressure Pipe, Non-cylinder Type, for Water and Other Liquids.

1.3 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Shop Drawings:
      a. Submit drawings showing design and construction details of all precast concrete and cast-in-place manholes and structures, including details of joints between the manhole bases and riser sections and stubs or openings for the connections.

PART 2 - PRODUCTS

2.1 PRECAST CONCRETE MANHOLES AND STRUCTURES

A. Precast manholes and structures shall conform to the details shown. Provide cast-in-place concrete bases where shown.

B. Except where otherwise specified precast manhole components shall consist of reinforced concrete pipe sections especially designed for manhole construction and manufactured in accordance with ASTM C 478, except as modified herein.

C. Precast, reinforced concrete manhole bases, riser sections, flat slabs and other components shall be manufactured by wet cast methods only, using forms which will provide smooth surfaces free from irregularities, honeycombing or other imperfections.

D. Joints between manhole components shall be the tongue and groove type employing butyl rubber sealant. The circumferential and longitudinal steel reinforcement shall extend into the bell and spigot ends of the joint without breaking the continuity of the steel.

E. All precast manhole components shall be of approved design and of sufficient strength to withstand the loads imposed upon them. They shall be designed for a minimum earth cover loading of 130 pounds per cubic foot, an H-20 wheel loading, and an allowance of 30 percent in roadways and 15 percent in rights-of-way for impact. Manhole bases shall have two cages of reinforcing steel in their walls, each of the area equal to that required in the riser sections. Wall thickness shall not be less than 5-inches. Concrete top slabs shall not be less than 8-inches thick.

F. Lifting holes, if used in manhole components, shall be tapered, and no more than two shall be cast in each section. Tapered, solid rubber plugs shall be furnished to seal the lifting holes. The lifting holes shall be made to be sealed by plugs driven from the outside face of the section only.

G. The point of intersection (P.I.) of the sewer pipe centerlines shall be marked with 1/4-inch diameter steel pin firmly enclosed in the floor of each manhole base and protruding approximately 1-inch above the finished floor of the base.

H. Mark date of manufacture and name or trademark of manufacturer on inside of barrel.

I. The barrel of the manhole shall be constructed of various lengths of riser pipe manufactured in increments of one foot to provide the correct height with the fewest joints. Openings in the barrel of the manholes for sewers or drop connections will not be permitted closer than one foot from the nearest joint. Special manhole base or riser sections shall be furnished as necessary to meet this requirement.

J. A precast or cast-in-place slab or precast eccentric cone, as shown or approved, shall be provided at the top of the manhole barrel to receive the cast iron frame and cover.

2.2 MANHOLE STEPS

A. Provide polyethylene encased, steel reinforced driven in manhole steps at 12-inch spacing as manufactured by M.A. Industries, Inc. or equal.

B. Coordinate step location with opening.

PART 3 - EXECUTION

3.1 LAYING MASONRY

A. For concrete block, the vertical keyways shall be completely filled with mortar.

B. Each grading ring shall be laid in a full bed of mortar and shall be thoroughly bonded.

3.2 PLASTERING

A. The outside of brick manholes and structures, brick stacks and grading rings shall be neatly plastered with 1/2 inch of cement mortar as the Work progresses.

3.3 MANHOLE BASES

A. Cast-in-place bases shall be placed on suitable foundations after the pipes are laid. They shall be cast monolithically to an elevation at least 12 inches above the top of the highest pipe entering the manhole, except where a drop connection is to be installed. Base, walls and bottom shall be at least of the thickness shown and reinforced to withstand the loads to be expected. Connections for sewer pipes shall conform to the details shown.

B. Precast bases shall be set on a crushed stone or crushed gravel foundation as shown. Precast bases shall be set at the proper grade and carefully leveled and aligned.

3.4 PRECAST MANHOLE SECTIONS

A. Set sections vertical with steps and sections in true alignment. The base of the bell or groove end at joints between components shall be buttered with 1:2 cement-sand mortar to provide a uniform bearing between components. All joints shall be sealed with cement mortar inside and out and troweled smooth to the contour of the wall surface. Raised or rough joint finishes will not be accepted.

B. Install sections, joints, and gaskets in accordance with manufacturers recommendations.

C. Lifting holes shall be sealed tight with a solid rubber plug driven into the hole from the outside of the barrel and the remaining void filled with 1 to 2 cement-sand mortar.

3.5 MANHOLE CHANNELS

A. All invert channels through manholes and structures shall be constructed of Class "A" concrete. Channels shall be properly formed to the sizes, cross sections, grades and shapes shown or as ordered. Benches shall be built up to the heights shown or as directed by the ENGINEER and given a uniform wood float finish. Care shall be taken to slope all benches for proper drainage to the invert channel.

3.6 GRADING RINGS

A. Grading rings or brick stacks shall be used for all precast and masonry manholes and structures, where required. Stacks or grade rings shall be a maximum of 12-inches in height, constructed on the roof slab or cone section on which the manhole frame and cover shall be placed. The height of the stack or grade rings shall be such as required to bring the manhole frame to the proper grade.

B. Each grade ring shall be laid in a full bed of mortar and shall be thoroughly bonded.

3.7 STUBS FOR FUTURE CONNECTIONS

A. As shown or required for connections, cast iron sleeves, bell end tile, ductile iron or reinforced concrete pipe stubs with approved watertight plugs shall be installed in manholes and structures. Where pipe stubs, sleeves or couplings for future connections are shown or directed by the ENGINEER, CONTRACTOR shall provide all materials and labor in order to complete the Work.

3.8 GRADING AT MANHOLES AND STRUCTURES

A. All manholes and structures in unpaved areas shall be built, as shown or directed by the ENGINEER, to an elevation higher than the original ground. The ground surface shall be graded to drain away from the manhole. Fill shall be placed around manholes to the level of the upper rim of the manhole frame, and the surface evenly graded on a 1 to 5 slope to the existing surrounding ground, unless otherwise shown or directed by the ENGINEER. The slope shall be covered with 4 inches of topsoil, seeded and maintained until a satisfactory growth of grass is obtained.

B. Manholes and structures in paved areas shall be constructed to meet the final surface grade. In paved areas on State Highways, all manholes and structures shall be 1/2 inch below final wearing surfaces. Manholes and structures shall not project above finished roadway pavements to prevent damage from snowplows.

C. CONTRACTOR shall be solely responsible for the proper height of all manholes and structures necessary to reach the final grade at all locations. CONTRACTOR is cautioned that ENGINEER's review of Shop Drawings for manhole components will be general in nature and CONTRACTOR shall provide an adequate supply of random length precast manhole riser sections to adjust any manhole to meet field conditions for final grading.

3.9 MANHOLE WATERTIGHTNESS

A. All manholes and structures shall be free of visible leakage. Each manhole shall be tested for leaks and inspected, and all leaks shall be repaired in a manner subject to ENGINEER's approval. Manhole testing shall conform to the requirements of Section 33 05 05, Buried Piping Installation.

3.10 FLEXIBLE PIPE JOINT AT MANHOLE BASE

A. An approved flexible joint shall be provided between each pipe entering and exiting the manhole. This may be accomplished by the installation in the manhole base of the bell end of a pipe or by other means subject to approval of ENGINEER. Joints shall be similar to the approved pipe joints. The joint into the manhole base shall be completely watertight.

++ END OF SECTION ++

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SECTION 33 40 00

SITE DRAINAGE

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish and install stormwater drainage piping.

B. Related Work specified elsewhere:
   1. Section 31 23 05, Excavation and Fill.
   2. Section 33 05 05, Buried Piping Installation.

1.2 QUALITY ASSURANCE

A. American Association of State Highway and Transportation Officials (AASHTO)

1.3 SUBMITTALS

A. Submit certification attesting that materials meet or exceed the specification requirements.

B. Submit design drawings of inlets and endwalls. Drawings to be sealed by a Professional Engineer registered in the state where work is located.

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Precast Concrete Units:
   1. After fabrication and curing, transport the units to the job site. Protect until required for installation.
   2. Handle to avoid damage to surfaces, edges and corners and to avoid creation of stresses within the units.

PART 2 - PRODUCTS

2.1 STORM DRAIN PIPE

A. ASTM D3350, High Density Polyethylene (HDPE) corrugated wall pipe with integrally formed smooth liner; meeting the requirements of AASHTO M252, Type S, for diameters between 3 inches and 10 inches and AASHTO M294, Type S, for diameters between 12 inches and 60 inches, soil-tight, bell and

spigot joints with rubber gaskets, with pipe and fittings manufactured from virgin PE compounds with cell classification 3254420C. of the sizes indicated on the Contract Drawings and conforming to Form 408/2011 Specifications, Section 601.2(a)6.

B. PVC Drain Pipe and Fittings:
   1. ASTM D2729 - Sizes shown on Contract Drawings.
   2. Provide all adapters, fittings, and reducers of same material as pipe.

PART 3 - EXECUTION

3.1 TRENCHING, BEDDING, AND BACKFILL

A. Conform to the requirements specified in Section 31 23 05, Excavation and Fill.

3.2 PIPE LAYING

A. Clean and inspect pipe before lowering into the trench; start pipe laying at the low end and proceed upgrade, unless otherwise approved by the ENGINEER; bed the pipe for its full length.

B. Lay bell and spigot pipe with the spigot inserted the full depth of the socket and with the bell end upgrade.

C. Replace broken or otherwise damaged pipe, and keep pipe clean of deposits and debris; piping, as laid, shall be approved by the ENGINEER before the trench is backfilled.

3.3 BACKFILLING

A. Backfill structures only after examination by the ENGINEER.

B. Perform backfilling and compaction as specified in Section 31 23 05, Excavation and Fill.

+ + END OF SECTION + +

SECTION 33 42 32

STORMWATER DRAINS AND INLETS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish and install all precast and masonry drainage structures, including drain inlets, catch basins, headwalls and similar structures.

B. General:
   1. Structures shall conform in shape, size, dimensions, materials, and other respects to the details shown or as directed by the ENGINEER.
   2. Cast iron frames, grates and covers shall be the standard frame and grate or cover, unless otherwise shown.
   3. All concrete shall be Class "A" and shall conform to the requirements specified under Section 03 30 00, Cast-In-Place Concrete.
   4. Inverts shall be as shown and shall conform accurately to the size and elevation of the adjoining pipes.

C. Related Sections:
   1. Division 31, Applicable Sections on Earthwork.
   2. Section 05 56 00, Castings.

1.2 QUALITY ASSURANCE

A. Standards referenced in this Section are listed below:
   1. American Society for Testing and Materials, (ASTM).
      a. ASTM C 32, Specification for Sewer and Manhole Brick (Made from Clay or Shale).
      b. ASTM C 139, Specification for Concrete Masonry Units for Construction of Catch Basins and Manholes.
      c. ASTM C 140, Test Methods for Sampling and Testing Concrete Masonry Units and Related Units.
      d. ASTM C 207, Specification for Hydrated Lime For Masonry Purposes.
      e. ASTM C 478, Specification for Precast Reinforced Concrete Manhole Sections.

1.3 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Shop Drawings:

a. Submit drawings showing design and construction of all precast concrete.

2. Samples:

a. Submit for approval samples of brick, block, gaskets and accessories, if any, for the structures.

PART 2 - PRODUCTS

2.1 PRECAST PRODUCTS

A. Where shown or otherwise approved by ENGINEER, precast concrete shall be used for items such as area drains, catch basins, splash pads, etc. Layout and details shall be as shown and specified. Design shall be adequate to withstand all loads imposed, including earth pressure, vehicle loads and construction loading.

B. Precast concrete sections shall conform to ASTM C 478, where applicable.

C. Where precast structures are made up of various precast components such as base sections, riser sections and top sections, the joint between sections shall be the tongue and groove type.

2.2 MISCELLANEOUS METALS

A. Metal frames, covers, grates, troughs and similar required items shall be provided as shown and in accordance with Division 05, Metals, and applicable Sections on Metal Fabrications.

PART 3 - EXECUTION

3.1 LAYING MASONRY

A. Brick shall be satisfactorily wet when being laid and each brick shall be laid in mortar so as to form full bed, end and side joints in one operation. The joints shall not be wider than 3/8-inch, except when the bricks are laid radially, in which case the narrowest part of the joint shall not exceed 1/4-inch.

B. For concrete block, the vertical keyways shall be completely filled with mortar.

C. Each layer of brick for the grading ring shall be laid in a full bed of mortar and shall be thoroughly bonded.

3.2 GRADING RINGS

A. Grading rings or brick stacks shall be used for all precast and masonry structures, where required. They shall be constructed on the top slab on which the frame will be

placed. The height of the stack shall be such as is necessary to bring the frame to the proper grade, but in no case greater than 12-inches.

3.3 PRECAST ITEMS

A. Precast products shall be placed on a concrete or crushed stone bed, set at the proper grade and carefully leveled and aligned.

B. Backfill shall be carried up evenly on all sides of the structures to prevent overturning forces.

3.4 PIPE JOINT IN STRUCTURE BASE

A. An approved joint shall be provided between each pipe entering and exiting the structure. Joint may be accomplished by the installation in the structure base of the bell end of a short pipe or by other means subject to approval of ENGINEER.

B. Pipes shall not protrude inside the structure, but shall be cut in an approved manner to be flush with the inside wall of the structure.

++ END OF SECTION ++

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SECTION 34 71 13.26

VEHICLE GUARD RAILS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish and install vehicle guard rails.
   2. Guard rails shall be of the galvanized, corrugated sheet steel beam type with galvanized steel posts supporting the rails.
   3. The extent of the vehicle guard rails shall be as shown.

B. Related Sections:
   1. Section 31 23 05, Excavation and Fill.
   2. Section 03 30 00, Cast-In-Place Concrete.

1.2 REFERENCES

A. Standards referenced in this Section are listed below:
   1. American Association of State Highway and Transportation Officials, (AASHTO).
      a. AASHTO M 180, Corrugated Sheet Steel Beams for Highway Guard Rail.
   2. American Society for Testing and Materials, (ASTM).
      a. ASTM A 36, Specification for Structural Steel.
      b. ASTM A 123, Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.

1.3 QUALITY ASSURANCE

A. Provide guard rails as a complete unit produced by a single manufacturer, including necessary erection accessories, fittings and fastenings.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Shop Drawings: Submit the following:
      a. Copies of manufacturer's technical data and installation instructions.

1.5 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Protect the guard rails from abuse so as to prevent nicks, gouges and dents.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Provide galvanized steel posts of size and shape as recommended by the manufacturer. Steel shall comply with ASTM A 36 and galvanized in accordance with ASTM A 123.

B. Provide guard rail complying with AASHTO M 180, Class A (12 gage), Type 2.

C. Products and Manufacturers: Provide one of the following:
   1. Deep Beam guard rail, as manufactured by Syro Steel Company.
   2. Flex Beam guard rail, as manufactured by Armco Steel Corporation.
   3. Or equal.

2.2 MISCELLANEOUS MATERIALS AND ACCESSORIES

A. Terminal Sections and Ends: Provide terminal sections and ends as shown on the Drawings. Where not shown, provide in accordance with the manufacturer's recommendations.

B. Concrete: Provide concrete for anchoring posts, complying with Class B concrete specified in Section 03 30 00, Cast-In-Place Concrete.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Do not begin guard rail installation and erection until paving or final grading is completed, unless otherwise acceptable to ENGINEER.

B. Drive posts, unless otherwise shown on the Drawings or directed by ENGINEER. Accomplish driving with approved equipment and methods that will leave the posts in their final position, free of distortion, burring, or other damage. When posts are driven through bituminous concrete, take care to prevent damage to the paved areas. Fill, compact and seal depressions and holes, caused by driving the posts, with bituminous concrete similar to that damaged. Posts shall be aligned to a tolerance of 1/4-inch for plumb and grade.

C. Excavation: As an alternate to driving posts on unpaved areas or where driving is not possible, excavate holes of widths and spacings as shown, for post footings in firm, undisturbed or compacted soil.
   1. If not shown, excavate holes to widths as recommended by guard rail manufacturer.
   2. Spread soil from excavations uniformly adjacent to guard rail line, or on adjacent areas of the Site, as directed by ENGINEER.
   3. When rock is encountered, excavate into rock to widths as recommended by the manufacturer.
   4. Setting Posts: Remove loose and foreign materials from sides and bottom of holes, and moisten soil prior to placing concrete. Place, trowel, cure and test concrete in accordance with Section 03 30 00, Cast-In-Place Concrete.

D. Where posts cannot be driven or anchored in concrete, use base plates as shown or as directed by ENGINEER.

E. When setting posts, align them to a tolerance of 1/4-inch for plumb and grade.

F. Rails: Connect rails to posts in accordance with manufacturer's instructions. Install terminal sections or ends.

3.2 REPAIR

A. Repair galvanized coating, damaged in the shop or during field erection, by recoating with manufacturer's recommended repair compound and applying compound in accordance with manufacturer's instructions.

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SECTION 40 05 05

EXPOSED PIPING INSTALLATION

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment and incidentals as shown, specified, and required to install and test all exposed piping, fittings, and specials. The Work includes the following:
      a. All types and sizes of exposed piping, except where exposed piping installations are specified under other Sections or other contracts.
      b. Unless otherwise shown or specified, this Section includes all piping beginning at the outside face of structures or structure foundations and extending into the structure. Piping embedded in concrete within a structure or foundation shall be considered as exposed and is included herein. Piping that is permanently or intermittently submerged, or installed in sub-aqueous environments, is considered as exposed and is included in this Section.
      c. Work on or affecting existing exposed piping.
      d. Installation of all jointing and gasket materials, specials, flexible couplings, mechanical couplings, harnessed and flanged adapters, sleeves, tie rods, and all Work required for a complete exposed piping installation.
      e. Supports, restraints, and other anchors.
      f. Field quality control, including testing.
      g. Cleaning and disinfecting.
      h. Incorporation of valves, meters, and special items shown or specified into the piping systems per the Contract Documents and as required

B. Coordination:
   1. Review installation procedures under this and other Sections and coordinate installation of items that must be installed with or before exposed piping Work.
   2. Coordinate with appropriate piping Sections of Division 40, Mechanical.
   3. Notify other contractors in advance of installation of exposed piping to provide them with sufficient time for installation of items included in their contracts that must be installed with or before exposed piping Work.

C. Related Sections:
   1. Section 09 91 00, Painting.
   2. Section 10 14 00, Signage.
   3. Section 40 05 07, Pipe Hangers and Supports.
   4. Section 40 05 06, Couplings, Adapters, and Specials for Process Piping.
   5. Section 40 05 08, Wall Pipes, Floor Pipes and Pipe Sleeves.
   6. Section 40 05 96, Vibration, Seismic, and Wind Controls.

1.2 REFERENCES

A. Standards referenced in this Section are:
   1. ANSI B16.1, Cast Iron Pipe Flanges and Flanged Fittings
   2. ASME Boiler and Pressure Vessel Code.
   3. ASME B31.3, Process Piping.
   4. American Society for Non-Destructive Testing (ASNT), ASNT-TC-1A, Recommended Practice, Personnel Qualification, and Certification in Non-destructive Testing.
   5. ASTM A380, Standard Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems
   6. ASTM B32, Specification for Solder Metal.
   7. ASTM D4174, Standard Practice for Cleaning, Flushing, and Purification of Petroleum Fluid Hydraulic Systems
   8. ASTM F2164, Standard Practice for Field Leak Testing of Polyethylene (PE) Pressure Piping Systems Using Hydrostatic Pressure
   9. AWS D1.1/D1.1M, Structural Welding Code-Steel.
   10. ANSI/AWWA C111, Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
   11. ANSI/AWWA C206, Field Welding of Steel Water Pipe.
   12. ANSI/AWWA C600, Installation of Ductile Iron Water Mains and Their Appurtenances.
   13. ANSI/AWWA C606, Grooved and Shouldered Joints.
   14. ANSI/AWWA C651, Disinfecting Water Mains.
   15. AWWA M11, Steel Pipe - A Guide for Design and Installation.
   16. AWWA M23, PVC Piping - Design and Installation.
   17. AWWA M41, Ductile-Iron Pipe and Fittings.
   18. AWWA M55, PE Pipe - Design and Installation.

1.3 QUALITY ASSURANCE

A. Regulatory Requirements:
   1. Comply with requirements and recommendations of authorities having jurisdiction over the Work.

B. The Work shall conform to seismic requirements in accordance with Section 40 05 96, Vibration, Seismic and Wind Controls.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Shop Drawings:
      a. Detailed drawings in plan and, as applicable, section.
      b. Details of piping, valves, supports, accessories, specials, joints, harnessing, and main anchor supports, and connections to existing piping, structures, equipment, and appurtenances.
   2. Testing Plans, Procedures, and Testing Limitations

a. Submit description of proposed testing methods, procedures, and apparatus, and obtain ENGINEER's approval prior to testing.

B. Informational Submittals: Submit the following:
1. Certificates:
a. Submit a certificate, signed by manufacturer of each product, certifying that product complies with applicable referenced standards.
2. Source Quality Control Submittals:
a. Submit copies of testing report for each test.
3. Site Quality Control Reports:
a. Submit copies of testing report for each test.

C. Closeout Submittals: Submit the following:
1. Record Documentation:
a. Maintain accurate and up-to-date record documents showing field and Shop Drawing modifications. Record documents for exposed piping Work shall show actual location of all piping and appurtenances on a copy of the Drawings, unless otherwise approved by ENGINEER.
b. Record documents shall show piping with elevations referenced to the project datum and dimensions from permanent structures. For straight runs of pipe provide offset dimensions as required to document pipe location.
c. Include section drawings with exposed piping record documents when the Contract Documents include section Drawings.
d. Conform to Section 01 78 39, Project Record Documents.

1.5 DELIVERY, STORAGE AND HANDLING

A. Delivery:
1. Deliver products to Site to ensure uninterrupted progress of the Work.
2. Upon delivery, inspect pipe and appurtenances for cracked, gouged, chipped, dented, and other damage and immediately remove damaged products from Site.
3. Conform to requirements of Section 01 65 00, Product Delivery Requirements.

B. Storage:
1. Store products for convenient access for inspection and identification. Store products off the ground using pallets, platforms, or other supports. Protect packaged products from corrosion and deterioration.
2. Pipe and fittings other than thermoplastic materials may be stored outdoors without cover. Thermoplastic pipe and fittings stored outdoors shall be covered.
3. Conform to requirements of Section 01 66 00, Product Storage and Handling Requirements.

C. Handling:
   1. Handle pipe, fittings, specials, and accessories carefully with approved handling devices. Do not drop or roll material of delivery vehicles. Do not otherwise drop, roll, or skid piping.
   2. Avoid unnecessary handling of pipe.
   3. Keep pipe interiors free of dirt and foreign matter.
   4. Protect interior linings and exterior coatings of pipe and fittings from damage. Replace pipe and fittings with damaged lining regardless of cause of damage. Repair damaged coatings.
   5. Conform to requirements of Section 01 65 00, Product Delivery Requirements.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Piping materials are specified in the Exposed Piping Schedule at the end of this Section. Piping materials shall conform to Specification for each type of pipe and piping appurtenances in applicable sections of Division 40, Process Integration.

B. Markings and Identification:
   1. Pipe Markings:
      a. Clearly mark each piece of pipe or fitting with a designation conforming to that shown on the approved Shop Drawings.
      b. Manufacturer shall cast or paint on each length of pipe and each fitting the pipe material, diameter, and pressure or thickness class.
   2. Pipe Identification Markers and Arrows: Refer to Section 10 14 00, Signage.

C. Appurtenances: Provide products that comply with:
   1. Section 40 05 07, Pipe Hangers and Supports.
   2. Section 40 05 06, Couplings, Adapters, and Specials for Process Piping.
   3. Section 40 05 08, Wall Pipes, Floor Pipes and Pipe Sleeves.

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine conditions under which the Work is to be installed and notify ENGINEER in writing of conditions detrimental to the proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. General:
   1. Install piping as shown, specified and as recommended by the pipe and fittings manufacturer.

2. If there is a conflict between manufacturer's recommendations and the Contract Documents, request in writing instructions from ENGINEER before proceeding.
3. Provide pipe manufacturer's installation specialist at Site as specified on this Section.

B. Temporary Blind Flanges, Plugs, Caps, and Bulkheads:
1. Temporarily plug installed pipe at the end of each day of work or other interruption of pipe installation to prevent entry of animals, liquids, and persons into pipe, and entrance or insertion of deleterious materials into pipe.
2. Install standard plugs in all bells at dead ends, tees, and crosses. Cap all spigot and plain ends.
3. Fully secure and block blind flanges, plugs, caps, and bulkheads installed for testing, designed to withstand specified test pressure.
4. Where plugging is required for phasing of Work or subsequent connection of piping, install watertight, permanent type blind flanges, plugs, caps, or bulkhead acceptable to ENGINEER.

C. Piping Installation:
1. Conform to manufacturer's instructions and requirements of standards and manuals listed in this Section, as applicable:
   a. Ductile Iron Pipe: ANSI/AWWA C600, AWWA M41.
   b. Thermoplastic Pipe: AWWA M23
   c. Polyethylene Pipe: AWWA M55
2. Install straight runs true to line and elevation.
3. Install vertical pipe truly plumb in all directions.
4. Install piping parallel or perpendicular to walls of structures. Piping at angles and 45 degree runs across corners of structures will not be accepted unless specifically shown on the Contract Documents or approved by the ENGINEER.
5. Install small diameter piping generally as shown when specific locations and elevations are not indicated. Locate such piping as required to avoid ducts, equipment, beams, and other obstructions.
6. Install piping to leave all corridors, walkways, work areas, and similar spaces unobstructed. Unless otherwise shown or approved by ENGINEER provide a minimum headroom clearance under piping and pipe supports of 7.5 feet. Clearances beneath piping shall be measured from the outermost edge of piping, flanges or other type of joint that extends beyond the nominal outside diameter of piping.
7. Protect and keep clean interiors, fittings, and valves of pipe that will convey potable water, chemicals, and other pipe designated by ENGINEER.
8. Cutting: Cut pipe from measurements verified at Site. Field cut pipe, where required, with a machine specially designed for cutting type of pipe being installed. Make cuts carefully without damage to pipe, coating, or lining, and with a smooth end at right angles to axis of pipe. Cut ends of push-on joint type pipe shall be tapered and sharp edges filed off smooth. Do not flame-cut pipe.
9. Additional General Requirements for Thermoplastic Piping:

a. Utilize wide band supports as recommended by pipe manufacturer and approved by ENGINEER to minimize localized stresses.
b. Provide piping passing through walls with a sleeve of wearing material to prevent abrasion damage to piping.
c. Provide anchored supports at elbows, valves, bends in piping, and at connections to equipment and tanks.
d. Spacing of supports shall be in accordance with the manufacturer's published recommendations at maximum design operating temperature of pipe.
e. Provide U-clamps with wide band circumferential contact.
f. Provide guides on long runs of piping to maintain alignment and reduce chance of elastic failure of pipe. Space guides as recommended by pipe manufacturer.
g. Provide anchored supports to restrain joints that allow expansion. Minimize use of bellows style joints. Where required and approved by the ENGINEER provide bellows style joints with low axial force to take up pipe expansion. Flexible connectors may be used to absorb thermal movement when approved in writing by ENGINEER.

D. Jointing Pipe:
1. General:
a. Make joints in accordance with pipe manufacturer's recommendations and Contract Documents.
b. Cut piping accurately and squarely and install without forcing or springing.
c. Ream out pipes and tubing to full inside diameter after cutting. Remove all sharp edges on end cuts.
d. Remove all cuttings and foreign matter from inside of pipe and tubing before installation. Thoroughly clean all pipe, fittings, valves, specials, and accessories before installing.
2. Ductile Iron Mechanical Joint Pipe:
a. Wipe clean the socket, plain end and adjacent areas immediately before making joint. Make certain that cut ends are tapered and sharp edges are filed off smooth.
b. Lubricate plain end and gasket with soapy water or pipe manufacturer's recommended pipe lubricant, per ANSI/AWWA C111, just prior to slipping gasket onto plain end of joint assembly.
c. Place gland on plain end with lip extension toward plain end, followed by gasket with narrow edge of gasket toward the plain end.
d. Insert pipe into socket and press gasket firmly and evenly into gasket recess. Keep joint straight during assembly.
e. Push gland toward socket and center it around pipe with the gland lip against the gasket.
f. Insert bolts and hand tighten nuts.
g. Deflect joint only after assembled when approved by ENGINEER.

h. Make deflection after joint assembly, if approved by ENGINEER, but prior to tightening bolts. Alternately tighten bolts 180 degrees apart to seat the gasket evenly. Bolt torque shall be:

Pipe Diameter (inches)	Bolt Diameter (inches)	Range of Torque (ft-lbs)
3	5/8	45 to 60
4 to 24	3/4	75 to 90

3. Ductile Iron and Steel Flanged Joints:
   a. Assemble flanged joints using ring-type gaskets, with thickness as recommended by pipe manufacturer but not less than 1/8-inch thick, for raised-face flanges. Use full-face gaskets for flat-face flanges, unless otherwise approved by ENGINEER or recommended by pipe manufacturer. Gaskets shall be suitable for the service intended in accordance with the manufacturer's ratings and instructions. Gaskets shall be properly centered.
   b. Tighten bolts in a sequence that provides equal distribution of bolt loads.
   c. Length of bolts shall be uniform. Bolts shall not project beyond the nut more than 1/4-inch or fall short of the nut when fully taken up. Machine-cut ends of bolts to be neatly rounded. Do not use washers.
   d. Prior to assembly of flanged joints, lubricate bolt threads and gasket faces.
   e. Alternately tighten bolts 180 degrees apart to compress the gasket evenly.
   f. After assembly, coat all bolts and nuts, except stainless steel bolts and nuts, with same coating specified in Section 09 91 00, Painting, for material of pipe and fittings being joined.
4. Thermoplastic Pipe Joints:
   a. Solvent Cement Welded Joints:
      1) Bevel pipe ends and remove all burrs before making joint. Clean pipe and fittings thoroughly. Do not make solvent cement joints if temperature is below 40 degrees F. Do not make solvent cement welded joints in wet conditions.
      2) Use solvent cement supplied or recommended by pipe manufacturer.
      3) Apply joint primer and solvent cement and assemble joints in accordance with recommendations and instructions of manufacturer of joint materials and pipe manufacturer.
      4) Implement appropriate safety precautions when using joint primers and solvent cements. Allow air to circulate freely through pipelines to allow solvent vapors to escape. Slowly admit fluid when flushing or filling pipelines to prevent compression of gases within pipes.
5. Copper Tubing Joints:
   a. Soldered Joints:
      1) Assemble copper tubing with soldered joints. Solder shall be 95-5 tin-antimony solder conforming to ASTM B32.
      2) Ream or file pipe to remove burrs.
      3) Clean and polish contact surfaces of joints.

4) Apply flux to both male and female ends.
5) Insert end of tube into full depth of fitting socket.
6) Heat joint evenly.
7) Form continuous solder bead around entire circumference of joint starting at the bottom.

6. Mechanical Coupling Joints:
   a. Mechanical couplings include: sleeve-type flexible couplings, split flexible couplings, ANSI/AWWA C606 grooved or shouldered end couplings, plasticized PVC couplings, and other mechanical couplings used.
   b. Prior to installing and assembling mechanical couplings, thoroughly clean joint ends with a wire brush to remove foreign matter.
   c. For mechanical couplings that incorporate gaskets, after cleaning apply lubricant to rubber gasket or inside of coupling housing and to joint ends. After lubrication, install gasket around joint end of previously installed piece and mate joint end of subsequent piece to installed piece. Position gasket and place coupling housing around gasket and over grooved or shouldered joint ends. Insert bolts and install nuts tightly by hand. Tighten bolts uniformly to produce an equal pressure on all parts of housing. When housing clamps meet metal to metal, joint is complete and further tightening is not required.
   d. For plasticized PVC couplings, loosen the stainless steel clamping bands and remove the clamps from the coupling. Slide the coupling over the plain ends of the pipes to be joined without using lubricants. Place clamps over each end of coupling at grooved section and tighten with a torque wrench to torque recommended by manufacturer.

E. Installing Valves and Accessories:
   1. Provide supports for large valves, flow meters, and other heavy items as shown or required to prevent strain on adjoining piping.
   2. Position flow measuring devices in pipe lines so that they have the amount of straight upstream and downstream runs recommended by the flow measuring device manufacturer, unless specific location dimensions are shown.
   3. Position swing check valves and butterfly valves so that they do not conflict with upstream and downstream elements of the piping system.

F. Unions:
   1. Install dielectric unions as specified in Section 40 05 06, Couplings, Adapters, and Specials for Process Piping**,** where dissimilar metals are connected, except for bronze or brass valves in ferrous piping.
   2. Provide a union downstream of each valve with screwed connections.
   3. Provide screwed or flanged unions at each piece of equipment, where shown, and where necessary to install or dismantle piping.

G. Transitions from One Type of Pipe to Another:
   1. Provide all necessary adapters, specials, and connection pieces required when connecting different types and sizes of pipe or connecting pipe made by different manufacturers.

H. Closures:
   1. Provide closure pieces, such as blind flanges and caps, shown or required to complete the Work.

3.3 THRUST RESTRAINT

A. Provide thrust restraint on all pressure piping systems and where otherwise shown or specified.

B. Thrust restraints shall be designed for axial thrust exerted by test pressure specified in the Exposed Piping Schedule at end of this Section.

C. Restrained Pipe Joints:
   1. Pipe joints shall be restrained by means suitable for the type of pipe being installed.
      a. Ductile Iron, Push-on Joints, and Mechanical Joints: Restrain with a proprietary restrained joint system as specified in Section 40 05 19. Ductile iron pipe, lugs, and tie rods, or other joint restraint systems approved by ENGINEER. Restrain ductile iron pipe connected by flexible couplings or flanged coupling adapters by harnessing across the coupling or adapter using tie rods or extended bolts connecting between flanges.
      b. Steel Pipe Joints: Provide butt-welded joints, lap welded joints, flanged joints, or mechanical coupling connections as shown and specified in Exposed Piping Schedule. Provide tie rods connected to lugs welded to the steel pipe for restraint at mechanical couplings.
      c. Thermoplastic and HDPE Joints: Where bell and spigot-type or other non-restrained joints are utilized, provide tie rods across the joint or other suitable joint restraint system, subject to approval of ENGINEER.

3.4 WORK AFFECTING EXISTING PIPING

A. Location of Existing Piping:
   1. Locations of existing piping shown on Drawings is approximate.
   2. Determine the true location of existing piping to which connections are to be made, crossed, and that could be disturbed, and determine location of other facilities that could be affected by the Work.

B. Taking Existing Pipelines Out of Service:
   1. Conform to Section 01 14 16, Coordination with CITY's Operations.

C. Work on Existing Pipelines:
   1. Cut or tap pipes as shown or required with machines and tools specifically designed for cutting or tapping pipelines.
   2. Install temporary plugs to prevent entry of mud, dirt, water, and debris into pipe.
   3. Provide necessary adapters, sleeves, fittings, pipe, and appurtenances required to complete the Work.
   4. Conform to applicable requirements of Section 01 14 16, Coordination with CITY's Operations, and Section 01 73 24, Connections to Existing Facilities.

3.5 PAINTING

A. Field painting shall conform to Section 09 91 00, Painting.

3.6 FIELD QUALITY CONTROL

A. Testing, General:
   1. Test all piping, except as exempted in the Exposed Piping Schedule.
   2. Notification:
      a. Notify ENGINEER at least 48 hours prior to testing.
      b. When authorities having jurisdiction are to witness tests, notify ENGINEER and authorities having jurisdiction in writing at least 48 hours in advance of testing.
   3. Conduct all tests in presence of ENGINEER.
   4. Remove or protect pipeline-mounted devices that could be damaged by testing.
   5. Provide all apparatus and services required for testing, including:
      a. Test pumps, compressors, hoses, calibrated gages, meters, test containers, valves, fittings, and temporary pumping systems required to maintain CITY's operations.
      b. Temporary bulkheads, bracing, blocking, and thrust restraints.
   6. Provide air if an air test is required, power if pumping is required, and gases if gases are required.
   7. Unless otherwise specified, CITY will provide fluid required for hydrostatic testing. CONTRACTOR shall provide means to convey fluid for hydrostatic testing into the pipe being tested. CONTRACTOR shall provide fluid for other types of testing required.
   8. Repair observed leaks and repair pipe that fails to meet acceptance criteria. Retest after repair.
   9. Unless otherwise specified, testing shall include existing piping systems that connect with new piping system. Test existing pipe to nearest valve. Piping not installed by CONTRACTOR and that fails the test shall be repaired upon authorization of ENGINEER or DEPARTMENT. Repair of existing piping will be paid as extra work unless otherwise specified.

C. Test Schedule:
   1. Refer to the Exposed Piping Schedule for type of test required and required test pressure.

2. Unless otherwise specified, the required test pressures are at lowest elevation of pipeline segment being tested.
3. For piping not listed in Exposed Piping Schedule:
   a. Hydrostatically test pipe that will convey liquid at a pressure greater than five psig. Provide process air pipe test for pipe that will convey air or gas under pressure or vacuum, except chlorine gas, which requires a separate test.
   b. Disinfect for bacteriological testing piping that conveys potable water.
4. Test Pressure:
   a. Use test pressures listed in Exposed Piping Schedule.
   b. If test pressure is not listed in Exposed Piping Schedule, or if a test is required for piping not listed in the Exposed Piping Schedule, test pressure will be determined by the ENGINEER based on the maximum anticipated sustained operating pressure and the methods described in the applicable ANSI/AWWA manual or standard that applies to the piping system.

D. Hydrostatic Testing:
1. Preparation for Testing:
   a. For thermoplastic pipe, follow procedures described in Section 7 of ANSI/AWWA Standard C605.
   b. For HDPE pipe, follow procedures described in ASTM F2164. Test duration, including time to pressurize, time for initial expansion, time at test pressure, and time to depressurize, shall not exceed eight hours. If re-testing of a test section or pipeline is required, at least eight hours shall elapse between tests.
   c. For steel pipe, follow procedures described in AWWA Manual M11. Wetting period is not required for pipe that is not cement-lined.
   d. For other piping follow procedures described in AWWA Manual M9. A wetting period is not required for pipe that is not cement mortar-lined.
   e. Prior to testing, ensure that adequate thrust protection is in place and all joints are properly installed.
2. Test Procedure:
   a. Fill pipeline slowly to minimize air entrapment and surge pressures. Fill rate shall not exceed one foot of pipe length per second in the pipe being tested.
   b. Expel air from pipe as required. Obtain approval of ENGINEER prior to tapping pipe for expelling air.
   c. Examine joints and valves, and make repairs to eliminate visible leakage.
   d. After specified wetting period, add fluid as required to pressurize line to required test pressure. Maintain test pressure for a stabilization period of ten minutes before beginning test.
   e. HDPE Pipe: After filling pipeline, gradually pressurize pipe to test pressure and maintain required test pressure for three hours for pipe to expand. During expansion, add fluid to maintain required test pressure. Begin timed test period after expansion period and other requirements are met.

f. Timed test period shall not begin until after the pipe has been filled, exposed to the required wetting period, air has been expelled, and pressure stabilized.

g. Timed Test Period: After the stabilization period, maintain test pressure for at least two hours. During timed testing period, add fluid as required to maintain pressure within five psig of required test pressure. For HDPE pipe, after three hour expansion phase, reduce test pressure by ten psig and do not add liquid. The test pressure shall then remain steady for one hour, indicating no leakage.

h. Pump from a test container to maintain test pressure. Measure volume of fluid pumped from test container and record on test report. Record pressure at test pump at fifteen minute intervals for duration of test.

3. Allowable Leakage Rates: Leakage is defined as the quantity of fluid supplied to pipe segment being tested to maintain pressure within five psi of the test pressure during timed test period. Allowable leakage rates for piping are:

a. No Leakage: Pipe with flanged, welded, fused, threaded, soldered, or brazed joints.

b. Rates based on formula or table in AWWA Manual M41:

1) Metal pipe joined with rubber gaskets as sealing members, including the following joint types:

a) Mechanical joints.

b) Bolted sleeve type couplings.

c) Grooved and shouldered couplings.

c. Rates based on formula or table in ANSI/AWWA C605:

1) Plastic pipe joined with O-ring gasket sealing members.

E. Bacteriological Testing:

1. Bacteriological testing for potable water lines, finished water lines, and other piping per Exposed Piping Schedule, is specified in Article 3.6 of this Section.

3.7 CLEANING AND DISINFECTION

A. Cleaning, General: Clean pipe systems as follows:

1. Thoroughly clean all piping, including flushing with water, dry air, or inert gas as required, in a manner approved by ENGINEER, prior to placing in service. Flush chlorine solution and sodium hypochlorite piping with water.

2. Piping 24-inch diameter and larger shall be inspected from inside and debris, dirt and foreign matter removed.

3. For piping that requires disinfection and has not been kept clean during storage or installation, swab each section individually before installation with a five percent hypochlorite solution.

B. Disinfection:

1. Disinfect all potable and finished water piping.

2. A suggested procedure for accomplishing complete and satisfactory disinfection is specified below. Other procedures may be considered for acceptance by ENGINEER.

a. Prior to disinfection, clean piping as specified and flush thoroughly.
b. Conform to procedures described in ANSI/AWWA C651. Continuous feed method of disinfecting shall be used, unless alternative method is acceptable to ENGINEER.

3. Water for initial flushing, testing, and disinfection will be furnished by CITY. CONTRACTOR shall provide all temporary piping, hose, valves, appurtenances, and services required. Cost of water required for re-disinfection will be paid by CONTRACTOR to CITY at the water utility's standard rates.
4. Chlorine shall be provided by CONTRACTOR.
5. Bacteriologic tests will be performed by CONTRACTOR.
6. Chlorine concentration in the water entering the piping shall be between 50 and 100 ppm, such that a minimum residual concentration of 25 mg/L remains after a 24-hour retention period. Disinfect the piping and all related components. Repeat as necessary to provide complete disinfection.
7. After required retention period, the chlorinated water shall be flushed to a closed drain line, unless otherwise directed by ENGINEER. Properly dispose of chlorinated water in accordance with applicable regulations. Do not discharge chlorinated water to storm sewers, ditches, or overland.

3.8 EXPOSED PIPING SCHEDULE

A. The schedules listed below, following the "End of Section" designation, are a part of this Specification section.
   1. Table 40 05 05-A, Exposed Piping Schedule.

+ + END OF SECTION + +

TABLE
40 05 05-A, EXPOSED PIPING SCHEDULE

Service	Diameter (inch)	Material	Interior Lining	Exterior Coating	Pressure Class/ Thickness	Joint	Test	Remarks
FW	8 to 12	DI	CL	P	150	Flg	HYD (100), DBT	
TW	8 to 24	DI	CL	P	150	Flg	HYD (100), DBT	
BF	8	DI	CL	P	150	Flg	HYD (150), DBT	
BD	8	DI	CL	P	150	Flg	HYD (150)	
HSW	6 to 20	DI	CL	P	150	Flg	HYD (150), DBT	
LSW	8 to 20	DI	CL	P	150	Flg	HYD (100), DBT	
CF	4	SS	None	None	Sch40	Victaulic	HYD (100)	Terminate with 4" SS "Kamlock" fittings at GAC Fill Stations, gender as recommended by GAC Media Supplier
CO	4	SS	None	None	Sch40	Victaulic	HYD (100)	
SMP	1	PVC	None	None	Sch80	SW	HYD (100)	
Chemicals	1	PVC	None	None	Sch80	SW	HYD (150)	Phosphate, Hypochlorite, Fluoride (and 2 spare)– transition from buried HDPE that penetrates wall in Chemical and GAC Treatment Buildings
Chemicals	1	HDPE	None	None	SDR9	n/a	HYD (150)	For potable water use
PLANT WATER	8	DI	CL	P	150	FLG	HYD (150), DPT	
PLANT WATER	2	C	n/a	n/a	Type: L	Sd	HYD (150), DPT	Hard Drawn

The following abbreviations are used in the Exposed Piping Schedule.

A. Service Abbreviations

Service	Abbrev.
Filtered Water	FW
Treated Water	TW
Backwash Feed	BF
Backwash Drain	BD
High Service Water	HSW
Low Service Water	LSW
Carbon Fill	CF
Carbon Out	CO
Sample	SMP

B. Material Abbreviations

Material	Abbrev
Ductile Iron	DI
Carbon Steel	CS
Stainless Steel	SS
Copper	C
Polyvinyl Chloride	PVC
High Density Polyethylene	HDPE

C. Lining/Coating Abbreviations

Lining	Abbrev
Cement Mortar Lined	CL
Painted	P

D. Joint Abbreviations

Joint Type	Abbrev
Flanged	Flg
Solvent Weld	SW
Soldered	Sd

E. Test Abbreviations

Test	Abbrev
Hydrostatic Test (test pressure in psig)	HYD ( )
Disinfection and Bacteriological Testing	DBT

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SECTION 40 05 06

COUPLINGS, ADAPTERS, AND SPECIALS FOR PROCESS PIPING

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install all couplings, adapters, and specials for process piping.

B. Coordination:
   1. Review installation procedures under this and other Sections and coordinate installation of items that must be installed with or before couplings, adapters, and specials for process piping Work.
   2. Notify other contractors in advance of the installation of couplings, adapters, and specials for process piping to provide them with sufficient time for installing items included in their contracts that must be installed with or before couplings, adapters, and specials for process piping Work.

C. Related Sections:
   1. Section 09 91 00, Painting.
   2. Section 33 05 05, Buried Piping Installation
   3. Section 40 05 05, Exposed Piping Installation.

1.2 REFERENCES

A. Standards referenced in this Section are:
   1. ANSI B16.1, Cast-Iron Pipe Flanges and Flanged Fittings.
   2. ANSI B16.39, Malleable Iron Threaded Pipe Unions.
   3. ASME B31, Standards of Pressure Piping.
   4. ASTM A53/A53M, Specification for Pipe, Steel, Black and Hot-dipped, Zinc-Coated, Welded and Seamless.
   5. ASTM A105/A105M, Specification for Carbon Steel Forgings and Piping Applications.
   6. ASTM B169/B169M Specification for Aluminum Bronze Sheet, Strip, and Rolled Bar.
   7. ASTM B650, Specification for Electro-Deposited Engineering Chromium Coatings of Ferrous Substrates.
   8. ASTM F593, Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs
   9. AWWA C606, Grooved and Shouldered Joints.

1.3 QUALITY ASSURANCE

A. Qualifications:
   1. Manufacturer shall have at least five years experience producing substantial similar products to those specified and shall be able to provide documentation of at least five installations in satisfactory operation for at least five years each.

B. Component Supply and Compatibility:
   1. Obtain each type of coupling, adapter, and special for process piping product included in this Section, regardless of component manufacturer, from a single couplings, adapters, and specials manufacturer.
   2. Supplier shall prepare, or review, and approve all submittals for components furnished under this Section.
   3. Components shall be suitable for specified service conditions and be integrated into overall assembly by the Supplier.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Shop Drawings:
      a. Submit piping layout Shop Drawings in accordance with Section 33 05 05, Buried Piping Installation, and Section 40 05 05, Exposed Piping Installation.
   2. Product Data:
      a. Submit product data on each type of coupling, expansion joint, and other piping specialties and accessories, including gaskets, hardware, and appurtenances sufficient to demonstrate compliance with the Contract Documents.

B. Informational Submittals: Submit the following:
   1. Certificates:
      a. When requested by ENGINEER submit certificate attesting to compliance with standards referenced in this Section, signed by manufacturer.
   2. Manufacturer's Instructions:
      a. Provide instructions for handling, storing, installing, and adjusting of products.
   3. Source Quality Control:
      a. When requested by ENGINEER, submit results of source quality control tests.
   4. Qualifications Statements:
      a. Submit qualifications of manufacturer when requested by ENGINEER.

1.5 DELIVERY, STORAGE AND HANDLING

A. Refer to Section 33 05 05, Buried Piping Installation, and Section 40 05 05, Exposed Piping Installation.

PART 2 – PRODUCTS

2.1 COUPLINGS

A. Sleeve-type, Flexible Couplings:
   1. Pressure and Service: Same as connected piping.
   2. Products and Manufacturers: Provide products of one of the following:
      a. Style 501, as manufactured by Romac Industries, Inc.
      b. Style 411 or 441, by Smith Blair, Inc.
      c. Or equal.
   3. Material: Steel (fusion bonded epoxy coated).
   4. Gaskets: Suitable for specified service, as recommended by manufacturer.
   5. Bolts and Nuts: Alloy steel, corrosion-resistant, primer-coated. For buried or submerged applications, provide stainless steel bolts complete with washers complying with ASTM F593, AISI Type 316 and with nitrided stainless nuts.
   6. Harnessing:
      a. Harness couplings to restrain pressure piping. For pipelines that will be under pressure, test pressures are specified in piping schedules in Section 33 05 05, Buried Piping Installation, and Section 40 05 05, Exposed Piping Installation.
      b. Tie adjacent flanges with bolts of corrosion-resistant alloy steel. Provide flange-mounted stretcher bolt plates to be designed by manufacturer, unless otherwise approved. For buried or submerged applications, provide external bolting and other hardware of Type 316 stainless steel, including tie bolts, bolt plates, lugs, nuts, and washers.
      c. On plain-end piping, for harnessing couplings, provide anchor restraint system.
      d. Conform to dimensions, size, spacing, and materials for lugs, bolts, washers, and nuts as recommended by manufacturer and approved by ENGINEER for pipe size, wall thickness, and test pressure required. Provide minimum 5/8-inch diameter bolts.
   7. Remove pipe stop(s) if used, unless otherwise shown or specified.

B. Flanged Coupling Adapters:
   1. Description: One end of adapter shall be flanged and opposite end shall have sleeve-type flexible coupling.
   2. Products and Manufacturers: Provide one of the following:
      a. Style 913, by Smith Blair, Inc.
      b. Or equal.
   3. Pressure and Service: Same as connected piping.
   4. Material: Steel (fusion bonded epoxy coated).
   5. Gasket: Recommended by the manufacturer.
   6. Bolts and Nuts: Alloy steel, corrosion-resistant, primer-coated. For buried or submerged applications, provide stainless steel bolts complete with washers complying with ASTM F593, AISI Type 316 and nitrided stainless nuts.
   7. Harnessing:

a. Harness adapters to restrain pressure piping. For pressure pipelines, test pressures are included in piping schedules in Section 33 05 05, Buried Piping Installation, and Section 40 05 05, Exposed Piping Installation.

b. For flanged adapters 12-inch diameter and smaller, provide 1/2-inch diameter (minimum) Type 316 stainless steel anchor studs installed in pressure-tight anchor boss. For buried or submerged applications, provide external bolting and other hardware of Type 316 stainless steel, including tie bolts, bolt plates, lugs, nuts, and washers. Provide number of studs required to restrain test pressure and service conditions. Harness shall be as designed and recommended by flanged adapter manufacturer. Provide the following minimum anchor studs unless otherwise approved by ENGINEER.
   1) Six-inch Diameter and Smaller: Two
   2) Eight-inch Diameter and Smaller: Four
   3) Ten-inch Diameter and Smaller: Six
   4) Twelve-inch Diameter and Smaller: Eight

c. For adapters larger than 12-inch diameter, provide split-ring harness clamps with minimum of four corrosion-resistant alloy steel bolts. For buried or submerged applications, provide external bolting and other hardware of Type 316 stainless steel, including tie bolts, bolt plates, lugs, nuts, and washers. Harness assembly shall be as designed and recommended by flanged adapter manufacturer. Dimensions, sizes, spacing and materials shall be suitable for service and conditions encountered and shall be approved by ENGINEER.

2.2 MISCELLANEOUS SPECIALTIES AND ACCESSORIES

A. Dielectric Connections:
   1. General: Where copper pipe connects to steel pipe, cast-iron pipe, or ductile iron pipe, provide either dielectric union or an insulating section of rubber or plastic pipe. When used, insulating section shall have minimum length of 12 pipe diameters.
   2. Manufacturers: Provide products of one of the following:
      a. Epco Sales, Inc.
      b. Watts Regulator Company.
      c. Capitol Manufacturing Company.
      d. Or equal.
   3. Dielectric Unions: Rated for 250 psi, ANSI B16.39.
   4. Insulating Sections: Rated for same pressure as associated piping test pressure. Material shall be suitable for the application and service.

2.3 PAINTING

A. Shop Painting:
   1. Clean and prime-coat ferrous metal surfaces of products in the manufacturer's shop in accordance with Section 09 91 00, Painting, unless otherwise specified in this Section
   2. Coat machined, polished and non-ferrous surfaces bearing surfaces and similar unpainted surfaces with corrosion prevention compound that shall be maintained during storage and until products are placed into operation.

B. Field painting shall conform to Section 09 91 00, Painting.

PART 3 - EXECUTION

3.1 INSPECTION

A. Inspect materials for defects in material and workmanship. Verify compatibility of products with pipe, fittings, valves, and appurtenances.

3.2 INSTALLATION

A. Installation:
   1. Install piping specialties in accordance with the Contract Documents and manufacturer's instructions.
   2. For buried installations, refer to Section 33 05 05, Buried Piping Installation.
   3. For exposed installations, refer to Section 40 05 05, Exposed Piping Installation.

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SECTION 40 05 07

PIPE HANGERS AND SUPPORTS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified and required to design, furnish, and install all hangers, supports and appurtenances necessary to complete the Work.

B. Coordination:
   1. Review installation procedures under other Sections and coordinate the installation of items that must be installed with the pipe hangers and supports Work.
   2. Notify other contractors in advance of the installation of the pipe hangers and supports to provide them with sufficient time for the installation of items included in their contracts that must be installed before the pipe hangers and supports Work.

C. Related Sections:
   1. Section 03 30 00, Cast-In-Place Concrete.
   2. Section 05 50 13, Miscellaneous Metal Fabrications.
   3. Section 09 91 00, Painting.
   4. Section 40 05 06, Couplers, Adapters, and Specials for Process Piping.

1.2 REFERENCES

A. Standards referenced in this Section are listed below:
   1. American Society for Testing and Materials, (ASTM).
      a. ASTM A 575, Specification for Steel Bars Carbon, Merchant Quality, M-Grades.
      b. ASTM E 84, Test Method for Surface Burning Characteristics of Building Materials.
   2. Federal Specification, (FS).
      a. FS A-A-1192, Hangers, Pipe.
   3. Manufacturers Standardization Society of the Valve and Fittings Industry, (MSS).
      a. MSS SP 58, Pipe Hangers and Supports-Materials, Design and Manufacture.
      b. MSS SP 69, Pipe Hangers and Supports - Selection and Application.
   4. Underwriters' Laboratories, Inc., (UL).
      a. UL 203, Pipe Hanger Equipment for Fire Protection Service.

1.3 QUALITY ASSURANCE

A. Each type of pipe hanger or support shall be the product of one manufacturer.

B. Component Supply and Compatibility:
   1. Obtain all equipment included in this Section regardless of the component manufacturer from a single pipe hangers and supports manufacturer.
   2. The pipe hangers and supports equipment manufacturer to review and approve or to prepare all Shop Drawings and other submittals for all components furnished under this Section.
   3. All components shall be specifically constructed for the specified service conditions and shall be integrated into the overall assembly by the pipe hangers and supports equipment manufacturer.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Shop Drawings:
      a. Detailed drawings showing all hangers and supports for each piping system specified. Shop Drawings shall show location, installation, material, loads or forces, and deflection of all hangers and supports.
      b. Submit and coordinate these with Shop Drawings required for all piping systems.
   2. Product Data:
      a. Submit manufacturers' catalogs, literature, and engineering data on all hangers and supports. Load ratings, materials and installation shall be consistent with the recommendations of the MSS SP 58, MSS SP 69 and Federal Specification A-A-1192.

1.5 DELIVERY, STORAGE AND HANDLING

A. Packing, Shipping, Handling and Unloading:
   1. Deliver materials to the Site to ensure uninterrupted progress of the Work. Deliver anchor bolts and anchorage devices which are to be embedded in cast-in-place concrete in ample time to prevent delay of that Work.

B. Storage and Protection:
   1. Store materials to permit easy access for inspection and identification. Keep all material off the ground, using pallets, platforms, or other supports. Protect steel members and packaged materials from corrosion and deterioration.
   2. Store materials in covered storage off the ground and prevent condensation.

C. Acceptance at Site:
   1. All boxes, crates and packages shall be inspected by CONTRACTOR upon delivery to the Site. CONTRACTOR shall notify ENGINEER, in writing, if any loss or damage exists to equipment or components. Replace loss and

repair damage to new condition in accordance with manufacturer's instructions.

PART 2 - PRODUCTS

2.1 GENERAL

A. Hangers and supports shall meet with the following requirements:
   1. Standard and fabricated hangers and supports shall be furnished complete with necessary inserts, bolts, nuts, rods, washers, and other accessories.
   2. Generally, run piping in groups where practicable and parallel to building wall. Provide minimum clearance of 1-inch between pipe and other work.
   3. Install hangers or supports at all locations where pipe changes direction.
   4. All hangers and supports shall be capable of adjustment after placement of piping.
   5. Different types of hangers or supports shall be kept to a minimum.
   6. All suspended or supported ductile iron pipe shall have a hanger or support adjacent to each hub.
   7. Support vertical piping at each floor and between floors by stays or braces to prevent rattling and vibration.
   8. Hanger rods shall be straight and vertical. Chain, wire, strap or perforated bar hangers shall not be used. Hangers shall not be suspended from piping.
   9. Maximum support spacing unless otherwise shown or approved for standard weight steel pipe shall be as follows:

Pipe Size (inches)	Maximum Pipe Span [1] (feet)			
	Steel	Copper	Plastic [2]	Cast/Ductile Iron [4]
3/8 to 3/4	5	6	Cont. [3]	-
1	6	6	5	-
1-1/4	6	6	5	-
1-1/2	6	6	5	-
2	10	10	5	-
2-1/2	10	10	5	-
3	10	10	5	-
4	12	12	5	12 feet for pressure pipe
6	12	12	5	
8	12	12	5	
10	12	-	5	
12	12	-	10	
14	12	-	-	
16	12	-	-	10 feet for soil pipe
18	12	-	-	
20	12	-	-	

[1]Pipe shall not have pockets formed in the span due to sagging of the pipe between supports caused by the weight of the pipe, medium in the pipe, insulation, valves and fittings.

[2]Span shown is for Schedule 80 CPVC pipe at 100°F. Spans for other plastics, other CPVC pipe Schedules and pipes at higher temperatures shall be shortened in accordance with the pipe manufacturer's recommendations.

[3]Continuous means pipe shall be in unistrut or similar channel.

[4] Pipe hanger and support selection shall be as shown and in this Section.

10. Maximum support spacing, unless otherwise shown for plastic pipe at ambient temperature, shall be one-half of the values specified for steel pipe.
11. Plastic pipe at temperature greater than 130ºF shall be continuously supported in a metal cradle or tray.
12. Where proper hanger or support spacing does not correspond with joist or rib spacing, structural steel channels may be attached to joists or ribs and pipes suspended there from.
13. Prevent contact between dissimilar metals when supporting copper tubing, by use of copper plated, rubber or vinyl coated, or stainless steel hangers or supports.
14. Isolate thin walled stainless steel piping from carbon steel by use of plastic coated hangers or supports or by taping at points of contact with PVC or vinyl.
15. Supports and hangers shall be of a material that is compatible with the fluid being conveyed in such pipe being supported.
16. Anchors for pipe support systems shall be compatible or protected by a coating system which is compatible with the fluid being conveyed in such pipe being supported.

B. Expansion compensation shall be designed for individual exposed piping systems with the following Design Criteria:
   1. $\Delta L = L \times \Delta T \times \alpha$
      a. Where ΔL = pipe length change (inches).
      b. L = pipe length between anchors (inches).
      c. ΔT = 100 (F).
      d. α = coefficient of thermal expansion (inches/inches/F).
   2. Expansion compensation shall be designed as an integral part of the piping hanger, support and anchorage system.
   3. Expansion compensation shall be achieved via expansion joints specified in Section 40 05 06, Couplers, Adapters, and Specials for Process Piping.

2.2 HANGERS AND SUPPORTS

A. Hangers and supports where shown shall be in accordance with detail drawings. Hangers and supports not shown shall be in accordance with MSS SP 58.

B. Products and Manufacturers: Provide one of the following:

1. Anvil International, Inc.
2. B-Line.
3. Unistrut Corporation.
4. Or equal.

2.3 ACCESSORIES

A. Hanger rods shall be made from ASTM A 575, with square head nut on top and running thread on bottom end.

B. Concrete Inserts:
   1. Concrete inserts shall be MSS SP 58 malleable Type 18.
   2. Manufacturers: Provide products of one of the following:
      a. Unistrut Corporation, Wayne, Michigan.
      b. Elcan Metal Products, Company, Franklin Park, Illinois.
      c. B-Line.
      d. Anvil International, Inc.
      e. Or equal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Locate hangers, supports, and accessories to support piping, valves, and at all concentrated loads.

B. Locate hangers, supports, and accessories within maximum span lengths specified to support continuous pipeline runs unaffected by concentrated loadings.

C. Locate hanger, supports to prevent vibration or swaying and to provide for expansion and contraction.
   1. Temperature differential specified in this Section.
   2. Support piping independently so that equipment is not stressed by piping weight or expansion.
   3. For Uninsulated Copper Pipe or Tubing: Clamps and supports, electroplated copper finish. Instrumentation tubing shall be supported in steel or aluminum troughs with covers. All tubing layout and connections shall be as approved by the manufacturer of the equipment.
   4. Uncoated Hangers, Rods and Supports: Dip in zinc chromate primer before installation.
   5. Maximum spacing for horizontal piping:
      a. Steel 1-Inch and Smaller: Seven feet.
      b. Steel 1-1/2-Inch and Larger: Ten feet.
      c. Brass or Copper 3-Inch and Smaller: Seven feet.
      d. Brass or Copper 4-Inch and Larger: Ten feet.
      e. Additional supports at:

1) Change in direction.
2) Branch piping and runouts over five feet.
3) Concentrated loads due to valves, strainers or other similar items.

f. Maximum support spacing for plastic pipe at ambient temperature shall be one-half the above values.

6. Hanger types for horizontal piping, except as noted and shown:
   a. Forged steel adjustable clevis type, rod support for all services.
   b. Slide Bases:
      1) Pipe stand, brackets, trapeze or other equivalent structural support.
      2) For piping 2-inches or larger.
   c. For pipe and covering provide:
      1) Saddles for rollers or slide bases.
      2) Protective shields or saddles for all other types of supports.
   d. Threaded Steel Rods:
      1) Two inch vertical adjustment with two nuts each end for positioning and locking.
      2) Size hanger rods according to the schedule below, unless otherwise noted:

Nominal Pipe (Inches)	Rod Diameter (Inches)
2 and less	3/8
2-1/2 to 3-1/2	1/2
4	5/8
6	3/4
8 through 12	7/8
14 through 18	1
20 through 30	1-1/4

      3) For Double Rod Hangers: One size smaller than above.
      4) Connection to Structure for Piping to 2-Inches: Concrete inserts, or expansion shields in shear into sides of beams.
      5) Connection to Structure for Piping 2-1/2-Inch or Larger: Concrete inserts, beam clamps or suitable bridging.
7. Vertical Piping:
   a. Base Support: Base elbow or welded equivalent.
      1) Bearing plate on structural support.
   b. Guides not to exceed:
      1) 25 feet for piping to 2-inches.
      2) 36 feet for piping 2-1/2-inches or larger.
   c. Top Support:
      1) Special hanger or saddle in horizontal connection.
      2) Provisions for expansion.
   d. Intermediate Supports: Steel pipe clamp at floor.
      1) Bolted and welded to pipe.
      2) Extension ends bearing on structural steel or bearing plates.

e. For Multiple Pipes: Coordinate guides, bearing plates and accessory steel.

D. Install items to be embedded before concrete placement.

E. Fasten embedded items securely to prevent movement during concrete placement.

F. Install hangers and support units on piping systems in accordance with manufacturer's recommendations.

G. Adjust hangers and supports and place grout for concrete supports to bring pipelines to specified elevations.

H. Bring all pipe systems up to operating pressures and temperatures. Cycle systems to duplicate operating conditions. Correct all support malfunctions.

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SECTION 40 05 08

WALL PIPES, FLOOR PIPES, AND PIPE SLEEVES

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish and install all floor pipes, pipe sleeves, wall pipes, other wall pieces, and escutcheons to complete the Work.
   1. CONTRACTOR shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish and install all floor pipes, pipe sleeves, wall pipes, other wall pieces and escutcheons to complete the general construction Work.

B. Coordination:

   1. Review installation procedures under other contracts and coordinate with other contractors the installation of floor pipes, pipe sleeves, wall pipes, other wall pieces and escutcheons that must be installed with or within formwork, walls, partitions, ceilings and panels constructed by such other contractors.
      a. Provide other contractors with detailed plans or sketches of the locations of the floor pipes, pipe sleeves, wall pipes, other wall pieces and escutcheons as may be required.
      b. Keep informed of the construction where floor pipes, pipe sleeves, wall pipes, other wall pieces and escutcheons are to be installed. Install the floor pipes, pipe sleeves, wall pipes, other wall pieces and escutcheons in such a manner and within such time periods as will not delay the work of the other contractors.

C. Related Sections:
   1. Section 03 30 00, Cast-In-Place Concrete.
   2. Section 07 92 00, Joint Sealants.

1.2 REFERENCES

A. Standards referenced in this Section are listed below:
   1. American National Standards Institute, (ANSI).
      a. ANSI B16.1, Cast-Iron Pipe Flanges and Flanged Fittings.
      b. ANSI B16.4, Gray-Iron Threaded Fittings.
   2. American Water Works Association, (AWWA).
      a. AWWA C104 (ANSI A21.4), Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water.

b. AWWA C110 (ANSI A21.10), Ductile-Iron and Gray-Iron Fittings, for Water.
c. AWWA C111 (ANSI A21.11), Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
d. AWWA C115 (ANSI A21.15), Flanged Ductile-Iron Pipe with Ductile-Iron or Gray-Iron Threaded Flanges.
e. AWWA C151 (ANSI A21.51), Ductile-Iron Pipe, Centrifugally Cast, for Water.
f. AWWA C200, Steel Water Pipe 6-Inches and Larger.

1.3 QUALITY ASSURANCE

A. Component Supply and Compatibility:
1. Obtain all equipment included in this Section regardless of the component manufacturer from a single wall pipes, floor pipes and pipe sleeves manufacturer.
2. The wall pipes, floor pipes and pipe sleeves manufacturer to review and approve or to prepare all Shop Drawings and other submittals for all components furnished under this Section.
3. All components shall be specifically constructed for the specified service conditions and shall be integrated into the overall assembly by the wall pipes, floor pipes and pipe sleeves manufacturer.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:
1. Shop Drawings:
a. Detailed drawings and data on all wall and floor pipe, and pipe sleeves. Submit and coordinate these with Shop Drawings required for all piping systems.

1.5 DELIVERY, STORAGE AND HANDLING

A. Comply with the requirements of Section 33 05 05, Buried Piping Installation, and Section 40 05 05, Exposed Piping Installation.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Wall and Floor Pipes:
1. Material: Same as specified for the piping connected to wall or floor pipe, unless otherwise approved by ENGINEER.
2. End Connections: As shown.
3. Thickness: Same as specified for the piping connected to wall or floor pipe.

4. Collars: Provide collars at mid-point of wall for anchorage and watertightness.
5. Pipes ends shall be flush with wall face, unless otherwise shown.
6. Drill and tap flanged ends and mechanical joint bells for studs. Provide studs of same material as connected piping, except submerged and buried studs shall be of Type 316 stainless steel.

B. Pipe Sleeves:
1. Ferrous and Plastic Pipe: Use standard weight galvanized steel pipe, unless otherwise shown.
2. Copper Pipe: Use Type K hard drawn copper pipe, unless otherwise shown.

C. Cast Wall Sleeves:
1. Material: Ductile iron furnished with integral wall collar.
2. Dimensions: As required for mechanical joint pipe to pass through sleeve. Length as required.

D. Link Seals: Provide link type mechanical seals suitable for 20 psi working pressure, corrosive service and accessible from one side, with glass-reinforced nylon pressure plate and stainless steel bolts and nuts.
1. Products and Manufacturers: Provide one of the following:
a. Link-Seal, as manufactured by Thunderline Corporation.
b. Or equal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Wall and Floor Pipes: Install as shown and in accordance with approved Shop Drawings.

B. Pipe Sleeves:
1. Use sleeves wherever pipes pass through walls, partitions, floors, and roofs, unless otherwise shown.
2. Extend all sleeves through floor slabs a minimum of 2 inches above finished floor.
3. Anchor sleeves to concrete and masonry walls as shown or otherwise approved.
4. All sleeves through walls shall be flush with wall face.
5. All pipe joints and annular spaces in exterior walls or walls subjected to hydrostatic pressure shall be completely watertight.
6. Use link type seals to seal sleeve against hydrostatic pressure. Size sleeves to provide annular space required to suit the link type mechanical seals that are used.
7. Do not install sleeves and pipes through structural members, unless specifically shown and approved by ENGINEER.

8. Size sleeves to provide annular space as follows:

Pipe Size	Sleeve ID Minus Pipe Or Insulation OD
Less than 2-inches	1/2-inches to 3/4-inches
2-inches to 4-inches	3/4 inches to 1-1/4-inches.
6-inches to 12-inches	1-1/4 inches to 2-inches
Over 12-inches	2-inches to 3-inches

C. Install wall plates in accordance with the manufacturer's recommendations and approved Shop Drawings.

++ END OF SECTION ++

SECTION 40 05 17

COPPER PROCESS PIPE

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish copper pipe and fittings.
   2. Extent of piping is shown and indicated in the piping schedule in Section 40 05 05, Exposed Piping Installation.

B. Coordination:
   1. Review installation procedures under this and other Sections and coordinate installation of items to be installed with or before copper pipe Work.
   2. Notify other contractors in advance of installation of copper pipe to provide other contractors with sufficient time to install items included in their contracts that will be installed with or before copper pipe Work.

C. Related Sections:
   1. Section 40 05 05, Exposed Piping Installation.

1.2 REFERENCES

A. Standards referenced in this Section are:
   1. ANSI/ASME B16.15, Cast Copper Alloy Threaded Fittings: Classes 125 and 150.
   2. ANSI/ASME B16.18, Cast Copper Alloy Solder Joint Pressure Fittings.
   3. ANSI/ASME B16.22, Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
   4. ANSI/ASME B16.26, Cast Copper Alloy Fittings for Flared Copper Tubes.
   5. ANSI/ASME B16.39, Malleable Iron Threaded Pipe Unions: Classes 150, 250, and 300.
   6. ANSI/ASME B16.50, Wrought Copper and Copper Alloy Braze-Joint Pressure Fittings.
   7. ANSI/ASME B18.2.1, Square and Hex Bolts and Screws, Inch Series.
   8. ANSI/ASME B18.2.2, Square and Hex Nuts.
   9. ASTM A194, Specification for Carbon and Alloy Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both.
   10. ASTM A307, Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
   11. ASTM B32, Specification for Solder Metal.
   12. ASTM B68, Specification for Seamless Copper Tube, Bright Annealed.
   13. ASTM B88, Specification for Seamless Copper Water Tube.

14. ASTM B251, Specification for General Requirements for Wrought Seamless Copper and Copper-Alloy Tube.
15. ASTM B302, Specification for Threadless Copper Pipe, Standard Sizes.
16. ASTM D1330, Specification for Rubber Sheet Gaskets.
17. FS WW-U-516, Unions – Brass or Bronze.
18. NSF/ANSI 61, Drinking Water System Components - Health Effects.

1.3 QUALITY ASSURANCE

A. Component Supply and Compatibility:
   1. Unless otherwise approved, obtain all pipe, fittings, and appurtenances included in this Section from a single copper pipe manufacturer.
   2. Copper pipe Supplier shall review and approve or prepare all Shop Drawings and other submittals for pipe, fittings, and appurtenances furnished under this Section.

B. Regulatory Requirements:
   1. Pipe and fittings that will convey potable water or water that will be treated to become potable, shall be certified by an accredited organization in accordance with NSF/ANSI 61 as being suitable for contact with potable water, and shall comply with requirements of authorities having jurisdiction at the Site.
   2. Pipe and fittings materials and joint types shall comply with requirements of authorities having jurisdiction at Site.

1.4 SUBMITTALS

A. Action Submittals: Submit the following with Shop Drawings required under Section 40 05 05, Exposed Piping Installation:
   1. Shop Drawings:
      a. Detailed layout drawings for pipe, fittings, and appurtenances.
   2. Product Data:
      a. Detailed data on pipe, fittings, and appurtenances.

B. Informational Submittals: Submit the following:
   1. Certificates:
      a. Submit certificate signed by manufacturer of each material that material conforms to applicable referenced standards and the Contract Documents.

1.5 DELIVERY, STORAGE AND HANDLING

A. Refer to Section 40 05 05, Exposed Piping Installation.

B. Maintain ASTM B68 pipe, fittings, and appurtenances free of scale and dirt during transportation, delivery, storage, and handling.

PART 2 – PRODUCTS

2.1 MATERIALS

A. Pipe for Plant Water (Potable): Pipe shall be seamless, bright annealed copper tubing, complying with ASTM B68. Pipe material shall be free from scale and dirt. Dimensions and tolerances shall comply with ASTM B251.

B. Potable Water Pipe:
   1. Pipe Materials: Comply with ASTM B88.
   2. For interior, exposed pipe, provide Type L, hard-drawn tube.
   3. Fittings shall be soldered except at valves, which may be flared or flanged joints.

2.2 JOINTS

A. Refer to piping schedule at the end of Section 40 05 05, Exposed Piping Installation for the service and joint type specified for each piping system.

B. Provide type of fittings corresponding to the specified joint type in accordance with Table 40 05 17-A.

TABLE 40 05 17-A
COPPER PIPE JOINT TYPE AND FITTING SCHEDULE

Joint Type	Fitting Type, Applicable Reference Standards
Soldered	ANSI/ASME B16.22, ANSI/ASME B16.29 (DWV)

C. When fully developed, the strength of the joint shall be greater than strength of adjoining pipe.

D. Unions for Potable Water Service: Shall be bronze, 250-pound class, conforming to FS WW-U-516.

E. Dielectric Connections for Potable Water Service:
   1. Manufacturers: Provide products of one of the following:
      a. Watts Regulator Company.
      b. Wilkins, a Zurn company.
      c. Or equal.
   2. Type: Union or flanged.
   3. Ratings:
      a. Unions: Rated for 250 psi, complying with ANSI/ASME B16.39.
      b. Flanges: Rated for 175 psi, complying with ANSI/ASME B16.42 (Ductile Iron), or ANSI/ASME B16.24 (Bronze).
   4. Bodies and flanges, and bolts and nuts shall be steel with galvanized coating. Insulator shall be nylon; tailpiece shall be brass. Provide EPDM gaskets for

pipe temperature up to 200 degrees F, and Viton gaskets for temperatures over 200 degrees F.

2.3 MARKING

A. Mark or label all materials with the following:
   1. Metal or alloy designation.
   2. Temper.
   3. Size and schedule.
   4. ASTM reference standard number.
   5. Name and location of Supplier.

PART 3 – EXECUTION

3.1 INSTALLATION

A. Refer to Section 40 05 05, Exposed Piping Installation, for exposed piping installation, disinfection, testing and cleaning.

+ + END OF SECTION + +

SECTION 40 05 19

DUCTILE IRON PROCESS PIPE

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish ductile iron pipe and fittings.
   2. Extent of piping is shown on the Drawings. Piping schedules in Section 33 05 05, Buried Piping Installation, and Section 40 05 05, Exposed Piping Installation, specify pipe service, diameter, material, lining, coating, pressure rating, joint type, and testing required.

B. Coordination:
   1. Review installation procedures under this and other Sections and coordinate installation of items to be installed with or before ductile iron pipe Work.
   2. Notify other contractors in advance of installation of ductile iron pipe to provide other contractors with sufficient time to install items included in their contracts that will be installed with or before ductile iron pipe Work.

C. Related Sections:
   1. Section 31 23 05, Excavation and Fill.
   2. Section 09 91 00, Painting.
   3. Section 33 05 05, Buried Piping Installation.
   4. Section 40 05 05, Exposed Piping Installation.
   5. Section 40 05 06, Couplers, Adapters, and Specials for Process Piping.

1.2 REFERENCES

A. Standards referenced in this Section are:
   1. ANSI B18.2.1, Square and Hex Bolts and Screws Inch Series.
   2. ANSI B18.2.2, Square and Hex Nuts. (Inch Series).
   3. ASTM A193, Alloy Steel and Stainless Steel Bolting Materials for High-Temperature Service.
   4. ASTM A194, Specification for Carbon Steel and Alloy Steel Nuts for Bolts for High-Pressure or High-Temperature Service, or Both.
   5. ASTM A307, Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength.
   6. ASTM A354, Specification for Quenched and Tempered Alloy Steel Bolts, Studs and Other Externally Threaded Fasteners.
   7. ASTM A563, Specification for Carbon and Alloy Steel Nuts.
   8. ASTM B117, Practice for Operating Salt Spray (Fog) Apparatus.
   9. ASTM C283, Test Methods for Resistance of Porcelain Enameled Utensils to

Boiling Acid.

10. ASTM D714, Test Method for Evaluating Degree of Blistering of Paints.
11. ASTM D792, Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement.
12. ASTM D5162, Discontinuity (Holiday) Testing of Non-Conductive Protective Coating on Metallic Substrates.
13. ASTM E96, Test Methods for Water Vapor Transmission of Materials.
14. ASTM G14, Test Method for Impact Resistance of Pipeline Coatings (Falling Weight Test).
15. ASTM G62, Test Methods for Holiday Detection in Pipeline Coatings.
16. ASTM G95, Test Methods for Cathodic Disbondment Test of Pipeline Coatings (Attached Cell Method).
17. ANSI/AWWA C104, Cement-Mortar Lining for Ductile Iron Pipe and Fittings for Water.
18. ANSI/AWWA C110, Ductile Iron and Gray Iron Fittings for Water.
19. ANSI/AWWA C111, Rubber-Gasket Joints for Ductile Iron Pressure Pipe and Fittings.
20. ANSI/AWWA C115, Flanged Ductile Iron Pipe with Ductile Iron or Gray Iron Threaded Flanges.
21. ANSI/AWWA C116, Protective Fusion-Bonded Epoxy Coatings for the Interior and Exterior Surfaces of Ductile Iron and Gray Iron Fittings for Water Service.
22. ANSI/AWWA C151, Ductile Iron Pipe, Centrifugally Cast, for Water.
23. ANSI/AWWA C153, Ductile Iron Compact Fittings, 3 inch through 24 inch and 54 inch through 64 inch for Water Service.
24. ANSI/AWWA C606, Grooved and Shouldered Type Joints.
25. European Standard (EN), EN 598: Ductile Iron Pipe, Fittings, Accessories and Their Joints for Sewerage Applications.
26. MSS-SP 60, Connecting Flange Joint Between Tapping Sleeves and Tapping Valves.
27. NACE RP0188, Discontinuity (Holiday) Testing of New Protective Coatings on Conductive Substrates.
28. NAPF 500-03, Surface Preparation Standard for Ductile Iron Pipe and Fittings Receiving Special External Coatings and/or Special Internal Linings.
29. NSF/ANSI 61, Drinking Water System Components - Health Effects.
30. SSPC PA 2, Measurement of Dry Coating Thickness with Magnetic Gages.
31. SSPC Painting Manual, Volume 1, Para. XIV.

1.3 QUALITY ASSURANCE

A. Qualifications:
   1. Manufacturer:
      a. Manufacturer shall have a minimum of five years successful experience producing ductile iron pipe and fittings and shall be able to show evidence of at least five installations in satisfactory operation in the United States that are similar applications to the specified service.
      b. Lining and coating products shall be manufactured by a firm with a

minimum of five years successful experience in protecting pipelines exposed to the specified service conditions, and shall be able to show evidence of at least five installations in satisfactory operation in the United States that are similar applications to the specified service.

c. When not applied by the manufacturer, lining and coating Subcontractor shall have a minimum of five years successful experience in the application of the specified linings and coatings for similar applications for the specified service, and shall be able to show evidence of at least five installations in satisfactory operation in the United States.

B. Supply and Compatibility:
1. Unless otherwise approved, obtain all pipe, fittings, and appurtenances included in this Section from a single ductile iron pipe manufacturer.
2. Ductile iron pipe manufacturer shall review and approve or prepare all Shop Drawings and other submittals for pipe, fittings, and appurtenances furnished under this Section.
3. Pipe, fittings, and appurtenances shall be suitable for the specified service and shall be integrated into overall piping system by ductile iron pipe manufacturer.
4. Ductile iron pipe manufacturer shall be responsible for all products and all factory-applied linings and coatings, whether installed at pipe manufacturer's facility or at manufacturer's Supplier's facility.

C. Regulatory Requirements:
1. Pipe and fittings, including linings and coatings, that will convey potable water or water that will be treated to become potable, shall be certified by an accredited organization in accordance with NSF/ANSI 61 as being suitable for contact with potable water, and shall comply with requirements of authorities having jurisdiction at Site.

1.4 SUBMITTALS

A. Action Submittals: Submit the following with Shop Drawings required under Section 33 05 05, Buried Piping Installation, and Section 40 05 05, Exposed Piping Installation:
1. Shop Drawings:
a. Detailed drawings and data for pipe, fittings, gaskets, appurtenances, linings, and coatings.
2. Product Data:
a. Surface preparation and application reports and procedures as required for lining and coating of pipe and fittings. Ductile iron pipe and fitting manufacturer and manufacturer and applicator of lining and coating, as specified, shall mutually determine recommended surface preparation and application methods, and provide written verification of mutually selected method in the submittals.
3. Samples:
a. Submit Sample of pipe and fitting with each type of lining, for use at the

Site to verify continuity, surface gloss, and color, as applicable, via visual inspection.

4. Test Procedures: For linings and coatings in pipe and fittings.

B. Informational Submittals: Submit the following:
   1. Certificates:
      a. Submit certificate signed by manufacturer of each product that product conforms to applicable referenced standards and the Contract Documents.
   2. Source Quality Control Submittals:
      a. Submit results of specified shop tests for pipe, fittings, linings, and coatings.
      b. Lining and coating test coupons.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Refer to Section 33 05 05, Buried Piping Installation, and Section 40 05 05, Exposed Piping Installation.

PART 2 – PRODUCTS

2.1 MATERIALS

A. General:
   1. Piping systems shall be suitable for their intended use.
   2. Joints shall be as specified in Section 33 05 05, Buried Piping Installation and Section 40 05 05, Exposed Piping Installation. If not specified, provide flanged joints for exposed piping and push-on or mechanical joints for buried piping. Provide couplings on pipe with plain or grooved ends where shown or where approved by ENGINEER.

B. Ductile Iron Pipe, Joints, and Fittings:
   1. Flanged Pipe: Fabricate in accordance with ANSI/AWWA C115.
      a. Pressure Rating: As specified in piping schedule in Section 40 05 05, Exposed Piping Installation. If not otherwise specified, use Special Thickness Class 53 for three-inch to 36-inch diameter pipe.
   2. Non-Flanged Pipe: Conform to ANSI/AWWA C151 for material, pressure, dimensions, tolerances, tests, markings, and other requirements.
      a. Pressure Class: As specified in piping schedules in Section 33 05 05, Buried Piping Installation and Section 40 05 05, Exposed Piping Installation. If not otherwise specified, use Pressure Class 250.
   3. Pipe Joints:
      a. Flanged Joints: Conform to ANSI/AWWA C110 and ANSI/AWWA C111 capable of meeting the pressure rating or special thickness class, and test pressure specified in piping schedule in Section 40 05 05, Exposed Piping Installation.
         1) Gaskets: Unless otherwise specified, gaskets shall be at least 1/8-inch

thick, ring or full-face as required for the pipe, of synthetic rubber compound containing not less than 50 percent by volume nitrile or neoprene, and shall be free from factice, reclaimed rubber, and other deleterious substances. Gaskets shall be suitable for the service conditions specified, specifically designed for use with ductile iron pipe and fittings.

2) Bolts: Comply with ANSI B18.2.1.
   a) Exposed: ASTM A307, Grade B.
   b) Buried or Submerged: ASTM A193, Grade B8M, Class 2, Heavy hex, Type 316 stainless steel.
3) Nuts: Comply with ANSI B18.2.2.
   a) Exposed: ASTM A563, Grade A, Heavy hex.
   b) Buried or Submerged: ASTM A194, Grade B8M, Heavy hex, Type 316 stainless steel.

b. Mechanical Joints: Comply with ANSI/AWWA C111 and ANSI/AWWA C151, capable of meeting pressure rating or special thickness class, and test pressure specified in piping schedules in Section 33 05 05, Buried Piping Installation, and Section 40 05 05, Exposed Piping Installation.
   1) Glands: Ductile iron.
   2) Gaskets: Plain tip.
   3) Bolts and Nuts: High strength, low alloy steel.
   4) Manufacturers: Provide products of one of the following:
      a) Clow Water Systems Company
      b) Atlantic States Cast Iron Pipe Company
      c) Canada Pipe Company, Ltd.
      d) McWane Cast Iron Pipe Company
      e) Pacific States Cast Iron Pipe Company
      f) Griffin Pipe Products Co.
      g) American Cast Iron Pipe Co.
      h) U.S. Pipe and Foundry Co.
      i) Or equal.

c. Push-On Joints: Comply with ANSI/AWWA C111 and ANSI/AWWA C151, capable of meeting pressure class or special thickness class, and test pressure specified in piping schedules in Section 33 05 05, Buried Piping Installation, and Section 40 05 05, Exposed Piping Installation.
   1) Gaskets: Vulcanized SBR, unless otherwise specified.
   2) Stripes: Each plain end shall be painted with a circular stripe to provide a guide for visual check that joint is properly assembled.
   3) Products and Manufacturers: Provide one of the following:
      a) Tyton or Fastite Joint by Clow Water Systems, Atlantic States Cast Iron Pipe Company, Canada Pipe Company, Ltd., McWane Cast Iron Pipe Company, Pacific States Cast Iron Pipe Company, and Griffin Pipe Products Company.
      b) Fastite Joint by American Cast Iron Pipe Company.
      c) Tyton Joint by U.S. Pipe and Foundry Company.
      d) Or equal.

d. Grooved End Joints: Comply with ANSI/AWWA C606.

1) Gaskets: Flush seal type designed for ductile iron that complies with or exceeds requirements of ASTM D2000
2) Bolts and nuts: As specified for flanged joints.
3) Unless otherwise specified, grooved end couplings shall be rigid joint for exposed service and flexible joint for buried service.
4) Products and Manufacturers: Provide one of the following:
   a) Victaulic, Style 31.
   b) Or equal.

e. Restrained Joints: Restrained push-on joints shall be capable of being deflected after full assembly. Field cuts of restrained pipe are not allowed without approval of ENGINEER.
   1) Products and Manufacturers: Provide restrained joints for mechanical joint piping by one of the following:
      a) Megalug, Series 1100, by EBBA Iron Sales, Inc.
      b) MJ Coupled Joint, by American Cast Iron Pipe Co.
      c) MJ Field Lok, by U.S. Pipe and Foundry Co.
      d) Or equal.
   2) Products and Manufacturers: Provide restrained joints for push-on joint piping by one of the following:
      a) Super-Lock Joint Pipe, by Clow Water Systems, a division of McWane, Inc.
      b) Lok-Ring Joint, or Flex-Ring Joint, by American Cast-Iron Pipe Company.
      c) TR Flex Joint, by U.S. Pipe and Foundry Company.
      d) Snap-Lok, by Griffin Pipe Products Company.
      e) Or equal.

4. Flanged and Push-On Joint Fittings: Comply with ANSI/AWWA C110 and ANSI/AWWA C111.
   a. Material: Ductile iron.
   b. Pressure rating, gaskets, bolts, and nuts shall be as specified for flanged joints. Pressure rating of fittings shall meet, but not exceed, specified pressure rating or special thickness class of the connected pipe.
5. Mechanical Joint Fittings: Comply with ANSI/AWWA C110 and ANSI/AWWA C111.
   a. Material: Ductile iron.
   b. Glands: Ductile iron.
   c. Pressure rating, gaskets, bolts, and nuts shall be as specified for mechanical joints. Pressure rating of fittings shall meet, but not exceed, specified pressure rating or special thickness class of connected pipe.

C. Lining, General:
   1. Typical Service Conditions:

Property	All Services
Fluid(s) Conveyed Through Pipe	Water
pH range	6.5-8
Temperature Range (degrees F)	33-70
Lining Type	As specified

D. Cement-mortar Lining:
   1. Where specified in piping schedules included with Section 33 05 05, Buried Piping Installation and Section 40 05 05, Exposed Piping Installation, pipe and fittings shall be lined with bituminous seal coated cement-mortar lining in accordance with ANSI/AWWA C104.

E. Couplings:
   1. Refer to Section 40 05 06, Couplings, Adapters, and Specials for Process Piping.

F. Specials:
   1. Transition Pieces:
      a. Provide suitable transition pieces (adapters) for connecting to existing piping.
      b. Unless otherwise shown or indicated, expose existing piping to determine material, dimensions, and other data required for transition pieces.
   2. Taps:
      a. Provide taps where shown or required for small-diameter piping or instrumentation connections.
      b. Provide corporation stops where shown or required.
      c. Where pipe wall thickness or tap diameter will not allow engagement of 5 full threads, provide tapping saddle with outlet joints conforming to requirements of Paragraph 2.1.B.3.a of this Section for four-inch through 12-inch diameter pipe, and Paragraph 2.1.B.3.b. for 14-inch through 36-inch diameter pipe.
      d. For flanged connections on tapping saddle outlet branch, counterbore flange in accordance with MSS SP-60 dimensions. Inside diameter of outlet shall be 1/4-inch greater than nominal diameter.

2.2 MARKING FOR IDENTIFICATION

A. In addition to identification markings specified in Section 33 05 05, Buried Piping Installation, and Section 40 05 05, Exposed Piping Installation, also stamp, mark, and identify push-on joint and mechanical joint pipe with:
   1. Name or trademark of manufacturer.
   2. Weight, class or nominal thickness, and casting period.
   3. Country where cast.
   4. Year the pipe was produced.
   5. Letters “DI” or “Ductile” shall be cast or metal stamped

B. In addition to identification markings specified in Section 33 05 05, Buried Piping Installation, and Section 40 05 05, Exposed Piping Installation, also stamp, mark, and identify flanged pipe with:
   1. Flange manufacturer's mark, size, and letters "DI" cast or stamped on the flanges.
   2. Fabricator's mark if other than flange manufacturer.
   3. Length and weight.

C. In addition to identification markings specified in Section 33 05 05, Buried Piping Installation, and Section 40 05 05, Exposed Piping Installation, also stamp, mark, and identify fittings with:
   1. Manufacturer's identification.
   2. Pressure rating.
   3. Nominal diameters of openings.
   4. Country where cast.
   5. Number of degrees or fraction of the circle on bends.
   6. Letters "DI" or "Ductile" cast on them.

2.3 EXTERIOR SURFACE PREPARATION AND COATINGS

A. General Coating Requirements:
   1. Coating types are specified in piping schedules in Section 33 05 05, Buried Piping Installation, and Section 40 05 05, Exposed Piping Installation.

B. Exposed Pipe and Fittings:
   1. Surface Preparation:
      a. Initial Surface Inspection: Pipe and fitting manufacturer and coating applicator shall inspect surface to be coated and mutually determine recommended NAPF 500-03 surface preparation method.
      b. Surface Preparation: Prepare surface in accordance with recommended NAPF 500-03 method.
      c. Finished Surface Inspection: Prepared surfaces shall be inspected by coating applicator prior to application to determine acceptability of finished surface. If surface is unacceptable, repeat surface preparation and re-application as necessary.
   2. After recommended surface preparation, prime coat exterior ferrous metal surfaces of pipe and fittings in the shop in accordance with Section 09 91 00, Painting.
   3. Field painting shall comply with Section 09 91 00, Painting.

C. Buried Pipe and Fittings:
   1. Asphaltic Coating: Where specified in piping schedule in Section 33 05 05, Buried Piping Installation, coat pipe and fittings with an asphaltic coating approximately one-mil thick, in accordance with ANSI/AWWA C151, ANSI/AWWA C115, ANSI/AWWA C110, and ANSI/AWWA C153, as applicable.

2. Fusion Bonded Epoxy Coating for Fittings:
   a. When specified in piping schedule in Section 33 05 05, Buried Piping Installation, fittings shall be factory coated with 100 percent solids, thermosetting, dry powder epoxy, in conformance with ANSI/AWWA C116.
   b. Apply coating utilizing a method, recommended by manufacturer that meets requirements of this Section, with finished dry film thickness of at least six mils, with exception of joint areas, which shall receive at least a four-mil dry film thickness coating. Heat and cure fittings in accordance with coating manufacturer's recommendations.
   c. Source Quality Control: Cut a test coupon from coated fitting no less than six inches in diameter, and approximately four inches long, and split coupon lengthwise into two equal sections. Surface preparation, application procedure, thickness, and curing parameters shall be the same for test coupon as for Project fittings. Perform the following tests on test coupon:
      1) Scribe coating material through to bare surface of fitting with an "X" across full length of test coupon. Immerse coupon for 500 hours in 150-degree F bath of distilled water. Coating shall show no signs of disbondment or blistering.
      2) Test coupon shall be impact tested using ASTM G14 test method with 20 in.-lbf impact applied near center of convex section of test coupon. Coating shall show no signs of cracking or disbondment without magnification.
   d. Manufacturer's Inspection and Certification:
      1) All coated fittings shall be visually inspected by manufacturer and show no sign of blisters, cracks, or lack of coverage.
      2) Check all coated fittings for coating thickness using magnetic film thickness gage utilizing method outlined in SSPC PA 2 Film Thickness Rating.
      3) Holiday-test all coated fittings in accordance with ASTM D5162, NACE RP0188, and SSPC Painting Manual Volume 1, Paragraph XIV, with low-voltage, wet sponge holiday detector. Repair methods and materials for holidays shall be as recommended by coating manufacturer and made prior to shipment to the Site.
   e. Products and Manufacturers: Provide one of the following:
      1) PipeClad 1500, by Valspar Corporation.
      2) Or equal.

PART 3 – EXECUTION

3.1 INSPECTION

A. Inspect piping to assure that piping is free from defects in material and workmanship. Verify compatibility of pipe, fittings, gaskets, linings, and coatings.

3.2 INSTALLATION AND FIELD QUALITY CONTROL

A. For buried piping installation and testing, refer to Section 33 05 05, Buried Piping Installation.

B. For exposed piping installation and testing, refer to Section 40 05 05, Exposed Piping Installation.

+ + END OF SECTION + +

SECTION 40 05 23.23

STAINLESS STEEL PROCESS PIPE FOR LIQUID SERVICE

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install stainless steel pipe and fittings for liquid service.
   2. Extent of piping is shown and shall be in accordance with piping schedule in Section 40 05 05, Exposed Piping Installation.

B. Coordination:
   1. Review installation procedures under this and other Sections and coordinate installation of items that must be installed with or before stainless steel piping Work.
   2. Notify other contractors in advance of installation of stainless steel piping to provide them with sufficient time for installing items included in their contracts that must be installed with or before the stainless steel piping Work.

C. Related Sections:
   1. Section 40 05 05, Exposed Piping Installation.

1.2 REFERENCES

A. Standards referenced in this Section include:
   1. ANSI B16.1, Cast-Iron Pipe Flanges and Flanged Fittings.
   2. ANSI B36.19, Stainless Steel Pipe (ASME B36.19M).
   3. ASTM A182/A182M, Specification for Forged or Rolled Alloy and Stainless Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service.
   4. ASTM A193/A193M, Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service.
   5. ASTM A240/A240M, Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
   6. ASTM A276, Specification for Stainless Steel Bars and Shapes.
   7. ASTM A312/A 312M, Specification for Seamless and Welded Austenitic Stainless Steel Pipes.
   8. ASTM A320/A320M, Specification for Alloy-Steel and Stainless Steel Bolting Materials for Low-Temperature Service.
   9. ASTM A403/A403M, Specification for Wrought Austenitic Stainless Steel Piping Fittings.

10. ASTM A409/A409M, Specification for Welded Large Diameter Austenitic Steel Pipe for Corrosive or High-Temperature Service.
11. ASTM A480/A480M, Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet and Strip.
12. ASTM A774/A774M, Specification for As-Welded Wrought Austenitic Stainless Steel Fittings for General Corrosive Service at Low and Moderate Temperatures.
13. ASTM A778, Specification for Welded, Unannealed Austenitic Stainless Steel Tubular Products.
14. ASTM F593, Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs
15. AWS D1.6/D1.6M, Structural Welding Code – Stainless Steel.

1.3 QUALITY ASSURANCE

A. Qualifications:
   1. Manufacturer's Qualifications: Manufacturer shall have a minimum of five years experience producing stainless steel pipe and fittings for liquid service substantively similar to the materials specified, and shall be able to provide documentation of satisfactory service in at least five completed installations.
   2. Welders shall be qualified in accordance with AWS D1.6.

B. Component Supply and Compatibility:
   1. Obtain all materials included in this Section, regardless of component Supplier, from a single stainless steel pipe manufacturer.
   2. Stainless steel pipe manufacturer shall review and approve to prepare all Shop Drawings and other submittals for all materials furnished under this Section.
   3. Materials shall be suitable for specified service conditions and shall be integrated into overall assembly by stainless steel pipe Supplier.

C. Regulatory Requirements: Comply with applicable provisions of the following.
   1. ASME Boiler and Pressure Vessel Code.
   2. National Fire Protection Association

1.4 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Shop Drawings:
      a. Piping layout Shop Drawings in accordance with Section 40 05 05, Exposed Piping Installation.
   2. Product Data:
      a. Product data on pipe, fittings, gaskets, hardware, and appurtenances sufficient to demonstrate compliance with the Contract Documents.

B. Informational Submittals: Submit the following:
   1. Certificates:
      a. Certificate of compliance standards referenced in this Section.

2. Qualifications Statements:
   a. Manufacturer's qualifications when requested by ENGINEER.

1.5 DELIVERY, STORAGE AND HANDLING

A. Refer to Section 40 05 05, Exposed Piping Installation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Provide products of one of the following:
   1. Alaskan Copper & Brass Company.
   2. Felker Brothers Corporation.
   3. Douglas Brothers Division, Robert Mitchell Co., Inc.
   4. Or equal.

2.2 MATERIALS

A. Fabricated Stainless Steel Pipe:
   1. Pipe:
      a. Type: Pipe and fittings less than three-inch diameter shall be seamless. Pipe three-inch diameter and larger may be electrically welded or seamless. Spiral welded pipe is not acceptable.
      b. Material: ASTM A240/A240M, Type 316L stainless steel.
      c. Diameter: Pipe diameters as shown and specified shall mean nominal outside diameter of pipe, except for pipes specified with schedule numbers for wall thickness. Pipes specified with schedule numbers for wall thickness shall conform to ANSI B36.19.
      d. Wall Design Criteria:
         1) Provide a piping that meets fabrication, installation, and service conditions as shown and specified.
         2) Based on internal design pressure indicated for test pressure in Section 40 05 05, Exposed Piping Installation.
         3) Minimum Wall Thickness:
            a) Stainless steel piping less than six-inch diameter shall be Schedule 10S.
      e. Fabrication of stainless steel pipe shall be in accordance with ASTM A312 and ASTM A778, where applicable. Large-diameter pipe in corrosive or high-temperature applications shall conform with ASTM A409.
         1) Longitudinal Seams: Maximum of two per section of pipe.
         2) Girth Seams: Not less than six feet apart, except at fittings and specials.
         3) Pipe Ends: Perpendicular to longitudinal axis.
         4) Roundness: Tolerance of 1/16-inch.

5) Straightness: Tolerance of 1/8-inch in ten feet.
6) Edges: Joint-edges shall be true so as to not leave shoulder on inside of pipe.

f. Welding:
1) Longitudinal Welds: Tungsten Inert Gas or Metal Inert Gas.
2) Circumferential Welds: Heliarc or metallic air process.
3) Grinding: Interior welds shall be ground smooth to provide internal bead of 1/16-inch or less.

g. Factory Finish:
1) Pipe and fittings shall be pickled after manufacture by immersing in acid bath until weld discoloration and iron pickup is removed.
2) Passivate piping welds after fabrication.
3) Thoroughly wash pipe and fittings with clear water after pickling.

2. Joints:
a. General:
1) Comply with Section 40 05 05, Exposed Piping Installation.

3. Fittings:
a. Type: As shown, all stainless steel.
b. Construction:
1) Unless otherwise specified, stainless steel fittings three-inch diameter and larger shall be of same material and same thicknesses as associated pipe. Short-radius, special-radius, and reducing bends shall be mitered construction. Reducers shall be tapered, cone type. Tees, crosses, laterals, and wyes shall be shop-fabricated pipe.
c. Wall Thickness: Conform to wall thickness specified in Section 40 05 05, Exposed Piping Installation, but in no case less than pipe wall thickness.
d. Base Fitting: Provide Type 316L stainless steel.

B. Specials:
1. Taps:
a. Provide taps as shown or required for small pipe and instrument connections.
b. Connections shall be welded, forged threaded Type 316L stainless steel boss.
c. Products and Manufacturers: Provide the following:
1) Thredolet by Grinnell Company.
2) Or equal.

2. Pipe Adapters: Where necessary to join pipe of different type, provide necessary adapters. Ends shall conform to the Specifications for appropriate type joint.

C. Welding of Pipe:
1. Welding performed under this Section shall be completed in shop. Field welding is not allowed. Welding shall conform to AWS D1.6.
2. Stainless steel joining welds shall be made using fully automatic, inert gas process. Before welding longitudinal butt seal, starting and run-off tabs shall be heliarc spot welded to each end of pipe. Ends shall be checked for trueness

to axis. Rigid jigs and fixtures shall be used for holding parts in proper alignment during welding.

3. During welding, joint shall be backed up from opposite side with chill bar. Chill bar shall have series of holes running its entire length through which gas is introduced to assure shielding to interior of joint. Welding of joint shall be by automatic arc, inert gas method. Gas shield shall be utilized top and bottom to assure that weld is made in completely inert atmosphere.
4. Filler wire shall be added to all gauges of material to provide cross section of weld metal equal to or greater than parent metal. Filler wire shall be at least one grade higher than parent metal and always of extra low carbon grade. Filler wire shall be automatically fed to weld with rate of travel of automatic welding machine. Use non-consumable tungsten electrode, with shielding gas being either argon or helium.
5. Welds shall be fully penetrated, sound, and of uniform bead. Circumferential welds shall be made using tungsten shielded arc process. Welds shall have full penetration to interior surface of pipe. Provide gas shielding to interior of joint as well as to exterior, to assure that weld is made in completely inert atmosphere.
6. Welds shall have surface finish equal to smoothness of 2D sheet finish. Interior weld beads shall be smooth, evenly distributed, with interior projection not exceeding 1/16-inch beyond inside diameter of pipe or fitting. Ripples or unevenness shall be finely ground to meet above requirements. Major grinding of interior seams to remove excess projection of welds or severe unevenness is not allowed.
7. Outside weld area shall be wire brushed. Brushes shall be of stainless steel and used only on stainless steel material. Exterior discoloration and deposits left by welding shall be removed mechanically with wire brushes or non-metallic abrasives.

2.3 FINAL CLEANING

A. After fabrication, mechanically clean accessible weld surfaces with wire brushes or non-metallic abrasives.

B. Pipe, fittings, and flanges shall be free of iron particulates and other foreign material.

2.4 IDENTIFICATION

A. Pipe and fitting materials shall be stamped, marked, or identified with the following:
   1. Name of manufacturer.
   2. Date of manufacture.
   3. Operating design pressure at operating design temperature.
   4. Type of service.
   5. Manufacturer's part number.

PART 3 - EXECUTION

3.1 INSPECTION

A. Inspect pipe materials for defects in material and workmanship. Verify compatibility of pipe and fittings.

3.2 INSTALLATION

A. Refer to Section 40 05 05, Exposed Piping Installation.

+ + END OF SECTION + +

SECTION 40 05 31

THERMOPLASTIC PROCESS PIPE

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install thermoplastic piping and fittings.
   2. Extent of piping is shown and shall be in accordance with piping schedules in Section 33 05 05, Buried Piping Installation, and Section 40 05 05, Exposed Piping Installation.

B. Coordination:
   1. Review installation procedures under this and other Sections and coordinate installation of items to be installed with or before thermoplastic piping Work.
   2. Notify other contractors in advance of installing thermoplastic piping to provide other contractors with sufficient time for installing items included in their contracts to be installed with or before the thermoplastic piping Work.

C. Related Sections:
   1. Section 33 05 05, Buried Piping Installation.
   2. Section 40 05 05, Exposed Piping Installation.

1.2 REFERENCES

A. Standards referenced in this Section are:
   1. AASHTO, Standard Specifications for Highway Bridges.
   2. ASTM D1784, Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds.
   3. ASTM D1785, Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80 and 120.
   4. ASTM D2464, Specification for Threaded Poly (Vinyl Chlorinated) (PVC) Plastic Pipe Fittings, Schedule 80.
   5. ASTM D2466, Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40.
   6. ASTM D2467, Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.
   7. ASTM D2564, Specification for Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Piping Systems.
   8. ASTM D683, Specification for Socket-Type Polyethylene Fittings for Outside Diameter-Controlled Polyethylene Pipe and Tubing.

9. ASTM D3035, Specification for Polyethylene (PE) Plastic Pipe (DR-PR) Based on Controlled Outside Diameter.
10. ASTM D3139, Specification for Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals.
11. ASTM D3222, Unmodified Poly (Vinylidene Fluoride) (PVDF) Molding Extrusion and Coating Materials.
12. ASTM D3261, Specification for Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing.
13. ASTM D3350, Specification for Polyethylene Plastic Pipe and Fittings Materials.
14. ASTM D4101, Specification for Polypropylene Injection and Extrusion Materials.
15. ASTM F437, Specification for Threaded Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80.
16. ASTM F438, Specification for Socket-Type Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 40.
17. ASTM F439, Specification for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80.
18. ASTM F441/F441M, Specification for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80.
19. ASTM F442/F442M, Specification for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe (SDR-PR).
20. ASTM F477, Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.
21. ASTM F656, Specification for Primers for Use in Solvent Cement Joints of Poly (Vinyl Chloride) (PVC) Plastic Pipe and Fittings.
22. ASTM F714, Specification for Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter.
23. ASTM F1055, Specification for Electrofusion Type Polyethylene Fittings for Outside Diameter Controlled Polyethylene Pipe and Tubing.
24. ASTM F1674, Standard Test Method for Joint Restraint Products for Use with PVC Pipe.
25. ASTM F1760, Specification for Coextruded Poly (Vinyl Chloride) (PVC) Non-Pressure Plastic Pipe Having Reprocessed-Recycled Content.
26. AWWA C900, Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 4 In.-12 In. (100 mm-300 mm), for Water Transmission and Distribution
27. AWWA C901, Polyethylene (PE) Pressure Pipe and Tubing, 1/2 In. (13 mm) Through 3 In. (76 mm), for Water Service.
28. AWWA C905, Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 14 In.-48 In. (350 mm-1,200 mm).
29. AWWA C906, Polyethylene (PE) Pressure Pipe and Fittings, 4 In. (100 mm) Through 63 In. (1,600 mm), for Water Distribution and Transmission.
30. AWWA C907, Injection-Molded Polyvinyl Chloride (PVC) Pressure Fittings, 4 In. Through 12 In. (100 mm Through 300 mm).
31. NSF 14, Plastic Piping Systems Components and Related Material.
32. ANSI/NSF 61, Drinking Water System Components - Health Effects.

33. Standards of U.S. Food and Drug Administration.

1.3 QUALITY ASSURANCE

A. Qualifications:
   1. Manufacturer: Shall have a minimum of five years experience producing thermoplastic pipe and fittings substantively similar to the materials specified, and shall be able to submit documentation of satisfactory service in at least five completed installations in operation for at least five years each.
   2. Installer:
      a. Engage a single pipe installer who shall be responsible for all thermoplastic pipe Work, and who shall employ only tradesmen with specific skills and experience in the type of Work required.
      b. Installer shall have a minimum of five years experience installing thermoplastic pipe and fittings substantively similar to the materials specified and substantively similar to or larger than the scope of thermoplastic piping Work on the Project, and shall be able to submit documentation of satisfactory experience in at least five completed installations in operation for at least five years each.

B. Component Supply and Compatibility:
   1. Obtain all materials included in this Section, regardless of component Supplier, from a single thermoplastic pipe Supplier. All pipe of each material type shall be furnished by the same manufacturer.
   2. Thermoplastic pipe Supplier shall review and approve to prepare all Shop Drawings and other submittals for all materials furnished under this Section.
   3. Materials shall be suitable for specified service conditions and shall be integrated into overall assembly by thermoplastic pipe Supplier.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Shop Drawings:
      a. Submit piping layout Shop Drawings in accordance with Section 33 05 05, Buried Piping Installation, and Section 40 05 05, Exposed Piping Installation.
   2. Product Data:
      a. Submit product data on pipe, fittings, gaskets, hardware, and appurtenances sufficient to demonstrate compliance with the Contract Documents.

B. Informational Submittals: Submit the following:
   1. Certificates:
      a. Submit manufacturer's certificate of compliance standards referenced in this Section.
   2. Source Quality Control Submittals:
      a. When requested by ENGINEER, submit results of source quality control tests.

3. Qualifications Statements:
   a. Submit qualifications of manufacturer when requested by ENGINEER.
   b. Submit qualifications of installer when requested by ENGINEER.

1.5 DELIVERY, STORAGE AND HANDLING

A. Refer to Section 33 05 05, Buried Piping Installation, and Section 40 05 05, Exposed Piping Installation.

PART 2 – PRODUCTS

2.1 SERVICE CONDITIONS

A. General:
   1. Pipe materials shall be suitable for services intended. Refer to piping schedules in Section 33 05 05, Buried Piping Installation, and Section 40 05 05, Exposed Piping Installation.
   2. Pipe shall be homogeneous throughout and free of visible cracks, holes, foreign inclusions, and other defects. Unless otherwise shown or indicated, pipe shall be uniform in color, opacity, density, and other physical properties.
   3. Comply with NSF 14.
   4. Buried pipe shall be capable of withstanding external live load, including impact, equal to AASHTO H-20 loading, with cover shown or indicated on the Drawings.
   5. Pipe, fittings, and appurtenances in contact with potable water or water that will be treated to become potable shall be listed in ANSI/NSF 61 as being suitable for contact with potable water, and shall comply with requirements of the authorities having jurisdiction at the Site.

2.2 POLYVINYL CHLORIDE (PVC) PIPING

A. PVC Pipe – General Applications: Unless otherwise shown or indicated, PVC pipe shall comply with the following:
   1. Manufacturers: Provide products of one of the following:
      a. Ipex, Inc.
      b. Spears Manufacturing Company.
      c. Or equal.
   2. Material: Unless otherwise specified, comply with the following:
      a. Type and Grade: Type 1, Grade 1.
      b. Wall Thickness: Schedule 80 complying with ASTM D1784 and ASTM D1785, and US Product Service PS 21-70 as having same outside diameter dimension as cast-iron pipe.
      c. Temperature Rating: Rated for temperature to 140 degrees F.
   3. Fittings: Type, grade, schedule, and color of fitting shall match the associated pipe.
      a. Solvent Weld: Comply with ASTM D2467.

b. Threaded: Threaded fittings shall comply with ASTM D2464.
c. Flanged: Provide flanged fittings with gaskets suitable for the liquid service of the associated piping.

4. Joints:
a. Solvent Weld: Use primer and solvent cement recommended by PVC pipe manufacturer for the application. Primer shall be in accordance with ASTM F656, and solvent cement shall be in accordance with ASTM D2564.
b. Threaded: Use 100 percent virgin polytetrafluoroethylene (Teflon or PTFE) tape for threaded fittings. Pipe shall not be threaded.
c. Flanged: Provide with backup flange minimum 1/8-inch thick. Backup flanges and connecting bolts shall be Type 304 stainless steel.

B. Buried PVC Gravity Sewer Pipe.
1. Manufacturers: Provide products of one of the following:
a. Ipex, Inc.
b. Diamond Plastics Corp.
c. Or equal.

2. Material:
a. Pipe shall comply with ASTM D3034 or ASTM F679 (as applicable).
b. Wall Thickness and Pipe Stiffness: Pipe stiffness shall be determined in accordance with test methods in ASTM D3034 or ASTM F679 (as applicable).
1) Main Line: SDR 35, with minimum ring stiffness of 46 psi.
2) Service Laterals: SDR 28, with minimum ring stiffness of 90 psi.

3. Fittings:
a. Injection-molded, gasketed fittings shall comply with ASTM F1336, and ASTM D3034 or ASTM F679 (as applicable).
b. Fabricated fittings shall comply with ASTM F1336.
c. Unless otherwise shown or indicated, saddle wyes are unacceptable.

4. Joints:
a. Provide bell and spigot joints. Bell shall consist of an integral wall section to hold securely in place (and prevent displacement during assembly of joint) elastomeric O-ring gasket.
b. Jointing lubricant shall be as recommended by pipe manufacturer.
c. Provide elastomeric gaskets complying with ASTM F477, and ASTM D3139 or ASTM D3212.

C. PVC Drain, Waste, and Vent (PVC-DWV) Pipe.
1. Manufacturers: Provide products of one of the following:
a. Chemtrol, manufactured by Nibco, Inc.
b. Spears Manufacturing Company.
c. Or equal.

2. Material: In accordance with ASTM D1784. Unless otherwise shown or indicated, PVC-DWV pipe shall be:
a. Type and Grade: Type 1, Grade 1.
b. Wall Thickness: Schedule 40.

c. Color: White.

3. Fittings: Manufactured in accordance with ASTM D2665 and ASTM D3311.
   a. Solvent weld.
   b. Spigot.
4. Joints:
   a. Solvent weld.
   b. Threaded.

2.3 IDENTIFICATION

A. Pipe material identification requirements are in Section 33 05 05, Buried Piping Installation, and Section 40 05 05, Exposed Piping Installation.

2.4 SOURCE QUALITY CONTROL

A. Shop Tests:
   1. Pipe manufacturer shall maintain continuous quality control program.
   2. Where applicable and when requested by ENGINEER, submit results of source quality control tests specified in reference standards.

PART 3 - EXECUTION

3.1 INSPECTION

A. Inspect pipe materials for defects in material and workmanship. Verify compatibility of pipe and fittings.

3.2 INSTALLATION

A. For buried piping installation, refer to Section 33 05 05, Buried Piping Installation.

B. For exposed piping installation, refer to Section 40 05 05, Exposed Piping Installation.

+ + END OF SECTION + +

SECTION 40 05 33

HIGH DENSITY POLYETHYLENE PROCESS PIPE

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish, test, and place in satisfactory service the High Density Polyethylene (HDPE) process pipe and fittings as shown.
   2. The extent of HDPE pipe and fittings to be furnished is shown and in the piping schedules included in Section 33 05 05, Buried Piping Installation.

B. Coordination:
   1. Review installation procedures under other Sections and coordinate the installation of items that must be installed with, or before, the HDPE process pipe Work.
   2. Notify other contractors in advance of the installation of the HDPE process pipe and fittings to provide them with sufficient time for the installation of items included in their contracts that must be installed with, or before, the HDPE process pipe and fittings Work.

C. Related Sections:
   1. Section 31 23 05, Excavation and Fill.
   2. Section 03 30 00, Cast-In-Place Concrete.
   3. Section 09 91 00, Painting.
   4. Section 33 05 05, Buried Piping Installation.
   5. Section 40 05 53, Process Valves.

1.2 REFERENCES

A. Standards referenced in this Section are listed below:
   1. American Society for Testing and Materials, Inc., (ASTM).
      a. ASTM D 638, Test Method for Tensile Properties of Plastics.
      b. ASTM D 696, Standard Test Method for Coefficient of Linear Thermal Expansion of Plastics between - 30°C and 30°C with a Vitreous Silica Dilatometer.
      c. ASTM D 746, Test Method for Brittleness Temperature of Plastics and Elastomers by Impact.
      d. ASTM D 790, Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.

e. ASTM D 1238, Test Method for Melt Flow Rates of Thermoplastics by Extrusion Plastometer.
f. ASTM D 1248, Specification for Polyethylene Plastics Extrusion Materials for Wire and Cable.
g. ASTM D 1505, Test Method for Density of Plastics by the Density-Gradient Technique.
h. ASTM D 1525, Test Method for Vicat Softening Temperature of Plastics.
i. ASTM D 1598, Test Method for Time-to-Failure of Plastic Pipe under Constant Internal Pressure.
j. ASTM D 1599, Test Method for Resistance to Short-Time Hydraulic Failure Pressure of Plastic Pipe, Tubing, and Fittings.
k. ASTM D 1603, Test Method for Carbon Black in Olefin Plastics.
l. ASTM D 1693, Test Method for Environmental Stress-Cracking of Ethylene Plastics.
m. ASTM D 2122, Test Method for Determining Dimensions of Thermoplastic Pipe and Fittings.
n. ASTM D 2240, Test Method for Rubber Property-Durometer Hardness.
o. ASTM D 2290, Test Method for Apparent Hoop Tensile Strength of Plasticor Reinforced Plastic Pipe by Split Disk Method.
p. ASTM D 2412, Test Method for Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading.
q. ASTM D 2657, Practice for Heat Fusion Joining of Polyolefin Pipe and Fittings.
r. ASTM D 2774, Practice for Underground Installation of Thermoplastic Pressure Piping.
s. ASTM D 2837, Test Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials or Pressure Design Basis for Thermoplastic Pipe Products.
t. ASTM D 3035, Specification for Polyethylene (PE) Plastic Pipe (DR-PR), Based on Controlled Outside Diameter.
u. ASTM D 3261, Specification for Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing.
v. ASTM D 3350, Specification for Polyethylene Plastics Pipe and Fittings Materials.
w. ASTM F 412, Terminology Relating to Plastic Piping Systems.
x. ASTM F 714, Specification for Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter.
y. ASTM F 1248, Test Method for Determination of Environmental Stress Crack Resistance (ESCR) of Polyethylene Pipe.

2. American Water Works Association, (AWWA).
   a. AWWA C901, Polyethylene (PE) Pressure Pipe and Tubing, 1/2-inch through 3-inch, for Water Service.
3. National Science Foundation, (NSF).
   a. NSF 14, Plastics Piping Components and Related Materials.

1.3 QUALITY ASSURANCE

A. Manufacturer's Qualifications:
   1. Manufacturer shall have a minimum of five years experience producing substantial similar type materials and shall be able to show evidence of at least five installations in satisfactory operation for at least five years.
   2. HDPE process pipe and fittings shall be the product of a single manufacturer.
   3. The HDPE process pipe and fittings manufacturer shall have an established Quality Assurance Program responsible for inspecting incoming and outgoing materials.
   4. The HDPE process pipe and fittings manufacturer shall have an established Quality Assurance program responsible for assuring the long-term performance of materials and products.
   5. The HDPE process pipe and fitting manufacturer shall maintain permanent Quality Assurance/Quality Control (QA/QC) records.

B. Installer's Qualifications:
   1. Engage a single installer regularly engaged in HDPE process piping installation and with experience in the installation of the types of materials required; and who agrees to employ only tradesmen with specific skill and experience in this type of Work. Submit name and qualifications to ENGINEER.
   2. Engage a single installer for the entire HDPE process piping system with undivided responsibility for performance and other requirements.

C. Component Supply and Compatibility:
   1. The HDPE process pipe and fittings manufacturer shall review and approve or prepare all Shop Drawings and other submittals for all components furnished under this Section.
   2. All components shall be specifically constructed for the specified service conditions and shall be integrated into the overall assembly by the HDPE process pipe and fittings manufacturer.

1.4 SUBMITTALS

A. Submit these with Shop Drawings required under Section 33 05 05, Buried Piping Installation.

B. Action Submittals: Submit the following:
   1. Shop Drawings:
      a. Details of piping system including location of supports, restraints, fittings, anchors, vents, low-point drains, termination assemblies and all accessories necessary for piping system.
      b. Pipe laying schedules.
   2. Product Data:

a. Details of construction, fabrication, and pipe materials.
b. Detailed procedures to be used in joining and installing piping system, including manufacturer's recommendations.

3. Testing Plans, Procedures, and Testing Limitations:
   a. Pipe testing procedures.

C. Informational Submittals:
1. Certificates:
   a. Materials Certificates of Conformance: Submit certificates of conformance with Referenced Standards as required in Article 2.4, below.
   b. Upon shipment, CONTRACTOR shall furnish the HDPE pipe manufacturer's Quality Assurance/Quality Control (QA/QC) certifications to verify that the materials supplied for the Project are in accordance with the requirements of this Section and a manufacturer's warranty covering materials and workmanship of the HDPE piping.
2. Suppliers Instructions:
   a. Detailed procedures to be used in joining and installing piping system, including manufacturer's recommendations.
3. Qualifications Statements:
   a. Installer's qualifications.

1.5 DELIVERY, STORAGE AND HANDLING

A. Refer to Sections 33 05 05, Buried Piping Installation.

PART 2 - PRODUCTS

2.1 SYSTEM PERFORMANCE

A. HDPE piping system shall be specifically designed, constructed, and installed for the service intended and shall comply with the following service conditions.

B. Design Criteria:

Location:	Buried Chemical Transmission
Nominal Pipe Size:	1-inch
Pipe Stiffness, (psi):	200
Min. Wall Thickness/Pipe Size, (in./in.):	0.125/1
Reinforced Wall Thickness, (in):	0.125

Fluid Temperature, (°F maximum):	70
Fluid Flow, (gpm):	10
Fluid Chemical Composition:	Solutions of: 1. Sodium Hypochlorite 2. Fluoride 3. Orthophosphate
Fluid Specific Gravity:	Approximately 1.0

2.2 PHYSICAL PROPERTIES

A. Materials used for the manufacture of polyethylene pipe and fittings shall meet the following physical property requirements:

	Property	Unit	Test Procedure	Value
1.	Material Designation	-	PPI/ASTM	-
2.	PPI Material Listing	-	PPI TR-4	PE 3408
3.	Material Classification	-	ASTM D 1248	III C 5 P34
4.	Cell Classification	-	ASTM D 3350	345434C or 355434C
5.	Density	g/cm3	ASTM D 1505	>0.941
6.	Melt Index (E)	g/10 min	ASTM D 1238	<0.15
7.	Flexural Modulus	psi	ASTM D 790	>110,000
8.	Tensile Strength	psi	ASTM D 638	<160,000
9.	ESCR (C)	hours	ASTM D 1693	3,000 to 3,500
10.	HDB	psi	ASTM D 2837	1,600 @ 23°C
11.	UV Stabilizer (C)	percent carbon black	ASTM D 1603	2 to 3
12.	Elastic Modulus	psi	ASTM D 638	110,000
13.	Brittleness Temperature	F	ASTM D 746	<-180
14.	Vicat Softening Temp	F	ASTM D 1525	255
15.	Thermal Expansion	in/in/ F	ASTM D 696	8 x 10E-5
16.	Hardness	Shore D	ASTM D 2240	64
17.	Molecular Weight Category	-	-	Extra-High

B. There shall be no evidence of splitting, cracking or breaking when the pipe is tested in accordance with Article 2.4, below.

C. Ring Stiffness Constant (RSC) values for the pipe can be directly related to the pipe's class designation. (Nominal RSC of Class 40 pipe = 40, etc.). The minimum RSC is 90 percent of the nominal.

D. The HDPE pipe and fittings shall be homogeneous throughout and free from visible cracks, holes, foreign inclusions or other injurious defects. The pipe shall be as uniform as commercially practical in color, opacity, density and other physical properties.

E. Clean rework or recycled material generated by the manufacturer's own production may be used as long as the pipe or fittings produced meet all the requirements of this Section.

2.3 PIPE AND FITTINGS

A. Dimensions:
   1. Pipe Dimensions: The nominal inside diameter of the pipe shall be true to the specified pipe size in accordance with AWWA C901 and AWWA C906. Standard laying lengths shall be 50 feet ± 2-inches.
   2. Fitting Dimensions: Fittings such as couplings, wyes, tees, adapters, etc. for use in laying pipe shall have standard dimensions that conform to ASTM D 3261.

B. Pipe and fittings shall be produced from identical materials, meeting the requirements of this Section, by the same manufacturer. Special or custom fittings may be exempted from this requirement.

C. Pipe and fittings shall be pressure rated to meet the service pressure requirements specified by ENGINEER. Whether molded or fabricated, fittings shall be fully pressure rated to at least the same service pressure rating as the pipe to which joining is intended.

D. Molded fittings shall meet the requirements of ASTM D 3261 and this Section. At the point of fusion, the outside diameter and minimum wall thickness of fitting butt fusion outlets shall meet the diameter and wall thickness specifications of the mating system pipe. Fitting markings shall include a production code from which the location and date of manufacture can be determined. The manufacturer shall provide an explanation of the production codes used.

E. Marking:
   1. Each standard and random length of pipe and fitting in compliance with this standard shall be clearly marked with the following information.
      a. ASTM or AWWA Standard Designation.
      b. Pipe Size.
      c. Class and Profile Number.
      d. Production Code.
      e. Standard Dimension Ratio (SDR).

2.4 SOURCE QUALITY CONTROL

A. At a minimum, incoming polyethylene materials shall be inspected for density in accordance with ASTM D 1505 and melt flow rate in accordance with ASTM D 1238. All incoming polyethylene materials shall be certified by the supplier. Certification shall be verified by CONTRACTOR and ENGINEER. Incoming materials shall be approved by Manufacturer's Quality Assurance Program before processing into finished goods.

B. Representative samples of polyethylene materials shall be tested against the physical property requirements required herein. Each extrusion line and molding machine shall be qualified to produce pressure rated products by taking representative production samples and performing sustained pressure tests in accordance with ASTM D 1598.

C. Quality Assurance test for representative pipe and fitting samples shall include:

Test	Standard	Pipe	Fittings
Ring ESCR	ASTM F 1248	Yes	Not Applicable
Sustained pressure at 176°F/725 psi hoop stress: (f_o>100 h)	ASTM D 1598	Yes	Yes
Sustained pressure at 73°F/1,600 psi hoop stress: (f_o>1000 h)	ASTM D 1598	Yes	Yes

D. Material shall be listed in the name of the HDPE pipe and fitting manufacturer as required by the Plastics Pipe Institute (PPI) in PPI TR-4 with the following Standard Grade ratings:

	73.4°F	140°F
1. Hydrostatic Design Basis (HDB)	1,600 psi	800 psi
2. Hydrostatic Design Stress (HDS)	800 psi	400 psi

PPI material listing in the name of the resin supplier is not acceptable in meeting this requirement.

PART 3 - EXECUTION

3.1 FIELD QUALITY CONTROL

A. Pipe may be rejected for failure to conform to these Specifications or following:
   1. Fractures or cracks passing through pipe wall, except single crack not exceeding 2 inches in length at either end of pipe which could be cut off and

discarded. Pipes within one shipment shall be rejected if defects exist in more than five percent of shipment or delivery.

2. Cracks sufficient to impair strength, durability or serviceability of pipe.
3. Defects indicating improper proportioning, mixing, and molding.
4. Damaged ends, where such damage prevents making satisfactory joint.
5. Gouges or scrapes exceeding ten percent of the specified wall thickness.

B. Acceptance of fittings, stubs or other specifically fabricated pipe sections shall be based on visual inspection at Site and documentation of conformance to these Specifications.

C. CONTRACTOR to provide as-built of pipe end point and angle point coordinates and elevations prior to backfilling trench.

3.2 INSTALLATION

A. Refer to Section 33 05 05, Buried Piping Installation.

B. Heat Fusion of Pipe:

1. HDPE pipe and fittings joints shall be heat fused by a qualified technician; trained by the manufacturer's representative in accordance with the manufacturer's recommended fusion procedures. Training must have occurred within the previous 12 months, or submittals verifying experience within the previous 12 months for all technicians performing heat fusion on polyethylene pipe and fittings.
2. Weld in accordance with manufacturer's recommendation for butt fusion methods. Personnel operating fusion equipment shall be certified by the HDPE pipe manufacturer.
3. The first butt fusion weld of each day's production welding and for each separate operator shall be tested by bent strap test method. No production welds shall be performed until successful completion of bent strap test.
4. Butt fusion equipment for joining procedures shall be capable of meeting conditions recommended by HDPE pipe manufacturer including, but not limited to, temperature requirements, alignment, and fusion pressures. The equipment used for the heat fusion joints shall be capable of recording the heating and fusion pressures used to join the HDPE pipe, recording heater temperature, and storing this information for future retrieval (data logger). Each field fusion shall be recorded by such equipment and this information shall be made compiled into daily log reports. Log reports shall be submitted to CONTRACTOR and ENGINEER daily. Reports shall also include the results of the bent strap tests.
5. For cleaning pipe ends, solutions such as detergents and solvents, when required, shall be used in accordance with manufacturer's recommendations.
6. Do not bend pipe to greater degree than minimum radius recommended by manufacturer for type and grade. Shop Drawings shall address locations and

deflections of required fittings to prevent installation that exceeds a greater degree of bending than the manufacturer's recommended minimum bending radius for each size and class of HDPE pipe.

7. Do not subject pipe to strains that will overstress or buckle piping or impose excessive stress on joints.
8. Branch saddle fusions shall be joined in accordance with manufacturer's recommendations and procedures. Branch saddle fusion equipment shall be of size to facilitate saddle fusion within trench.
9. Before butt fusing pipe, inspect each length for presence of dirt, sand, mud, shavings, and other debris or animals. Remove debris from pipe.
10. Cover open ends of fused pipe at the end of each day's Work. Cap to prevent entry by animals or debris.

C. Pipe Placement:
1. Grade control equipment shall be of type to accurately maintain design grades and slopes during installation of pipe.
2. Dewatering: Remove standing water in trench before pipe installation.
3. Unless otherwise specifically stated, install pipe in accordance with manufacturer's recommendations.
4. Maximum lengths of fused pipe to be handled as one section shall be placed according to manufacturer's recommendations as to pipe size, pipe SDR, and topography so as not to cause excessive gouging or surface abrasion, but shall not exceed 400 feet.
5. Cap pipe sections longer than single joining (usually 50 feet) on both ends during placement, except during fusing operations.
6. Notify ENGINEER prior to installing pipe into trench and allow time for ENGINEER's inspection.
   a. Correct irregularities found during inspection.
7. Complete tie-ins within trench whenever possible to prevent overstressed connections.
8. Allow pipe sufficient time to adjust to trench temperature prior to testing, segment tie-ins or backfilling activity.
9. Install reducers adjacent to laterals and tees.
10. To reduce branch saddle stress, install saddles at slope equal to and continuous with lateral piping.
11. Pipe shall be snaked in trench to allow a minimum of 12 inches/100 feet for thermal contraction and expansion.
12. Allow extra length at future connection points to be cut to fit after backfill and prior to tie-in.

3.3 LEAKAGE TESTS

A. Refer to Section 33 05 05, Buried Piping Installation.

++ END OF SECTION ++

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SECTION 40 05 53

PROCESS VALVES

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install process valves and appurtenances, complete and operational.

B. Coordination:
   1. Review installation procedures under this and other Sections and coordinate installation of items that must be installed with or before process valves Work.
   2. Notify other contractors in advance of the installation of process valves and appurtenances to provide them with sufficient time for installing items included in their contracts that must be installed with or before process valves Work.

C. Related Sections:
   1. Section 05 05 33, Anchor Systems.
   2. Section 09 91 00, Painting.
   3. Section 33 05 05, Buried Piping Installation.
   4. Section 40 05 05, Exposed Piping Installation.

1.2 REFERENCES

A. Standards referenced in this Section are listed below:
   1. American Bearing Manufacturers Association (ABMA).
   2. ANSI B16.1, Cast-Iron Pipe Flanges and Flanged Fittings.
   3. ANSI B16.34, Valves-Flanged, Threaded and Welding end. (ASME B16.34).
   4. ANSI/NSF 61 Drinking Water Components – Health Effects.
   5. API STD 594, Check Valves, Flanged Lug, Wafer and Butt-Welding.
   6. API STD 598, Valve Inspection and Testing.
   7. API STD 609, Butterfly Valves: Double Flanged, Lug-Type and Wafer-Type.
   8. ASTM A126, Specification for Gray Iron Castings for Valves, Flanges and Pipe Fittings.
   9. ASTM A193/A193M, Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service.
   10. ASTM A194/A194M, Specification for Carbon and Alloy Steel Nuts for Bolts for High Pressure and High Temperature Service, or Both.

11. ASTM A240/A240M, Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
12. ASTM A276, Specification for Stainless Steel Bars and Shapes.
13. ASTM A307, Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength.
14. ASTM A351/A351M, Specification for Castings, Austenitic, Austenitic-Ferritic (Duplex), for Pressure-Containing Parts.
15. ASTM A380, Practice for Cleaning, Descaling and Passivation of Stainless Steel Parts, Equipment and Systems.
16. ASTM A536, Specification for Ductile Iron Castings.
17. ASTM A564/A564M, Specification for Hot-Rolled and Cold-Finished Age-Hardening Stainless Steel Bars and Shapes.
18. ASTM A743/A743 M, Specification for Castings, Iron-Chromium, Iron-Chromium-Nickel, Corrosion Resistant, for General Application.
19. ASTM B62, Specification for Composition Bronze or Ounce Metal Castings.
20. ASTM B98/B98M, Specification for Copper-Silicon Alloy Rod, Bar, and Shapes.
21. ASTM B138/B138M, Specification for Manganese Bronze Rod, Bar and Shapes.
22. ASTM B265, Specification for Titanium and Titanium Alloy Strip, Sheet and Plate.
23. ASTM B584, Specification for Copper Alloy Sand Castings for General Applications.
24. ASTM D429, Test Methods for Rubber Property - Adhesion to Rigid Substrates.
25. AWWA C500, Metal-Seated Gate Valves for Water Supply Service.
26. AWWA C504, Rubber-Seated Butterfly Valves.
27. AWWA C507, Ball Valves, 6-inch through 48-inch.
28. AWWA C508, Swing-Check Valves for Waterworks Service, 2-inch through 24-inch NPS.
29. AWWA C509, Resilient-Seated Gate Valves for Water Supply Service.
30. AWWA C540, Power-Actuating Devices for Valve and Slide Gates.
31. AWWA C550, Protective Interior Coatings for Valves and Hydrants.
32. AWWA Manual M49, Butterfly Valves: Torque, Head Loss, and Cavitation Analysis.
33. FS TT-C-494, Coating Compound, Bituminous, Solvent Type, Acid-Resistant.
34. NEMA MG 1, Motors and Generators.

1.3 QUALITY ASSURANCE

A. Manufacturer's Qualifications:
   1. Manufacturer shall have minimum of five years of experience producing substantially similar materials and equipment to that required and be able to

provide evidence of at least five installations in satisfactory operation for at least five years.

B. Component Supply and Compatibility:
   1. Obtain each type of equipment and appurtenances included in this Section, regardless of the component manufacturer, from a single manufacturer of the type of process valve. For each type of valve, do not furnish valves of more than one manufacturer.
   2. Supplier of each type of equipment specified shall review and approve or prepare all Shop Drawings and other submittals for all components associated with the type of process valve Supplier is furnishing.
   3. Components shall be suitable for use in the specified service conditions. Components shall be integrated into the overall assembly by the process valve manufacturer.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Shop Drawings:
      a. Installation drawings for valves larger than 4-inch showing orientation of valve in both plan and elevation view. Drawings shall clearly identify valve and its appurtenances, including controls, actuators, valve stems, and other components. Show dimensions of valves and appurtenances in relation to piping and structural and architectural components, where applicable.
      b. Controls for and control characteristics of modulating valves.
      c. Power and control wiring diagrams, including terminals numbers for electric-motor actuators.
      d. Calculations for sizing of electric actuators.
      e. Calculations for sizing of operating mechanism with extension stems.
      f. Calculations for sizing of gear actuators.
   2. Product Data:
      a. Product data sheets.
      b. Complete catalog information, including dimensions, weight, specifications, and identification of materials of construction of all parts.
      c. Corrosion resistance information to confirm suitability of valve materials for the application. Furnish information on chemical resistance of elastomers from elastomer manufacturer.
      d. Cv values and hydraulic headloss curves.
   3. Testing Plans:
      a. Submit plan for shop testing of each valve for which shop testing is specified, including testing plan's and test facility's limitations proposed.

B. Informational Submittals: Submit the following:
   1. Certificates:

a. Certificates of compliance with referenced standards, where applicable, including those of AWWA, NSF, and others required by ENGINEER.

2. Manufacturer Instructions:
   a. Submit manufacturer's instructions for handling, storing, and installing valves and appurtenances. Provide templates and setting drawings for valves and appurtenances that require anchor bolts or similar anchorages.
3. Source Quality Control Submittals:
   a. Submit copies of shop test results and inspection data, certified by manufacturer.
4. Field Quality Control Submittals:
   a. Submit results of field tests required.
5. Supplier's Reports:
   a. When requested by ENGINEER, submit written report of results of each visit to Site by Supplier's serviceman, including purpose and time of visit, tasks performed and results obtained.
6. Qualifications Statements:
   a. When requested by ENGINEER, submit manufacturer's qualifications demonstrating compliance with the Specifications, including list of existing installations with contact names and telephone number(s) for each.

C. Closeout Submittals: Submit the following:
   1. Operations and Maintenance Data:
      a. Furnish operation and maintenance manuals in accordance with Section 01 78 23, Operations and Maintenance Data.
      b. Furnish in operations and maintenance manuals complete nameplate data for each valve and electric actuator.

D. Maintenance Material Submittals: Submit the following:
   1. Spare Parts, Extra Stock Materials, and Tools:
      a. Spare Parts and Extra Stock Materials: Furnish as specified for each valve type.
      b. Tools: Furnish two sets of special tools (excluding metric tools, if applicable) for each size and type of valve furnished.

1.5 DELIVERY, STORAGE AND HANDLING

A. Packing, Shipping, Handling, and Unloading:
   1. Deliver materials and equipment to Site to ensure uninterrupted progress of the Work. Deliver anchorage products that are to be embedded in concrete in ample time to prevent delaying the Work.
   2. Inspect boxes, crates, and packages upon delivery to Site and notify ENGINEER in writing of loss or damage to materials and equipment. Promptly remedy loss and damage to new condition in accordance with manufacturer's instructions.

3. Conform to Section 01 65 00, Product Delivery Requirements.

B. Storage and Protection:
   1. Keep products off ground using pallets, platforms, or other supports. Store equipment in covered storage and prevent condensation and damage by extreme temperatures. Store in accordance with manufacturer's recommendations. Protect steel, packaged materials, and electronics from corrosion and deterioration.
   2. Conform to Section 01 66 00, Product Storage and Handling Requirements.

PART 2 - PRODUCTS

2.1 GENERAL

A. Valves, General:
   1. Provide each valve with manufacturer's name and rated pressure cast in raised letters on valve body.
   2. Provide valves 4-inch and larger with brass or Type 316 stainless steel nameplate attached with Type 316 stainless steel screws. Nameplates shall have engraved letters displaying the following minimum information:
      a. Valve size.
      b. Pressure and temperature ratings.
      c. Application (other than water and wastewater).
      d. Date of manufacture.
      e. Manufacturer's name.
   3. Provide valves to turn clockwise to close, unless otherwise specified.
   4. Provide valves with permanent markings for direction to open.
   5. Manually operated valves, with or without extension stems, shall require not more than 40-pound pull on manual operator to open or close valve against specified criteria. Gear actuator and valve components shall be able to withstand minimum pull of 200 pounds on manual operator and input torque of 300-foot pounds to actuator nut. Manual operators include handwheel, chainwheel, crank, lever, and T-handle wrench.

B. Valve Materials:
   1. Valve materials shall be suitable for the associated valve's service or application, as shown.
   2. Protect wetted parts from galvanic corrosion caused by contact of different metals.
   3. Wetted components and wetted surfaces of valves used with potable water or water that will be treated to become potable shall conform to ANSI/NSF 61.
   4. Clean and descale fabricated stainless steel items in accordance with ASTM A380 and the following:
      a. Passivate all stainless steel welded fabricated items after manufacture by immersing in pickling solution of six percent nitric acid and three

percent hydrofluoric acid. Temperature and detention time shall be sufficient for removing oxidation and ferrous contamination without etching surface. Perform complete neutralizing operation by immersing in trisodium phosphate rinse followed by clean water wash.

b. Scrub welds with same pickling solution or pickling paste and clean with stainless steel wire brushes or by grinding with non-metallic abrasive tools to remove weld discoloration, and then neutralize and wash clean.

C. Valve Joints:
1. Exposed Valves: Unless otherwise specified, provide with flanged ends conforming to ANSI B16.1. Pressure class of flanges shall be equal to or greater than specified pressure rating of the associated valve.
2. Buried Valves: Unless otherwise specified, provide with mechanical or push-on joints, restrained or unrestrained, as required by piping with which valve is installed.
3. For stainless steel bolting, except where nitrided nuts are required, use graphite-free anti-seize compound to prevent galling. Strength of joint shall not be affected by using anti-seize compound.

2.2 RESILIENT-SEATED GATE VALVES

A. Manufacturers: Provide products of one of the following:
1. M&H Valve Company
2. US Pipe and Foundry.
3. Or equal.

B. General:
1. Provide valves conforming to AWWA C509 and as specified in this Section.
2. Sizes: Four-inch through 12-inch diameter, 16-inch and 20-inch diameter.
3. Type:
   a. Provide non-rising stem (NRS) valves for buried service.
   b. For interior and exposed service, provide outside screw and yoke (OS&Y) rising-stem valves, unless otherwise specified.
   c. Provide position indicators for NRS valves used in exposed service.
4. Minimum Rated Working Pressure:
   a. Valves 12-inch Diameter and Smaller: 200 psig.
   b. Valves 16-inch and 20-inch Diameter: 150 psig.
5. Maximum Fluid Temperature: 150 degrees F.
6. Provide valves with fully encapsulated resilient wedges, unless otherwise specified.

C. Materials of Construction: Shall conform to AWWA C509 and shall be as follows:
1. Valve Body, Bonnet, and Stuffing Box: Cast-iron.
2. Wedge: Cast-iron, symmetrically and fully encapsulated with molded rubber having minimum 1/8-inch thickness.

3. Stem: Manganese bronze.
4. Rubber Items: Buna-N or other synthetic rubber suitable for the application.
5. Internal and external bolting and other hardware including pins, set screws, plug, studs, bolts, nuts, and washers shall be Type 316 stainless steel.

D. Interior Coating:
1. Valves shall be coated inside. Steel, cast-iron and ductile iron surfaces, except machined surfaces, shall be epoxy coated in accordance with AWWA C550.

E. Testing:
1. Test valves in valve manufacturer's shop in accordance with AWWA C509.

F. Gear Actuators for Manually-operated Valves:
1. Provide valves with gear actuators conforming to AWWA C500.
2. Size gear actuators for the following maximum differential pressures:
a. Maximum Differential Pressure Across Closed Valve: 100 psi.

2.3 PVC BALL VALVES

A. Manufacturers: Provide products of one of the following:
1. Nibco Incorporated.
2. Hayward Manufacturing Company.
3. Or equal.

B. General:
1. Ball valves on PVC piping shall be manufactured of polyvinyl chloride (PVC) material with Teflon seats and Viton seals.
2. PVC shall be Type 1, Grade 1 in accordance with ASTM D 1784, and shall be dark grey in color.
3. Valve shall be flanged and rated for 150 psi service.
4. Ball valves for sodium hypochlorite service shall be vented with the vent directed to the upstream side of the valve. Valves shall be vented by the manufacturer or vented by the CONTRACTOR according to the manufacturer's recommendations. Vented ball valves shall have a unique colored handle compared to all other PVC ball valves used in the Work.

2.4 BUTTERFLY VALVES

A. Manufacturers: Provide products of one of the following:
1. DeZurik.
2 Henry Pratt Company.
3. Or equal.

B. General:
1. Provide butterfly valves conforming to AWWA C504 and as specified herein.

2. Sizes:
   a. Flanged: Four-inch through 72-inch diameter.
   b. Mechanical Joint: Four-inch through 48-inch diameter.
3. Rated Working Pressure: 150 psig, Class 150B.
4. Maximum Fluid Temperature: 150 degrees F.
5. Valves shall provide drip-tight bi-directional shutoff at rated pressures.
6. Mount valve seats in valve body. Rubber seats for 24-inch diameter and larger valves shall be replaceable in the field.
7. Valves shall be capable of being maintained in open or partially open position for manual operation, and for automatic operation. When valve disc is maintained, there shall be no chatter or vibration of disc or operating mechanism.
8. Valve packing shall be replaceable without dismantling valve.
9. Disc shall be offset from shaft to provide uninterrupted 360-degree seat seal.

C. Materials of Construction: materials of construction shall conform to AWWA C504 and shall be as follows:
1. Body: Cast-iron, ductile iron, or alloy cast-iron.
2. Shaft: Type 316 stainless steel.
3. Discs:
   a. Valves Smaller than 30-inch Diameter: Cast-iron.
   b. Valves 30-inch Diameter and Larger: Ductile iron.
4. Seats: Buna-N or other synthetic rubber suitable for the application.
5. Seating Surfaces: Type 316 stainless steel.
6. Bearings:
   a. Valves Smaller than 24-inch Diameter: Nylon.
   b. Valves 24-inch Diameter and Larger: Fiberglass with Teflon lining.
7. Shaft Seals: Externally adjustable, material same as for seats. For services that are either buried or submerged, self-adjusting V-type chevron, material same as for seats.
8. Tapered Pins for Attachment of Shaft to Disc: Type 316 stainless steel.
9. Internal and external bolting and other hardware; including pins, set screws, studs, bolts, nuts, and washers shall be Type 316 stainless steel.

D. Interior Coating:
1. Valves shall be coated inside. Steel, cast-iron, and ductile iron surfaces, except machined surfaces, shall be epoxy-coated in accordance with AWWA
C550.

E. Testing:
1. Test each valve in the manufacturer's shop in accordance with AWWA C504.

F. Gear Actuators for Manual Valves:
1. Provide gear actuators conforming to AWWA C540.

2. Gear actuators for valves 20-inch diameter and smaller shall be constructed for 150 psi differential pressure and 16 feet per second port velocity.
3. Gear actuators for valves 24-inch diameter and larger shall be constructed for maximum differential pressures and velocities as specified below:
   a. Maximum Differential Pressure Across Closed Valve: 100 psi.

2.5 SWING CHECK VALVES (FOUR INCHES DIAMETER AND LARGER)

A. Manufacturers: Provide products of one of the following:
   1. APCO Willamette Valve & Primer Corp.
   2. Crispin Valve
   3. G.A. Industries.

B. General:
   1. Provide valves conforming to AWWA C508 and as specified herein.
   2. Sizes: Four-inch through 24-inch diameter.
   3. Type: Resilient-seated.
   4. Rated Working Pressure:
      a. Smaller than 12-inch Diameter: 175 psig.
      b. 12-inch Diameter and Larger: 150 psig.
   5. Provide valves suitable for horizontal or vertical mounting.
   6. Check valves shall have clear waterway with full-open area equal to nominal pipe size.
   7. Provide check valves with outside adjustable weight and lever.
   8. Provide valves larger than six-inch diameter with adjustable air cushion chambers.
   9. Valve seats shall be mechanically attached and shall be field replaceable.

C. Materials of Construction: All materials of construction shall conform to AWWA C508 and shall be as follows:
   1. Body, Disc, Cover and Gland: Cast-iron or ductile iron.
   2. Disc Arm: Ductile iron.
   3. Hinge Shaft: Type 316 stainless steel.
   4. Hinge Shaft Bushings: Bronze, or Type 316 stainless steel for sewage service.
   5. Shaft End Plate: Type 316 stainless steel.
   6. Body Seat: Type 316 stainless steel.
   7. Follower Ring for Rubber Seat on Disc: Type 316 stainless steel.
   8. Disc Center Pin Assembly: Type 316 stainless steel.
   9. Air Cushion Chamber:
      a. Chamber and Plunger: Bronze.
      b. Linkages and Pins: Type 316 stainless steel.
      c. Air Check Valve and Tubing: Brass or stainless steel.
   10. Rubber Items: Buna-N or other synthetic rubber suitable for the application.
   11. Internal and external bolting and other hardware; including pins, set screws, studs, bolts, nuts, and washers shall be Type 316 stainless steel.
   12. Gland Packing: Graphite and Kevlar.

D. Interior Coating:
   1. Valves shall be coated inside. Steel, cast-iron and ductile iron surfaces, except machined surfaces, shall be epoxy coated in accordance with AWWA C550.

E. Testing:
   1. Test each valve in manufacturer's shop in accordance with AWWA C508.
   2. Allowable Leakage at Rated Pressures: Zero.

2.6 CHECK VALVES (3 INCHES DIAMETER AND SMALLER):

A. Product and Manufacturers: Provide products of one of the following:
   1. Fig. 92 A, as manufactured by Jenkins Brothers.
   2. Fig. 34 1/2, as manufactured by Crane Company.
   3. G.A. Industries.

B. General:
   1. Check valves shall absolutely prevent the return of water through the valve when the upstream pressure is decreased below the downstream pressure. The valve shall be tight seating.
   2. Valves shall be bronze, screwed ends with screw in cap suitable for 125 psi service.

2.7 AUTOMATIC FLOW CONTROL VALVES

A. Manufacturers: Provide products of one of the following:
   1. Flomatic Corporation.
   2. Or equal.

B. General:
   1. Application: Maintain preset flow rate regardless of changing upstream and downstream pressure.
   2. Rated Working Pressure: 250 psig.
   3. Sizing Data:
      a. Design Flow Rate: 500 gpm.
      b. Maximum Upstream Pressure: 80 psig.
      c. Minimum Upstream Pressure: 40 psig.
      d. Flow Rate shall be field adjustable.
   4. Valves shall not suffer cavitation damage within five-year period from date of Substantial Completion when exposed to specified operating conditions.
   5. All necessary repairs and/or modifications other than replacement of the main valve body shall be made possible without removing the valve from the pipeline.
   6. Valve FCV-042 shall be configured to operate in-line with the supplied backflow prevention device shown.
   7. Valve FCV-042 shall be supplied with a solenoid set to receive a 110V open/close signal to open or close the valve according to demand as shown.

C. Valve Construction:
   1. Type: Hydraulically operated, single diaphragm-actuated globe valves as shown, with no pistons operating the valve or pilot controls.
   2. Valves shall contain a resilient, synthetic rubber seat seal, with a rectangular cross-section contained on three and one half sides by the spool and seat plate, and form a tight seal against a single removable seat ring.
   3. No o-ring type seal shall be permitted as the seating surface.
   4. Diaphragm assembly shall be fully guided at both ends and for the entire range of travel, in the cover by a removable bushing and in the valve by an integral bearing in the cover end.

D. Materials of Construction:
   1. Body: Ductile iron.
   2. Seat Seal: Resilient, synthetic rubber, suitable for the application.
   3. Diaphragm Assembly Stem: Type 304 stainless steel.
   4. Internal and external bolting and other hardware: Type 316 stainless steel.

E. Interior Coating:
   1. Valves shall be coated inside. Steel, cast-iron and ductile iron surfaces shall be epoxy coated in accordance with AWWA C550.

F. Testing:
   1. Test each assembled valve, except control piping, hydrostatically at 1.5 times rated working pressure of valve for minimum of five minutes per valve.
   2. Test each valve for leakage at rated working pressure against closed valve. Test duration shall be minimum 15 minutes and allowable leakage shall be zero.
   3. Perform functional test on each valve to verify proper operation at specified performance.

2.8 ELECTRIC ACTUATORS (OPEN/CLOSE)

A. Manufacturers: Provide products of one of the following:
   1. Limitorque.
   2. Rotork.
   3. Or equal.

B. Application Criteria:
   1. Ambient Temperature Rating: -20 to +158 degrees F.
   2. Ambient Humidity: 100 percent.
   3. Maximum Differential Pressures Across Closed Valves: 100 psi.
   5. Power Supply: 480-volt, three-phase, 60 Hertz.
   6. Control Voltage: 120 VAC, single phase, 60 Hertz.
   7. Torques: As determined by valve manufacturer.
   8. Duty Cycle: Sixty starts per hour, minimum.

C. General:
   1. Conform to AWWA C540 and this Section.
   2. Provide actuator operable with handwheel or chainwheel, even after disengaging and removing electric motor.
   3. Provide valves with electric actuators that are located more than five feet above operating floor with separate control panels installed so that panel controls and indicators are approximately five feet above operating floor, at location approved by ENGINEER. Modify electrical wiring as required for remote location of control panels.
   4. Coordinate sizing of each electric actuator with valve manufacturer, who shall furnish valve and associated electric actuator and appurtenances as a unit.
   5. Electric actuators shall be suitable for valve orientation as shown.
   6. FCV-059 shall be provided with a spring return electric actuator. Springs shall open the valve in the event of a total power failure.

D. Electric Motor:
   1. General:
      a. Provide motors suitable for "open/close" service, with high torque characteristics and minimum 70 degree C temperature rating.
   2. Motor Construction:
      a. Enclosure: NEMA 6.
      b. Insulation: Class F.
      c. Service Factor: 1.15.
      d. Power Supply: 120VAC.
      e. Motor Size: 1 horsepower or smaller.
      f. Provide winding thermostats for overcurrent protection.
      g. Efficiency: High-efficiency conforming to NEMA MG 1.
      h. Bearings: Anti-friction with minimum B-10 life of 100,000 hours, lifetime pre-lubricated and sealed.

E. Actuator Gearing:
   1. Housing: Die-cast aluminum or cast-iron.
   2. Close-coupled to electric motor.
   3. Input Shaft Gearing: Spur or bevel gear assembly.
   4. Output Shaft Gearing: Self-locking worm gears with minimum gear backlash to prevent valve disc chatter or vibration.
   5. Gearing shall be of hardened alloy steel or combination of hardened alloy steel and alloy bronze, accurately cut by hobbing machine.
   6. Lubrication: Grease or oil bath.
   7. Bearings: Ball or roller with minimum B-10 life of 100,000 hours, lifetime pre-lubricated and sealed.
   8. Input Shaft: Hardened alloy steel.
   9. Provide mechanical stops adjustable to plus-or-minus five degrees at each end of travel.

F. Limit Switches:
   1. Provide each actuator with "end of travel" limit switches to allow control of desired end position for each direction of travel.
   2. Provide open and close limit switches geared to drive mechanism and in step at all times, whether unit is operated electrically or manually, and whether or not actuator is powered by electric power supply. Friction devices or set-screw arrangements shall not be used to maintain the setting.
   3. Limit switch gearing shall be appropriately lubricated.
   4. Provide driven mechanism totally enclosed to prevent entrance of foreign matter and loss of lubricant.
   5. Provide each limit switch with four auxiliary contacts. Two contacts shall close and two contacts shall open at a desired end position for each direction of travel.
   6. Switches shall be rated five amperes at 120 volts.

G. Torque Switches:
   1. Provide adjustable torque switches with each valve actuator. Torque switches shall operate during complete valve cycle without using auxiliary relays, linkages, latches, or other devices.
   2. Wire torque switches to de-energize valve actuator motor when excessive torque is developed during each direction of travel.
   3. It shall be possible to select the torque switches to control open and close limit positions in each direction of valve travel.
   4. Provide dry contacts (five-amp, 120 VAC) for remote high torque alarm.

H. Handwheel and Chainwheel Operation:
   1. Provide actuator with handwheel (or chainwheel as required) for manual operation, so connected that operation by motor will not cause handwheel or chainwheel to rotate.
   2. Should electric power be returned to motor while handwheel or chainwheel is in use, unit shall prevent transmission of motor torque to handwheel or chainwheel.
   3. Handwheel or chainwheel shall require no more than 80-pound effort on rim for seating or unseating load, and no more than 60 pounds on running load.
   4. Handwheel or chainwheel shall have an arrow and the word "OPEN" or "CLOSE" indicating required rotation. Handwheel or chainwheel shall operate in clockwise direction to close.
   5. Chain Operators:
      a. Valves more than five feet above operating floor level shall be equipped with chain operators.
   6. Handwheels and chain operators shall be as specified in Article 2.9 of this Section.
   7. Provide stem covers for rising stem gate valves as specified in Article 2.9 of this Section.

I. Controls:
   1. Provide the following controls in separate compartment integral with actuator.
   2. Enclosure: NEMA 4X.
   3. Starter: Combination reversing magnetic starter with circuit breaker and disconnect switch.
   4. Control Power Transformer: Provide transformer to transform rated three-phase, 60 Hertz power to 120 volts, single-phase. Transformer shall be complete with grounded and fused secondary and dual primary fuses.
   5. Provide "LOCAL/OFF/REMOTE" selector switch. In "LOCAL" position actuator shall be operated by "OPEN/CLOSE/STOP" pushbuttons. In "OFF" position, actuator shall be disabled from local and remote operation. In "REMOTE" position, "open/close/stop" control from remote source shall be enabled.
   6. Provide "OPEN/CLOSE/STOP" pushbuttons with hold-to-run or momentary contact selection.
   7. Provide "OPEN/CLOSE/STOP" indicating lights and zero-to-100 percent position indication in liquid crystal display window.
   8. Provide thermal overload and single-phasing protection of motor.
   9. Provide set of dry contacts to remotely indicate that actuator is available for remote operation.
   10. Actuator circuit boards shall be rated for high temperature service, minimum 55 degrees C.
   11. Provide electrical interlocks as shown.
   12. Provide 120 VAC space heater to maintain internal housing temperature at 20 degrees C.

J. Remote-mounted Control Stations:
   1. Where required by valve location or as indicated, provide remote control panels.
   2. Enclosure: NEMA 4X, Type 316 stainless steel.
   3. Provide "LOCAL/OFF/REMOTE" selector switch. In "LOCAL" position actuator shall be operated by "OPEN/CLOSE/STOP" pushbuttons. In "OFF" position, actuator shall be disabled from local and remote operation. In "REMOTE" position, "open/close/stop" control from remote source shall be enabled Provide contact when switch is in "REMOTE" position for remote indication.
   4. Provide "OPEN/CLOSE/STOP" pushbuttons with hold-to-run or momentary contact selection.
   5. Provide "OPEN/CLOSE/STOP" indicating lights and zero-to-100 percent position indication with liquid crystal display.

K. Testing:
   1. Test each actuator in manufacturer's shop in conformance with AWWA C540.

2.9 BACKFLOW PREVENTERS: RPZ

A. Products and Manufacturers: Provide one of the following:
   1. Febco, Model 825YD.
   2. Watts Regulator Company, Series 909.
   3. Or equal.

B. General:
   1. Type: Reduced pressure zone device with two independently acting check valves, together with an automatically operated pressure differential relief valve located between the two check valves.
   2. Materials:
      a. Body: Bronze or cast-iron.
      b. Valve Discs: Buna-N rubber.
      c. Diaphragm: Silicon rubber or Buna-N rubber.
   3. Maximum Working Pressure: 175 psi.
   4. End Connections: Screwed or flanged.

C. Accessories:
   1. Air gap drain funnel with threaded outlet and vent below furnished by manufacturer.
   2. Strainer with blow-off on inlet.
   3. Outside screw and yoke gate valves on inlet and outlet.
   4. Reduced pressure principle backflow preventer test kit for each unit furnished with carrying case, provided in molded plastic carrying case with foam inserts.

D. References: ASSE 1013, AWWA C511 and authority having jurisdiction at the Site.

2.10 BACKFLOW PREVENTERS: DCV

A. Products and Manufacturers: Provide one of the following:
   1. Febco, Model 805Y.
   2. Conbraco Industries, Incorporated, Series 40-100.
   3. Watts Regulator Company, Series 709.
   4. Or equal.

B. General:
   1. Type: Assembly of two single independently acting check valves with tight closing shut off valves at each end and suitable connections for testing the water tightness of each check valve.
   2. Materials:
      a. Body: Bronze.
      b. Valve Discs: Silicon rubber.
      c. Springs: Stainless steel.
      d. Poppets: Glass-filled Celcon.

e. Replaceable Seats: Glass-filled Noryl.
f. Fasteners: Stainless steel.
g. Test cocks: Bronze, four required.

3. Maximum Working Pressure: 150 psi.
4. End Connections: Screwed.

C. Accessories:
1. Ball valves on inlet and outlet with UL listed, FM approved tamper switches.
2. DCV backflow preventer test kit provided in molded plastic carrying case with foam inserts for each unit furnished to be turned over to the owner.
a. Products and Manufacturers: Provide one of the following:
1) CMB Industries, Inc., Febco Division, Double Check Valve Backflow Prevention Assembly Differential Pressure Test Kit with carrying case.
2) Watts Regulator, Backflow Preventer Test Kit with carrying case.
3) Or equal.

D. Reference: Underwriters Laboratory listed, Factory Mutual approved.

E. All backflow preventers shall meet with the approval of U.S.C. Cross Connection Control Lab, U.S. Army Corps of Engineers, U.S. Navy, AMPS, Southern Building Code Congress, AWWA, and ASSE.

2.11 APPURTENANCES FOR EXPOSED METALLIC VALVES

A. General:
1. For valves located less than five feet above operating floor, provide levers on four-inch diameter quarter-turn valves, and provide handwheels on all other valves, unless otherwise shown or specified.
2. For valves located five feet or more above operating floor, provide chain operators.
3. Where indicated, provide extension stems and floorstands.

B. Handwheels:
1. Conform to applicable AWWA standards.
2. Material of Construction: Ductile iron, or cast aluminum.
3. Arrow indicating direction of opening and word “OPEN” shall be cast on trim of handwheel.
4. Maximum Handwheel Diameter: 2.5 feet.

C. Chain Operators:
1. Chains shall extend to three feet above operating floor.
2. Provide 1/2-inch stainless steel hook bolt to keep chain out of walking area.
3. Materials of Construction:
a. Chain: Type 316L stainless steel.

b. Chainwheel: Recessed groove type made out of Type 316 stainless steel.
c. Guards and Guides: Type 316L stainless steel.

4. Chain Construction:
   a. Chain shall be of welded link type with smooth finish. Chain that is crimped or has links with exposed ends is unacceptable.
5. Provide geared operators where required to position chainwheels in vertical position.

D. Crank Operator:
1. Crank operator shall be removable and fitted with rotating handle.
2. Maximum Radius of Crank: 15 inches.
3. Materials:
   a. Crank: Cast-iron or ductile iron.
   b. Handle: Type 304 stainless steel.
   c. Hardware: Type 304 stainless steel.

E. Extension Stems and Floor Stands for Gate Valves:
1. Conform to the applicable requirements of AWWA C501 for sizing of complete lifting mechanism.
2. Bench and Pedestal Floor Stands:
   a. For valves requiring extension stems, provide bench or pedestal floor stands with handwheel or crank as indicated. Provide provisions for using portable electric actuator for opening and closing of valves.
   b. Type: Heavy-duty with tapered roller bearings enclosed in a weatherproof housing, provided with positive mechanical seals around lift nut and pinion shaft to prevent loss of lubrication and to prevent moisture from entering housing. Provide lubrication fitting for grease. For valves conveying water that is potable or that will be treated to become potable, grease shall be food-grade and ANSI/NSF 61-listed. Base shall be machined.
   c. Materials of Construction:
      1) Housing: Cast-iron, ASTM A126, Class B.
      2) Lift Nut: Cast bronze, ASTM B98/B98M.
      3) Grease Fitting: Stainless steel.
      4) Bolting: Type 316 stainless steel.
3. Wall brackets for floor stands shall be Type 316L stainless steel construction.
4. Extension Stems:
   a. Materials of Stems and Stem Couplings: Type 316 stainless steel.
   b. Maximum Slenderness Ratio (L/R): 100.
   c. Minimum Diameter: 1.5-inch.
   d. Threads: Acme.
   e. Provide stem couplings where stems are furnished in more than one piece. Couplings shall be threaded and keyed or threaded and bolted and shall be of greater strength than the stem.

f. Weld to bottom of extension stem a Type 316 stainless steel cap suitable for square end of valve stem.

5. Bottom Couplings: Ductile iron with Type 316 stainless steel pin and set screw.
6. Stem Guides:
   a. Material: Type 316 cast stainless steel with bronze bushing for stem. For submerged service, Type 316 cast stainless steel with stainless steel bushing for stem.
   b. Maximum Stem Length Between Guides: Seven feet.
   c. Stem guides shall be adjustable in two directions.
7. Furnish stem cover of clear butyrate plastic or Grade 153 Lexan with cast adapter for mounting cover to bench and floor stands. Provide stem cover with gasketing and breathers to eliminate water intrusion into operator and condensation within cover. Provide stem cover with mylar tape with legible markings showing valve position at one-inch intervals and open and close limits of valve.

F. Floor Boxes: Provide cast-iron floor boxes for valves that are to be operated from floor above valve. Boxes shall be equal in depth to floor slab. Boxes shall have cast-iron covers and be fitted with bronze bushing.

2.12 APPURTENANCES FOR BURIED METALLIC VALVES

A. Wrench Nuts:
   1. Provide wrench nuts on buried valves of nominal two-inch size, in accordance with AWWA C500.
   2. Arrow indicating direction of opening the valve shall be cast on the nut along with the word “OPEN”.
   3. Material: Ductile iron or cast-iron.
   4. Secure nut to stem by mechanical means.

B. Extension Stems for Non-Rising Stem Gate Valves and Quarter-turn Buried Valves:
   1. Provide extension stems to bring operating nut to six inches below valve box cover.
   2. Materials of Stems and Stem Couplings: Type 316 stainless steel.
   3. Maximum Slenderness Ratio (L/R): 100
   4. Provide top nut and bottom coupling of ductile iron or cast-iron with pins and set screws of Type 316 stainless steel.

C. Valve Boxes:
   1. Valve boxes shall be as indicated and as required.
   2. Type: Heavy-duty, suitable for highway loading, two-piece telescopic, and adjustable. Lower section shall enclose valve operating nut and stuffing box and rest on valve bonnet.
   3. Material: Cast-iron or ductile iron.
   4. Coating: Two coats of asphalt varnish conforming to FS TT-C-494.

5. Marking: As required for service.

2.13 ANCHORAGES AND MOUNTING HARDWARE

A. General:
   1. Comply with Section 05 05 33, Anchor Systems, except as modified in this Section.
   2. Obtain bolts, nuts, and washers for connection of valve and appurtenances to concrete structure or other structural members from valve Supplier.
   3. Bolts, nuts, and washers shall be of ample size and strength for purpose intended. Anchorages in concrete shall be at least 5/8-inch diameter.
   4. Provide stem guide anchorages of required strength to prevent twisting and sagging of guides under load.
   5. Materials: Provide bolts and washers of Type 316 stainless steel and nitrided nuts. Bolts shall have rolled threads. Bolts and nuts shall be electropolished to remove burrs.

2.14 TOOLS, LUBRICANTS, AND SPARE PARTS

A. Provide the following T-handle operating wrenches for buried valves:
   1. Length of T-Handle Operating Wrench: as required to operate with tee handle at 3 feet above grade.
   2. Quantity: one.

B. Lubricants: For valves, actuators, and appurtenances requiring lubricants, provide suitable lubricants for initial operation and for first year of use following Substantial Completion. Lubricants for equipment associated with conveying potable water or water that will be treated to become potable shall be food-grade and ANSI/NSF 61-listed.

C. Tools, spare parts, and maintenance materials shall conform with Section 01 78 43, Spare Parts and Extra Materials.

2.15 PAINTING OF EXPOSED VALVES, HYDRANTS, AND APPURTENANCES

A. Exterior steel, cast-iron, and ductile iron surfaces, except machined surfaces of exposed valves and appurtenances, shall be finish painted in manufacturer's shop. Surface preparation, priming, finish painting, and field touch-up painting shall conform to Section 09 91 00, Painting.

2.16 PAINTING OF BURIED VALVES

A. Exterior steel, cast-iron, and ductile iron surfaces, except machined or bearing surfaces of buried valves, shall be painted in valve manufacturer's shop with two coats of asphalt varnish conforming to FS TT-C 494.

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine conditions under which materials and equipment are to be installed and notify ENGINEER in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. General:
   1. Install valves and appurtenances in accordance with:
      a. Supplier's instructions and the Contract Documents.
      b. Requirements of applicable AWWA standards.
      c. Applicable requirements of Section 33 05 05, Buried Piping Installation, and Section 40 05 05, Exposed Piping Installation.
   2. Install valves plumb and level. Install all valves to be free from distortion and strain caused by misaligned piping, equipment, and other causes.
   3. Position swing check valves and butterfly valves so that, when valve is fully open, valve disc does not conflict with piping system elements upstream and downstream of valve.
   4. Touch up any damaged painted surfaces on valves with coating systems as specified by valve manufacturer.

B. Exposed Valves:
   1. Provide supports for large or heavy valves and appurtenances as shown or required to prevent strain on adjoining piping.
   2. Operators:
      a. Install valves so that operating handwheels or levers can be conveniently turned from operating floor without interfering with access to other valves, piping, structure, and equipment, and as approved by ENGINEER.
      b. Avoid placing operators at angles to floors or walls.
      c. Orient chain operators out of way of walking areas.
      d. Install valves so that indicator arrows are visible from floor level.
      e. For motor-operated valves located lower than five feet above operating floor, orient motor actuator to allow convenient access to pushbuttons and handwheel.
   3. Floor Stands and Stems:
      a. Install floor stands as shown and as recommended by manufacturer.
      b. Provide lateral restraints for extension bonnets and extension stems as shown and as recommended by manufacturer.
      c. Provide sleeves where operating stems pass through floor. Extend sleeves two inches above floor.

C. Buried Valves:
   1. Install valve boxes plumb and centered, with soil carefully tamped to a lateral distance of four feet on all sides of box, or to undisturbed trench face if less than four feet.
   2. Provide flexible coupling next to each buried valve.

D. Plug Valves:
   1. Install plug valves that are in horizontal liquid piping with stem horizontal and plugs on top when valve is open. Plug shall be on upstream end when valve is closed.
   2. Install plug valves that are in vertical liquid piping with plug at top when closed or as recommended by valve Supplier.
   3. Supplier shall tag or mark plug valves to indicate proper mounting position.

3.3 FIELD QUALITY CONTROL

A. Field Tests:
   1. Adjust all parts and components as required to provide correct operation of valves.
   2. Conduct functional field test on each valve in presence of ENGINEER to demonstrate that each valve operates correctly.
   3. Verify satisfactory operation and controls of motor operated valves.
   4. Demonstrate satisfactory opening and closing of valves at specified criteria requiring not more than 40 pounds effort on manual actuators.
   5. Test ten percent of valves of each type by applying 200 pounds effort on manual operators. There shall be no damage to gear actuator or valve.

B. Supplier's Services:
   1. Provide services of qualified factory-trained service technicians to check and approve installation of the following types of valves:
      a. Pressure Reducing Valve.
   2. Supplier's serviceman shall perform the following:
      a. Supervise unloading of the following equipment.
      b. Instruct CONTRACTOR in installing equipment.
      c. Supervise installation of equipment.
      d. Inspect and adjust equipment after installation and ensure proper operation.
      e. Instruct CITY'S personnel in operating and maintaining the equipment.
   3. Manufacturer's representative shall make a minimum of two visits, with a minimum of two hours onsite for each visit. First visit shall be for assistance in installing equipment; second visit shall be for checking completed installation, start-up of system, and to instruct operations and maintenance personnel. Representative shall revisit the Site as often as necessary until installation is acceptable.
   4. Training: Furnish services of Supplier's qualified factory trained specialists to instruct CITY'S operations and maintenance personnel in recommended

operation and maintenance of equipment. Training requirements, duration of instruction and qualifications shall be in accordance with Section 01 79 23, Instruction of Operations and Maintenance Personnel.

5. All costs, including expenses for travel, lodging, meals and incidentals, and cost of travel time, for visits to the Site shall be included in the Contract Price.

+ + END OF SECTION + +

SECTION 40 05 93

COMMON MOTOR REQUIREMENTS FOR PROCESS EQUIPMENT

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Electric motors and accessories to be furnished under other equipment Sections shall comply with this Section, unless specified otherwise in the Section for the associated driven equipment.
   2. Motor horsepower and voltage ratings, speed, enclosure type, and unusual service conditions (such as ambient temperatures above 40 degrees C, corrosive areas requiring severe duty motors, and variable frequency drive applications requiring inverter duty motors), and requirements for witnessing shop tests shall be as specified in the Sections for the associated driven equipment. Specific accessories and construction features may also be required by the Sections on the associated driven equipment.

1.2 REFERENCES

A. Standards referenced in this Section are:
   1. ASTM A48/A48M, Specification for Gray Iron Castings.
   2. ASTM B117, Practice for Operating Salt Spray (Fog) Apparatus.
   3. IEEE 112, Test Procedure for Polyphase Induction Motors and Generators.
   4. IEEE 522, Guide for Testing Turn-to-Turn Insulation on Form-Wound Stator Coils for Alternating Current Electric Machines.
   5. IEEE 841, Petroleum and Chemical Industry - Premium-Efficiency, Severe-Duty, Totally Enclosed Fan-Cooled (TEFC) Squirrel Cage Induction Motors – Up to and Including 370 KW (500 HP).
   6. IEEE 1043, Recommended Practice for Voltage Endurance Testing of Form-Wound Bars and Coils.
   7. NEMA MG 1, Motors and Generators. (This Section's references to NEMA MG 1 followed by a hyphen and number, such as “NEMA MG 1-20.14”, indicate the associated NEMA MG 1 paragraph reference.)
   8. ANSI/NETA ATS, Acceptance Testing Specifications for Electrical Power Equipment and Systems
   9. UL 674, Electric Motors and Generators, for Use in Division 1 Hazardous (Classified) Locations.
   10. UL 1004, Electric Motors.

1.3 QUALITY ASSURANCE

A. Qualifications:
   1. Manufacturer:
      a. Manufacturer shall have not less than five years experience producing equipment substantially similar to that required and shall be able to submit documentation of at least five installations in satisfactory operation for at least five years each.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Shop Drawings:
      a. Data sheets indicating nameplate data for fractional-horsepower motors.
      b. Outline drawing or data sheet indicating complete motor dimensions for motors rated greater than 1/3-hp. Several motors of the same type and rating for the same application may be covered by an appropriate single drawing or data sheet. Drawings and data sheets shall have complete identifying data including frame size, speed, horsepower ratings, and application for each particular motor.
      c. Details of motor heaters, winding thermal protection, and other accessories.
      d. Copies of motor characteristic curves and data inputs when required for programming motor protection and management relays.
   2. Product Data:
      a. Submit motor test data sheets for each motor rated one horsepower or greater. Values indicated on test data sheets shall be from tests of a previously manufactured, electrically duplicate motor or calculated data. Mark each test data sheet to indicate the Project motor application location, manufacturer, type, frame size, horsepower, voltage, speed, bearing type, lubrication medium and enclosure type. Test data sheet shall also include:
         1) Winding resistances.
         2) Torques.
         3) Efficiencies.
         4) Power factors.
         5) Slip.
         6) Full load amperes.
         7) Locked rotor and no load amperes.
         8) Nameplate temperature and results of dielectric tests.
   3. Testing Plans and Procedures:
      a. When witnessed source quality control testing is required in the Section for associated driven equipment, submit description of proposed shop testing methods, procedures, and testing apparatus with calibration dates, together with proposed testing schedule and proposed travel and logistical plans for testing.

B. Informational Submittals: Submit the following:
   1. Manufacturer's Instructions:
      a. Instructions and recommendations for handling, storing, protecting the motors.
      b. Installation data for motors, including setting drawings, templates, and directions and tolerances for installing anchorage devices.
   2. Source Quality Control Submittals:
      a. Written reports presenting results of required shop testing. Shop test reports shall be dated and signed by motor manufacturer.
      b. When witnessed shop tests are required, shop test results shall be signed by and shall bear the seal of registered professional engineer. Name on seal, registration or license number, and jurisdiction or registration of license shall be legible.
   3. Field Quality Control Submittals:
      a. Written reports presenting results of required field testing and inspections. Field testing reports shall be dated and signed by CONTRACTOR.
   4. Supplier Reports:
      a. Submit written report of results of each visit to Site by Supplier's service personnel, including purpose and time of visit, persons contacted, problems encountered and resolved, tasks performed, results obtained, and other pertinent information. Submit within two days of completion of visit to the Site.
   5. Qualifications Statements:
      a. Submit manufacturer's qualifications data when requested by ENGINEER.

C. Closeout Submittals: Submit the following:
   1. Operation and Maintenance Data:
      a. Furnish operation and maintenance data for motors as part of the operations and maintenance data for the associated driven equipment.
      b. Comply with Section 01 78 23, Operations and Maintenance Data.

D. Maintenance Material Submittals: Submit the following:
   1. Spare Parts and Extra Stock Materials: For each motor size and type, furnish spare parts in accordance with motor manufacturer's recommendations, including the following for three-phase motors:
      a. One set of fans and guards for each set of three or fewer motors, for each size of totally-enclosed fan-cooled motor.
      b. One set of bearing liners, or renewable ball or roller bearings, for each set of three or fewer motors, for each type and size of motor.
      c. One set of oil rings, for each sleeve bearing motor.
      d. One set of bearing temperature detectors, for each set of three or fewer motors, of each type of motor.

1.5 DELIVERY, STORAGE AND HANDLING

A. Packing, Shipping, Handling, and Unloading:
   1. Ship motors with openings sealed.

B. Storage and Protection:
   1. Protect materials and equipment from corrosion and deterioration.

PART 2 – PRODUCTS

2.1 EQUIPMENT PERFORMANCE

A. Equipment Description:
   1. Comply with motor requirements specified in the Sections for the associated driven equipment.
   2. Motors shall be suitable for continuous operation at an elevation of up to 3,300 feet above mean sea level, at ambient temperatures ranging from -25 degrees C to 40 degrees C, unless specified otherwise in the Section for the associated driven equipment.

2.2 CONSTRUCTION – GENERAL

A. Unless specified otherwise in Sections on the associated driven equipment, motors shall have the following features of construction and operation:
   1. Successfully operate under power supply variations in accordance with NEMA MG 1-14.30 and NEMA MG 1-20.14.
   2. NEMA Design B with torque and starting currents in accordance with NEMA MG 1, except in special high-torque applications, as specified in the Section for the associated driven equipment, which may require NEMA Design C.
   3. Motors shall operate within their full load rating without applying the service factor, unless specified otherwise in Section for the associated driven equipment.
   4. Speed and horsepower specified or required to properly operate the associated driven equipment and torque characteristics required by the drive load and suitable for direct coupling or V-belt drive, as specified in the Section for the associated driven equipment.
   5. Constructed for full-voltage starting.
   6. Fabricated steel or cast-iron frames with integrally cast feet or bases, cast-iron end bells, cast iron or steel conduit boxes and covers and bases with precision machined bearing fits, ASTM A48/A48M, Class 25 or better. For each TEFC motor, provide UL-approved automatic stainless steel breather drains in lowest part of front and back brackets to allow drainage of condensation.
   7. Stator core assembly shall consist of stacked lamination made from specially selected electrical sheet silicon steel.

8. Rotor cages shall be die-cast or fabricated aluminum or fabricated copper or copper alloy. Shafts shall be carbon steel unless specified otherwise in this Section or in the Section on the associated driven equipment.
9. Rotors on frames 213T and larger shall be keyed shrunk or welded to shaft and rotating assembly, dynamically balanced to NEMA limits. Use rivets to secure balance weights, if required, to rotor resistance ring or fan blades. Machine screws and nuts are unacceptable. Coat entire rotating assembly between bearing inner caps with corrosion-resistant epoxy.
10. Bolt and cap screws shall be high-strength, SAE Grade 5 zinc-plated and chromatic steel. Screwdriver slot fasteners are unacceptable.
11. Motors shall be shop-painted at the motor fabrication facility. Finish coat shall be the same color as the associated driven equipment. Final paint finish shall be corrosive resistant and capable of passing ASTM B117 250-hour salt spray test. Motors that will be located outdoors shall have coating resistant to degradation or chalking in sunlight.

2.3 SINGLE-PHASE AC MOTORS

A. Motors shall be rated 115-, 200-, or 230-volt, 60 Hertz.

B. Bearings shall be grease-lubricated ball type with grease fittings or with lubrication for 10 years of normal operation.

C. Motors shall be totally enclosed except fractional-horsepower motors may be open type if motor is suitably protected from moisture, dripping water, and airborne particulates accumulation. Motor features shall be in accordance with the following:
   1. Open motors shall be split-phase or capacitor start in accordance with torque requirements, with service factor of not less than 1.25, 40 degrees C ambient rating, and Class B insulation.
   2. Enclosed motors shall be capacitor start, with service factor of not less than 1.15, 40 degrees C ambient rating, and Class F insulation. Motors shall be fan-cooled or non-ventilated.
   3. Severe duty type motors shall be designed to withstand chemical corrosion and equipped with cast iron end shields, neoprene gaskets, stainless steel shaft, heavy pressed steel fan cover and provision for threaded conduit connection.
   4. Provide direct drive fan motors with conduit fittings and leads to allow external connection.
   5. Explosion-proof motors shall comply with UL 674.

2.4 THREE-PHASE AC MOTORS

A. General: Unless specified otherwise in the Sections for the associated driven equipment, provide three-phase motors with the following features:
   1. Premium, energy-efficient construction complying with NEMA MG 1.
   2. Motor efficiency determined in accordance with NEMA MG 1-12.58.

3. Minimum and nominal full-load efficiencies not less than those listed in: NEMA MG 1 Table 12-12 for motors rated 600 volts and smaller, and NEMA MG 1 Table 12-13 for motors rated larger than 600 volts and equal to or less than 5,000 volts.
4. Motors shall be constructed for operation on three-phase, 60 Hertz, alternating current system. Motor voltage and variable frequency operation, where required, shall be as specified in the Sections for the associated driven equipment. Voltage ratings shall be 200 volts for operation on 208-volt systems, 230 volts for 240-volt systems, 460 volts for 480-volt systems, 2300 volts for 2400-volt systems, and 4000 volts for 4160-volt systems.
5. Unless otherwise required by the load, motors shall be NEMA Design B, normal starting torque. Locked rotor KVA/HP shall not exceed NEMA Code Letter G for motors 20 hp and larger.
6. Motor frame shall be a rigid structure, constructed to maintain the lamination in correct alignment, and shall not depend on lamination or bolts for rigidity.
7. Severe-duty totally-enclosed motors shall comply with IEEE 841.

B. Bearings:
1. Provide horizontal motors with rolling element (anti-friction) or sliding element (sleeve) type bearings. Use anti-friction type bearings for NEMA frame motors. Use sleeve type bearings when specified in the Section for the associated driven equipment.
2. Insulate the bearings for motors larger than 200 hp and for inverter-duty motors 100 hp and larger, to prevent shaft currents and related bearing damage.
3. Bearings for open drip-proof, TEFC, and explosion-proof motors shall be grease lubricated, ball type, unless specified otherwise in the Section for the associated driven equipment. Bearings shall have inlet fittings and outlet plugs. Protect bearings and grease reservoirs from entry of contaminants. Provide suitable fittings to allow convenient positive purging of old grease during re-greasing.
4. For horizontal motors with ratings up to and including 500 hp, or for motors with speeds up to and including 3600 rpm, and where both conditions apply, anti-friction bearings furnished shall have a minimum L-10 bearing life of 100,000 hours, as defined by the ABMA, for direct-connected motors, and L-10 bearing life of 50,000 hours for belted motors.
5. Sleeve bearings shall be ring-oiled with adequate, integral self-cooled oil reservoir. Bearing sleeves shall be lined with high tin content babbitt to minimize oil contamination. Close running shaft seals shall prevent oil leakage as well as prevent entrance of foreign material such as water and dirt into the bearing area. Provide oil level sight gauges with permanently-marked easily-discernible oil level. Provide inspection openings to observe the oil rings.
6. When specified in Section for the associated driven equipment or required by motor speed and bearing size, provision shall be made for forced lubrication. Provide oil rings and an adequate oil reservoir in bearing housings to allow orderly shutdown of motor in the event of failure of forced feed lubrication system.

7. Provide vertical motors with thrust bearings adequate for all thrusts to which motor can be subjected. Rated minimum L-10 life of the thrust bearings shall be at least 15,000 hours when operated at rated speed and full load thrust. Manufacturers of the associated driven equipment shall furnish motor manufacturer with speed and thrust conditions required by the associated driven equipment.

C. Insulation:
1. Insulation systems shall be rated Class F, with a service factor of 1.15 times motor's nameplate horsepower rating when operated on a sine wave power supply, and a service factor of 1.00 on an adjustable frequency power supply. Temperature rise shall be limited to Class B insulation system when motor is operated continuously at rated horsepower with ambient temperature not exceeding 40 degrees C, unless specified otherwise in the Section for the associated driven equipment.
2. Windings shall be epoxy-coated. Treat windings with insulating compound suitable for protecting against moisture, salt air, and slightly acidic and alkaline conditions. Insulation system for enclosed motors shall be upgraded to increase moisture resistance.
3. Motors for outdoor service and all motors larger than 200 hp shall have vacuum/pressure-impregnated epoxy insulation (VPI) for moisture resistance. Motors shall be preheated before VPI and baked in temperature-controlled oven.
4. Stator windings and end turn connections shall be fully brazed to withstand full voltage starting, regardless of the starting method indicated in the Section for the associated driven equipment. Bracing system shall essentially eliminate coil vibration under the high-current conditions of starting as well as during normal operation. When a tied system is used, system shall be such that no tie depends on the integrity of another tie within the system.
5. Motors larger than 200 hp shall be form wound. Form wound coils with micaceous ground wall insulation shall have additional insulation and hot-pressed to provide sealed system. Complete stator shall be vacuum/ pressure-impregnated.

D. Enclosures:
1. Motor enclosure type shall be as specified in the Section for the associated driven equipment. Enclosure types shall comply with the following:
   a. Open Drip Proof: Motors shall have a steel or cast-iron frame, cast-iron end brackets, and steel conduit box. Provide vertical motors of the open type with drip hoods. When the drip hood is too heavy to be easily removed, provide access for testing. Provide stainless steel corrosion-resistant screens over air openings in accordance with NEMA requirements for guarded machines.
   b. Weather Protected Type I and Type II: Weather-protected motor shall be an open drip proof guarded machine with ventilating passages constructed to minimize entrance of rain, snow, and airborne particles to motor's

electric parts complying with NEMA MG 1-1.25.8

c. Totally enclosed fan cooled and non-ventilated motors shall have cast-iron frame, cast-iron end brackets, and cast-iron conduit box. Provide drain holes on each end of motor.

d. Explosion-proof motors shall comply with NEMA MG 1-1.26.10 and UL 674.

2. Motor conduit box shall be split from top to bottom, shall be capable of being rotated to four positions 90 degrees apart, and shall comply with the following:

a. Box shall be gasketed with rubber-like gaskets between frame and conduit box and between conduit box and conduit box cover.

b. Provide box or opening in motor housing with conduit hub type fitting to allow threaded conduit connections.

c. Box sizes shall be in accordance with code requirements and shall accommodate medium-voltage terminations or stress cones, when required.

d. Protective and auxiliary devices shall terminate in auxiliary conduit boxes.

e. Terminal leads shall be flexible and of sufficient length to extend for distance of not less than ten inches beyond face of terminal box. Terminal leads shall be fitted with solderless lugs suitable for attachment to lugs installed on external wiring. Leads shall be sealed with non-wicking, non-hygroscopic insulating material, or insulating "wrap-cap" as manufactured by Ideal Industries, or equal.

f. Provisions for terminal box size, length of leads, size of conduit openings, and type of terminal lugs shall be complied with irrespective of other standards or practice.

g. Provide motor frame grounding stud inside conduit box. Stud shall include a drilled and tapped hole.

E. Motors for Use with Variable Frequency Drives:

1. Motors shall be compatible with characteristics of the intended variable frequency inverters.

2. Motors shall comply with the performance standards of NEMA MG 1-31.

F. Vertical Motors:

1. Vertical motors shall have Type P base specifically constructed for vertical installation. Universal position motors are unacceptable.

2. Vertical motors shall have solid shafts, unless otherwise specified in Section for the associated driven equipment.

G. Lifting Eyes: Motors weighing more than 50 pounds shall include at least one lifting eye or lifting lug. Construct motor and lifting eyes or lifting lugs to bear motor's full weight.

2.5 ACCESSORIES

A. General:
   1. Provide motor accessories in accordance with this Section unless specified otherwise in the Section for the associated driven equipment.
   2. Provide space heaters in motors five horsepower and larger installed outdoors, and in enclosed motors five horsepower and larger installed indoors in unheated spaces.
   3. Provide thermostat type winding thermal protection for motors in accordance with the following:
      a. Variable speed motors up to and including 25 hp.
      b. Constant speed motors when specified in Section for the associated driven equipment.
   4. Provide thermistor type winding thermal protection for motors in accordance with the following:
      a. Constant speed motors 50 hp and larger up to and including 200 hp.
      b. Variable speed motors 30 hp and larger up to and including 200 hp.
   5. Provide resistance temperature detector (RTD) type winding thermal protection for all motors larger than 200 hp.
   6. Provide stator and bearing temperature detectors for each motor 250 hp and larger.

B. Space Heaters:
   1. Space heaters for condensation prevention shall operate at 120 volts and shall be sized to provide approximately 10 degrees C temperature rise above ambient.
   2. Heaters shall be low-density type for low surface temperature and long life.

C. Winding Thermal Protection:
   1. Thermostats shall be bi-metal disk or rod type embedded in the stator windings. Thermostat contacts shall be normally-closed, automatic-reset type, rated 120 vac, five amps minimum, opening on excessive temperature. Provide three thermostats, one in each phase, wired to motor junction box.
   2. Thermistors embedded in each stator phase winding shall be in direct contact with the winding conductors. Each thermistor circuit shall be factory-wired to 120-volt solid-state control module mounted at the motor in box rated NEMA 4X. Control module contacts shall be automatic-reset type, rated 120 vac, five amps minimum, opening on excessive temperature. Provide normally-closed isolated contact for motor shutdown.
   3. Resistance temperature detectors (RTD) shall be 100-ohm platinum three-lead type with calibrated resistance-temperature characteristics. Position detectors, two per phase for non-explosion proof motors and one per phase for explosion proof motors, to detect highest winding temperature and located between coil sides in stator slots. Detector leads shall be wired to a separate terminal box.

D. Single-Phase Motors: Single-phase motors requiring auxiliary starting resistors, capacitors or reactors and switching devices shall be provided as combination units with such auxiliaries either incorporated within motor housings or housed in suitable enclosures mounted on motor frames. Each combination unit shall be mounted on a single base and be provided with a single conduit box.

2.6 IDENTIFICATION

A. Nameplates:
   1. Nameplates shall be Type 316 stainless steel with embossed or pre-printed lettering and fastened to the motor frame with Type 316 stainless steel pins.
   2. Nameplates shall have stamped on them the motor manufacturer's name, voltage, number of Hertz and phases, horsepower rating, amperes and temperature rise at rated load, full load speed, locked rotor amperes or code letter, service factor, NEMA nominal efficiency, model number, insulation class, bearing number, serial number and maintenance manual number.
   3. Name plates for explosion proof motors shall indicate the Division, Class and Group of the hazardous location in which the motor is intended for use.
   4. Dual-voltage motor nameplates shall include connection diagrams.
   5. Nameplate markings shall be in accordance with NEMA MG 1-10.

2.7 SOURCE QUALITY CONTROL

A. Shop Tests:
   1. Perform shop testing on the motors at the manufacturer's facility. Shop test shall be in accordance with NEMA MG 1, UL 674, and UL 1004 and shall demonstrate that the motors tested comply with the Contract Documents.
   2. Submit shop test reports identifying tests performed and results obtained.
   3. Motors shall be given Routine Test in accordance with NEMA MG 1-12.55 and IEEE 112. Test shall include the following:
      a. Measurement of winding resistance.
      b. No-load readings of current and speed at normal voltage and frequency.
      c. Current input at rated frequency with rotor at standstill for squirrel-cage motors (locked rotor amperes).
      d. High-potential test.
      e. Bearing inspection.
   4. Motors rated 200 hp and larger shall be given a "Complete Test" in accordance with IEEE 112 consisting of a "Routine Test" and a full-load heat run. When "Complete Tests" are required for a group of the same type, rating and horsepower for the same application, each motor of the group shall be given a "Complete Test", unless specified otherwise in the Section for the associated driven equipment. Testing shall document the following:
      a. Percent **s**lip.
      b. No-**l**oad **s**peed, **v**oltage, **c**urrent, and losses at rated frequency.
      c. Full-**l**oad **c**urrent.
      d. Locked-rotor **t**orque.

e. Locked-rotor **c**urrent.
f. Breakdown **t**orque (**c**alculated).
g. Starting **t**orque (squirrel-cage).
h. Winding **r**esistance.
i. Sound pressure level at no-load.
j. Vibration levels.
k. Efficiency current, and power factor at 100, 75, and 50 percent of full load and at service factor load.
l. Stabilized full load temperature rise.

5. Motors with stator windings rated greater than six kV shall have the following additional tests:
   a. Voltage endurance test of the ground-wall insulation system in accordance with IEEE 1043.
   b. Partial discharge testing of the stator coils to insure proper impregnation and clearances. Acceptance criteria shall be based on manufacturer's quality assurance data base.
   c. Voltage surge test on multi-turn stator coils in accordance with IEEE 522.

PART 3 – EXECUTION

3.1 INSTALLATION

A. General:
   1. Install motors in accordance with the Contract Documents and manufacturer's instructions and recommendations. Obtain written interpretation from ENGINEER in the event of conflict between manufacturer's instructions and recommendations and the Contract Documents.
   2. Install in accordance with Laws and Regulations.
   3. Do not modify structures to facilitate installation of motors, unless approved in writing by ENGINEER.
   4. Carefully and properly align motors with the driven equipment.
   5. Secure motors to mounting surfaces with anchorage devices complying with manufacturer's recommendations that are of sufficient size and quantity to secure motor to equipment.
   6. Until start-up and operation, tightly cover and protect motors from dirt, water, and chemical and mechanical damage.

3.2 FIELD QUALITY CONTROL

A. Site Tests:
   1. Inspect motors prior to supplying electricity to (energizing) equipment. Do not energize equipment without ENGINEER's permission. Inspections shall include the following:
      a. Inspect motor and equipment for physical damage.
      b. Inspect motor for proper anchorage, mounting, grounding, connection,

and lubrication.

c. Check for unusual noise and indications of overheating during initial or test operation.

+ + END OF SECTION + +

SECTION 40 05 96

VIBRATION, SEISMIC, AND WIND CONTROLS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all professional services, labor, materials, tools, equipment, and incidentals as shown, specified, and required to design, furnish, and install Vibration Control, Seismic Control, and Wind Control for Process Mechanical, HVAC, plumbing, fire protection, electrical, instrumentation and control, and architectural Components.
   2. CONTRACTOR that provides Component shall provide Controls associated with the Component.
   3. Extent of Components requiring Controls are described in this Section and as required by Laws and Regulations. The Work includes:
      a. Vibration Controls for Components.
      b. Seismic Controls for Isolated and Non-Isolated Components.
      c. Seismic Controls for buried Components, including entry of services to buildings, including piping and conduit up to but not including utility connection point.
      d. Wind Controls for Isolated and Non-Isolated Components.

B. Coordination:
   1. Review installation procedures under other Sections and coordinate installation of items that must be installed with or before Controls.
   2. Notify other contractors in advance of installation of Controls to provide other contractors with sufficient time for installing items included in their contracts that must be installed with or before Controls.

C. Related Sections:
   1. Section 05 05 33, Anchor Systems.
   2. Section 05 50 13, Miscellaneous Metal Fabrications.
   3. Section 09 91 00, Painting.
   4. Section 10 14 00, Signage.

1.2 REFERENCES

A. Standards referenced in this Section are:
   1. AWS D1.1, Structural Welding Code – Steel.
   2. AWS D1.2, Structural Welding Code – Aluminum.
   3. AWS D1.3, Structural Welding Code – Sheet Steel.

4. AWS D1.6, Structural Welding Code – Stainless Steel.
5. Ceilings and Interior Systems Construction Association (CISCA), CISCA 0-2, Recommendations for Direct-Hung Acoustical Tile and Lay-in Panel Ceilings, Seismic Zones 0-2
6. CISCA 3-4, Recommendations for Direct-Hung Acoustical Tile and Lay-in Panel Ceilings, Seismic Zones 3-4
7. National Roofing Contractors Association (NRCA) Standards.

1.3 DEFINITIONS

A. The following definitions are used in this Section:
1. Certificate of Compliance: Certificate provided by Component manufacturer indicating that Component has been tested or analyzed in accordance with Laws and Regulations, including applicable building code, and is capable of resisting design forces defined in Laws and Regulations.
2. Components: Process Mechanical, HVAC, plumbing, fire protection, electrical, instrumentation and control, architectural, and other non-structural equipment, systems, and elements permanently attached to structures, including supporting structures and attachments.
3. Component Assembly: Component assembled by CONTRACTOR from individual components of different Suppliers.
4. Controls: Vibration Control, Seismic Control, and Wind Control.
5. Controls Design Engineer: Professional engineer responsible for Vibration Control, Seismic Control, and Wind Control.
6. Essential Facility: Buildings and other structures intended to remain operational in event of extreme environmental loading from flood, wind, snow, or earthquakes.
7. Failure: Separation of an attachment between Components, or Components and structure, vertical permanent deformation greater than 1/8-inch, horizontal permanent deformation greater than 1/4-inch, or failure of the equipment to perform its function.
8. Hazardous Contents: Material that is highly toxic or potentially explosive in sufficient quantity to pose significant life-safety threat to personnel working in building or the general public if an uncontrolled release were to occur.
9. Importance Factor (Ip): Factor that accounts for degree of hazard to human life and damage to property.
10. Isolated Component: Component indirectly connected to structure through Control designed to prevent transmission of Component vibration to structure.
11. Lateral Forces: Horizontally applied forces resulting from wind or seismic event, combined with operational horizontal forces. Wind and seismic forces are considered separately.
12. Life Safety Systems: All systems involved with fire protection including sprinkler piping, water service piping, jockey pumps, fire pumps, fire dampers, smoke dampers, smoke exhaust systems, control panels and fire alarm panels

associated with fire protection Components, and Components in Essential Facilities necessary for keeping the Essential Facility Operational.

13. Non-Isolated Component: Component that is connected to structure in such a way that allows transmission of Component vibration to structure.
14. Operational: Capable of providing intended function.
15. Process Mechanical: All mechanical Components that are not part of HVAC, plumbing and fire protection Components.
16. Seismic Control: Seismic restraining systems.
17. Seismic Use Group: Classification assigned to building based on use defined in applicable building code.
18. Vibration Control: Vibration isolating systems.
19. Wind Control: Wind restraining systems.

1.4 QUALITY ASSURANCE

A. Qualifications:
   1. Supplier:
      a. Minimum of five years of experience producing Controls substantially similar to those specified in the Contract Documents and able to provide evidence of at least five installations in satisfactory operation for at least five years in the United States.
      b. Design and analysis delegated through Supplier shall be performed by a registered professional engineer licensed in New York State.
   2. Controls Design Engineer:
      a. Engage registered professional engineer licensed in New York State, who has a minimum of five years of experience in providing engineering services for Vibration, Seismic, and Wind Controls.
      b. Submit qualifications data and include professional liability insurance certificate in amount of at least $1,000,000 per claim/aggregate with maximum deductible of $100,000.
      c. Responsibilities include:
         1) Reviewing performance and design criteria for Controls specified in the Contract Documents.
         2) Determining sizes and locations of Controls.
         3) Preparing or supervising preparation of design calculations and related drawings, Shop Drawings and submittals, testing plan development, test result interpretation, and comprehensive engineering analysis verifying compliance of Controls with the Contract Documents.
         4) Signing and sealing all calculations, design drawings, and Shop Drawings.
         5) Certifying that:
            a) Design of Controls was performed in accordance with performance and design criteria stated in the Contract Documents.
            b) Design conforms to Laws and Regulations, and to prevailing standards of practice.

6) Provide installation instructions and drawings.
7) Provide field quality control in accordance with Paragraph 3.3 of this Section.

3. Installer:
   a. Engage an experienced installer to perform the Work of this Section who specializes in installing Controls similar to that required for this Project.
   b. Submit name and qualifications to ENGINEER with the following information on a minimum of three completed, successful projects:
      1) Names and telephone numbers of owners, and architects or engineers responsible for project.
      2) Approximate cost of Control work for which installer was responsible.
4. Welder:
   a. Qualify welding processes and welding operators in accordance with AWS D1.1, D1.2, D1.3, and D1.6 as appropriate for material to be welded.
   b. Provide certification that welders employed on or to be employed for the Work have satisfactorily passed AWS qualification tests within previous 12 months. Ensure that all certifications are current.

1.5 SUBMITTALS

A. Informational Submittals: Submit the following:
   1. Shop Drawings:
      a. Detailed schedules of flexible and rigidly mounted Components to receive Controls. Schedules shall be numbered and include Contract Drawing number references where Component is located.
      b. Fabrication details of Component bases including dimensions, structural member sizes, support point locations, and weight distribution.
      c. Specific details of Controls and anchorages, including number, size, and locations for each Component.
      d. Details of suspension and support for ceiling-hung Components.
      e. Details of attachment methods where walls, floors, slabs, or supplementary steel work are used for restraint attachment.
      f. Location of all attachment and support points and forces transferred to supporting structure at each location, as a result of each load combination of static forces and Lateral Forces.
      g. Detailed piping, ductwork, and conduit restraining system layout drawings showing their attachment to building or structure. Include dimensions, size, and location of restraints and attachment connections. Coordinate with system layout Shop Drawings provided under other Sections, as applicable.
      h. Where Seismic Controls exclusions are allowed in applicable building code, identify in writing proposed exclusions to be taken and include a reference to the building code section and paragraph.
   2. Product Data:

a. Supplier and model of Controls.
b. Supplier's literature, performance data, weight, illustrations, specifications, identification of materials of construction, dimensions of individual parts, and finishes.
c. Setting drawings, templates, and directions for installation of anchor bolts and other anchorages.

3. Certifications:
   a. Component Certificates of Compliance: Where Component Suppliers are required by Laws and Regulations to provide a Certificate of Compliance for Components, submit the following:
      1) Component Certificate of Compliance from an agency that is accepted by authority having jurisdiction for compliance with building code. Analytical or shaker test certification shall be based on Project-specific seismic forces applied at Component's center of gravity, verifying capacity to transfer forces in continuous load path to supporting structure. Certification shall include design of anchorage or attachment to the supporting structure and post-seismic Operational capability. Submittals will not be reviewed without a Certificate of Compliance.
   b. Provide completed Professional Design Services Performance Certification on Attachment A to this Section.
   c. Controls Design Engineer's professional liability insurance certificate per Paragraph 1.4.A.2.b of this Section.
4. Delegated Design Submittals:
   a. Information required to clearly demonstrate basis of design for Controls, including calculations, design dimensions, approach and assumptions, and Laws and Regulations on which design of Controls and anchorage is based. Design documents prepared by Controls Design Engineer shall bear the seal and original signature and date of the Controls Design Engineer. State of engineer's registration, name, and license number shall be clearly legible on the seal.
5. Test Reports:
   a. Component test reports to confirm statements made on Certificate of Compliance, for Components where a Certificate of Compliance is required.
   b. Test reports substantiating seismic restraint designs when calculations are not used.
6. Supplier's Instructions:
   a. Instructions for shipping, storage protection, handling, and installation.
   b. Routine maintenance requirements prior to start-up.
7. Field Quality Control Submittals:
   a. Supplier's Field Reports: Submit reports confirming that Controls have been installed in accordance with Supplier's recommendations and approved Shop Drawings and submittals.
   b. Controls Design Engineer Report: Submit report confirming that Controls

have been installed in accordance with the Controls design. Report shall bear the professional engineering seal, date, and original signature of the Controls Design Engineer.

8. Qualifications Statements: Submit qualifications for.
    a. Supplier
    b. Controls Design Engineer
    c. Installer
    d. Welder

B. Closeout Submittals:
1. Operation and Maintenance Data:
    a. Submit complete operation, and maintenance manuals, including, test reports, maintenance data and schedules, description of operation, and spare parts information.
    b. Conform to Section 01 78 23, Operations and Maintenance Data.

PART 2 - PRODUCTS.

2.1 SYSTEM PERFORMANCE

A. System Description:
1. Schedules in Part 3 of this Section describe Components that are to receive Vibration Control and systems to receive Seismic Control.
2. Tables in Part 3 and performance criteria specified in Paragraph 2.1.C of this Section describe Controls to be provided on Components and systems described in the schedules. Tables are general in nature and may include certain Components that may not be specified in the schedules to receive Controls, while the schedules are Project-specific.
3. Where Components are subject to wind, design Component and related anchorage to supporting structure to resist wind loads per applicable building code using wind load factors indicated on structural Drawings. Using guy wires is allowed for assisting in support of Components.
4. Design of Components, including Vibration Controls provided by Component Supplier if required, and associated anchorage to supporting structure, are delegated through Supplier. Design shall resist seismic forces according to requirements of Laws and Regulations using seismic load factors indicated on structural Drawings. Design shall demonstrate that Component is capable of transferring Project-specific seismic forces (at minimum) applied at Component's center of gravity, and center of gravity of Component's major elements, to supporting structure without losing structural integrity.
5. Interconnection design of Component Assemblies, including Vibration Controls if required, and anchorage to supporting structure, shall be by Controls Design Engineer. Design of individual Components within assembly to resist seismic forces is responsibility of individual Component Supplier.

Component Assembly design shall resist seismic forces according to requirements of Laws and Regulations using seismic load factors indicated on structural Drawings. Design shall demonstrate that Component Assembly is capable of transferring Project-specific seismic forces (at minimum) applied at Component's center of gravity, and center of gravity of Component's major elements, to supporting structure without losing structural integrity. Coordinate design with each Supplier of Components used in the assembly and obtain approval of each Supplier prior to providing Shop Drawings for Component Assembly.

6. Equivalency: Products or methods specified for Controls are not intended to limit use of other products or methods of equivalent or superior quality and effectiveness.

B. Design Criteria:

1. Determine seismic design loads as stipulated in Section 1613 of building code. Exact force shall be determined by calculation for each Component, considering all factors of Laws and Regulations.
2. Determine vertical seismic forces based on acceleration equal to two-thirds of building code-defined horizontal acceleration. Combine vertical seismic forces with horizontal seismic forces based on square root of sum of squares method.
3. Testing or calculations to support seismic restraint designs shall include shear, flexural, and axial loads, and at least one test or analyses at 45 degrees to weakest mode.
4. Analyses for anchorage shall include calculated dead loads, Lateral Forces, and capacity of materials utilized for connections to Components and structure. Analysis for anchorage shall include anchoring methods, bolt diameter, embedment, and weld requirements. Design Seismic Controls to accept, without failure, forces acting through Component's center of gravity and distributed relative to Component's mass distribution.
5. Design Wind Controls to accept, without failure, wind forces acting on Component's exposed wind surface area. Analyses for wind forces shall consider Lateral Forces applied on a minimum of two orthogonal axes in two directions per axis. Overturning moments may result in uplift forces that exceed gravitational forces at ground level that shall be incorporated into analysis.

C. Performance Criteria:

1. Design and provide Components to maintain structural integrity and to provide continuous load path to transfer Lateral Forces through elements of Component and through anchorage to supporting structure.
2. Fan and compressor Components shall be protected against excessive displacement that results from high air thrust in relation to Component weight. Horizontal thrust restraints shall be provided when horizontal motion exceeds 3/8-inch.

3. Internally Isolated Components, when provided in lieu of external isolation and restraint systems, shall conform to requirements of this Section.
4. Curb or roof rail-mounted Components shall be attached to the curb or rails that shall, in turn, be attached to supporting structure, creating continuous load path for vertical and Lateral Forces. Sheet metal screw attachment is unacceptable.
5. Where location and characteristics of elements of supporting structure are not appropriate for supporting Component and transferring vertical and Lateral Forces, notify ENGINEER in writing.
6. Where changes in specified Components or location of Components are proposed by CONTRACTOR for convenience of CONTRACTOR and accepted by ENGINEER, modifications to supporting structure required by such changes shall be responsibility of CONTRACTOR at no additional cost to DEPARTMENT. Design of modification shall consider all vertical and Lateral Forces and be signed, dated, and sealed by Controls Design Engineer.
7. Where ceilings are not braced, lighting fixtures shall have independent four corner diagonal wire ties to structure.
8. Design lay-in ceilings, including accessory Components, in accordance with CISCA 0-2 or CISCA 3-4, as applicable.
9. Seismic Restraint of Piping:
    a. For Isolated piping use Type V seismic cable restraints or resilient single arm braces. For piping that is not Isolated, use Type V seismic cable restraints or Type VI seismic solid braces.
    b. Maximum seismic bracing distances are specified in Table 40 05 96-E in this Section. Fuel oil, natural gas piping, thermoplastic piping, and glass-lined pipe are exceptions to requirements of Table 40 05 96-E. Fuel oil and natural gas piping transverse restraints shall be at maximum intervals of 20 feet and longitudinal restraints at maximum intervals of 40 feet. Brace thermoplastic and glass-lined pipe with bottom shields at maximum intervals of 20 feet transversely and 40 feet longitudinally.
    c. Determine by calculation required bracing distances when multiple runs of pipe are located on same support.
    d. Use hanger rod braces when hanger rod lengths are greater than three feet.
    e. Provide spacers inside clevis hangers at seismic brace locations.
    f. Where thermal expansion guides and anchors are provided, guides and anchors may be used as transverse and longitudinal restraints provided they have a capacity equal to or greater than restraint loads plus loads induced by expansion and contraction.
    g. Transverse restraints for one pipe section may also act as longitudinal restraint for another pipe section of same size connected perpendicular to it if restraint is installed within two feet of elbow or tee, or combined stresses are within allowable limits at longer distances.
    h. Use hold-down clamps to attach pipe to trapeze members before applying restraints. Use Type V or VII restraint, if trapeze is smaller than 48 inches wide.

i. Do not use smaller piping to restrain larger pipe.
j. Fire protection branch piping shall be end-tied and seismically restrained.

10. Seismic Restraint of Electrical Conduit, Bus Duct, and Cable Tray:
    a. For Components not Isolated, use Type V seismic cable restraints or Type VI seismic solid braces.
    b. Maximum seismic bracing distances are specified in Table 40 05 96-E in this Section.
    c. Determine by calculation bracing distances for multiple runs of conduit on same support.
    d. Use hanger rod braces when hanger rod lengths are greater than three feet.
    e. Use hold-down clamps to attach conduits to trapeze members before applying restraints. Use Type V or VII restraint, if trapeze is smaller than 48 inches wide.
11. Seismic Restraint of HVAC Ductwork:
    a. Provide Type V seismic cable restraints or Type VI seismic solid braces.
    b. Maximum bracing distances are specified in Table 40 05 96-E of this Section.
    c. Reinforce ductwork at restraint locations. Reinforcement shall consist of an additional angle on top of ductwork that is attached to support hanger rods. Attach ductwork to both upper angle and lower trapeze.
    d. A group of ducts may be combined in a larger frame so that combined weights and dimensions of ducts are less than or equal to maximum weight and dimensions of duct for which bracing details are selected.
    e. Walls, including gypsum board used for non-bearing partitions, that have duct penetrations may replace a typical transverse brace. Provide channel framing around ducts and solid blocking between duct and frame.
    f. Support and laterally brace independent of duct system Components with an operating weight greater than 75 pounds installed in ductwork.

D. Seismic Control Exclusions
    1. Exclusions for Seismic Control of Components per building code are allowed, except where noted otherwise in the Contract Documents.

2.2 MANUFACTURERS

A. Provide products of one of the following:
    1. Vibration Mountings and Controls, Inc.
    2. Mason Industries
    3. Kinetics Noise Control
    4. Amber/Booth Company, Inc.
    5. Or equal

2.3 VIBRATION ISOLATION TYPES

A. Type A: Spring Isolator - Free Standing
   1. Spring isolators shall be free standing and laterally stable without housing, and complete with a molded neoprene cup or 1/4-inch neoprene acoustical friction pad between baseplate and support.
   2. Mountings shall have leveling bolts rigidly bolted to the Component.
   3. Spring diameters shall be no less than 0.8 of compressed height of spring at rated load.
   4. Springs shall have minimum additional travel to solid equal to 50 percent of rated deflection.
   5. Product and Manufacturer: Provide one of the following:
      a. ASC, manufactured by Vibration Mountings and Controls.
      b. SLF, manufactured by Mason Industries.
      c. Or equal.

B. Type B: Seismically Restrained Spring Isolator
   1. Restrained spring mountings shall have Type A spring isolator within rigid housing that includes vertical limit stops to prevent spring extension when weight is removed. Housing shall serve as blocking during erection. Remove steel spacer after adjustment. Installed and operating heights are equal. Provide minimum clearance of 1/4-inch around restraining bolts and internal neoprene deceleration bushings to avoid interfering with spring action. Limit stops shall be out of contact during normal operation. Because housings shall be bolted or welded in position, provide an internal isolation pad. Design housing to resist seismic forces.
   2. Product and Manufacturer: Provide one of the following:
      a. AWRS, ASCM, manufactured by Vibration Mountings and Controls.
      b. SLR, manufactured by Mason Industries.
      c. Or equal.

C. Type C: Combination Spring/Elastomer Hanger Isolator (30-degree Type)
   1. Hangers shall consist of rigid steel frames containing minimum 1.25-inch thick neoprene elements at top and steel spring with general characteristics specified for Type A. Neoprene element shall have neoprene bushings projecting through steel box.
   2. Spring diameters and hanger box lower hole sizes shall be large enough to allow hanger rod to swing through a 30-degree arc from side to side before contacting rod bushing and short-circuiting the spring.
   3. Submittals shall include hanger drawing showing 30-degree capabilities.
   4. Hanger locations requiring pre-compression for holding piping at fixed elevation shall be pre-compressed by manufacturer.
   5. Product and Manufacturer: Provide one of the following:
      a. RSH30, manufactured by Vibration Mountings and Controls.
      b. 30N, manufactured by Mason Industries.

c. Or equal.

D. Type D: Elastomer Double Deflection Hanger Isolator
1. Molded neoprene element, minimum 1.25-inch thick, with Projecting bushing lining rod clearance hole. Static deflection at rated load shall be minimum of 0.35 inches.
2. Steel retainer box encasing neoprene mounting capable of supporting Component up to four times rated capacity of element.
3. Product and Manufacturer: Provide one of the following:
   a. RHD, manufactured by Vibration Mountings and Controls.
   b. HD, manufactured by Mason Industries.
   c. Or equal.

E. Type E: Combination Spring/Elastomer Hanger Isolator
1. Spring and neoprene elements in a steel retainer box with the features as specified in this Section for Type C and Type D isolators.
2. Hanger locations requiring pre-compression for holding piping at fixed elevation shall be pre-compressed by manufacturer.
3. Thirty-degree angularity feature is not required.
4. Product and Manufacturer: Provide one of the following:
   a. RSH, manufactured by Vibration Mountings and Controls.
   b. DNHS, manufactured by Mason Industries.
   c. Or equal.

F. Type F: Seismically Restrained Elastomer Floor Isolator
1. Neoprene mountings shall have minimum static deflection of 0.2 inches and all-directional seismic capability. Mount shall consist of two separated and opposing molded neoprene elements. Elements shall prevent central threaded sleeve and attachment bolt from contacting casting during normal operation. Shock absorbing neoprene materials shall be compounded to bridge-bearing specifications.
2. Product and Manufacturer: Provide one of the following:
   a. RSM, manufactured by Vibration Mountings and Controls.
   b. BR, manufactured by Mason Industries.
   c. Or equal.

G. Type G: Pad Type Elastomer Isolator (Standard)
1. One layer of 3/4-inch thick neoprene pad consisting of two-inch square modules.
2. Use load distribution plates as required.
3. Provide bolting for seismic compliance. Provide neoprene and duck washers and bushings to prevent short circuiting.
4. Product and Manufacturer: Provide one of the following:
   a. Maxiflex, manufactured by Vibration Mountings and Controls.
   b. Super W, manufactured by Mason Industries.

c. Or equal.

H. Type H: Pad Type Elastomer Isolator (High Density)
1. Laminated canvas duck and neoprene, minimum 1/2-inch thick, with loading capacity of 1,000 psi.
2. Use load distribution plate as required.
3. Bolting as required for seismic compliance. Provide neoprene and duck washers and bushings to prevent short circuiting.
4. Product and Manufacturer: Provide one of the following:
   a. Fabriflex, manufactured by Vibration Mountings and Controls.
   b. HL, manufactured by Mason Industries.
   c. Or equal.

I. Type I: Thrust Restraints
1. Spring element similar to that specified for Type A isolator shall be combined with steel angles, backup plates, threaded rod, washers, and nuts to produce a pair of devices capable of limiting movement of Components to 1/4-inch.
2. Restraint shall be easily converted in field from compression type to tension type.
3. Unit shall be factory pre-compressed.
4. Product and Manufacturer: Provide one of the following:
   a. RSHTR, manufactured by Vibration Mountings and Controls.
   b. WBI \ D, manufactured by Mason Industries.
   c. Or equal.

J. Type J: Pipe Anchors
1. Provide all-directional acoustical pipe anchor, consisting of two sizes of steel tubing separated by minimum 1/2-inch thick 60-durometer neoprene.
2. Allowable loads on isolation material shall not exceed 500 psi. Balance design for equal resistance in all directions.
3. Product and Manufacturer: Provide one of the following:
   a. MDPA, manufactured by Vibration Mountings and Controls.
   b. ADA, manufactured by Mason Industries.
   c. Or equal.

K. Type K: Pipe Guides
1. Pipe guides shall consist of telescopic arrangement of two sizes of steel tubing separated by minimum 1/2-inch thick 60-durometer neoprene.
2. Height of guides shall be pre-set with shear pin to allow vertical motion induced by pipe expansion and contraction. Shear pin shall be removable and re-insertable to allow selection of pipe movement.
3. Guides shall be capable of minimum 1-5/8-inch motion in both directions
4. Product and Manufacturer: Provide one of the following:
   a. PG, manufactured by Vibration Mountings and Controls.
   b. VSG, manufactured by Mason Industries.

c. Or equal.

L. Type L: Isolated Pipe Hanger System
1. Provide pre-compressed spring and elastomer isolation hanger combined with pipe support into one assembly. Replaces standard clevis, single or double rod roller, or double rod fixed support.
2. Provide with spring element specified for Type A, with steel lower spring retainer and upper elastomer retainer cup with integral bushing to insulate support rod from isolation hanger.
3. Neoprene element under lower steel spring retainer shall have integral bushing to insulate support rod from steel spring retainer.
4. Design and construct hangers to support loads over three times the rated load without Failure.
5. System shall be pre-compressed to allow for rod insertion and standard leveling.
6. Product and Manufacturer: Provide one of the following:
   a. CIH, CIR, TIH, PIH, manufactured by Vibration Mountings and Controls.
   b. Or equal.

2.4 SEISMIC RESTRAINT TYPES

A. Type I: Spring Isolator, Restrained
1. Refer to vibration isolation Type B.
2. Product and Manufacturer: Provide one of the following:
   a. ASCM, AWR, manufactured by Vibration Mountings and Controls.
   b. SLR, SLRS, manufactured by Mason Industries.
   c. Or equal.

B. Type II: Seismically Restrained Elastomer Floor Isolator
1. Refer to vibration isolation Type F.
2. Product and Manufacturer: Provide one of the following:
   a. RSM, manufactured by Vibration Mountings and Controls.
   b. BR, manufactured by Mason Industries.
   c. Or equal.

C. Type III: All-Directional Seismic Snubber
1. All-directional seismic snubbers shall consist of interlocking steel members restrained by one-piece molded neoprene bushing of bridge bearing neoprene. Bushing shall be replaceable and minimum of 1/4-inch thick. Rated loadings shall not exceed 1,000 psi. Minimum air gap of 1/8-inch shall be incorporated in snubber in all directions before contact is made between rigid and resilient surfaces. Snubber end caps shall be removable to allow inspection of internal clearances. Neoprene bushings shall be rotated to insure no short circuits exist before systems are activated.
2. Product and Manufacturer: Provide one of the following:

a. Type SR, manufactured by Vibration Mountings and Controls.
b. Z1225, manufactured by Mason Industries.
c. Or equal.

D. Type IV: Floor or Roof Anchorage
1. Rigid attachment to structure utilizing wedge-type anchor bolts, anchored plates machine screw, bolting or welding. Powder shots are unacceptable.
2. Product and Manufacturer: Provide one of the following:
a. FA, manufactured by Vibration Mountings and Controls.
b. SAB, manufactured by Mason Industries.
c. Or equal.

E. Type V: Seismic Cable Restraints
1. Seismic Cable Restraints shall consist of steel aircraft cables sized to resist seismic loads with minimum safety factor of 2.0, and arranged to provide all-directional restraint. Cable end connections shall be steel assemblies that swivel to final installation angle and utilize two clamping bolts to provide proper cable engagement. Cables shall not bend across sharp edges. Single arm braces with resilient bushings can be substituted for seismic cable restraints. Deck fitting shall have two through-bolts for attachment.
2. Product and Manufacturer: Provide one of the following:
a. SCR, manufactured by Vibration Mountings and Controls.
b. SCB, manufactured by Mason Industries.
c. Or equal.

F. Type VI: Rigid Arm Brace
1. Seismic solid braces shall consist of steel angles or channels to resist seismic loads with minimum safety factor of 2.0, and arranged to provide all directional restraint. Seismic solid brace end connectors shall be steel assemblies that swivel to final installation angle and utilize two through-bolts to provide attachment.
2. Product and Manufacturer: Provide one of the following:
a. SAB, manufactured by Vibration Mountings and Controls.
b. SSB, manufactured by Mason Industries.
c. Or equal.

G. Type VII: Internal Clevis Cross Brace
1. Internal clevis cross braces at seismic locations shall be pre-cut pipe sized for internal clevis dimensions.
2. Product and Manufacturer: Provide one of the following:
a. ICB, manufactured by Vibration Mountings and Controls.
b. CCB, manufactured by Mason Industries.
c. Or equal.

2.5 COMPONENT BASES

A. General
   1. All curbs and roof rails shall be anchored to building structural steel for resisting Lateral Forces. Fastening to metal deck is unacceptable.

B. Type B-1: Integral Structural Steel Base
   1. Rectangular bases are preferred for all Components.
   2. Centrifugal refrigeration machines and pump bases may be T- or L-shaped when there are space constraints. When the pump has pump-mounted suction and discharge fittings, base of pump shall include required supports.
   3. All perimeter members shall be steel beams with minimum depth equal to 1/12 of the longest dimension of base.
   4. Base depth need not exceed 12 inches provided that deflection and misalignment is within acceptable limits as determined by Supplier.
   5. Height-saving brackets shall be employed on all mounting locations to provide minimum base clearance of two inches.
   6. Product and Manufacturer: Provide one of the following:
      a. WFB, manufactured by Vibration Mountings and Controls.
      b. MSL, WSFL, manufactured by Mason Industries.
      c. Or equal.

C. Type B-2: Concrete Inertia Base
   1. Vibration isolation manufacturer shall furnish rectangular steel concrete pouring forms for floating and inertia foundations.
   2. When pump has pump-mounted suction and discharge fittings, base of pump shall include required supports
   3. Base depth shall be a minimum of 1/12 of the longest dimension of the base but not less than six inches.
   4. Base depth need not exceed 12 inches unless specifically recommended by base manufacturer for mass or rigidity.
   5. Forms shall include minimum concrete reinforcing consisting of 1/2-inch bars welded in place on six-inch centers running both ways in layer 1.5 inches above bottom.
   6. Provide forms with steel templates to hold anchor bolts sleeves and anchors while concrete is poured.
   7. Provide height-saving brackets on all mounting locations to maintain a two-inch minimum clearance below base.
   8. Flush-profile wooden formed bases having correct depth and reinforcing requirements are acceptable.
   9. Product and Manufacturer: Provide one of the following:
      a. MPF, manufactured by Vibration Mountings and Controls.
      b. BMK, manufactured by Mason Industries.
      c. Or equal.

D. Type B-3: Seismic Isolation Curb

1. Curb-mounted rooftop Components shall be mounted on structural seismic spring isolation curbs. Upper frame shall provide continuous support for Component and be captive to resiliently resist Lateral Forces. Lower frame shall accept point support for both seismic attachment and leveling. Upper frame shall provide positive fastening provisions (welding or bolting) to anchor roof top unit to curb. Sheet metal screws are unacceptable. Contact points between roof top unit, curb, and building's structure shall allow load path through those locations only.
2. All-directional neoprene snubber bushings shall be a minimum of 1/4-inch thick. Steel springs shall be laterally stable and rest on 1/4-inch thick neoprene acoustical pads.
3. Curbs' waterproofing shall meet NRCA standards.
4. All spring locations shall have access ports with removable waterproof covers and all isolators shall be adjustable, removable, and interchangeable.
5. Curb shall be sound-attenuating type utilizing standard two-inch roof insulation supplied and installed by CONTRACTOR to act thermally outside and acoustically inside. Curbs supplied without this feature shall be acoustically lined in the factory with two-inch duct liner.
6. Option No. 1 - Where a sound barrier is required, curb shall have full-size lay-in attenuation panels having minimum STC rating of 60 when combined with roof deck's rating. Attenuation system shall add full sound attenuation structural floor to curb capable of spanning curb's width and designed for live loads of 20 psf. Panels shall not weigh more than six psf. Four-inch nominal galvanized panel shall be joined for airtight construction and shall have support system where panels are used below an outside condenser section. Panels shall be waterproof for both outdoor and indoor application. Space below curb panels and roof deck shall have four inches of insulation provided by CONTRACTOR. Curb wall construction shall utilize roofer's standard insulation where curbs use open thermal acoustical screening system. Solid wall curbs shall use two inches of factory duct liner installed by curb manufacturer. Entire curb shall have continuous neoprene air seal. Type RPFMA shall use open return system with roof return opening set as far as possible from unit's return opening.
7. Option No. 2 - When curb type SRPFMA (Supply Return Plenum Construction) is required, in addition to Option No. 1, walls of supply section shall use two inches of sound-attenuating panels and continuous inner neoprene air seal and Isolated plenum divider. Both supply and return ducts shall seal directly to curb base floor attenuation panels.
8. Product and Manufacturer: Provide one of the following:
   a. Models P6200 or P6300. Type RPFMA/SRPFMA where Option No. 1 or Option No. 2 is specified, manufactured by Vibration Mountings and Controls.
   b. RCS, manufactured by Mason Industries.
   c. Or equal.

E. Type B-4: Seismic Non-Isolated Curbs
   1. Curbs shall conform to Type B-3 curbs except spring isolation is not required.
   2. Product and Manufacturer: Provide one of the following:
      a. Model P6000. Type RPFMA/SRPFMA where Option No. 1 or Option No. 2 is specified, manufactured by Vibration Mountings and Controls.
      b. RRC, manufactured by Mason Industries.
      c. Or equal.

F. Type B-5: Isolated Component Supports
   1. Continuous structural Component support rails that combine Component support and isolation mounting into one utilized roof flashed assembly with same features specified for Type B-3.
   2. System shall provide for positive anchorage or welding of Component to supports and welding of supports to building steel.
   3. Product and Manufacturer: Provide one of the following:
      a. R7200/R7300, manufactured by Vibration Mountings and Controls.
      b. RSR, manufactured by Mason Industries.
      c. Or equal.

G. Type B-6: Non-Isolated Component Supports
   1. Shall be as specified for Type B-5, except without spring isolation.
   2. Product and Manufacturer: Provide one of the following:
      a. R7000, manufactured by Vibration Mountings and Controls.
      b. RRC, manufactured by Mason Industries.
      c. Or equal.

H. Type B-7: Control/Electric Room Air Conditioning Unit Base
   1. Components shall be welded or bolted to welded structural steel stands having minimum 0.5 “G” certified lateral acceleration capabilities.
   2. Non-Isolated stand shall have one-inch adjustment capability to accommodate floor irregularities.
   3. Bolting or welding required to meet seismic criteria.
   4. Product and Manufacturer: Provide one of the following:
      a. CRC, manufactured by Vibration Mountings and Controls.
      b. CRMSL, manufactured by Mason Industries.
      c. Or equal.

2.6 FLEXIBLE CONNECTORS

A. Type FC-2: Flexible Stainless Steel Hose
   1. Flexible stainless steel hose shall have stainless steel braid and carbon steel fittings. Sizes three-inch diameter and larger shall be flanged. Smaller sizes shall have male nipples.

2. Connector shall be braided bronze for refrigerant connections.
   a. Minimum lengths shall be as tabulated:

Flanged: diameter x length (inches)		**Male Nipples: diameter x length (inches)**	
3 x 14	10 x 26	0.5 x 9	1.5 x 13
4 x 15	12 x 28	0.75 x 10	2 x 14
5 x 19	14 x 30	1 x 11	2.5 x 18
6 x 20	16 x 32	1.25 x 12	
8 x 22			

3. Provide hoses on Component side of shut-off valves horizontally and parallel to Component shafts, where possible.
4. Product and Manufacturer: Provide one of the following:
   a. BS, manufactured by Vibration Mountings and Controls.
   b. BSS, manufactured by Mason Industries.
   c. Or equal.

2.7 MATERIALS OF CONSTRUCTION AND FINISHES

A. Controls including all miscellaneous structural steel and appurtenances shall be constructed of steel.

B. Controls shall be factory-painted per Section 09 91 00, Painting.

C. Miscellaneous steel angles, supports, and appurtenances shall be cleaned and prime-coated in the shop and field-painted per Section 09 91 00, Painting.

D. Hardware shall be galvanized steel.

E. Neoprene and elastomer parts shall be resistant to ultraviolet radiation and constructed from high grade materials suitable for exposure to high concentrations of hydrogen sulfides, mercaptans, chlorine, and moisture in air.

2.8 IDENTIFICATION

A. Provide each Control device with embossed or engraved with serial number cross-referenced to Component schedule, in accordance with Section 10 14 00, Signage.

2.9 ANCHORAGE

A. Anchorages shall be per Section 05 05 33, Anchor Systems.

2.10 MISCELLANEOUS METAL

A. Miscellaneous metal fabrications shall be per Section 05 50 13, Miscellaneous Metal Fabrications.

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine areas and conditions under which Control Work is to be performed and notify ENGINEER in writing of conditions detrimental to proper and timely completion of Work. Do not proceed with Work until unsatisfactory conditions have been corrected in a manner acceptable to ENGINEER.

B. Coordinate anchorage of Components to receive Controls with installation locations. Examine roughing-in of reinforcing and cast-in-place anchor bolts to verify locations before installation.

3.2 COMPONENT INSTALLATION

A. Install Controls in accordance with Supplier's written instructions and Shop Drawings and submittals accepted by ENGINEER.

B. Rigid connections between Components and building structure shall not be made in a manner that degrades performance of Control systems.

C. Do not rigidly connect Isolated Components to building structure.

D. Bracing may occur from flanges of structural beams, upper truss chords in bar joist construction, and concrete inserts or cast-in-place anchor bolts. Component support shall not overstress the structure.

E. Install cable restraints with minimum slack to avoid short-circuiting associated Component.

F. Install cable assemblies without slack on Non-Isolated systems. Solid braces may be used in place of cables on rigidly attached systems except where single arm braces incorporate resilient bushings.

G. At locations where restraints or solid braces are located, brace support rods as required to accept compressive loads.

H. Minimum operating clearance under all Isolated Component bases shall be two inches.

3.3 FIELD QUALITY CONTROL

A. Controls Design Engineer Services:
   1. Controls Design Engineer shall check Controls installation before Controls and related equipment are placed into operation.
   2. Controls Design Engineer shall make at least one visit(s) to the Site.
   3. After Controls installation is complete, Controls Design Engineer shall inspect completed Controls Work and certify in writing to CONTRACTOR that all systems are installed in accordance with design. CONTRACTOR shall submit Control Design Engineer's report to ENGINEER, certifying correctness of the Work.

B. Supplier's Services:
   1. Supplier shall check Controls installation before Controls and related equipment are placed into operation.
   2. Supplier shall make at least one visit(s) to the Site.
   3. After installation of Controls is complete, Supplier shall inspect completed Controls Work and certify in writing to CONTRACTOR that Controls are installed in accordance with Supplier's recommendations and Shop Drawings and submittals accepted by ENGINEER. CONTRACTOR shall submit Supplier's report to ENGINEER certifying correctness of the Work

3.4 ADJUSTING

A. After entire system is started and under full operating load, adjust Controls so that Controls operate as designed.

3.5 CLEANING

A. Remove debris from beneath Components and in and around the vibration isolator.

3.6 SUPPLEMENTS

A. Supplements listed below, following the "End of Section" designation, are a part of this Section:
   1. Controls Schedules:
      a. Schedule of Process Mechanical Components for Vibration Control.
      b. Schedule of Process Mechanical Components for Seismic Control.
      c. Schedule of HVAC Components for Vibration Control.
      d. Schedule of HVAC Components for Seismic Control.
      e. Schedule of Plumbing Components for Vibration Control.
      f. Schedule of Plumbing and Fire Protection Components for Seismic Control.
      g. Schedule of Electrical Components for Vibration Control.
      h. Schedule of Electrical Components for Seismic Control.

i. Schedule of Instrumentation Components for Vibration Control.
j. Schedule of Instrumentation Components for Seismic Control.
k. Schedule of Architectural Components for Vibration Control.
l. Schedule of Architectural Components for Seismic Control.

2. Controls Tables:
   a. Table 40 05 96-A - HVAC Components.
   b. Table 40 05 96-B - Plumbing Components.
   c. Table 40 05 96-C - Electrical Components.
   d. Table 40 05 96-D – Not Used.
   e. Table 40 05 96-E - Seismic Bracing.
   f. Table 40 05 96-F - Minimum Deflection Guide.
3. Attachment 40 05 96-A – Professional Design Services Performance Certification

+ + END OF SECTION + +

CONTROLS SCHEDULES FOR SECTION 40 05 96

Section 40 05 96 Schedule of Process Mechanical Components for Vibration Control		
Item No.	**Component**	**Notes**
1	Vibration Controls are not required.	
2		
3		
4		
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NOTES:

Section 40 05 96 Schedule of Process Mechanical Systems for Seismic Control				
Item No.	**Systems**	**I_p**	**Certificate of Compliance Required**	**Notes**
1	Seismic Controls are not required.			
2				
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NOTES:

Section 40 05 96 Schedule of HVAC Components for Vibration Control		
Item No.	**Component**	**Notes**
1	Desiccant Dehumidification Unit - DAHU-1	1.
2	Air Cooled Condensing Units – ACCU-1, 2 & 3	2.
3	Air Conditioning Units – AC-1, 2 & 3	1.
4	Radiant Heater Vacuum Pumps – VP-1 & 2	
5		
6		
7		
8		
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NOTES:

1. Vibration Controls for internal fans shall be factory installed by the unit manufacturer in accordance with Section 40 05 96.
2. Vibration Controls for internal compressors shall be factory installed by the unit manufacturer in accordance with Section 40 05 96.

Section 40 05 96 Schedule of HVAC Systems for Seismic Control				
Item No.	**Component**	**I_p**	**Certificate of Compliance Required**	**Notes**
1	Seismic Controls are not required.			
2				
3				
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NOTES:

Section 40 05 96 Schedule of Plumbing Components for Vibration Control		
Item No.	**Component**	**Notes**
1	Vibration Controls are not required.	
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NOTES:

Section 40 05 96 Schedule of Plumbing and Fire Protection Systems for Seismic Control				
Item No.	**Component**	**I_p**	**Certificate of Compliance Required**	**Notes**
1	Seismic Controls are not required.			
2				
3				
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NOTES:

Section 40 05 96 Schedule of Electrical Components for Vibration Control		
Item No.	**Component**	**Notes**
1	Vibration Controls are not required.	
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NOTES:

Section 40 05 96 Schedule of Electrical Systems for Seismic Control				
Item No.	**Component**	**I_p**	**Certificate of Compliance Required**	**Notes**
1	Seismic Controls are not required.			
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3				
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NOTES:

Section 40 05 96 Schedule of Instrumentation Components for Vibration Control		
Item No.	**Component**	**Notes**
1	Vibration Controls are not required.	
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3		
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NOTES:

Section 40 05 96 Schedule of Instrumentation Systems for Seismic Control				
Item No.	**Component**	**I_p**	**Certificate of Compliance Required**	**Notes**
1	Seismic Controls are not required.			
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3				
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NOTES:

Section 40 05 96 Schedule of Architectural Components for Vibration Control		
Item No.	**Component**	**Notes**
1	Vibration Controls are not required.	
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NOTES:

Section 40 05 96 Schedule of Architectural Systems for Seismic Control				
Item No.	**Component**	**I_p**	**Certificate of Compliance Required**	**Notes**
1	Metal Stairs and associated metal landings	1.5	Yes	
2				
3				
4				
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NOTES:

SECTION 40 05 96 TABLES

Abbreviations for Tables 40 05 96-A, 40 05 96-B, 40 05 96-C, and 40 05 96-D:

ISOL	Vibration Isolator
DEFL	Deflection
RESTR	Seismic Restraint
MTNG	Mounting
MDG	Minimum Deflection Guide – Table 40 05 96-F

General Notes (G) for Tables 40 05 96-A, 40 05 96-B, 40 05 96-C, and 40 05 96-D:

Note G1: For variable speed Components with an operating speed below 600 RPM, select isolation deflection from Table 40 05 96-F, Minimum Deflection Guide.

Note G2: Determine static deflection based on Table 40 05 96-F, Minimum Deflection Guide.

Note G3: Deflections indicated are minimum at actual load and shall be selected for Supplier's nominal 5-, 4-, 3-, 2- and 1-inch deflection spring series; RPM is defined as lowest operating speed of Component.

Note G4: Single stroke compressors may require inertia bases with thickness greater than 14-inch maximum specified for Base B-2. Inertia base mass shall be sufficient to maintain double amplitude for 1/8-inch.

Note G4: For floor-mounted fans, substitute base Type B-2 for Class 2 or 3 and fan having static pressure over five inches of water column.

Note G5: Indoor utility sets with wheel diameters less than 24 inches need not have deflections greater than 0.75 inches.

Note G6: For Components with multiple motors, horsepower classification applies to largest single motor.

Reference Notes (R) for Tables 40 05 96-A, 40 05 96-B, 40 05 96-C, and 40 05 96-D:

Note R1: For roof applications, use base Type B-5.

Note R2: Curb Type B-3 shall use sound barrier RPFMA when there is no concrete underneath rooftop units. Curbs can be used for return plenums. (See Option No. 1 under Type B-3 base in Article 2.5 of this Section.)

Note R3: Where curbs require supply and return sound attenuation package, use Type SRRFMA. (See Option No. 2 under Type B-3 base in Article 2.5 of this Section.)

Note R4: Units may not be capable of point support. Refer to separate Specification Section for Component. If base is not specified in that Section and external isolation is required, provide Type B-1 base under this Section for entire unit.

Note R5: Use Type B-6 where Non-Isolated seismic support is required.

Note R6: Use Type B-4 where Non-Isolated seismic curbs are used.

TABLE 40 05 96-A - HVAC COMPONENTS										
			Mounted on Soil Supported Slab				Mounted on Suspended Slab and Floor or Roof System			
COMPONENT	HP, CLASS, OR SIZE	MTNG	ISOL	DEFL (in.)	BASE	RESTR	ISOL	DEFL (in.)	BASE	RESTR
Absorption Machine		Flr.	---	---	---	IV	B	0.75	B-2	IV
Air Handling Units Indoor		Flr	B	0.75	---	IV	B	See MDG	---	IV
		Clg	E	0.75	---	V	E	See MDG	---	V
Air Compressor Tanks	To 10 HP	Flr	B	0.75	---	IV	B	0.75	---	IV
	>10 HP	Flr	B	0.75	B-2	IV	B	1.50	B-2	IV
Dry Coolers Condensers/Condensing Outdoor Units		Roof	---	---	---	IV	B	2.50 (minimum)	B-5	IV
Axial Fans (Inline Type)		Flr	B	0.75	---	IV	B	See MDG	---	IV
		Clg	E	0.75	---	V	E	See MDG	---	V
Base Mounted Pumps	To 15 HP	Flr	B	0.75	B-2	IV	B	0.75	B-2	IV
	>15 HP	Flr	B	0.75	B-2	IV	B	1.50	B-2	IV
Boilers		Flr	G	0.10	---	IV	B	0.75	---	IV
Cabinet Fans & Packaged AHU Indoor	To 1 HP	Flr	F	0.20	---	IV	B	0.75	---	IV
		Clg	D	0.35	---	V	E	0.75	---	V
	>1 HP	Flr	B	0.75	---	IV	B	See MDG	---	IV
		Clg	E	0.75	---	V	E	See MDG	---	V
Centrif. Chillers		Flr	B	0.75	---	IV	B	1.50	---	IV
Centrif. Fans Arr. 1 & 3	Class 1	Flr	B	0.75	B-1	IV	B	See MDG	B-1	IV
	Class 2 & 3	Flr	B	0.75	B-2	IV	B	See MDG	B-2	IV
Centrif. Fans (Vent Sets) Arr. 9 & 10	Class 1	Flr	B	0.75	---	IV	B	See MDG	See Note R1	IV
	Class 2 & 3	Clg	E	0.75	B-2	V	E	See MDG	B-2	V
Computer Room Units		Flr	F	0.20	B-7	IV	B	1.5	B-7	IV
Condensate Pumps		Flr	F	0.20	If req.	IV	F	0.20	If req.	IV
Cooling Towers		Flr	B	0.75	---	IV	B	2.50	B-5 opt.	IV
Curb Mtd. Equip. (Non-Isol.)		Roof	---	---	---	IV	---	---	B-6	IV
Fan Coil Units		Flr	F	0.20	---	IV	B	0.75	---	IV
		Clg	D	0.35	---	V	E	0.75	---	V
Outdoor Reciprocating, Rotary or Screw Chillers		Flr	F	0.20	---	IV	B	1.50	---	IV
		Roof	---	---	---	IV	B	2.50	B-5 See note R5	IV

TABLE 40 05 96-A - HVAC COMPONENTS (Continued)										
			Mounted on Soil Supported Slab				Mounted on Suspended Slab and Floor or Roof System			
COMPONENT	HP, CLASS, OR SIZE	MTNG	ISOL	DEFL (in.)	BASE	RESTR	ISOL	DEFL (in.)	BASE	RESTR
Rooftop AHU/AC	< 10 Ton	Roof	---	---	---	IV	B	1.50	B-3 see notes R2, R3, R6	IV
	> 10 Ton	Roof	---	---	---	IV	B	2.50	B-3 see notes R2, R3,R6	IV
Unit/Cab Heaters		Clg	D	0.30	---	V	D	0.30	---	V

TABLE 40 05 96-B - PLUMBING COMPONENTS										
			Mounted on Soil Supported Slab				Mounted on Suspended Slab and Floor or Roof System			
COMPONENT	HP	MTNG	ISOL	DEFL (in.)	BASE	RESTR	ISOL	DEFL (in.)	BASE	RESTR
Air Compressors & Vacuum Pumps	to 10	Flr	B	0.75	---	IV	B	0.75	---	IV
	>10	Flr	B	0.75	B-2	V	B	1.50	B-2	IV
Base Mounted Pumps	to 15	Flr	B	0.75	B-2	IV	B	0.75	B-2	IV
	>15	Flr	B	0.75	B-2	IV	B	1.50	B-2	IV

TABLE 40 05 96-C - ELECTRICAL COMPONENTS										
			ON GRADE				ABOVE GRADE			
COMPONENT	SIZE	MTNG	ISOL	DEFL	BASE	RESTR	ISOL	DEFL	BASE	RESTR
Transformer Dry type	All	Flr	--	--	--	IV	D	0.30	See note R4	IV
		Ceiling	--	--	--	V	E	0.20	See note R4	V
Generators	All	Flr	B	1.0	--	IV	B	1.50	See note R4	IV
Generators	All	Over Occupied Space					B	2.50	See note R4	IV
UPS Systems	M		II	0.40		IV	B	1.50	See note R4	IV

TABLE 40 05 96-E – SEISMIC BRACING (Max. Brace Spacing Shown – Actual Spacing to be Determined by Calculation)			
COMPONENT	**ON CENTER TRANSVERSE (Spacing in Feet)**	**ON CENTER LONGITUDINAL (Spacing in Feet)**	**CHANGE OF DIRECTION (Distance in Feet)**
HVAC Duct	30	60	4
PIPE – NO HUB OR BELL AND SPIGOT			
2.5-inch dia. and larger	10	20	4
PIPE – ALL OTHER JOINT TYPES			
16-inch dia. and smaller	40	80	4
18 to 28-inch dia.	30	60	4
30 to 40-inch dia.	20	60	4
42-inch dia. and larger	10	30	4
MISCELLANEOUS			
Breeching	30	60	4
Chimneys and Stacks	30	60	4
Electrical Conduit	40	80	4
Electrical Bus Duct	20	40	4
Cable Tray	40	80	4

Table 40 05 96-F – MINIMUM DEFLECTION GUIDE	
RPM	**MINIMUM REQUIRED DEFLECTION (inches)**
Less than 400	3.5
401 to 600	2.5
601 to 900	1.5
Over 900	0.75

ATTACHMENT 40 05 96-A
Professional Design Services Performance Certification
(Page 1 of 2)

1. My name is _____.

2. My New York State professional engineering license number is _____.

3. My license expires _____, 20_____.

4. The Project for which I have performed professional design services is described as
   _____.

5. The Specification Section(s) under which I have performed my services is/are
   _____.

6. The name and address of the individual or entity for whom I have performed professional design services is:

   _____
   _____
   _____

ATTACHMENT 40 05 96-A
Professional Design Services Performance Certification
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7. I hereby certify that, to the best of my knowledge, information, and belief, I have performed or supervised performance of the professional design services hereunder, and that said services have been performed in accordance with Laws and Regulations and in accordance with the standard of care currently expected of professional engineers/architects performing similar services for Projects of similar size and complexity in New York State.

_____ Date

_____ Signature

_____ Type or Print Name

_____ Name of Firm

_____ Street Address

[PROFESSIONAL SEAL]

_____ City/State/Zip Code

Telephone: _____ Fax: _____

SECTION 40 60 05

INSTRUMENTATION AND CONTROL

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope
   1. CONTRACTOR shall retain services of a System Integrator to provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish, install, calibrate, train, test, start-up, and place in satisfactory operation a complete and operating instrumentation and control system in accordance with the Contract Documents. The DEPARTMENT furnished GAC Contactor System will be furnished with field instruments that shall be installed and integrated by the CONTRACTOR.
   2. CONTRACTOR shall assign PLC Input/Output (I/O) tags using the Contract tag numbers.
   3. Work includes, but is not limited to, the following:
      a. Installation of GAC Control Panel (GAC-CP) including configuration of GAC PLC and OIT.
      b. Installation of new GAC Contactor System field instruments and interfacing the signals identified in the contract documents with GAC Control Panel.
      c. Configuration of Remote OIT panel.
      d. GAC Feed Pumps and High Lift Pumps controls.
      e. Installation of Head House Control Panel (HH-CP) including configuration of HH PLC and OIT.
      f. Configuration of Remote OIT panel.
      g. Providing all the field instruments, with the exception of Vendor supplied, and supervision of the installation of all instruments.
      h. Intercept Existing Clearwell No. 3 Level signal and loop to new panel. The System Integrator shall coordinate with the plant to ensure all existing signals/communications and functionality of the existing controls are maintained after the signal is split.
      i. Intercept Exsiting 1.2 MG Tank Level signal and loop to new panel. The System Integrator shall coordinate with the plant to ensure all existing signals/communications and functionality of the existing controls are maintained after the signal is split.
      j. Chemical Analyzer Monitoring System with online Chlorine, Fluoride, Phosphate and pH monitoring. Flow pacing of the chemical pumps.
      k. All work as shown and as described in the Contract Documents.

B. Abbreviations:
   1. PLC: Programmable Logic Controller

2. OIT: Operator Interface Terminal
3. R-OIT: Remote Operator Interface Terminal
4. GAC: Granular Activated Carbon
5. HH: Head House
6. VFD: Variable Frequency Drive

1.2 REFERENCES

A. The following organizations have generated standards that are to be used as guides in assuring quality and reliability of components and systems; govern nomenclature; define parameters of configuration and construction, in addition to specific details in this Specification and the Contract Drawings:
   1. ISA, International Society of Automation.
   2. API, American Petroleum Institute.
   3. UL, Underwriters' Laboratories, Inc.
   4. AWWA, American Water Works Association.
   5. NRC, Nuclear Regulatory Commission.
   6. NEMA, National Electrical Manufacturers Association.
   7. OSHA, Occupational Safety and Health Administration.
   8. ANSI, American National Standards Institute.
   9. NFPA, National Fire Protection Association.
   10. SAMA, Scientific Apparatus Manufacturers Association.
   11. IEEE, Institute of Electrical and Electronic Engineers.
   12. NEC, National Electrical Code.
   13. FM, Factory Mutual.

1.3 QUALITY ASSURANCE

A. Qualifications:
   1. System Integrator:
      a. Shall be financially sound with at least five years' continuous experience in designing, implementing, supplying, and supporting instrumentation and control systems comparable to the instrumentation and control systems required for the Project, relative to hardware, software, cost, and complexity.
      b. Shall have record of successful instrumentation and control system equipment installations. Upon Engineer's request, submit record of experience listing for each project: project name and contact information, name and contact information for CONTRACTOR, name and contact information for engineer or architect, approximate contract value of instrumentation and controls Work for which Instrumentation Supplier was responsible.
      c. Shall have at time of Bid experienced engineering and technical staff capable of designing, supplying, implementing, and supporting the instrument and control system and complying with submittal and training requirements of the Contract Documents.

d. Shall be capable of training operations and maintenance personnel in instrumentation and control applications, and in operating, programming, and maintaining the control system and equipment.
Shall have UL-approved panel shop.

B. Manufacturer:

a. Manufacturers of instrumentation and control equipment furnished under this Section shall be experienced producing similar equipment and shall have the following qualifications:
1) Shall manufacture instrumentation and control system components that are fully-developed, field-proven, and of standardized designs.
2) Shall have system of traceability of manufactured unit through production and testing in accordance with ANSI/ASQ Z1.4.
3) Shall have guaranteed availability clause (99.99 percent, minimum for one year) for microprocessor-based components and appurtenances.
4) Shall have documented product safety policy relevant to products proposed for the Work.

C. Pre-submittal Conference
1. Schedule and conduct pre-submittal conference for instrumentation and control system within 30 days after Notice to Proceed.
2. Required attendance for pre-submittal conference: CONTRACTOR, Systems Integrator, GAC CONTACTOR SYSTEM MANUFACTURER, ENGINEER, and DEPARTMENT. Pre-submittal conference will be 4 hours. Conference will be held at the Site.
3. Purpose of pre-submittal conference is to review manner in which CONTRACTOR intends to comply with requirements of the Contract Documents before submittals are prepared.
4. Prepare items listed below for presentation at pre-submittal conference. Submit information to ENGINEER two weeks prior to pre-submittal conference.
a. List of materials and equipment required for instrumentation and control system, and brand and model proposed for each item.
b. List of proposed exceptions to the Contract Documents along with brief explanation of each.
c. Sample of each type of submittal specified in this Section. These may be submittals prepared for other projects.
d. Flow chart showing steps to be taken in preparing and coordinating instrumentation and control system submittals.
e. General outline of types of tests to be performed to verify that all sensors and transducers, instruments, and digital processing equipment are functioning properly.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Shop Drawings:
      a. Field Instruments:
         1) Manufacturer's product name and complete model number of devices proposed for use, including manufacturer's name and address.
         2) Instrument tag number in accordance with the Contract Documents.
         3) Data sheets and manufacturer's catalog literature. Provide data sheets in accordance with ISA 20 and annotated for features proposed for use. For instruments not included in ISA 20, submit data sheets using a format similar to ISA 20.
         4) Description of construction features.
         5) Performance and operation data.
         6) Installation, mounting, and calibration details; instructions and recommendations.
         7) Service requirements.
         8) Dimensions of instruments and details of mating flanges and locations of closed tanks, pipe sizes for insertion instruments, and upstream/downstream straight run pipe lengths required.
         9) Range of each device and calibration information.
         10) Descriptions of materials of construction and listing of NEMA ratings for equipment.
      b. Panels and Enclosures:
         1) Layout drawings that include:
            a) Front, rear, and internal panel views to scale.
            b) Tag number and functional name of components mounted in and on panel, or enclosure, as applicable.
            c) Product information on panel components.
            d) Nameplate location and legend including text, letter size and colors to be used.
            e) Location of anchorage connections.
            f) Location of external wiring and piping connections.
            g) Mounting and installation details, coordinated with actual application.
            h) Calculations for heating and cooling of panels.
            i) Subpanel layouts and mounting details for items located inside control panels.
         2) Product information on panel components including:
            a) Manufacturer's product name and complete model number of devices being provided, including manufacturer's name and address.
            b) Instrument tag number in accordance with the Contract Documents.

c) Data sheets and catalog literature. Submit data sheets in ISA 20 Format and annotated for features proposed for use.
d) Description of construction features.
e) Performance and operation data.
f) Installation, mounting, and calibration details; instructions and recommendations.
g) Service requirements.

3) Wiring and piping diagrams, including the following:
a) Name of each panel, or enclosure.
b) Wire sizes and types.
c) Pipe sizes and types.
d) Terminal strip and terminal numbers.
e) Wire color coding.
f) Functional name and manufacturer's designation for components to which wiring and piping are connected.
g) Lightning and surge protection grounding.

4) Electrical control schematics in accordance with NFPA 79. Drawings shall be in accordance with convention indicated in Annex D of the NFPA 79. Typical wiring diagrams that do not accurately reflect actual wiring to be furnished are unacceptable. Tables or charts for describing wire numbers are unacceptable.

5) Bill of materials for each panel including tag number, functional name, manufacturer's name, model number and quantity for components mounted in or on the panel or enclosure.

6) Detail showing anchorage plan of wire bundles between subpanels and front panel mounted devices.

c. Chemical Monitoring System, include the following:
1) Provide complete shop drawings as a packaged Chemical Monitoring System based on the schematic shown in the Contract Documents for ENGINEER approval.

d. Field wiring and piping diagrams, include the following:
1) Wire and pipe sizes and types.
2) Terminal numbers at field devices and in panels.
3) Fiber optic termination designations in the field and in panels.
4) Color coding.
5) Conduit numbers in which wiring will be located.
6) Locations, functional names, and manufacturer's designations of items to which wiring or piping are connected.

e. Functional Description, include the following:
1) Detailed functional descriptions for all the equipment provided under this contract.

f. Proposed operator interface graphics layouts are shared by all three screens. Each graphic display layout will be subject to modification from System Integrator's submitted format within limits of software package used for development. Implement such modifications in accordance with ENGINEER's comments. Provide at minimum one

meeting where screens can be reviewed live (over Web) or in person prior to approval.

g. Complete point-to-point interconnection wiring diagrams of field wiring associated with the system. Diagrams shall include the following:
   1) Field wiring between each equipment item, panel, instruments, and other devices, and wiring to control stations, panel boards, and motor starters. Some of this equipment may be specified in other Sections, CONTRACTOR is responsible for providing complete point-to-point interconnection wiring diagrams for control and monitoring of that equipment.
   2) Numbered terminal block and terminal identification for each wire termination.
   3) Identification of assigned wire numbers for interconnections. Assign each wire a unique number.
   4) Schedule showing the wiring numbers and the conduit number in which the numbered wire is installed.
   5) Junction and pull boxes through which wiring will be routed.
   6) Identification of equipment in accordance with the Contract Documents.

B. Informational Submittals: Submit the following:
   1. Manufacturer's Instructions:
      a. Shipping, handling, storage, installation, and start-up instructions.
   2. Special Procedure Submittals:
      a. Submit notification to ENGINEER at least 14 days before readiness to begin system checkout. Schedule system checkout on dates agreed to by ENGINEER.
      b. Submit written procedure for system checkout to ENGINEER one months prior to starting system checkout. Two months prior to starting system checkout submit written procedure for start-up to ENGINEER.
   3. Field Quality Control Submittals:
      a. Submit the following prior to commencing system checkout and start-up.
         1) Completed calibration sheets for each installed instrument showing five-point calibration (0, 25, 50, 75, 100 percent of span), signed by factory-authorized serviceman.
      b. Field calibration reports.
      c. Field testing reports.
   4. Reports:
      a. Installation inspection and check-out report.
      b. Submit written report of results of each visit to Site including purpose and time of visit, tasks performed, and results obtained. Submit within two days of completion of visit to the Site.
   5. Qualifications Statements:
      a. Systems Integrator, when required by ENGINEER.

b. Manufacturer, when required by ENGINEER.

C. Closeout Submittals: Submit the following:

1. Operations and Maintenance Data:

a. Submit in accordance with Contract requirements.

b. Include acceptable test reports, maintenance data and schedules, description of operation, wiring diagrams, and list of spare parts recommended for one year of operation with current price list.

c. Shall include Name, address and telephone number of the control panel supplier and local service representative.

d. Complete list of supplied system hardware parts with full model numbers referred to system part designations, including spare parts and test equipment provided.

e. Revise all system Shop Drawing submittals including any revised controls to reflect as-built conditions in accordance with the following.

1) Two copies of each revised Shop Drawings and documentation to replace outdated drawings and documentation contained in operation and maintenance manuals. Submit half-size black line drawings for each drawing larger than 11 inches by 17 inches. Include specific instructions for outdated drawing removal and replacement with record documents submittal.

2) Half-size black line prints of wiring diagrams applicable to each control panel shall be placed in clear plastic envelopes and stored in a suitable print pocket or container inside each control panel.

3) Submit CADD drawings of the point-to-point interconnection wiring diagrams updated to reflect final as-built equipment information and as-installed field installation information.

f. Manufacturer's Original Copies of Hardware, Software and Installation, Assembly and Operations Manuals for all control system components. Manuals shall include the following information:

1) Include complete up-to-date system software documentation. Provide hardcopy and electronic copies.

2) General descriptive information covering the basic features of the equipment.

3) Physical description covering layout and installation requirements and all environmental constraints.

4) Functional and operational descriptions covering the procedures for programming, operation, start up, shutdown, and calibration of the control system equipment and explaining how the various control functions are performed.

5) Principles of operation explaining the logic of operation; provide information covering operation to a component level.

6) Maintenance procedures covering checkout, troubleshooting, and servicing; checkout procedures shall provide the means to verify the satisfactory operation of equipment, troubleshooting procedures shall serve as a guide in determining faulty components and

servicing procedure shall cover requirements and recommended time schedule for calibration, cleaning, lubrication and other housekeeping and preventive maintenance procedures.

7) Wiring, schematic and logic diagrams.
8) Safety considerations relating to operation and maintenance procedures.

D. ISA data sheets
1. ISA Data Sheets shall comply with ISA–TR20.00.01–2001 requirements and shall be computer generated.
2. All field and panel instruments ISA Data Sheets shall contain the following information, as a minimum.
   a. Tag number per the Specifications and Contract Drawings.
   b. Product (item) name used herein and on the Contract Drawings.
   c. Name of manufacturer or supplier.
   d. Manufacturers complete model number.
   e. Location of the device.
   f. Input output characteristics.
   g. Range, size, and graduations.
   h. Physical size with dimensions, NEMA enclosure classification and mounting details.
   i. Materials of construction of all components.
   j. Instrument or control device sizing calculations, where applicable.
   k. Certified calibration data on all flow metering devices, where applicable.
   l. Environmental requirements during storage and operation.

E. ISA Loop Diagrams: for all analog display, control and I/O loops prepared using ISA standard symbols in accordance with ISA Standard S5.4, include the following:
1. Instrument tag numbers from Contract Documents.
2. Functional name of each item.
3. Manufacturer's model, product, or catalog number for each item.
4. Location of each item.
5. Calibrated range of instrument
6. I/O point address

F. Maintenance Materials Submittals: Submit the following:
1. Spare Parts:
   a. General:
      1) Provide source quality control for spare parts prior to shipment of instrumentation and control equipment.
      2) For process sensors and other analog instruments, provide manufacturers recommended list of spare parts and test equipment. Separately list each item recommended.
2. Software:

a. Submit copies of programming and configuration files developed specifically for the Project in accordance with Contract requirements.

1.5 STORAGE AND HANDLING

A. CONTRACTOR shall make all arrangements for transportation, and delivery of the equipment and materials in accordance with the requirements of the Contract Documents, requirements of the System Integrator, and requirements of equipment manufacturers.

B. All hardware shall be packaged at the factory prior to shipment to protect each item from damage during shipment and storage. Containers shall be protected against impact, abrasion, corrosion, discoloration and/or other damages. Clearly label contents of each container and provide information on the required storage conditions necessary for the equipment. Keep ENGINEER and DEPARTMENT informed of equipment delivery.

C. All equipment shall be handled in accordance with manufacturer's instructions and relevant organization standards. Equipment shall be protected from weather, moisture and other conditions which could cause damage. Items which require a controlled environment for storage such as microprocessor units shall be stored in a climate controlled warehouse or facility. Supplier shall notify ENGINEER in writing with copies to DEPARTMENT of the storage requirements and recommendations for the equipment prior to shipment.

1.6 GENERAL DESIGN REQUIREMENTS

A. Power Supplies:
   1. All electrically powered equipment and devices shall be suitable for operation on 115 volt +/- 10 percent, 60 Hz +/- 2 Hz power. If a different voltage or closer regulation are required, a suitable regulator or transformer shall be provided at no additional cost.
   2. Appropriate power supplies shall be furnished by CONTRACTOR for all two wire transmitters. Power supplies shall be mounted in enclosures and installed in the appropriate Control Panels or field panel.
   3. Design all power supplies for a minimum of 130 percent of the maximum simultaneous current draw.
   4. A power on-off switch or an air circuit breaker shall be furnished for each item requiring electrical power.

B. Signal Requirements:
   1. The control system shall be designed to use 4 to 20 mA dc analog signals, unless otherwise specified.
   2. Signal converters and repeaters shall be provided where required. Power supplies shall be sized adequately for signal converter and repeater loads.
   3. Signals shall be isolated from ground.

4. Signals shall not have a transient dc voltage exceeding 300 volts over one millisecond nor a dc component over 300 volts.

C. Miscellaneous:
1. All instrumentation components shall be heavy duty types, designed for continuous service. The system is to contain products of a single manufacturer, when possible, and to consist of equipment models which are currently in production.
2. All equipment provided is to be of modular construction and be capable of field expansion through the installation of plug-in circuit cards and additional cabinets as necessary. Design all logic and control loops to fail safe.
3. System shall consist of equipment models currently in production.
4. Material and equipment, including cabling and interconnections, shall be in accordance with electrical and manufacturer's recommendations, unless indicated otherwise in the Contract Documents.
5. Materials and equipment shall, where applicable, be in accordance with UL standards and be so marked and labeled
6. All instrumentation components shall be designed to return automatically to accurate measurement within 15 seconds upon restoration of power, unless stated otherwise, after a power failure or when transferred to standby power supply.
7. Surge protection shall be provided for all instruments and all other control system components which could be damaged by electrical surges. Lightning arresters shall be provided on both ends of communication lines external to the building, except for Fiberoptic, including leased telephone lines.
8. All field-mounted instruments and system components shall be designed for installation in humid and corrosive service conditions. All field mounted instrument enclosures, junction boxes and appurtenances shall conform to NEMA 4X requirements unless otherwise specified.
9. All relays with interconnections to field devices shall be wired through terminal blocks. Terminals as part of the relay base are not an acceptable alternate.
10. All panel mounted instruments, switches, and other devices shall be selected and arranged to present a pleasing coordinated appearance. All front of panel mounted devices shall be of the same manufacturer and model line.
11. All components furnished, including field and rear of panel instruments, shall be tagged with the item number and nomenclature indicated on the Contract Documents and/or approved Shop Drawings.
12. Coordinate ranges and scales specified in the Contract Documents with manufacturer of the equipment actually furnished for operability over the intended range. Complete the coordination prior to submitting Shop Drawings to ENGINEER.
13. Field-mounted devices shall be treated with an anti-fungus spray.
14. Protect field-mounted devices from exposure to high and freezing temperatures to provide complete operability under the environmental conditions indicated in the Contract Documents.

15. Miscellaneous hardware such as fittings, fasteners, and screws, shall be Type 316 stainless steel or other appropriate material to prevent galvanic reactions, and shall be suitable for service intended. Piping stands shall be provided for fastening instruments as required. Provide threaded pipe stands with flange bolted to slab. Use carbon steel piping and flanges painted in accordance with Contract Documents.
16. Data processing equipment and relays with interconnections to field devices shall be wired through field wiring terminal blocks in the panel. Terminals as part of relay base are unacceptable.
17. Arrange panel-mounted instruments, switches, and other devices ergonomically for functional use and ease of maintenance. Similar types of panel-mounted devices shall be by one same manufacturer and of the same model line.

PART 2 – PRODUCTS

2.1 SYSTEM DESIGN REQUIREMENTS

A. I/I Current Isolator
   1. Provide electrical isolation of current signals without auxiliary supply. Loop-powered without an external power supply to split analog current signals of 4-20 mA into two individual 4-20 mA current signals.
   2. Shall have low internal voltage drop of less than or equal to 2.5 V
   3. Product Manufacturer:
      a. ABB, Phoenix Contact, Rockwell Automation
      b. Or Equal

B. Signal Requirements:
   1. Control system shall use 4 to 20 mA DC analog signals, unless otherwise shown or indicated.
   2. Provide signal converters and repeaters where required. Adequately size power supplies for signal converters and repeater loads.
   3. Isolate signals from ground.
   4. Signals transient DC voltage shall not exceed 300 volts over one millisecond, and shall not have a DC component over 300 volts.
   5. Discrete signals shall use 24 VDC.

C. Surge Protection Requirements:
   1. Provide surge protection to protect electronic instrumentation and control systems from surges propagating along signal and power supply cabling. Protection systems shall be such that the protection level shall not interfere with normal operation, but shall be lower than instrument surge withstand level, and be maintenance-free and self-restoring.
   2. Provide instruments in suitable metallic cases, properly grounded. Ground wires for surge protectors shall be connected to good earth ground and, where practical, run each ground wire individually and insulated from other wires.

Mount protectors within instrument enclosure or in separate junction box compatible with the area designation coupled to the enclosure.

D. Horn
   1. General:
      a. Electronic Audible Horn
      b. Power Supply: 24 VDC
      c. Operating Temperature: 32 to 120 degrees F
      d. Volume: 90 dB at 10 feet minimum; Internal volume control
      e. Enclosure: NEMA 4X
      f. Approved: UL and FM Approved
   2. Manufacturer:
      a. Federal Signal, 350 Vibratone
      b. Or Equal

E. Strobe Light
   1. General:
      a. LED based industrial Beacon, suitable for Dustproof and Weatherproof environment.
      b. Power Supply: 24 VDC
      c. Signal Color: Amber
      d. Operating Temperature: -4 to 113 degrees F
      e. Rating: IP 65 Rated
      f. RoHS Certified
   2. Manufacturer:
      a. Federal Signal, VS-205LED
      b. Or Equal

F. Programmable Logic Controller (PLC)
   1. General:
      a. The PLC shall be configured to perform functions shown and specified.
      b. Provide a dry contact rated at 2 amperes and 120 volts AC for remote indication of processor failure.
      c. PLCs shall be capable of being programmed and updated where installed.
      d. Provide interposing relays for all outputs to motor control centers, solenoids or contactor circuits.
      e. Provide individual fuses for all inputs and outputs. Fuses shall be capable of being inspected without removal of and replaced without disassembly of the module. For individually isolated output modules, front-of-module blown fuse LED status indicators shall be provided for each output point.
   2. Required PLC Features:
      a. Memory: Lithium Battery-backed RAM with minimum retention time of 2 years under worst case conditions, or RAM with EEPROM or NOVRAM backup modules.

b. Provide type and quantity of I/O as required to perform the operational and functional requirements plus 20 percent spare (minimum of one module) for each type of I/O module used. Spare points shall be mounted and wired ready for use and shall require only field wiring connections and software configuration to place the point in service.
c. Operating Temperature: 0 degrees C to 195 degrees C.
d. Power Supply: 24 VDC
e. Data Communications: The PLC shall communicate with the DTAM keypad.
f. PLC Programming Software: Provide one copy of Windows based software, as specified herein, which will provide the ability to develop, document, and maintain ladder logic programs online while directly connected to a processor, or offline on a stand-alone programming terminal. Within five business days prior to the expiration of the Contract, the CONTRACTOR is responsible for upgrading the PLC programming software to the latest version, which includes any new releases and/or patches. The CONTRACTOR shall provide a copy of the latest version of the software to the DEPARTMENT.

3. PLC Manufacturer and Product: Provide the following:
   a. PLC Hardware: Compactlogix Series Processor, as manufactured by Allen-Bradley or Equal.
   b. PLC Software: Provide latest version of RSLogix Studio Programming Software and license as supplied by Allen-Bradley, or equal.

G. Operator Interface Terminal (OIT)
1. System Integrator shall provide three programmable Operator Interface Terminal (OIT), listed below, to enable Operator to control and monitor all equipment. All OIT units shall be flush panel mounted on the front of the panel. OIT units shall be provided with all necessary hardware, cables and software to accomplish the interface as specified herein and shown on the Contract Drawings.
   a. List of 3 OIT Units:
      1) GAC Control Panel OIT on GAC-CP
      2) GAC Building Remote OIT (R-OIT) provided with its on enclosure at the shown location as per the Contract Drawings
      3) Head House Control Panel OIT on HH-CP
2. Performance Requirements:
   a. HH-CP and GAC-CP OITs shall be connected to respective panel PLC via Ethernet switch and shall be able to transfer up to twenty-two 64 word blocks each way.
   b. All OITs shall be provided with off-line development software which allows development of graphic picture files, touch screen key files, alarm files, trend files, system configurations, variables, and screen definitions. Provision shall be made to store commonly used symbols and screen definitions.
3. Each OIT shall be provided with the following minimum requirements:

a. Display: 19-inch Flat Panel Monitor, analog touch screen.
b. Field replaceable Backlight.
c. Aspect Ratio: 5:4
d. Memory: Available Flash: 512MB; RAM: 512MB.
e. Communication: Ethernet.
f. Input Voltage: 18 – 30VDC.
g. Power Consumption: 105 VA.
h. Operating Temperature: 0 – 55 degrees Celsius.
i. Humidity: 5 - 90% without condensation.
j. Rating: NEMA 4X, UL-listed.

4. Product and Manufacturer: Provide one of the following:
   a. PanelView Plus 7 Performance, as manufactured by Allen-Bradley
   b. Software: Latest version of configuration software fully licensed.

H. DIN-RAIL Mounted Managed Network Switch
1. General:
   a. Switch shall be managed industrial rated with fiber optic and Ethernet connections..
   b. Managed type switch shall have a full set of management features, including Command Line Interface, SNMP agent, and web interface. In addition, managed switch shall have features to manipulate configurations, such as the ability to modify, backup and restore configurations.
   c. Provide equipment to operate on 115 VAC, single phase, 60-hertz electrical service.
   d. Provide all necessary items for installation, including mounting brackets, interconnecting cables, hardware and appurtenances.
2. Required Features:
   a. Type: Managed, industrial grade switch with Ethernet connections.
   b. Housing: NEMA TS2.
   c. Ports:
      1) Ethernet: Copper ports, 10/100MB, RJ-45. Quantity as require. Minimum four (4) spare ports at the end of the project.
      2) Fiber Optic: Multi-mode fiber-optic connections. Fiber ports shall be compatible with fiber connectors as specified in specification section 40 66 33, Fiber Optic Cable and Appurtenance. Minimum one (1) spare ports shall be available at the end of the project. Quantity of ports required for the cabinets shall be minimum as follows:
      3) Indicators:
         a) Per-port status LED: Link integrity, disabled, activity, speed, full-duplex indications
         b) System-status LED: System, link status, link duplex, link speed, indications.
      4) Provide per unit: One (1) IEC power cord.

5) Management features shall include
   a) Ability to turn particular port range on or off.
   b) Link speed and duplex settings.
   c) Prioritize settings for ports.
   d) MAC filtering and "port security" features to prevent MAC flooding.
   e) 802.1d Spanning Tree protocol.
   f) SNMP monitoring of device and link health.
   g) VLAN settings.
   h) 802.1q trunking.
   i) QoS settings
   j) IGMP snooping and query.
   k) UL 60950-1 Safety certification
   l) Operating Temperature: -40°C to +140°F
   m) Relative Humidity: 5 to 95 % non-condensing
   n) Sized for Din-rail mounting

3. Products and Manufacturers: Provide one of the following;
   a. Cisco IE 3000 Series (with Cisco IEM-3000-8FM expansion module if required to meet the fiber ports count)
   b. Or Equal.

I. Environmental Conditions:
   1. Provide control system suitable for continuous operation under the following conditions:
      a. Indoor Instruments:
         1) Ambient Temperature: Zero degrees F to 120 degrees F.
         2) Relative Humidity: 100 percent, maximum.
      b. Outdoor Instruments:
         1) Ambient Temperature: 20 degrees F to 140 degrees F.
         2) Relative Humidity: 100 percent, maximum.
   2. Protect outdoor-mounted field instruments from direct sunlight by providing sunshade for instruments. Construct sunshade out of non-corrosive material. Sunshade shall withstand wind velocity of (100) miles per hour.

2.2 PROCESS TAPS, SENSING LINES, AND ACCESSORIES

A. Pressure Tap Sensing Lines and Accessories:
   1. For Process Sensing Taps in Ductile Iron, Steel, and Stainless Steel Piping Systems:
      a. Material and Fittings: Type 316 stainless steel pipe, ASTM A312; and threaded fittings and adapters, ASTM A403 or ASTM A778.
      b. Sizes: 1/2-inch diameter minimum for main sensing piping and 1/4-inch diameter gauge and switch connections.
      c. Pressure Rating: Equal to or greater than the applicable system test pressure as specified in the Contract Documents.

d. Accessories:
   1) For applications not requiring diaphragm seals, provide separate 1/2-inch diameter Type 316 stainless steel threaded ball valve for each gauge and switch.
   2) For applications requiring diaphragm seals, provide separate 1/2-inch diameter threaded Type 316 stainless steel ball valve for seal process side shutoff.

2. For Process Sensing Taps in Copper and Thermoplastic Piping Systems:
   a. Pipe Material and Fittings: Use same type of pipe material and fittings as that used in the process piping system. Provide PVC and CPVC piping in accordance with Contract requirements for Thermoplastic Pipe.
   b. Sizes: 1/2-inch diameter minimum for sensing piping and instrument connections.
   c. Pressure Rating: Equal to or greater than the applicable system test pressure as specified in the Contract Documents.
   d. Accessories:
      1) For copper piping system taps with or without seals, provide separate 1/2-inch diameter minimum threaded brass or bronze ball valve for each gauge and switch.
      2) For PVC and CPVC piping systems with or without diaphragm seals, provide separate 1/2-inch diameter threaded ball valve for process sensing line shutoff.

2.3 PANELS

A. General Provisions:
   1. Provide electrical components and devices, support hardware, fasteners, and interconnecting wiring and piping required to provide control panels complete and operational.
   2. Locate and provide hardware so that connections can be easily made and there is ample room for servicing each item.
   3. Prevent movement by adequately supporting and restraining devices and components mounted on or within panel.
   4. Provide panels with sub-panels for installation of all internally mounted hardware.
   5. Provide numbered terminal strips for terminating field wiring and wiring from other panels, unless otherwise shown or indicated.
   6. Provide copper grounding studs for hardware requiring grounding.
   7. Provide the following convenience accessories inside each panel:
      a. One 120 vac, 20-amp duplex, grounding type receptacle.
      b. One 120 vac fluorescent service light fixture with 20-watt lamp and protective plastic shield or appropriate wattage incandescent bulb for panels two feet by two feet and smaller.

c. One 120 vac snap switch, to turn on service light, mounted in outlet box with cover and located so that switch is easily accessible from access door.
d. Service light with switch and duplex receptacle shall have a dedicated circuit breaker.

8. Control of Environment (Except NEMA 7 Panels):
   a. Provide 120 vac thermostatically-controlled fan-driven heater units to maintain stable temperature within enclosure to protect equipment from harmful effects of condensation, corrosion, and low temperatures inside panels.
   b. Provide automatically controlled closed-loop heat exchangers or closed loop air conditioners to maintain temperature inside each enclosure at optimum operating temperature rating of components inside the enclosure.
   c. Each heat exchanger or air conditioner shall have a dedicated, properly sized and -rated circuit breaker.
   d. Submit supporting calculations as part of panel Shop Drawing submittal if panel equipment to comply with specified environmental requirements is proposed to be deleted as unnecessary.
9. Panels to be located in non-hazardous (non-classified) environments shall comply with UL 50 and UL 508A.
10. Panels to be located in hazardous (classified) environments shall comply with UL 698A and UL 2062.
11. Provide panels under this Section with twenty percent additional space requirements for future use. Install nothing in space reserved for future use.
12. CONTRACTOR is responsible for detailed layout and design of panels, in accordance with the Contract Documents. Base cutouts and design on instrument manufacturers' requirements.
13. Lower 12 inches of free standing panels shall be free of devices, including panduits and terminal strips, for ease of installation and maintenance.
14. For front-opening panels, install no device less than three feet above operating floor level, unless otherwise shown or indicated. For rear-opening panels, install no devices on the door.
15. Wire bundles between subpanels and front panel-mounted devices shall be anchored and protected from damage by opening and closing of panel door.
16. Do not locate front panel-mounted devices requiring manipulation by operating personnel, such as pushbuttons, hand switches, controllers, and similar devices, higher than 5.5 feet above finished floor.
17. Panduits located on either side of terminal strips shall have minimum clearance of 1.5 inches between panduit and terminal strip.
18. Provide three-inch high channel base assembly, drilled to mate panel to floor pad.
19. Provide easily-accessible pocket built into panel door to enclose "as built" panel wiring diagrams.
20. Panels shall be UL-listed.

B. Identification:

1. Provide laminated plastic nameplate for identification of panels. Use self-tapping stainless steel screws for fastening nameplates to panels. When self-tapping screws may degrade panel's NEMA rating, retain NEMA rating intact by using gaskets on each side of panel surface and use retaining plate on the panel back that is same size as nameplate. When gaskets and retaining plate are used, use full-penetration screws with nuts.
2. Panel identification nameplates shall have 1/2-inch high engraved letters.
3. Identify front panel-mounted devices with nameplates engraved with functional description of the device. Nameplate engraving shall be in accordance with the identification provided in the Drawings.
4. Tag electric components and devices mounted within panels with high adhesive labels.
5. Identify terminal strips with nameplate engraved as "TB-XX" where "XX' is the numerical identification of terminal strip.
6. Identify terminals within each terminal strip with sequential numbers and wire numbers.
7. Internal panel wiring shall be color-coded and numerically identified with unique wire numbers affixed at each end of each wire. Color coding shall be in accordance with panel wiring color code table, below:

Panel Wiring Color Code Table

Description	Color
110 VAC panel power before fuses or breakers	Black
Controlled 110 VAC power (e.g., after relay contacts, selector switch contacts, and similar equipment.)	Red
110 VAC power source from devices external to panel	Yellow
110 VAC neutral	White
24 VDC positive power from power supplies	Brown
24 VDC negative power from power supplies	Brown and white trace
Controlled 24 VDC power (e.g., after PLC output contacts, relay contacts, and similar)	Blue
24 VDC positive power from devices external to panel	Orange
24 VDC negative power from devices external to panel	Orange with white trace
24 VDC four to 20 mA DC signal cable	Grey with red positive, clear negative
Grounding wire	Green

C. Panel Construction Features:
   1. Control panels located in non-environmentally controlled areas and outdoor areas shall be rated NEMA 4X and with the following features:
      a. Panels shall be Type 316L stainless steel construction with minimum thickness of 12-gage for all surfaces, except areas requiring reinforcing, with a smooth-brushed finish.
      b. Stainless steel screw clamp assemblies on three sides of each door.
      c. Rolled lip around three sides of door and along top of enclosure opening.
      d. Hasp and staple for padlocking.
      e. Provide clear-plastic, gasketed lockable hinged door to encompass non NEMA 4X front-of-panel devices.
   2. Wall-Mounted Panels:
      a. General: Wall-mounted panels shall comply with applicable features and standards specified in this Section for the associated NEMA-rated panel.
      b. Unless otherwise indicated or approved by ENGINEER, depth of wall mounted panels shall not exceed 18 inches.
      c. Panels may be all stainless steel, fiberglass, polycarbonate, or acrylonitrile butadiene and styrene (ABS).
      d. Provide appropriate size and number of external mounting feet.
      e. Drilled holes or knockouts in back of wall-mounted panels are not allowed.
      f. Provide corrosion-resistant polyester quick release latches (for nonstainless steel panels) or stainless steel screw clamp assemblies (for stainless steel panels).
   3. Remote-Operator Interface (R-OIT) Enclosure
      a. Free-Stand Consoles
         1) Free-stand shall be stainless steel construction.
         2) Seams shall be continuously welded and ground smooth.
         3) Side and back panel(s) shall be fixed in place.
         4) Console shall have front access door. Door shall be removable or hinged. For removable doors, provide stainless steel quick release screws and clamps on three sides. Do not mount devices on doors.
         5) Hardware, including hinge and means of locking, shall be corrosion-resistant.

D. Electrical Systems:
   1. Power Source and Internal Power Distribution:
      a. Provide in the panel, near where incoming power is terminated, nameplate with panel power supply source, type, voltage, and circuit number.
      b. Protect incoming 120 vac power feeds to power the panel by providing lightning and surge arrestors, properly connected to grounds.
      c. Provide panels with internal 120 vac power distribution system with properly-sized and -rated circuit breakers to distribute power. Power not more than six devices from a single breaker. When power supplies are

included in the panel, not more than two power supplies shall be powered from a single breaker. Convenience receptacles and interior panel lights shall have their own breakers. When one or more field instruments require 120 vac power from the panel for instrument power, power not more than three instruments from a given breaker.

d. Provide space for a minimum of two spare breakers in each panel.

2. Electrical Systems:

a. Internal wiring shall be Type MTW and THW stranded copper wire with thermoplastic insulation rated for 600 volts at 85 degrees C for single conductors, color-coded and labeled with wire identification.

b. For DC signal wiring, use shielded cable with 18-gage conductors. DC field signal wiring terminal strips shall be capable of handling wires up and including No. 12 size.

c. For AC power wiring, use No. 12 minimum AWG. For AC signal and control wiring, use No. 16 minimum AWG. For wiring carrying more than 15 amps, use sizes required by the NEC (NFPA 70).

d. Inside of panels, route DC signal wiring separately from power wiring with minimum separation distance of six inches.

e. Use covered panduits to route internal panel cables and wiring. Panduits in each section of panel shall be appropriately sized to accommodate the quantity of wires to be routed with a spare capacity of 40 percent.

f. Install wire troughs inside panels along horizontal or vertical routes to present a neat appearance. Angled runs are unacceptable.

g. Wiring that is routed without panduits shall be adequately supported and restrained to prevent sagging or other movement. Use of adhesive anchors to support or restrain wiring is unacceptable.

h. Terminate internal panel wiring using tube, insulated, crimp-on connectors; soldered connectors are unacceptable. use screw type terminal blocks 600-volt rated, mounted on DIN rails. Fused terminal blocks shall have LED blown fuse indication. Terminal blocks for 4-20 mA signals shall be fused and knife disconnect terminal blocks. Terminal strips shall be identified as specified in this section. Identifiers shall be self-stick, plastic tape strips with permanent type, machine printed numbers. Hand-written labels are not acceptable.

i. Wiring in panels shall be installed such that, if wires are removed from any one device, power will not be disrupted to other devices.

j. Provide spare terminals equal in number to 20 percent of terminals used for each type of wiring (e.g., DC signal and AC power).

k. Provide ground terminals to terminate the shield wire of shielded cables. Termination of more than two shielded wires on a single ground terminal is unacceptable.

l. Provide a single copper bus bar with 5/16-inch diameter copper grounding stud to connect the panel to external ground. Panel's internal grounds shall be terminated to the bus bar.

m. Where wires pass through panel walls, provide suitable bushings to prevent cutting or abrading of insulation.

n. When DC power or low voltage AC power is required, furnish and install in the panel required power supplies and transformers.
o. Provide complete wiring diagram of "as-built" circuitry enclosed in transparent plastic.

E. Unwitnessed Factory Test (UFT)
1. The CONTRACTOR shall submit information on factory testing procedures to verify that testing shall fulfill the requirements as specified herein. Witnesses by ENGINEER shall not be part of testing. Submittal shall be made at least two months in advance of any scheduled testing and shall include dates of scheduled tests.
2. When the factory tests have been successfully completed, a report shall be submitted to ENGINEER. The equipment shall not be shipped until Notice of Acceptance of the test is received by the CONTRACTOR.
3. Inspection shall include, but not be limited to, the following:
   a. Nameplates and tags.
   b. Wire sizes and color coding.
   c. Terminal block contact ratings and numbers.
   d. Terminal block spares.
   e. Proper wiring practices and grounding.
   f. Enclosure flatness, finish and color.
4. All input/output devices and components shall be tested to verify operability and basic calibration.
5. The testing is to demonstrate the capability of the equipment, interconnections and accessories to perform as specified.
6. The CONTRACTOR shall demonstrate system software functionality and capability is met as specified.
7. The CONTRACTOR shall demonstrate the operation and display of all software based on a simulation of 100 percent of total input/output count, both analog and discrete. Demonstration shall show that the monitoring and control application software associated with the input/output points performs the functions intended.
8. Testing of communication between PLC and OIT shall be included in the Test Procedure to verify data is updated periodically to OIT.
9. Operator Interfaces Terminal (OIT): Prior to the staging and testing of the system, the display environments shall have been configured per the agreed upon display structure, loaded, and data base parameters linked to the specified fields. During this phase of the factory test, the overall display structure shall be tested, including graphic configuration, passwords, security, etc. Navigation amongst screens shall be thoroughly tested. The operation of alarm displays shall also be tested.
10. Report shall be signed by a licensed Professional Engineer (PE) in control systems.

2.4 EQUIPMENT AND PROCESS CONTROL CRITERIA

A. CONTRACTOR shall provide the services to load, configure, develop, test, document and place in satisfactory operation all software associated with the Instrumentation System and all its ancillary devices, as described herein, required by other sections, indicated on the Contract Drawings and as necessary to provide a properly operating and integrated system.

B. In general, the software packages that will be required to configure and develop shall include but shall not be limited to:
   1. New PLC configuration programs as required.
   2. New OIT configuration programs as required.

C. Control Philosophy:
   1. In order to provide the most reliable system of control and monitoring, a distributed approach to programming shall be implemented.
   2. All control logic, loop control, critical alarming and I/O shall be done at the local PLC level.
      a. GAC-CP PLC
      b. HH-CP PLC
   3. OIT workstations shall contain the database for their attached PLCs, and get the rest of the data over the data highway. All of the following OIT workstations shall have the same screen display and control configuration:
      a. GAC-CP OIT
      b. GAC Building Remote OIT (R-OIT)
      c. HH-CP OIT
   4. OIT shall send only valid data to the PLC where it shall be attached until such time as new valid data is made available. A failure of the OIT shall not prevent PLC from continuing to function normally using the last valid data it received.
   5. OITs, PLCs and network components, shall be monitored for failures by the redundancy of components through the use of watchdog timers. Failure of any component shall be alarmed and annunciated.
   6. OIT's shall monitor and display all digital and analog data available on their connected PLCs and all pertinent data available on the system-wide network. Where possible, the software shall be configured to verify the validity of that data. Data that is in disagreement or out of valid range shall indicate as such through the extensive use of displays and alarms.
   7. All critical alarms initiated in Head House PLC shall energize the Horn and the Alarm Light on the Head House Control Panel. OIT shall be configured with Alarm Test and Acknowledge functions:
      a. In-Test: Horn and the Alarm Light shall energize temporarly for testing purposes.
      b. Acknowledge function: shall acknowledge the Alarm and silent the Horn, while the Alarm Light shall stay 'ON' till the Alarm condition has been cleared. Alarm Light shall de-energize once the Critical Alarm

condition has cleared. Critical Alarms shall be identified and submitted for ENGINEER approval.

8. All critical alarms initiated in GAC PLC shall energize the Horn and the Alarm Light on the Remote OIT Panel and the Alarm Light on the GAC Control Panel. Both OITs (R-OIT and GAC-OIT) shall be configured with Alarm Test and Acknowledge functions:
    a. In-Test: Horn and the Alarm Light shall energize temporarly for testing purposes.
    b. Acknowledge function: shall acknowledge the Alarm and silent the Horn, while both Alarm Lights shall stay 'ON' till the Alarm condition has been cleared. Alarm Light shall de-energize once the Critical Alarm condition has cleared. Critical Alarms shall be identified and submitted for ENGINEER approval.
9. Clearwell No 3 Level (I-02):
    a. Signal for the Existing Clearwell No. 3 is hardwired to the Existing Instrumentation & Control (I&C) Console in the Head House Control Room. Location shown in Contract Drawings. Existing transmitter is a BIF unit that is wired to existing chart recorder on I&C Console.
    b. CONTRACTOR shall intercept the existing signal wired to the Level Recorder and provide signal conditioning as required and an I/I isolator, as specified in this specification, to split and provide one 4-20 mA analog signal to HH-CP and one signal same as existing for the chart recorder. Modifications shall not affect performance of the chart recorder. Proposed location for all this hardware is identified in the Contract Drawings.
    c. CONTRACTOR shall confirm with the CITY existing functionality of the Level Recorder and Alarms has been restored.
    d. Any internal panel modification, wiring and components shall be provided by the System Integrator. Wire new Level signal to Terminal Blocks for connection by the Electrician to HH-CP.
    e. This signal shall be used for GAC Feed Pump control along with being recorded. High and Low Alarms shall also be generated in the PLC based on the Operator Adjustable Alarm Setpoints.
10. GAC Feed Pumps Control Logic (I-02):
    a. All three GAC Feed Pumps shall be provided with a local control station (GFP1-LCS, GFP2-LCS and GFP3-LCS) provided by Electrical Contractor with Local/Off/Remote selector switch, Start/Stop selector switch and Run Status Indicating Light. Each Pump shall have the following modes of operation:
        1) In-Local: Pump shall be controlled Locally through the Start/Stop selector switches on the Local Control Station.
        2) In-Off: Pump shall not be allowed to run.
        3) In-Remote: Pump shall be operated remotely from the GAC PLC in the GAC Control Panel. PLC controls shall include Auto/Manual selection for the pumps based on which the following modes shall be available:

a) In Remote-Manual:
   i. GAC Feed Pumps shall be controlled through OIT, via 'Soft' Start/Stop selector switch and manual LIC Speed Command.
b) In Remote-Auto:
   i. GAC Feed Pumps shall be level controlled based on the Level in the Existing Clearwell No. 3.
   ii. GAC Feed Pumps shall operate in AUTO/LEAD/LAG/STANDBY duty sequence. In Auto duty assignment pump duty shall be cycled automatically based on the pump runtime during the last run cycle.
   iii. At any given time if two pumps are not In-Remote position then the Auto duty sequence shall be disabled and last assigned duty shall be retained for all three pumps.
   iv. In an event that any duty pump fails, standby pump shall replace it immediately for seamless operation.
   v. If a duty pump is in manual, then the duty shall automatically skip to the next pump in the sequence.
   vi. Operating Pump shall be controlled with a Proportional Only Controller configure through a PID block in the PLC. Proportional band shall be adjustable for any two points in the clearwell such that the output from the level controller shall increase its output proportionally from minimum band point (in Feet) to maximum band point (in Feet).
   vii. Low Level in Clearwell No. 3 as sensed via soft Level Switch Lo-Lo LALL-001 shall prevent any GAC Feed Pumps from running to avoid them running dry.
   viii. If Low Level is not detected in Clearwell No. 3 and the Level in the Clearwell No. 3 as sensed via LI-001 has reached the bottom of the Proportional band, defined in the PLC, turn on the lead GAC Feed Pump.
   ix. Proportionally ramp up or down speed of the lead pump within the defined proportional band.
   x. Once Proportional band high limit is detected by the Level Switch High and Lead Pump speed has maxed out, turn on the lag GAC Feed Pump.
   xi. Once the level in Clearwell No. 3 starts decreasing and reaches back to the Proportional band lower limit, turn off the lag pump.
   xii. If the level keeps decreasing further and reaches the Low Level in Clearwell No. 3 as sensed via LAL-001, turn off the lead pump.
   xiii. Pumps shall be alternating Automatically if AUTO duty sequence mode is selected.

b. At all times for each GAC Feed pump following signals shall be displayed:

1) Pump Speed Feedback
2) VFD Enabled Status
3) Pump Fault Status
4) Pump Not In-Remote

11. GAC Contactors (I-02):
    a. GAC Contactor Systems 1 through 9 shall all be manually controlled locally. All GAC Contactor systems are configured in pairs for Duty/Standby configuration.
    b. Following Flows are measured for the GAC Contactor Pairs:

Process Measurement	Flowmeter Tag
Combined Flow to GAC Contactor Pairs 1, 2 and 3	FIT-005
Combined Flow to GAC Contactor Pairs 4, 5 and 6	FIT-006
Combined Flow to GAC Contactor Pairs 7, 8 and 9	FIT-007
Combined Flow to GAC Contactor Pairs 2 and 3	FIT-008
Combined Flow to GAC Contactor Pairs 5 and 6	FIT-009
Combined Flow to GAC Contactor Pairs 8 and 9	FIT-010
Flow to GAC Contactor Pair 3	FIT-011
Flow to GAC Contactor Pair 6	FIT-012
Flow to GAC Contactor Pair 9	FIT-013

    c. Following Flow calculations shall be made in the PLC:

Process Calculation	Difference calculation to be configured in the PLC
Flow to GAC Contactor Pair 1	(FI-005) – (FI-008)
Flow to GAC Contactor Pair 2	(FI-008) – (FI-011)
Flow to GAC Contactor Pair 4	(FI-006) – (FI-009)
Flow to GAC Contactor Pair 5	(FI-009) – (FI-012)
Flow to GAC Contactor Pair 7	(FI-007) – (FI-010)
Flow to GAC Contactor Pair 8	(FI-010) – (FI-013)

    d. All Flows shall be continuously monitored, calculated, recorded and totalized for all individual GAC Contactor units with displays configured as shown on P&ID.
    e. Pressure Switches shall be provided by GAC Contactor Manufacturer, which shall indicate High Differential Pressure Across each of the GAC Contactor Units through following High Pressure Differential Switches:
        1) PDS-016A & PDS-016B
        2) PDS-018A & PDS-018B
        3) PDS-020A & PDS-020B
        4) PDS-022A & PDS-022B
        5) PDS-024A & PDS-024B
        6) PDS-026A & PDS-026B

7) PDS-028A & PDS-028B
8) PDS-030A & PDS-030B
9) PDS-032A & PDS-032B

12. GAC Feed Discharge Temperature (I-02):
    a. GAC Feed Discharge on the Discharge Line shall be continuously monitored through a RTD type Temperature sensor (TIT-014). Temperature shall also be continuously recorded.
    b. Temperature Indication shall be shared with GAC-CP from HH-CP along with all other displays and controls via the Fiber Optic Communication Link. From the GAC-CP PLC the indication shall be hard wired to the HVAC unit DAHU-1. CONTRACTOR shall field coordinate wiring with HVAC supplier. Location of the units is shown in the Contract Drawings.
    c. Obtain a Common Alarm from DAHU-1, wired to the GAC-CP PLC for DAHU-1 unit monitoring.
13. 1.2 MG Contact Tank Level (I-03):
    a. Existing 1.2 MG Contact Tank Level/Pressure Transmitter is mounted in the Transmitter vault (TLPT Vault), location for which has been identified in the Contract Drawings.
    b. CONTRACTOR shall intercept the existing signal wired to the temporary system and provide signal condition as required and an I/I isolator, as per this specification, to split and provide one 4-20 mA analog signal to GAC-CP and one signal same as existing. Modifications shall not affect performance of the existing temporary system
    c. All this hardware shall be housed in a NEMA 6P enclosure within the 1.2 MG Contact Tank Level/Pressure Transmitter vault (TLPT).
    d. CONTRACTOR shall confirm with the CITY existing functionality has been restored.
    e. This signal shall be recorded. High and Low Alarms shall also be generated in the PLC based on the Operator Adjustable Alarm Setpoints.
14. Backwash Tank Level Control (I-03):
    a. Backwash Tank Level (LIT-043): level shall be constantly monitored and recorded in the GAC-CP PLC. Level shall also be used to control the Backwash Feed Valve in the Backwash Feed Vault.
    b. Backwash Feed Valve (FCV-042):
        1) Backwash tank inlet is designed such that it allows Backwash water supply at a constant flow rate.
        2) Backwash Tank Valve (FCV-042) shall be controlled through the GAC-CP PLC and shall have two modes of operations:
            a) In-Manual: Valve shall be controlled through OIT, via 'Soft' Open & Close Push Buttons.
            b) In-Automatic: Valve shall be controlled based on the level in the tank based on following:

i. When the Level in the Backwash tank is below Low level sensed via LSL-043 (Operator adjustable setpoint), the Valve shall open.
ii. When the Level in the Backwash tank is above High Level sensed via LSH-043 (Operator adjustable setpoint), the Valve shall close.
iii. Back-up Float Switch (LSHH-043) shall immediately close the Valve if a High-High level is sensed. It shall also generate an alarm that Level Control based on LIT-043 is not functional.

15. Backwash/Storm Water Tanks Interstitial Space Leak Detection (I-03):
    a. Stormwater leak shall be immediately detected in the Interstitial space between the Backwash and Storm Water Tanks.
    b. Leak detection shall trigger an Operator adjustable timer, once the timer expires the GAC-CP PLC shall close the Backwash Feed Valve (FCV-042).
16. GAC Building Ambient Temperature and Relative Humidity (I-03):
    a. Continuously Monitor Ambient Temperature (TI-057) and Relative Humidity (MI-058) in the GAC Building.
    b. Generate High and Low Ambient Temperature Alarms based on the Operator adjustable Setpoints.
    c. GAC-CP PLC shall compute and display Dew Point Value based on the calculation below. PLC shall also compute Fahrenheit to Celsius Temperature Conversion, if required, for the Dew Point calculation.
    d. Dew Point =
       243.04*(LN(RH/100)+((17.625*T)/(243.04+T)))/(17.625-LN(RH/100)-((17.625*T)/(243.04+T)))

       Where:

RH	=	Relative Humidity between 0 to 100%
T	=	Temperature in Celsius
LN	=	Natural Logarithm Function

    e. Dew Point value calculated shall be continuously compared with the GAC Feed Pipe temperature (TI-014) and if the two get within 3°F (Operator Adjustable), generate an Alarm and send it to the Dehumidifier Unit (DAHU-1).
    f. Monitor and Display, General Fault Alarm signal from the Dehumidifier Unit (DAHU-1).
17. GAC Building Electrical Room Ambient Temperature (I-03):
    a. Continuously Monitor Ambient Temperature (TI-058) in the Electrical Room.
    b. Generate High and Low Temperature Alarms based on the Operator adjustable Setpoints.
18. 3” Vacuum relief Valve – FCV-059 (I-03):
    a. Vacuum relief Valve shall be provide with a Local Control Station with Local/Remote, Open/Close selector switches and local indications for

Open & Closed positions. Open/Close indications shall be wired to the limit switches provided with the valve to get the respective position feedback from the field.

b. High Vacuum Pressure in the 24" GAC discharge line shall be monitored and indicated via PSL-059.

c. Valve shall normally be controlled in Remote-Auto position, control based on High Vaccum sensed in the 24" GAC discharge Line through PSL-059, therefore the selector switch on the Local Control Station shall normally be placed in the Remote position for PLC Auto control.

d. Valve have the ability to operate in following modes of operation:

1) In-Local: the valve shall be controlled from the Local Control Station with the Open/Close selector switch. This mode shall only be used for maintenance and the selector switch shall always be placed in Remote position under normal operation of the Plant.

2) In-Remote: the valve control from the GAC-CP PLC shall provide Auto/Manual selection. Based on the selection following two modes of operation shall be provided:

a) Remote-Manual: Valve shall be controlled through OIT, via 'Soft' Open & Close Push Buttons.

b) Remote-Automatic:

i. Valve shall automatically open when there is High Vacuum sensed through PSL-059.

ii. When the High Vacuum signal has cleared for atleast 1-minute (operator adjustable timer), i.e. Low Pressure is not detected by PSL-059 automatically close the valve.

19. Chemical Pumps Pacing Strategy (I-03):

a. Chlorine, Fluoride and Phosphate Pumps in the Chemical building shall be Flow paced based on the Total Flow to the GAC Contact Tank (FI-035).

b. 0.5 to 1.25 adjustable multiplier shall be used for Flow Pacing ratio controllers. Three individual Analog Outputs shall be hardwired to Chemical Control Panel, Fluoride Pump and Phosphate Pump from the GAC-CP PLC for chemical pacing.

20. Electrical Generator & Transfer Switch Signals (I-04):

a. Following Status signals shall be hard wired to the GAC-CP PLC from the respective equipment for status monitoring:

1) Emergency Power
2) Generator Fault
3) ATS Normal
4) MTS Normal

21. High Pressure Distribution Line Pressure (I-04):

a. Pressure shall be continuously monitored and shall be used for High Lift Pumps control to maintain the desired distribution pressure.

b. High Pressure Distribution Line Flow (FI-053) setpoints FSH-053A and FSL-053B shall also be used for High Lift Pump Control.

22. High Lift Pumps Control Logic (I-04):

a. All three High Lift Pumps shall be provided with a local control station (HLP1-LCS, HLP2-LCS and HLP3-LCS), provided by Electrical Contractor, with Local/Off/Remote selector switch, Start/Stop selector switch and Run Status Indicating Light. Each Pump shall have the following modes of operation:
   1) In-Local: Pump shall be controlled Locally through the Start/Stop selector switches on the Local Control Station.
   2) In-Off: Pump shall not be allowed to run, despite the state of the Start/Stop selector switch.
   3) In-Remote: Pump shall be operated remotely from the GAC PLC in the GAC Control Panel. PLC controls shall include Auto/Manual selection for the pumps based on which the following modes shall be available:
      a) In Remote-Manual:
         i. High Lift Pumps shall be controlled through OIT, via 'Soft' Start/Stop selector switch and manual Speed Command.
      b) In Remote-Auto:
         i. High Lift Pumps shall be controlled based on the discharge pressure and flow in the High Pressure Service line.
         ii. Lead pump Start/Stop and operating pumps speed shall be controlled based on a pressure setpoint dialed in by the operator. Operating Pumps shall ramp up and down based on a PID Controller to Maintain the desired pressure setpoint. Lead Pump shall run continuously.
         iii. If the Flow reaches HLP Lag Pump Start Setpoint (FSH-053A), Turn On Lag Pump. Lag Pump shall initially ramp up to 95% of its maximum speed and eventually both Lead & lag Pump speeds shall converge at the output calculated by the PID Controller. Setup and tuning of both controllers and drives shall be performed such that lag pump successfully comes online.
         iv. If the Flow reaches HLP Lag Pump Stop Setpoint (FSL-053B), Turn Off Lag Pump.
         v. High Lift Pumps shall operate in AUTO/LEAD/LAG/STANDBY duty sequence. In Auto duty assignment pump duty shall be cycled automatically based on the pump runtime during the last run cycle.
         vi. At any given time if two pumps are not In-Remote position then the Auto duty sequence shall be disabled and last assigned duty shall be retained for all three pumps.
         vii. In an event that any duty pump fails, standby pump shall replace it immediately for seamless operation.
         viii. Pump vendor shall configure the following permissive along with all the other interlocks:
            a. If Operating Pump is turned on and low current is sensed by VFD then after 30 seconds, Turn off the pump.

b. At all times for each High Lift Pump following signals shall be displayed:
   1) Pump Speed Feedback
   2) VFD Enabled Status
   3) Pump Fault Status
   4) Pump Not In-Remote

23. Flow Readings: Following Flow readings shall continuously be monitored, recorded and totalized in the PLC, and shall be accessible through any of the three OIT's:
    a. Total GAC Treated Water Flow to Contact Tank (FIT-035)
    b. Low Pressure Distribution Flow (FIT-054)
    c. High Pressure Distribution Flow (FIT-053)
    d. GAC Backwash Water Flow (FIT-051)
24. Flow Calculations: Following Flow calculation shall be performed by the PLC continuously to monitor Plant Operation. Flow Calculation shall also be totalized in the PLC, and shall be accessible through any of the three OIT's:
    a. Total Water Distribution Flow = Summation of Low Pressure & High Pressure Distribution Lines (FI-053 + FI-054)
25. Chemical Monitoring System (I-04):
    a. Constantly monitor, record and generate High/Low alarms for following Chemical Parameters for regulation and reporting:
       1) Chlorine Value
       2) Fluoride Value
       3) Phosphate Value
       4) pH Value
    b. High and Low Alarm Setpoints shall be operator adjustable.
26. Fire Alarm Signal (I-04)
    a. Monitor and indicate Fire Alarm from FACP-1. Active alarm shall be displayed at the OIT for the operator.

D. PLC Programming Conventions
1. General:
   a. All logic, sequencing, interlocking, safety and critical alarm and control, shall be implemented at the PLC level using ladder type logic. Individual rungs shall be provided for each logic function. Subroutines shall be used where repetitive logic is required. Alarm logic shall not be performed in subroutines as they may not be active at all times.
   b. Commands such as start, stop, open, close, operating mode, sequence selection, etc., that are sent from the OITs by operator initiative or response, shall be pulsed and latched via PLC software.
   c. All analog loop control such as temperature, flow or level shall be performed at the PLC level, not in the OITs. All calculations and logic necessary to keep an individual loop in operation, in the event of failure of, or loss of communication with the OITs, shall also be done in the PLC.

d. All data points, both analog and digital, associated with the PLC based loop controllers, shall be available to the operator at the OITs and fully displayed and adjustable (where possible).

e. The PLC ladder program shall be written so that the operator, via OIT, can select the mode in which he wants each individual loop to operate (i.e. manual/auto or local/remote setpoint). He shall also be able to view and manually adjust all parameters such as setpoint, output, gain, integral, derivative, etc. from the OITs. Once entered, the valid data shall remain stored in the PLC until such time as new valid data is received.

2. Program Structure:

a. All programming shall be implemented using ladder logic style programming only. Other styles of programming shall only be used with the prior written permission of the ENGINEER and only when the task cannot be performed using ladder type logic.

b. The program shall be written using a well-organized and well documented structured approach. All common elements shall be grouped together as much as possible. For example, all logic for a single piece of equipment such as start/stop logic, indication, fault and alarm logic shall be grouped together to allow easy startup and trouble shooting.

3. Safeties and Interlocks:

a. Upon initial startup or a subsequent restart of the PLC, the program shall be written to first initialize all logic and data; next, bring all equipment and controls to a safe and ready status as allowed by safety and interlock status and only then allow equipment to be started as indicated in the individual control strategies. When the system has decided that all conditions are satisfied, it shall then issue a ready status for each piece of affected equipment, for display by the OIT.

b. Upon startup or restart of equipment and systems after a power failure, the program shall retain the status of all equipment prior to the interruption. Upon restoration of stable power, with a suitable and adjustable time delay on each piece of equipment, the program shall check the status of all controlled equipment and systems for faults and safety trips and only then allow equipment to be started as indicated in the individual control strategies. Items indicating a faulted or unsafe condition shall be immediately locked out and the appropriate alarms generated for display by the OIT.

c. All preset values (for timers, counters, etc.) and variables shall be stored in register memory and shall be made available to the operator at the OIT for display. Adjustment shall be through the keypad.

2.5 SYSTEM DESIGN REQUIREMENTS

A. CONTRACTOR shall include as a minimum, the following spare parts and test equipment for this section:

1. Spare PLC power supply
2. Spare Input/Output four of each type provided
3. One spare field instrument per type shall be provided except for magnetic flowmeters
4. Six of each type of fuse, relay, lamps used and one of specified power supply.

2.6 SOURCE QUALITY CONTROL

A. Operational Testing:
   1. Test all input/output components to verify that internal panel wiring is properly terminated at correct locations. Verify initial ranges and settings.
   2. Test all system hardware and software to verify proper operation as stand-alone units. Test shall include, but not be limited to, the following:
      a. Power distribution and breaker ratings to match approved Shop Drawings.
      b. Power fail/restart tests.
      c. Diagnostics checks.
      d. Demonstrate that all specified equipment functional capabilities are working properly.
      e. Check and verify process displays are in accordance with approved Shop Drawings.
   3. Test components and devices requiring data transmission to verify that communication between such components is working properly. Verify communication by using the same media required for the completed system at the Site as indicated in the Contract Documents.
   4. Perform integrated system test with all control panels. Simulate inputs/outputs to verify that equipment is performing properly as an integrated system.
   5. Simulation devices shall be of suitable quality to not mask control panel defects.

PART 3 – EXECUTION

3.1 INSPECTION

A. Examine conditions under which the Work will be installed and notify ENGINEER in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions are corrected.

3.2 INSTALLATION

A. Environmental Requirements:
   1. Do not install instruments in areas where construction may cause equipment to be damaged, without providing adequate protection for said equipment.

B. Panel shall be factory wired. All internal panel components shall be installed at the factory.

C. Perform all power wiring and control wiring per National Electric Code.

D. Installation of Instrumentation:
   1. Secure field-mounted instruments to stands or brackets in accordance with manufacturer's recommendations, approved or accepted (as applicable) submittals, and the Contract Documents.
   2. Locate sensors where shown on the Contract Drawings. Confirm exact locations in the field with ENGINEER.
   3. Install all devices so that devices are readily accessible for service and do not cause potential hazards.
   4. Control Panels and OITs shall be installed where shown on the Contract drawings.

3.3 FIELD QUALITY CONTROL

A. Tests and Inspections: Field-verify calibration and performance of each instrument prior to start-up of the associated equipment, and document on a separate sheet for each.
   1. For each calibration certification sheet, include the following information:
      a. Project name.
      b. Tag number and description.
      c. Manufacturer.
      d. Model and serial number.
      e. Date, time and person who performed calibration.
      f. Calibration data to include.
         1) Input, output, and error at 0, 25, 75, and 100 percent of span for analog instruments.
         2) Switch setting, contact action and deadband, if applicable, for discrete elements.
      g. Space for comments.
      h. Signature and date.
   2. System Check-Out and Start-Up Responsibilities:
      a. CONTRACTOR shall perform check-out and start-up of all system components. As part of these services, the CONTRACTOR shall include for those equipment items not manufactured by him the services of an authorized manufacturer's representative to check the equipment installation and place the equipment into operation. The manufacturer's representative shall be thoroughly knowledgeable about the installation, operation and maintenance of the equipment.
      b. Check and approve the installation of all instrumentation and control system components and all cable and wiring connections between the various system components prior to placing the various processes and equipment into operation.

c. Conduct a complete system checkout and adjustment, including calibration of all instruments, tuning of control loops, checking operation functions, and testing of final control actions. When there are future operational functions included in the Work, they should be included in the system checkout. All problems encountered shall be promptly corrected to prevent any delays in start-up of the various unit processes.

d. CONTRACTOR shall provide all test equipment necessary to perform the testing during system checkout and start-up.

e. CONTRACTOR, shall be responsible in conjunction and coordination with the GAC CONTACTOR SYSTEM MANUFACTURER for initial operation of DEPARTMENT furnished GAC Conactor System and shall make any required changes, adjustments or replacements for operation, monitoring and control of the various processes and equipment necessary to perform the functions intended at no additional cost to the DEPARTMENT. These changes or adjustments shall be documented by the CONTRACTOR and submitted to the ENGINEER as part of the Installation Inspection Report described in Paragraph g. below.

f. CONTRACTOR shall furnish to the ENGINEER certified calibration reports for field instruments and panel mounted devices specified in this Section as soon as calibration is completed.

g. CONTRACTOR shall furnish ENGINEER an Installation Inspection Report certifying that all equipment has been installed correctly and is operating properly. The report shall be signed by authorized representatives of both CONTRACTOR and the Instrumentation Supplier.

h. Instrumentation and Control System Field Test:

1) Following the instrumentation and control system checkout and initial operation, CONTRACTOR, under the supervision of the Instrumentation Supplier, shall perform a complete system test to verify that all equipment and programmed software is operating properly as a fully integrated system, and that the intended instrumentation and control functions are fully implemented and operational. Any defects or problems found during the test shall be corrected by CONTRACTOR and then retested to demonstrate proper operation.

2) Following demonstration of all system functions, the instrumentation and control system, including field sensors/transducers and instruments shall be running and fully operational for a continuous 48-hour period.

B. Field Services and Operator Instruction:

1. Provide repairs or replacement of defective materials, equipment or workmanship, including with respect to equipment, the services of factory trained servicemen.

2. In addition to the calibration required for check-out, provide two additional calibrations on all instruments. The first re-calibration shall be approximately six months after acceptance of the system, and the second shall be approximately eleven months after acceptance. As part of each calibration, provide two copies of the calibration sheets, a detailed list of deficiencies (should any be found), and a statement that the entire system is in proper operation and condition (except for the deficiencies noted) and shall be turned over to the CITY.

3.4 MANUFACTURER'S SERVICES

A. General:
   1. CONTRACTOR shall provide operation and maintenance training for all instrumentation and control system equipment as specified herein.
   2. For all instruments, the CONTRACTOR shall provide for on-Site training by an authorized representative of the equipment manufacturer as part of his services. The manufacturer's representative shall be fully knowledgeable in the operation and maintenance of the equipment.
   3. CONTRACTOR shall be responsible for all costs associated with training and shall provide all required materials, texts and required supplies.
   4. Training shall conform to the requirements of Section 01 79 23, Instruction of Operations and Maintenance Personnel and include training for the topics listed and for personnel specified. Include separate site visits as required to accommodate schedule. Overall length of schedule and total number of hours included in the training schedule shall be sufficient to provide the training required in this specification, including hours for specific topics listed herein.

B. On-Site Training:
   1. General:
      a. Provide on-Site operation and maintenance training and the equipment manufacturer representatives prior to placing the equipment in continuous operation.
      b. Training courses shall include time for plant personnel (up to five people) to develop and demonstrate understanding of training concepts. Training shall include hands on training with equipment.
      c. At the conclusion of each course the instructor shall review and summarize the course material with plant personnel. Review and summary shall include exercises demonstrating proper response to normal operational needs, emergencies and maintenance tasks.
      d. Training shall accomplish the following:
         1) Provide instruction covering use and operation of the equipment to perform the intended functions.
         2) Provide instruction covering procedures for routine, preventive and troubleshooting maintenance, including equipment calibration.

3) Explain procedures for placing the equipment in and out of operation and explain necessary actions and precautions to be taken regarding the overall control system.
4) Provide classes and field training as to how to change process control and alarm set points in all microprocessor based controllers and transmitters. Maintenance personnel shall be trained to enter passwords, programming or configuration data, etc.

2. Primary Sensors/Transducers and Field Instruments:
   a. The services of equipment manufacturer's representatives shall be provided for a minimum of 2 hours for each type of instrument.
   b. Training shall include:
      1) Basic repair and maintenance capabilities of installed equipment.
      2) Procedures for placing the equipment in and out of operation.
      3) Use of any special repair equipment or software packages that are used for repair or maintenance.
      4) Procedures for testing any repair before placing equipment back in service.
3. PLC and OIT Training
   a. Training shall be provided for atleast 2 full days and include:
      1) Hardware and software configuration of PLC and OIT programs.
      2) Perform a walk through with students identifying system components. Instructor shall test each student's knowledge of system components during walk through.
      3) Identify key operating and alarm features of the project specific PLC and HMI programs.
      4) Test students knowledge of proper response to alarms, capabilities to replace hardware components, switch hardware and software between online and offline, add new components, know when to call for assistance, demonstrate understanding of hardware and safety requirements, understand impact of changes made to rest of the control system.
      5) Provide instruction covering basic editing of PLC programs and OIT screens. Instruction shall include testing students programming capabilities by having students make minor changes to programs and test changes online.

3.5 OPERATIONAL AVAILABILITY DEMONSTRATION

A. Operational Availability Demonstration:
   1. Operational Availability Demonstration (OAD) shall begin following completion of the GAC Control System Field Test as specified herein and after all training and contract documents requirements for acceptance have been satisfied. OAD shall continue until a time frame has been achieved wherein the system (both hardware and software) availability meets or exceeds 99.9 percent for 30 consecutive days and no system failures have occurred which result in starting the OAD over again. During the OAD the

system shall be available to plant operating personnel for use in normal operation of the plant.

2. For the purpose of the OAD the system will be defined as consisting of the following systems and components:
   a. All operator interfaces (conventional and digital) and connected PLC's.
3. The conditions listed below shall constitute system failures which are considered critical to the operability and maintainability of the system. The OAD shall be terminated if one or more of these conditions occur. Following correction of the problem, a new 30 consecutive day OAD shall begin.
   a. Failure to repair a hardware or software problem within 120 consecutive hours from the time of notification of a system failure.
   b. Recurrent hardware or software problems: if the same type of problem occurs three times or more.
   c. Software problem causing a processor to halt execution.
4. The following conditions shall constitute a system failure in determining the system availability based on the equation specified herein:
   a. Failure of any operator interface (conventional or digital) or PLC.
   b. Loss of communications between devices on the communications network.
   c. Failure of one or more input/output components.
   d. Failures of any type affecting ten or more input/output points simultaneously.
   e. Failure of any type affecting one or more regulatory control loops or sequential control strategies thereby causing a loss of the automatic control of the process variable or process sequence operation.
   f. Failure of power supply. Where redundant power supplies are provided, failure of one power supply shall not constitute a system failure; provided the backup power supply operates properly and maintains supply power. Failure of the backup supply to operate properly and maintain supply power shall constitute a system failure.
   g. Failure of two or more primary sensors/transducers or field instruments simultaneously.
5. The system availability shall be calculated based on the following equation:

$$A = \frac{TTO}{TTO + TTR} \; x \; 100\%$$

   Where:

   A = system availability in percent
   TTO = total time in operation
   TTR = total time to repair

6. Time to repair shall be the period between the time that CONTRACTOR is notified of a system failure and the time that the system has been restored to proper operation in terms of hours with an allowance for the following dead times which shall not be counted as part of the time to repair period.
   a. Actual travel time for service personnel to get to the plant site up to 6 hours per incident from the time CONTRACTOR is notified of a system failure.

b. Time for receipt of spare parts to the plant site once requested up to 24 hours per incident. No work shall be done on the system while waiting for delivery of spare parts.

c. Dead time shall not be counted as part of the system available period. The dead time shall be logged and the duration of the OAD extended for an amount of time equal to the total dead time.

1) Completion of a 30 consecutive day period without any restarts of the OAD and with system availability in excess of 99.99 percent shall satisfactorily demonstrate a successful OAD test. When all contract work is completed and with a successful OAD test, this will constitute acceptance of the system by the OWNER.

2) All parts and maintenance materials required to repair the system prior to completion of the OAD shall be supplied by CONTRACTOR at no additional cost to DEPARTMENT. If parts are obtained from the required plant spare parts inventory, they shall be replaced to provide a full complement of parts as specified.

B. A Control System Malfunction/Repair Reporting Form shall be completed by the plant personnel and ENGINEER to document system failures, to record CONTRACTOR notification, arrival and repair times and CONTRACTOR repair actions. Format of the form shall be developed and agreed upon prior to the start of the OAD.

+ + END OF SECTION + +

TAG	DESCRIPTION	DRAWING NO.	SIGNAL TYPE	RANGE /SETPOINT	UNITS	SIGNAL FROM/TO DEVICE	SIGNAL TO/FROM CONTROL PANEL (PLC)
	HEAD HOUSE CONTROL PANEL (HH-CP)						
LI-001	Clearwell No. 3 Level	I-02	AI		FT.	LY-001	PLC
SI-002	GAC Feed Pump No. 1 Speed Feedback	I-02	AI	0-100	%	VFD GAC FEED PUMP 1	PLC
SI-003	GAC Feed Pump No. 2 Speed Feedback	I-02	AI	0-100	%	VFD GAC FEED PUMP 2	PLC
SI-004	GAC Feed Pump No. 3 Speed Feedback	I-02	AI	0-100	%	VFD GAC FEED PUMP 3	PLC
SC-002	GAC Feed Pump No. 1 Speed Command	I-02	AO	0-100	%	PLC	VFD GAC FEED PUMP 1
SC-003	GAC Feed Pump No. 2 Speed Command	I-02	AO	0-100	%	PLC	VFD GAC FEED PUMP 2
SC-004	GAC Feed Pump No. 3 Speed Command	I-02	AO	0-100	%	PLC	VFD GAC FEED PUMP 3
HS-002A	GAC Feed Pump No. 1 Start/Stop	I-02	DO			PLC	VFD GAC FEED PUMP 1
HS-003A	GAC Feed Pump No. 2 Start/Stop	I-02	DO			PLC	VFD GAC FEED PUMP 2
HS-004A	GAC Feed Pump No. 3 Start/Stop	I-02	DO			PLC	VFD GAC FEED PUMP 3
YIL-002	GAC Feed Pump No. 1 VFD Enabled	I-02	DI			VFD GAC FEED PUMP 1	PLC
UA-002	GAC Feed Pump No. 1 Fault	I-02	DI			VFD GAC FEED PUMP 1	PLC
YIL-003	GAC Feed Pump No. 2 VFD Enabled	I-02	DI			VFD GAC FEED PUMP 2	PLC
UA-003	GAC Feed Pump No. 2 Fault	I-02	DI			VFD GAC FEED PUMP 2	PLC
YIL-004	GAC Feed Pump No. 3 VFD Enabled	I-02	DI			VFD GAC FEED PUMP 3	PLC
UA-004	GAC Feed Pump No. 3 Fault	I-02	DI			VFD GAC FEED PUMP 3	PLC
YN-002	GAC Feed Pump No. 1 Not In Remote	I-02	DI			LCS PUMP 1	PLC
YN-003	GAC Feed Pump No. 2 Not In Remote	I-02	DI			LCS PUMP 2	PLC
YN-004	GAC Feed Pump No. 3 Not In Remote	I-02	DI			LCS PUMP 3	PLC
TI-014	GAC Influent Water Temperature	I-02	AI			TIT-014	PLC
UA-064A	Head House Control Panel Horn Output		DO			PLC	HH-CP
UA-064B	Head House Control Panel Alarm Strobe Output		DO			PLC	HH-CP
	GAC CONTROL PANEL (GAC-CP)						
TI-014	GAC Influent Water Temperature	I-02	AO			PLC	DAHU-1
UA-014	Dehumudifier (DAHU-1) Common Alarm	I-02	DI			DAHU-1	PLC

TAG	DESCRIPTION	DRAWING NO.	SIGNAL TYPE	RANGE /SETPOINT	UNITS	SIGNAL FROM/TO	SIGNAL TO/FROM
						DEVICE	CONTROL PANEL (PLC)
FI-005	Flow to GAC Pair 1, 2 & 3	I-02	AI			FIT-005	PLC
FI-008	Flow to GAC Pair 2 & 3	I-02	AI			FIT-006	PLC
FI-011	Flow to GAC Pair 3	I-02	AI			FIT-007	PLC
FI-006	Flow to GAC Pair 4, 5 & 6	I-02	AI			FIT-008	PLC
FI-009	Flow to GAC Pair 5 & 6	I-02	AI			FIT-009	PLC
FI-012	Flow to GAC Pair 6	I-02	AI			FIT-010	PLC
FI-007	Flow to GAC Pair 7, 8 & 9	I-02	AI			FIT-011	PLC
FI-010	Flow to GAC Pair 8 & 9	I-02	AI			FIT-012	PLC
FI-013	Flow to GAC Pair 9	I-02	AI			FIT-013	PLC
PDA-016A	High Differential Pressure GAC Unit 1A	I-02	DI			PDS-016A	PLC
PDA-018A	High Differential Pressure GAC Unit 2A	I-02	DI			PDS-018A	PLC
PDA-020A	High Differential Pressure GAC Unit 3A	I-02	DI			PDS-020A	PLC
PDA-022A	High Differential Pressure GAC Unit 4A	I-02	DI			PDS-022A	PLC
PDA-024A	High Differential Pressure GAC Unit 5A	I-02	DI			PDS-024A	PLC
PDA-026A	High Differential Pressure GAC Unit 6A	I-02	DI			PDS-026A	PLC
PDA-028A	High Differential Pressure GAC Unit 7A	I-02	DI			PDS-028A	PLC
PDA-030A	High Differential Pressure GAC Unit 8A	I-02	DI			PDS-030A	PLC
PDA-032A	High Differential Pressure GAC Unit 9A	I-02	DI			PDS-032A	PLC
PDA-016B	High Differential Pressure GAC Unit 1B	I-02	DI			PDS-016B	PLC
PDA-018B	High Differential Pressure GAC Unit 2B	I-02	DI			PDS-018B	PLC
PDA-020B	High Differential Pressure GAC Unit 3B	I-02	DI			PDS-020B	PLC
PDA-022B	High Differential Pressure GAC Unit 4B	I-02	DI			PDS-022B	PLC
PDA-024B	High Differential Pressure GAC Unit 5B	I-02	DI			PDS-024B	PLC
PDA-026B	High Differential Pressure GAC Unit 6B	I-02	DI			PDS-026B	PLC
PDA-028B	High Differential Pressure GAC Unit 7B	I-02	DI			PDS-028B	PLC
PDA-030B	High Differential Pressure GAC Unit 8B	I-02	DI			PDS-030B	PLC
PDA-032B	High Differential Pressure GAC Unit 9B	I-02	DI			PDS-032B	PLC
LI-040	1.2 MG Contact Tank Level	I-03	AI			PY-040	PLC
FI-035	Total Flow to GAC Contact Tank	I-03	AI			FIT-035	PLC
LAH-055	Stormwater Detected	I-03	DI			LSH-055	PLC
HS-042	Backwash Feed Valve Open/Close Command	I-03	DO			PLC	FCV-042
ZIC-059	Treated Water Drain Valve Closed	I-03	DI			ZSC-059	PLC
ZIO-059	Treated Water Drain Valve Open	I-03	DI			ZSO-059	PLC
YIL-059	Treated Water Drain Valve In-Remote	I-03	DI			LCS FCV-059	PLC
HS-059	Treated Water Drain Valve Line	I-03	DO			PLC	FCV-059
PAL-059	High Vacuum GAC Discharge Line	I-03	DI			PSL-059	PLC
LI-043	Backwash Tank Level	I-03	AI			LIT-043	PLC
LAHH-043	Backwash tank Level High-High (Backup Float)	I-03	DI			LSHH-043	PLC

TAG	DESCRIPTION	DRAWING NO.	SIGNAL TYPE	RANGE /SETPOINT	UNITS	SIGNAL FROM/TO	SIGNAL TO/FROM
						DEVICE	CONTROL PANEL (PLC)
TI-056	GAC Building Electrical Room Ambient Temperature	I-03	AI	10-120	F	TIT-056	PLC
TI-057	GAC Building Ambient Temperature	I-03	AI	10-120	F	TIT-057	PLC
MI-058	GAC Building Relative Humidity	I-03	AI	0-100	%	MIT-058	PLC
FI-054	Low Pressure Distribution Flow	I-03	AI			FIT-054	PLC
FFIC-035A	Chlorine Pacing Signal	I-03	AO	0-100	%	PLC	CHEMICAL CP
FFIC-035B	Fluoride Pacing Signal	I-03	AO	0-100	%	PLC	FLUORIDE DOSING PUMP
FFIC-035C	Phosphate Pacing Signal	I-03	AO	0-100	%	PLC	PHOSPHATE DOSING PUMP
AI-044	Distribution Chloride Value	I-04	AI			AIT-044	PLC
AI-045	Distribution Fluoride Value	I-04	AI			AIT-045	PLC
AI-046	Distribution Phosphate Value	I-04	AI			AIT-046	PLC
AI-047	Distribution pH Value	I-04	AI	0-14	pH	AIT-047	PLC
SI-048	High Lift Pump No. 1 Speed Feedback	I-04	AI	0-100	%	VFD HIGH LIFT PUMP 1	PLC
SI-049	High Lift Pump No. 2 Speed Feedback	I-04	AI	0-100	%	VFD HIGH LIFT PUMP 2	PLC
SI-050	High Lift Pump No. 3 Speed Feedback	I-04	AI	0-100	%	VFD HIGH LIFT PUMP 3	PLC
SC-048	High Lift Pump No. 1 Speed Command	I-04	AO	0-100	%	PLC	VFD HIGH LIFT PUMP 1
SC-049	High Lift Pump No. 2 Speed Command	I-04	AO	0-100	%	PLC	VFD HIGH LIFT PUMP 2
SC-050	High Lift Pump No. 3 Speed Command	I-04	AO	0-100	%	PLC	VFD HIGH LIFT PUMP 3
YIL-002	High Lift Pump No. 1 VFD Enabled	I-04	DI			VFD HIGH LIFT PUMP 1	PLC
UA-002	High Lift Pump No. 1 Fault	I-04	DI			VFD HIGH LIFT PUMP 1	PLC
YIL-003	High Lift Pump No. 2 VFD Enabled	I-04	DI			VFD HIGH LIFT PUMP 2	PLC
UA-003	High Lift Pump No. 2 Fault	I-04	DI			VFD HIGH LIFT PUMP 2	PLC
YIL-004	High Lift Pump No. 3 VFD Enabled	I-04	DI			VFD HIGH LIFT PUMP 3	PLC
UA-004	High Lift Pump No. 3 Fault	I-04	DI			VFD HIGH LIFT PUMP 3	PLC
YN-002	High Lift Pump No. 1 Not In Remote	I-04	DI			LCS PUMP 1	PLC
YN-003	High Lift Pump No. 2 Not In Remote	I-04	DI			LCS PUMP 2	PLC
YN-004	High Lift Pump No. 3 Not In Remote	I-04	DI			LCS PUMP 3	PLC
HS-048	High Lift Pump No. 1 Start/Stop	I-04	DO			PLC	VFD HIGH LIFT PUMP 1
HS-049	High Lift Pump No. 2 Start/Stop	I-04	DO			PLC	VFD HIGH LIFT PUMP 2
HS-050	High Lift Pump No. 3 Start/Stop	I-04	DO			PLC	VFD HIGH LIFT PUMP 3
YN-015A	ATS Normal	I-04	DI			STANDBY GENERATOR	PLC
YN-015B	MTS Normal	I-04	DI			STANDBY GENERATOR	PLC
UA-015A	Emergency Power	I-04	DI			STANDBY GENERATOR	PLC
UA-015B	Generator Fault	I-04	DI			STANDBY GENERATOR	PLC
FI-051	GAC Backwash Flow	I-04	AI			FIT-051	PLC
FI-053	High Pressure Distribution Flow	I-04	AI			FIT-053	PLC
PI-052	High Pressure Distribution Pressure	I-04	AI			PIT-052	PLC
UA-061	Fire Alarm	I-04	DI			FFCP-1	PLC
UA-062B	GAC Control Panel Alarm Strobe Output		DO			PLC	GAC-CP

TAG	DESCRIPTION	DRAWING NO.	SIGNAL TYPE	RANGE /SETPOINT	UNITS	SIGNAL FROM/TO	SIGNAL TO/FROM
						DEVICE	CONTROL PANEL (PLC)
UA-063A	Remote OIT (R-OIT) Horn Output		DO			PLC	R-OIT
UA-063B	Remote OIT (R-OIT) Alarm Strobe Output		DO			PLC	R-OIT

DATA SHEETS - PRIMARY SENSORS AND FIELD INSTRUMENTS

PRODUCT		**Analyzer - Chlorine**	SHEET 1 OF 1	
PROJECT		GAC TREATMENT SYSTEM AT WASHINGTON LAKE FILTRATION PLANT	SPEC. NO. 40 60 05 - 3.5.C.4	ADDENDUM/C.O.
TAG NO.		**AE / AIT - 044**		
Ref. Dwg. No.:	1	I-04		
PROCESS				
Location:	2	GAC Building Mezz. Floor		
Service:	3	Distribution Water		
Vessel / Line No.:	4	Chemical Monitoring System		
Fluid:	5	Potable Water		
Temp. Min/Max:	6	33 to 80 F		
Level Min/Max:	7	N/A		
SENSOR				
Type:	8	Colorimetric		
Element:	9	Colorimetric DPD chemistry (Reagents) to continuosuly monitor free or total residual chlorine		
Range:	10	0.03 to 5 mg/L		
Inlet Pressure	11	1 to 5 psig		
Sample Flow Rate	12	200 to 500 mL per minute minimum		
Pressure Limit	13	1.5 to 75 PSI		
Cycle Time	14	2.5 minutes		
Inlet/Drain Connections	15	1/4" OD polyethlyene tube, quick-disconnect fitting Inlet and 1/2" flexible hose Drain		
TRANSMITTER				
Type:	16	Analyzer/Transmitter.		
Output:	17	4-20 mADC isolated.		
Power Supply:	18	120 VAC, 60 Hz @ 2.5 A		
Relays:	19	Two SDPT.		
Switch Action:	20	Selectable for sample concentration alarm, analyzer system warning, or analyzer system shutdown alarms.		
Setpoints:	21	Not Applicable		
Rating:	22	10 A at 120 VAC, non-inductive.		
Indication / Display:	23	Integral LCD; 3-1/2" digit measurement readout		
Enclosure/Housing:	24	ABS plastic, two clear polycarbonate windows, IP62-rated with the gasgeted door latched.		
Mounting:	25	Wall Mounting		
Dimensions	26	454 mm x 314 mm x 179 mm		
Additional Features:	27			
NOTES				
General:	28	The analyzer assembly shall contain all wiring. No exposed wiring shall be permitted.		
Materials:	29	All wetted parts shall be compatible with the process fluid. Refer to Materials Compatibility Chart.		
Installation:	30	Refer to Contract Drawing Installation Details and manufacturer's recommendations for installation sahll be followed for piping & connections.		
Replaceable Cap:	31	N/A		
Consumables:	32	1 year supply of all required reagents for full functionality of the analzyer.		
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MANUFACTURE		Provide the following:		
Manufacturer:	36	HACH CL17		

DATA SHEETS - PRIMARY SENSORS AND FIELD INSTRUMENTS

PRODUCT		**Analyzer - pH**	SHEET 1 OF 1	
PROJECT		GAC TREATMENT SYSTEM AT WASHINGTON LAKE FILTRATION PLANT	SPEC. NO. 40 60 05 - 3.5.C.13	ADDENDUM/C.O.
TAG NO.		**AE / AIT - 047**		
Ref. Dwg. No.:	1	I-04		
PROCESS				
Location:	2	GAC Building Mezz. Floor		
Service:	3	Distribution Water		
Vessel / Line No.:	4	Chemical Monitoring System		
Fluid:	5	Potable Water		
Temp. Min/Max:	6	33 to 80 °F		
Press. Limit:	7	100 PSI at 80 °F		
PERFORMANCE				
Range:	8	0 - 14 pH units.		
Sensitivity:	9	±0.01 pH		
Temperature:	10	Ambient: -4 to 140 deg F; Coefficient: < 0.03% of Range per deg C.		
Relative Humidity:	11	0-95% pH non-condensing.		
Repeatability:	12	±0.01% of Span.		
Stability:	13	0.03 pH per 24 hours, non-cumulative		
Resolution:	14	0.004% mA(12-bit) analog output.		
Response Time:	15	95% of Range in 5 seconds.		
SENSOR				
Type:	16	Probe Type		
Element:	17	pH and Reference Electrodes.		
Enclosure/Housing:	18	Epoxy Body; Chemical Resistant Liquid Crystal Polymer.		
Mounting:	19	Flow Through Cell, Insertion Type.		
Connections:	20	Process Conn.: 3/4 inch NPT.		
Commun. Cable:	21	PVC jacketed submersible cable to transmitter; Length as required.		
Additional Features:	22	Thermistor for Process Temperature Correction.		
TRANSMITTER				
Type:	23	Microprocessor-based, dual sensor Analyzer/Transmitter.		
Output:	24	4-20 mADC direct acting, 0-600 ohms.		
Power Supply:	25	120 VAC ±10, 50/60 Hz, 10 watts.		
Relays:	26	Four SPDT, form C relays; Selectable Hi-Hi, Hi, Lo, Lo-Lo.		
Rating:	27	5 A at 120 VAC.		
Indication / Display:	28	Local LCD; 1/2 inch character height min.; Built-In Self-Diagnostics and Simulator (See Notes, Lines 36 & 37).		
Enclosure/Housing:	29	NEMA 4X; Polycarbonate face panel; Epoxy-coated cast aluminum door and case.		
Mounting:	30	Surface Mount (Mount on 1/4" S.S. Back Plate)		
Area Classification:	31	Not Applicable		
Additional Features:	32	Keypad (See Notes, Line 38).		
NOTES				
Function:	33	Continuous monitoring system shall consist of pH sensor and a microprocessor based analyzer/transmitter designed to measure sample pH and produce a proportional output signal linear to the pH.		
Materials:	34	All wetted parts shall be chemical resistant liquid crystal polymer or other material compatible with the process fluid. Refer to Materials Compatibility Chart.		
Installation:	35	Refer to Contract Drawing Installation Details and manufacturer's recommendations for installation.		
Simulator:	36	Provide simulator used in conjunction with front panel controls and display to verify calibration, proper internal functioning of the analog-to-digital conversion, processing, outputs and setting up alarms.		
Self-Diagnostics:	37	Error messages shall indicate operational/equipment malfunctions, including EPROM failure (data is not valid), scaling card not present/not recognized, analog-to-digital converter not responding, RAM failure, and internal serial communication failure. All configuration data shall be stored in non-volatile EEPROM.		
Keypad:	38	Provide front panel, membrane sealed keypad for display control and transmitter function control testing and calibration. Front panel switch shall also allow alternate display of readouts for pH, Temperature and mA outputs.		
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MANUFACTURE		Provide products of one of the following, Or Equal:		
Manufacturer:	40	Hach	ABB	Endress & Hauser

DATA SHEETS - PRIMARY SENSORS AND FIELD INSTRUMENTS

PRODUCT		**Analyzer - Phosphate**	SHEET 1 OF 1	
PROJECT		GAC TREATMENT SYSTEM AT WASHINGTON LAKE FILTRATION PLANT	SPEC. NO. 40 60 05 - 3.5.C.14	ADDENDUM/C.O.
TAG NO.		**AE / AIT - 046**		
Ref. Dwg. No.:	1	I-04		
PROCESS				
Location:	2	GAC Building Mezz. Floor		
Service:	3	Distribution Water		
Vessel / Line No.:	4	Chemical Monitoring System		
Fluid:	5	Potable Water		
Temp. Min/Max:	6	33 to 80 degree F		
PERFORMANCE				
Range:	7	4 ppb - 3000 ppb as PO4		
Accuracy:	8	±4% of Reading.		
Repeatability:	9	±1% of Reading.		
Temperature:	10	41 to 113 degrees F.		
Response Time:	11	10 minutes at 77 degrees F		
SENSOR				
Type:	12	Phosphate Sensor.		
Reagent:	13	Type as recommended by manufacturer; (See Notes, Line 32).		
Capillary Tubing:	14	Sample tubing length as required from process port to Analyzer/Transmitter.		
Mounting:	15	Integral Mount to Analyzer/Transmitter.		
Sample Pressure:	16	2 to 87 PSI		
Additional Features:	17	Sensitivity Adjustment Dial; Air Purge Option; Provide means to filter process fluid.		
TRANSMITTER				
Type:	18	Microprocessor-based Phosphate Analyzer/Transmitter to continuously monitor in a sample stream.		
Output:	19	4-20 mADC.		
Power Supply:	20	120 VAC, 60 Hz.; Battery backup for Controller Memory Storage and Date/Time.		
Relays:	21	4 Programmable Relays (2 Sample Concentration Alarms, 1 System Warning Alarm, 1 Malfunction Alarm).		
Indication / Display:	22	5.7" LCD sreen. Programmable Controller/Recorder with keypad and LCD display; Date/Time Stamp Indication; Engineering Units.		
Enclosure/Housing:	23	NEMA 4X Enclosure with Viewing Window.		
Mounting:	24	Wall or Surface Mount; 316 S.S. Mounting Hardware/Brackets.		
Connections:	25	Sample Inlet: 6mm OD quick connect fitting. Drain Outlet: 11mm ID slip-on fitting		
Commun. Cable:	26	As required		
Area Classification:	27	Not Applicable		
Additional Features:	28	Integral Auto 1-point Calibration System; Security Features.		
NOTES				
General:	29	Unit shall consist of a sensor and a microprocessor based analyzer/transmitter designed to measure sample phosphate and produce an output signal linear to phosphate. All components shall be housed in one enclosure.		
Materials:	30	All wetted parts shall be compatible with the process fluid. Refer to Materials Compatibility Chart.		
Installation:	31	Refer to Contract Drawing Installation Details and manufacturer's recommendations for installation.		
Consumables:	32	Provide sufficient quantities of reagents and expendables for one year of operation. Bi or Tri-Monthly replacement cycle. The analyzer shall use quick connect reagent bottles with pre-installed tubing. Reagents shall be pressurized using a built-in air compressor.		
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MANUFACTURE		Provide products of one of the following, Or Equal:		
Manufacturer:	35	Hach		

DATA SHEETS - PRIMARY SENSORS AND FIELD INSTRUMENTS

PRODUCT		Flow Indicator - Rotameter		SHEET 1 OF 2
PROJECT		GAC TREATMENT SYSTEM AT WASHINGTON LAKE FILTRATION PLANT		SPEC. NO. 40 60 05 - 3.5.C.27 / ADDENDUM/C.O.
TAG NO.		FI - 060	FI - 062	FI - 063
Ref. Dwg. No.:	1	I-08	I-08	I-08
PROCESS				
Location:	2	GAC Building Mezz. Floor	GAC Building Mezz. Floor	GAC Building Mezz. Floor
Service:	3	Pressurized Sampling Inlet	Chlorine Sample Flow	Fluoride Sample Flow
Vessel / Line No.:	4	-	-	-
Fluid:	5	Potable Water	Potable Water	Potable Water
Temp. Min/Max:	6	33 to 150 F	33 to 150 F	33 to 150 F
Press. Min/Max:	7	0 - 100 PSI	0 - 100 PSI	0 - 100 PSI
Flow Min/Max:	8	0 to 32 GPH	0 to 8 GPH	0 to 8 GPH
PERFORMANCE				
Range:	9	0 to 32 GPH	0 to 8 GPH	0 to 8 GPH
Accuracy:	10	± 2 to 5 % of Maximum Flow	± 2 to 5 % of Maximum Flow	± 2 to 5 % of Maximum Flow
Operating Temp.:	11	150 degrees F maximum.	150 degrees F maximum.	150 degrees F maximum.
Operating Press.:	12	100 PSIG maximum.	100 PSIG maximum.	100 PSIG maximum.
ROTAMETER				
Type:	13	Low Flow Variable-Area Flow Meter; (See Notes, Line 25).	Low Flow Variable-Area Flow Meter; (See Notes, Line 25).	Low Flow Variable-Area Flow Meter; (See Notes, Line 25).
Tube:	14	Borosilicate Glass Tube	Borosilicate Glass Tube	Borosilicate Glass Tube
Float:	15	316 S.S.	316 S.S.	316 S.S.
O-Ring:	16	Buna N	Buna N	Buna N
Retainers:	17	316 S.S.	316 S.S.	316 S.S.
Plugs/Adapters:	18	316 S.S.	316 S.S.	316 S.S.
End Fittings:	19	316 S.S.	316 S.S.	316 S.S.
Indication / Display:	20	Scaled Indication	Scaled Indication	Scaled Indication
Enclosure/Housing:	21	Rugged Glass type	Rugged Glass type	Rugged Glass type
Mounting:	22	Pipeline Mount 1" NPT	Pipeline Mount 1" NPT	Pipeline Mount 1" NPT
Area Classification:	23	Not Applicable	Not Applicable	Not Applicable
Additional Features:	24	RoHS Certified	RoHS Certified	RoHS Certified
NOTES				
General:	25	A Low Flow Rotameter constitutes flow conditions BELOW (and including) 40 GPH or 115 SCFH. A High Flow Rotameter constitutes flow conditions ABOVE 40 GPH or 115 SCFH.		
Materials:	26	All wetted parts shall be compatible with the process fluid. Refer to Materials Compatibility Chart.		
Installation:	27	Refer to Contract Drawing Installation Details and manufacturer's recommendations for installation.		
Tube Material:	28	A Borosilicate Glass Tube shall be used for most applications. A glass tube is not suited for applications with: water over 90°C (194°F), high pH (softens glass), wet steam (softens glass), caustic soda (dissolves glass), and hydrofluoric acid (etches glass). For these applications a stainless steel tube shall be used with a float that is magnetically coupled with an indicating gauge.		
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MANUFACTURE		Provide products of one of the following, Or Equal:		
Manufacturer:	38	Brooks Instruments	Yokogawa	OMEGA

DATA SHEETS - PRIMARY SENSORS AND FIELD INSTRUMENTS

PRODUCT		**Flow Indicator - Rotameter**	SHEET 2 OF 2	
PROJECT		GAC TREATMENT SYSTEM AT WASHINGTON LAKE FILTRATION PLANT	SPEC. NO. 40 60 05 - 3.5.C.27	ADDENDUM/C.O.
TAG NO.		**FI - 064**		
Ref. Dwg. No.:	1	I-08		
PROCESS				
Location:	2	GAC Building Mezz. Floor		
Service:	3	Phosphate Sample Flow		
Vessel / Line No.:	4	-		
Fluid:	5	Potable Water		
Temp. Min/Max:	6	33 to 150 F		
Press. Min/Max:	7	0 - 100 PSI		
Flow Min/Max:	8	0 to 8 GPH		
PERFORMANCE				
Range:	9	0 to 8 GPH		
Accuracy:	10	± 2 to 5 % of Maximum Flow		
Operating Temp.:	11	150 degrees F maximum.		
Operating Press.:	12	100 PSIG maximum.		
ROTAMETER				
Type:	13	Low Flow Variable-Area Flow Meter; (See Notes, Line 25).		
Tube:	14	Borosilicate Glass Tube		
Float:	15	316 S.S.		
O-Ring:	16	Buna N		
Retainers:	17	316 S.S.		
Plugs/Adapters:	18	316 S.S.		
End Fittings:	19	316 S.S.		
Indication / Display:	20	Scaled Indication		
Enclosure/Housing:	21	Rugged Glass type		
Mounting:	22	Pipeline Mount 1" NPT		
Area Classification:	23	Not Applicable		
Additional Features:	24	RoHS Certified		
NOTES				
General:	25	A Low Flow Rotameter constitutes flow conditions BELOW (and including) 40 GPH or 115 SCFH. A High Flow Rotameter constitutes flow conditions ABOVE 40 GPH or 115 SCFH.		
Materials:	26	All wetted parts shall be compatible with the process fluid. Refer to Materials Compatibility Chart.		
Installation:	27	Refer to Contract Drawing Installation Details and manufacturer's recommendations for installation.		
Tube Material:	28	A Borosilicate Glass Tube shall be used for most applications. A glass tube is not suited for applications with: water over 90°C (194°F), high pH (softens glass), wet steam (softens glass), caustic soda (dissolves glass), and hydrofluoric acid (etches glass). For these applications a stainless steel tube shall be used with a float that is magnetically coupled with an indicating gauge.		
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MANUFACTURE		Provide products of one of the following, Or Equal:		
Manufacturer:	38	Brooks Instruments	Yokogawa	OMEGA

DATA SHEETS - PRIMARY SENSORS AND FIELD INSTRUMENTS

PRODUCT		Flow Meter - Magnetic Flow Tube		SHEET 1 OF 2
PROJECT		GAC TREATMENT SYSTEM AT WASHINGTON LAKE FILTRATION PLANT		SPEC. NO. 40 60 05 - 3.5.C.29 / ADDENDUM/C.O.
TAG NO.		**FE / FIT - 005, 006, 007**	**FE / FIT - 008, 009, 010**	**FE / FIT - 011, 012, 013**
Ref. Dwg. No.:	1	I-02	I-02	I-02
PROCESS				
Location:	2	GAC Building	GAC Building	GAC Building
Service:	3	GAC Contactor Feed To 3 Units	GAC Contactor Feed To 2 Units	GAC Contactor Feed
Line Size:	4	12"	12"	12"
Fluid:	5	Water	Water	Water
Temp. Min/Max:	6	33 to 80 F	33 to 80 F	33 to 80 F
Flow Min/Max:	7	0-3000 GPM	0-2000 GPM	0-1000 GPM
PERFORMANCE				
Range:	8	0-3000 GPM	0-2000 GPM	0-1000 GPM
Accuracy:	9	±0.5% of flow rate over 1-31 fps range; ±0.005 fps for flows below 1 fps.	±0.5% of flow rate over 1-31 fps range; ±0.005 fps for flows below 1 fps.	±0.5% of flow rate over 1-31 fps range; ±0.005 fps for flows below 1 fps.
Temperature:	10	32.2 to 122 degrees F.	32.2 to 122 degrees F.	32.2 to 122 degrees F.
Repeatability:	11	±0.2% of range.	±0.2% of range.	±0.2% of range.
Fluid Conductivity:	12	> 20 µS/cm.	> 20 µS/cm.	> 20 µS/cm.
Impedance:	13	Minimum Pre-amp Input: 1012 ohms.	Minimum Pre-amp Input: 1012 ohms.	Minimum Pre-amp Input: 1012 ohms.
Drift:	14	Complete zero stability.	Complete zero stability.	Complete zero stability.
FLOW TUBE				
Type:	15	Lined Metal Flow Tube.	Lined Metal Flow Tube.	Lined Metal Flow Tube.
Element:	16	Conical or Elliptical Shaped Electrode.	Conical or Elliptical Shaped Electrode.	Conical or Elliptical Shaped Electrode.
Electrode/Liner:	17	Polypropylene (or Equal)	Polypropylene (or Equal)	Polypropylene (or Equal)
Line Size:	18	12"	12"	12"
Enclosure/Housing:	19	Die-cast, Low-copper Aluminum Alloy; Submersible in 30 feet water for 48 hours; Epoxy paint finish.	Die-cast, Low-copper Aluminum Alloy; Submersible in 30 feet water for 48 hours; Epoxy paint finish.	Die-cast, Low-copper Aluminum Alloy; Submersible in 30 feet water for 48 hours; Epoxy paint finish.
Mounting:	19	Carbon Steel Flange End Connections.	Carbon Steel Flange End Connections.	Carbon Steel Flange End Connections.
ANSI Class:	20			
Additional Features:	21	316 S.S. Grounding Rings/Straps.	316 S.S. Grounding Rings/Straps.	316 S.S. Grounding Rings/Straps.
TRANSMITTER				
Type:	22	Pulsed DC Magnetic Flow Transmitter.	Pulsed DC Magnetic Flow Transmitter.	Pulsed DC Magnetic Flow Transmitter.
Output:	23	4-20 mADC direct-acting, galvanically isolated; into 0-1000 ohms.	4-20 mADC direct-acting, galvanically isolated; into 0-1000 ohms.	4-20 mADC direct-acting, galvanically isolated; into 0-1000 ohms.
Power Supply:	24	120 VAC ±10%, 60 Hz ±3 Hz.	120 VAC ±10%, 60 Hz ±3 Hz.	120 VAC ±10%, 60 Hz ±3 Hz.
Indication / Display:	25	Local LCD; Display Flow in Engineering Units; Provide Totalizer (See Notes, Line 39).	Local LCD; Display Flow in Engineering Units; Provide Totalizer (See Notes, Line 39).	Local LCD; Display Flow in Engineering Units; Provide Totalizer (See Notes, Line 39).
Enclosure/Housing:	26	Integral	Integral	Integral
Mounting:	27	Wall Mount; 316 S.S. hardware.	Wall Mount; 316 S.S. hardware.	Wall Mount; 316 S.S. hardware.
Connections:	28	Electrical Conn.: 3/4 inch NPT.	Electrical Conn.: 3/4 inch NPT.	Electrical Conn.: 3/4 inch NPT.
Commun. Cable:	29	Shielded Cable to flow tube.	Shielded Cable to flow tube.	Shielded Cable to flow tube.
Area Classification:	30	N/A	N/A	N/A
Additional Features:	31	Automatic zeroing.	Automatic zeroing.	Automatic zeroing.
NOTES				
Function:	32	System shall monitor liquid flows, display monitored flow value, and output a signal proportional to monitored flow.		
Installation:	33	Refer to Contract Drawing Installation Details and manufacturer's recommendations for installation.		
Calibration:	34	Provide ISO Factory Calibration Certificate. Provide one calibrator suitable to calibrate all flow tubes provided.		
Accuracy:	35	Accuracy shall be: - Unaffected by changes in fluid velocity, density, pressure, temp. or conductivity (above min. conductivity limits). - Verified by flow test curves. Submit flow test curves for furnished meters with a minimum of 10 equally spaced flow points, using water and a weight or volume tank. A "master meter" used as a reference standard is not acceptable. A test setup shall be submitted and approved prior to testing.		
Span Adjustment:	36	Unit shall have pre-calibrated continuous span adjustment over entire range. Provide direct reading thumbwheel switch or potentiometer for 1-31 ft/sec.		
Signal Conditioning:	37	Adjustable signal conditioning damping circuit with response times of 1-25 seconds minimum.		
Low Flow Cutoff:	38	Automatic low flow cutoff circuitry shall stop pulse output and local totalization when flow drops below 0.5% ±0.2% of calibrated upper range value.		
Totalizer:	39	Totalizer shall be: - 7-digit electromechanical or 8-digit electronic LCD unit, with reset and lithium battery backup. - Driven by high accuracy, field adjustable scaled pulse output (0.1-10 Hz or greater). - Integral with transmitter and visible through viewing window, or externally mounted adjacent to transmitter in a separate NEMA 4X enclosure or condulet with viewing window.		
Spool Piece:	40	Provide a replacement spool piece for each size flow tube where no bypass piping is provided.		
	41	**FE / FIT - 005, 006, 007, 008, 009, 010, 011, 012 & 013**		
MANUFACTURE		Provide products of one of the following, Or Equal:		
Manufacturer:	42	Endress & Hauser	Krohne America, Inc.	ABB

DATA SHEETS - PRIMARY SENSORS AND FIELD INSTRUMENTS

PRODUCT		Flow Meter - Magnetic Flow Tube		SHEET 2 OF 2
PROJECT		GAC TREATMENT SYSTEM AT WASHINGTON LAKE FILTRATION PLANT		SPEC. NO. 40 60 05 - 3.5.C.29 / ADDENDUM/C.O.
TAG NO.		**FE / FIT - 035**	**FE / FIT - 051**	**FE / FIT - 053**
Ref. Dwg. No.:	1	I-03	I-04	I-04
PROCESS				
Location:	2	FIT-035 Meter Vault	GAC Building	GAC Building
Service:	3	Contact Tank Feed	GAC Backwash Supply	High Pressure Distribution
Vessel / Line No.:	4	24"	8"	20"
Fluid:	5	Water	Water	Water
Temp. Min/Max:	6	33 to 80 F	33 to 80 F	33 to 80 F
Flow Min/Max:	7	0 - 6200 GPM	0-1000 GPM	0 - 4000 GPM
PERFORMANCE				
Range:	8	0 - 6500 GPM	0-1500	0 - 6000 GPM
Accuracy:	9	±0.5% of flow rate over 1-31 fps range; ±0.005 fps for flows below 1 fps.	±0.5% of flow rate over 1-31 fps range; ±0.005 fps for flows below 1 fps.	±0.5% of flow rate over 1-31 fps range; ±0.005 fps for flows below 1 fps.
Temperature:	10	32.2 to 122 degrees F.	32.2 to 122 degrees F.	32.2 to 122 degrees F.
Repeatability:	11	±0.2% of range.	±0.2% of range.	±0.2% of range.
Fluid Conductivity:	12	> 20 µS/cm.	> 20 µS/cm.	> 20 µS/cm.
Impedance:	13	Minimum Pre-amp Input: 1012 ohms.	Minimum Pre-amp Input: 1012 ohms.	Minimum Pre-amp Input: 1012 ohms.
Drift:	14	Complete zero stability.	Complete zero stability.	Complete zero stability.
FLOW TUBE				
Type:	15	Lined Metal Flow Tube.	Lined Metal Flow Tube.	Lined Metal Flow Tube.
Element:	16	Conical or Elliptical Shaped Electrode.	Conical or Elliptical Shaped Electrode.	Conical or Elliptical Shaped Electrode.
Electrode/Liner:	17	Elastomer (or Equal)	Elastomer (or Equal)	Elastomer (or Equal)
Line Size:	18	24"	8"	20"
Enclosure/Housing:	19	Die-cast, Low-copper Aluminum Alloy; Submersible in 30 feet water for 48 hours; Epoxy paint finish.	Die-cast, Low-copper Aluminum Alloy; Submersible in 30 feet water for 48 hours; Epoxy paint finish.	Die-cast, Low-copper Aluminum Alloy; Submersible in 30 feet water for 48 hours; Epoxy paint finish.
Mounting:	19	Carbon Steel Flange End Connections.	Carbon Steel Flange End Connections.	Flange End Connections.
ANSI Class:	20			
Additional Features:	21	316 S.S. Grounding Rings/Straps.	316 S.S. Grounding Rings/Straps.	316 S.S. Grounding Rings/Straps.
TRANSMITTER				
Type:	22	Pulsed DC Magnetic Flow Transmitter.	Pulsed DC Magnetic Flow Transmitter.	Pulsed DC Magnetic Flow Transmitter.
Output:	23	4-20 mADC direct-acting, galvanically isolated; into 0-1000 ohms.	4-20 mADC direct-acting, galvanically isolated; into 0-1000 ohms.	4-20 mADC direct-acting, galvanically isolated; into 0-1000 ohms.
Power Supply:	24	120 VAC ±10%, 60 Hz ±3 Hz.	120 VAC ±10%, 60 Hz ±3 Hz.	120 VAC ±10%, 60 Hz ±3 Hz.
Indication / Display:	25	Local LCD; Display Flow in Engineering Units; Provide Totalizer (See Notes, Line 39).	Local LCD; Display Flow in Engineering Units; Provide Totalizer (See Notes, Line 39).	Local LCD; Display Flow in Engineering Units; Provide Totalizer (See Notes, Line 39).
Enclosure/Housing:	26	Integral	Integral	Integral
Mounting:	27	Wall Mount; 316 S.S. hardware.	Wall Mount; 316 S.S. hardware.	Wall Mount; 316 S.S. hardware.
Connections:	28	Electrical Conn.: 3/4 inch NPT.	Electrical Conn.: 3/4 inch NPT.	Electrical Conn.: 3/4 inch NPT.
Commun. Cable:	29	Shielded Cable to flow tube.	Shielded Cable to flow tube.	Shielded Cable to flow tube.
Area Classification:	30	N/A	N/A	N/A
Additional Features:	31	Automatic zeroing.	Automatic zeroing.	Automatic zeroing.
NOTES				
Function:	32	System shall monitor liquid flows, display monitored flow value, and output a signal proportional to monitored flow.		
Installation:	33	Refer to Contract Drawing Installation Details and manufacturer's recommendations for installation.		
Calibration:	34	Provide ISO Factory Calibration Certificate. Provide one calibrator suitable to calibrate all flow tubes provided.		
Accuracy:	35	Accuracy shall be: - Unaffected by changes in fluid velocity, density, pressure, temp. or conductivity (above min. conductivity limits). - Verified by flow test curves. Submit flow test curves for furnished meters with a minimum of 10 equally spaced flow points, using water and a weight or volume tank. A "master meter" used as a reference standard is not acceptable. A test setup shall be submitted and approved prior to testing.		
Span Adjustment:	36	Unit shall have pre-calibrated continuous span adjustment over entire range. Provide direct reading thumbwheel switch or potentiometer for 1-31 ft/sec.		
Signal Conditioning:	37	Adjustable signal conditioning damping circuit with response times of 1-25 seconds minimum.		
Low Flow Cutoff:	38	Automatic low flow cutoff circuitry shall stop pulse output and local totalization when flow drops below 0.5% ±0.2% of calibrated upper range value.		
Totalizer:	39	Totalizer shall be: - 7-digit electromechanical or 8-digit electronic LCD unit, with reset and lithium battery backup. - Driven by high accuracy, field adjustable scaled pulse output (0.1-10 Hz or greater). - Integral with transmitter and visible through viewing window, or externally mounted adjacent to transmitter in a separate NEMA 4X enclosure or condulet with viewing window.		
Spool Piece:	40	Provide a replacement spool piece for each size flow tube where no bypass piping is provided.		
	41			
MANUFACTURE		Provide products of one of the following, Or Equal:		
Manufacturer:	42	Endress & Hauser	Krohne America, Inc.	ABB

DATA SHEETS - PRIMARY SENSORS AND FIELD INSTRUMENTS

PRODUCT		**Level Transmitter - Submersible Pressure Type**	SHEET 1 OF 1	
PROJECT		GAC TREATMENT SYSTEM AT WASHINGTON LAKE FILTRATION PLANT	SPEC. NO. 40 60 05 - 3.5.C.53	ADDENDUM/C.O.
TAG NO.		**LE / LIT - 043**		
Ref. Dwg. No.:	1	I-03		
PROCESS				
Location:	2	Backwash Tank Stilling Well		
Service:	3	Backwash Tank Level		
Vessel / Line No.:	4	Backwash Tank		
Fluid:	5	Potable Water		
Temp. Min/Max:	6	33 to 80 F		
Press. Min/Max:	7	0 to 6 PSI		
Level Min/Max:	8	0 to 9.23 Feet		
PERFORMANCE				
Range:	9	0 - 10 Feet		
Span:	10	±0.50% Full Scale.		
Accuracy:	11	±0.25% Full Scale.		
Temperature:	12	-25 to 180 degrees F.		
Zero Offset:	13	±0.50% Full Scale.		
SENSOR				
Type:	14	Hydrostatic Pressure Sensor.		
Diaphragm Seal:	15	Hastelloy C (or Equal)		
Enclosure/Housing:	16	Submersible Sensor, IP68 Type 6 ingress protection; Refer to Materials Compatibility Chart.		
Mounting:	17	316 S.S. Brackets/Hardware. (See I-08 for detail)		
Commun. Cable:	18	Submersible cable; Length as required.		
Area Classification:	19	N/A		
Additional Features:	20	Vent to the atmosphere, as necessary.		
TRANSMITTER				
Type:	21	Differential Pressure Transmitter.		
Input:	22	4-20 mADC.		
Output:	23	4-20 mA. 2 wire, current limited to 30 mA DC		
Power Supply:	24	24 VDC with surge and lightning protection.		
Relays:	25	2 relay outputs for Low Level Alarm.		
Indication / Display:	26			
Enclosure/Housing:	27	NEMA 4X; 316 S.S. Enclosure.		
Mounting:	28	Panel Mount; Provide Mounting Bracket and Hardware.		
Elec. Connections:	29	Attached 3-wire, 20 gauge polyethylene shielded unspliced cable.		
Area Classification:	30	Not Applicable		
Additional Features:	31	Terminal Housing and Protective Cap.		
NOTES				
Function:	32	System shall measure level by continuously measuring hydrostatic pressure via its sensing element, an ion implanted silicon semiconductor chip with integrated Wheatstone Bridge.		
Installation:	33	Refer to Contract Drawing Installation Details and manufacturer's recommendations for installation.		
Calibration:	34	Provide ISO Factory Calibration Certificate.		
Materials:	35	All wetted parts shall be compatible with the process fluid. Refer to Materials Compatibility Chart.		
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MANUFACTURE		Provide products of one of the following, Or Equal:		
Manufacturer:	39	AMETEK/Drexelbrook	GE/Druck	KPSI

DATA SHEETS - PRIMARY SENSORS AND FIELD INSTRUMENTS

PRODUCT		**Level Switch - Conductance Type**	SHEET 1	OF 1
PROJECT		GAC TREATMENT SYSTEM AT WASHINGTON LAKE FILTRATION PLANT	SPEC. NO. 40 60 05 - 3.5.C.57	ADDENDUM/C.O.
TAG NO.		**LE/LSH - 055**		
Ref. Dwg. No.:	1	I-03		
PROCESS				
Location:	2	Backwash/Stormwater Tanks		
Service:	3	Interstitial Space Leak Detection		
Vessel / Line No.:	4	BW/SW Tank Interstitial Space		
Fluid:	5	Potable Water		
Temp. Min/Max:	6	32 to 100 F		
Level Min/Max:	7	0 - 5		
PERFORMANCE				
Temperature:	8	-40 to 140 degrees F.		
Sensitivity:	9	10K ohms resistance; (See Notes, Line 31).		
SENSOR				
Type:	10	Level Sensor Control/Alarm Electrode.		
Element:	11	Electrode.		
No. of Electrodes:	12	1		
Insulation:	13	PVC		
Electrode Rod:	14	Shell-303 SS Insulator-Ceramic Seal-Glass & Copper		
Mounting:	15	3/8-18 PTF SAE Short Mounting Thread		
Additional Features:	16	Electrode Spacer. Wire suspension electrodes.		
SWITCH				
Type:	17	Solid State Control Relay.		
Power Supply:	18	120 VAC (-20, +10%), 60 Hz.; 9 V-A, 6 watts required.		
Relays:	19	3 separate, isolated sets of Form C (SPDT) contacts: 1 set wetted for local use, 2 sets dry for remote monitoring or external load control.		
Rating:	20	10A at 120 VAC.		
Contacts:	21	Silver cadmium oxide.		
Switch Action:	22	Switch Opens/Closes at predefined setpoint(s); Normally Closed contact.		
Setpoints:	23	High		
Indication / Display:	24	Not Applicable		
Enclosure/Housing:	25	Electorde Relay shall be mounted in GAC-CP. Appropriate length of cable from the electrode to the Electrode Relay shall be provided.		
Mounting:	26	-		
Area Classification:	27	Not Applicable		
Additional Features:	28			
NOTES				
Function:	29	Complete level sensing system shall utilize conductance type measuring techniques to energize and de-energize independent control relays when the monitored medium reaches the corresponding level electrode elevation.		
Installation:	30	Refer to Contract Drawing Installation Details and manufacturer's recommendations for installation.		
Sensitivity:	31	Sensitivity shall be field changeable to adjust for process fluid conductivity by means of external resistor replacement and relay shall be field convertible for direct or inverse operation.		
Quantity:	32	Provide one control relay per control or alarm electrode. Ground common electrode to each relay.		
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MANUFACTURE		Provide products of one of the following, Or Equal:		
Manufacturer:	36	B/W Controls - Division of AMETEK	Endress + Hauser	

DATA SHEETS - PRIMARY SENSORS AND FIELD INSTRUMENTS

PRODUCT		**Level Switch - Float Type (Single Point)**	SHEET 1 OF 1	
PROJECT		GAC TREATMENT SYSTEM AT WASHINGTON LAKE FILTRATION PLANT	SPEC. NO. 40 60 05 - 3.5.C.59	ADDENDUM/C.O.
TAG NO.		**LSHH - 043**		
Ref. Dwg. No.:	1	I-03		
PROCESS				
Location:	2	Backwash Tank Stilling Well		
Service:	3	Backwash Tank		
Vessel / Line No.:	4	Backwash Tank		
Fluid:	5	Water		
Temp. Min/Max:	6	33 to 80 F		
Level Min/Max:	7			
Density Min/Max:	8	0 - 10 Feet		
PERFORMANCE				
Operating Temp.:	9	-40 to 140 degrees F.		
SWITCH				
Type:	10	Displacement Type Liquid Level Sensor with Mechanical (Non-Mercury) Switch.		
Relays:	11	SPDT rated 16A resistive at 120 VAC and 5A resistive at 30 VDC.		
Switch Action:	12	Switch Opens/Closes at predefined setpoint(s); Normally Closed contact.		
Setpoints:	13	High High		
Enclosure/Housing:	14	NEMA 4X; Hollow hermetically sealed, rigidly molded polypropylene float body; Contains switch and weight.		
Mounting:	15	Pole Mount; 316 S.S. Hardware.		
Electrical Cable:	16	Heavy duty, 3-conductor, flexible, submersible cable sheathed in PVC with watertight seal; Length as required.		
Area Classification:	17	Not Applicable		
Additional Features:	18	Weight (See Notes, Line 21).		
NOTES				
General:	19	Direct acting, pear shaped, eccentric weighted, displacement type liquid level sensor.		
Installation:	20	Refer to Contract Drawing Installation Details and manufacturer's recommendations for installation.		
Weight:	21	Provide eccentric metal weight to cause sensor to hang straight down from cable when not immersed and only allow float to pivot when immersed in liquid.		
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MANUFACTURE		Provide products of one of the following, Or Equal:		
Manufacturer:	34	FLYGT - Division of ITT Industries	STI	SJE-Rhombus

DATA SHEETS - PRIMARY SENSORS AND FIELD INSTRUMENTS

PRODUCT	Pressure Gauge - Bourdon Type	SHEET 1 OF 1	
PROJECT	GAC TREATMENT SYSTEM AT WASHINGTON LAKE FILTRATION PLANT	SPEC. NO. 40 60 05 - 3.5.C.73	ADDENDUM/C.O.

GAUGE		
Type:	1	Liquid Filled Gauge for pressure ranges >15 psi and vacuum ranges <30 inches-Hg.
Element:	2	316 S.S. Bourdon Tube and Socket; Heliarc Welded, unless otherwise specified.
Accuracy:	3	±0.5% of span.
Diaphragm Seal:	4	A diaphragm seal is required for all mediums except air or potable water. Diaphragm material shall be compatible with the process fluid. Refer to Diaphragm Seal Data Sheet for requirements.
Pressure Snubber:	5	Provide sintered stainless steel or brass (for copper pipe) pressure snubber threaded into gauge socket or in external steel housing with 1/4 inch NPT male and female connections.
Indication / Display:	6	Glass window; White and Black markings on Dial; 300 series S.S. movement; Built-In overload/underload stops; Rotary geared with Teflon S coating, or cam and roller type.
Enclosure/Housing:	7	4-1/2 inch Black Case; Solid front design constructed of glass filled polyester; Full blowout back for overpressure protection.
Mounting:	8	Stem Mounting; 1/4 inch male NPT connection on bottom.
Additional Features:	9	Threaded, glass filled polyester ring.
NOTES		
General:	10	All wetted parts shall be compatible with the process fluid. Refer to Materials Compatibility Chart.
Installation:	11	Refer to Contract Drawing Installation Details and manufacturer's recommendations for installation.
Calibration:	12	Adjustable pointer and externally accessible zero adjustment; Provide ISO Factory Calibration Certificate.
Process Isolation:	13	Provide all valves for process isolation in accordance with specifications in this Section.
Fill Fluid:	14	Use silicone except for process fluids containing chlorine. When the process fluid contains chlorine, the filling liquid shall be Halocarbon 63 or Fluorolube 63.
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MANUFACTURE		Provide products of one of the following, Or Equal:
Manufacturer:	18	Ashcroft / Helicoid / WIKA Instrument Corporation

INSTRUMENT

Requirements specified above shall apply to all instrument tag numbers listed below.

	Tag No.	Process Fluid	Area Classification / Process Press. Min/Max (PSI)	Performance Range	Location / Service / Reference Drawing No.
1	PI - 054A	Potable Water	N/A / 0 - 15 PSI	30" Hg - 30 PSI	Contact Tank Discharge Pressure / I-03
2	PI - 054B	Potable Water	N/A / 0 - 15 PSI	30" Hg - 30 PSI	Low Pressure Line Regulated Press. / I-03
3	PI - 048A	Potable Water	N/A / -10 - 15 PSI	30" Hg - 30 PSI	High Lift Pumps Combined Suction / I-04
4	PI - 048B	Potable Water	N/A / 0 - 100 PSI	0 - 150 PSI	High Lift Pump 1 Discharge Pressure / I-04
5	PI - 049B	Potable Water	N/A / 0 - 100 PSI	0 - 150 PSI	High Lift Pump 2 Discharge Pressure / I-04
6	PI - 050B	Potable Water	N/A / 0 - 100 PSI	0 - 150 PSI	High Lift Pump 3 Discharge Pressure / I-04
7	PI - 061	Potable Water	N/A / 0 - 40 PSI	0 - 60 PSI	Pressurized Sampling Inlet Pressure / I-08
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DATA SHEETS - PRIMARY SENSORS AND FIELD INSTRUMENTS

PRODUCT		**Pressure Switch**	SHEET 1 OF 1	
PROJECT		GAC TREATMENT SYSTEM AT WASHINGTON LAKE FILTRATION PLANT	SPEC. NO. 40 60 05 - 3.5.C.75	ADDENDUM/C.O.
TAG NO.		**PSL - 059**		
Ref. Dwg. No.:	1	I-03		
PROCESS				
Location:	2	GAC Building		
Service:	3	GAC Contactors Discharge		
Line Size:	4	24"		
Fluid:	5	Potable Water		
Temp. Min/Max:	6	33 to 80 F		
Press. Min/Max:	7	28/1 in.Hg (Vacuum Type)		
Velocity Min/Max:	8	1 to 5 fps		
PERFORMANCE				
Range:	9	30/0 in.Hg		
Temperature:	10	-4 to 140 degrees F.		
Repeatability:	11	±1% of range.		
Deadband:	12	Adjustable		
SENSOR				
Type:	13	Diaphragm/Piston Pressure Sensor. Vacuum Type.		
Element:	14	Transducer.		
Diaphragm Seal:	15	Refer to Materials Compatiblity Chart		
Capillary Tubing:	16	316 S.S. Capillary to extend from process connection to switch.		
Mounting:	17	Integral Mount to Switch.		
Area Classification:	18	Not Applicable		
Additional Features:	19			
SWITCH				
Type:	20	Snap Action Switch.		
Power Supply:	21	24 VDC		
Relays:	22	SPDT, snap action.		
Rating:	23	10A at 120 VAC; 0.5A at 30 VDC.		
Switch Action:	24	Switch Opens/Closes at predefined setpoint(s); Normally Closed contact.		
Setpoints:	25	Low Pressure. Field Adjustable		
Enclosure/Housing:	26	NEMA 4;		
Mounting:	27	Pipe Stand Mount; External Mounting Lugs; 316 S.S. Hardware.		
Connections:	28	Process Conn.: 1/4 inch NPT male; Electrical Conn.: 1/2" NPT male conduit with free leads.		
Area Classification:	29	No Applicable		
Additional Features:	30	Set/Reset Point Adjustment (See Notes, Line 34).		
NOTES				
General:	31	All wetted parts shall be compatible with the process fluid. Refer to Materials Compatibility Chart.		
Function:	32	Pressure Switch shall sense gauge or absolute pressure and open or close a contact when the pressure reaches the specified trip point.		
Installation:	33	Refer to Contract Drawing Installation Details and manufacturer's recommendations for installation.		
Set/Reset Point:	34	Provide Set and Reset Point adjustable external adjusting nuts and pressure setting scales. Provide metal cover with gasket for adjusting nuts.		
Diaphragm Seal:	35	A diaphragm seal is required for all mediums except air or potable water. Diaphragm material shall be compatible with the process fluid. Refer to Diaphragm Seal Data Sheet for requirements.		
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MANUFACTURE		Provide products of one of the following, Or Equal:		
Manufacturer:	39	Barksdale Inc	Ashcroft	United Electric

DATA SHEETS - PRIMARY SENSORS AND FIELD INSTRUMENTS

PRODUCT		**Pressure Transmitter**	SHEET 1 OF 1	
PROJECT		GAC TREATMENT SYSTEM AT WASHINGTON LAKE FILTRATION PLANT	SPEC. NO. 40 60 05 - 3.5.C.76	ADDENDUM/C.O.
TAG NO.		**PIT - 052**		
Ref. Dwg. No.:	1	I-04		
PROCESS				
Location:	2	GAC Building		
Service:	3	High Distribution Service Line		
Vessel / Line No.:	4			
Fluid:	5	Water		
Temp. Min/Max:	6	33 to 80 F		
Press. Min/Max:	7	0 to 100 psi		
PERFORMANCE				
Range:	8	0 to 150 psi		
Accuracy:	9	±0.1% of calibrated span (includes effects of linearity, hysteresis, and repeatability).		
Temperature:	10	-20 to 180 °F; (See Notes, Line 35).		
Repeatability:	11	±0.05% of calibrated span.		
Damping:	12	Internal Adjustment.		
Hysteresis:	13	±0.05% of calibrated span.		
Stability:	14	Less than ±0.25% of Transmitter upper range limit (drift over 6 month period).		
Overrange Protec.:	15	Positive overrange protection: At least 1.25 times maximum span limit.		
SENSOR				
Type:	16	Pressure Gauge.		
Element:	17	Transducer.		
Diaphragm Seal:	18	Not Required		
Capillary Tubing:	19	316 S.S. Capillary to extend from process connection to transmitter.		
Mounting:	20	Integral Mount to Transmitter.		
Area Classification:	21	Not Applicable		
Additional Features:	22			
TRANSMITTER				
Type:	23	Solid state, 2-wire, Differential Capacitance or Resonant Wire Type Transmitter.		
Output:	24	4-20 mADC; (See Notes, Line 36).		
Power Supply:	25	24 VDC; Operates on power from receiver or remote power supply.		
Indication / Display:	26	Integral LCD Indication for Pressure in Engineering Units.		
Enclosure/Housing:	27	NEMA 4X; Epoxy painted; Die-cast low copper aluminum alloy housing; Covers threaded and seated on O-rings.		
Mounting:	28	Pipe Stand Mount.		
Connections:	29	Process Conn. 1/2 inch NPT; Electrical Conn.: 1/2 inch NPT.		
Area Classification:	30	Not Applicable		
Additional Features:	31	Built-In Surge and RFI protection.		
NOTES				
General:	32	All wetted parts shall be compatible with the process fluid. Refer to Materials Compatibility Chart.		
Installation:	33	Refer to Contract Drawing Installation Details and manufacturer's recommendations for installation.		
Calibration:	34	Zero and Span (coarse & fine) adjustments in electronics compartment. Provide Zero Elevation and Suppression so that the extent of suppression plus the calibration span does not exceed the upper range limits of the sensor.		
Amb. Temp. Effect:	35	Total Error per 100 deg. F change between Ambient Temperature Limits: < ±1.0% transmitter range limit (max. span).		
Output:	36	Digital process variable signal superimposed on 4-20 mADC signal without compromising loop integrity.		
Shutoff Valve:	37	Provide a single shutoff valve at each process line tap to enable live process removal of transmitter. Provide Type 316 S.S. 3-valve manifold for shutoff and pressure equalization on differential pressure and flow measurement applications.		
Calibration Valve:	38	For each unit, provide an additional calibration valve port.		
Hand-held Unit:	39	Provide a hand held interface with keyboard and LED display for easy configuration and testing of transmitter.		
Diaphragm Seal:	40	A diaphragm seal is required for all mediums except air or potable water. Diaphragm material shall be compatible with the process fluid. Refer to Diaphragm Seal Data Sheet for requirements.		
	41			
MANUFACTURE		Provide products of one of the following, Or Equal:		
Manufacturer:	42	ABB	Rosemount - Division of Emerson	

DATA SHEETS - PRIMARY SENSORS AND FIELD INSTRUMENTS

PRODUCT		**Temperature Transmitter - RTD Type**	SHEET 1 OF 2	
PROJECT		GAC TREATMENT SYSTEM AT WASHINGTON LAKE FILTRATION PLANT	SPEC. NO. 40 60 05 - 3.5.C.80	ADDENDUM/C.O.
TAG NO.		**TIT - 014**		
Ref. Dwg. No.:	1	I-02		
PROCESS				
Location:	2	Head House Building		
Service:	3	GAC Pumps Discharge Temperature		
Vessel / Line No.:	4	-		
Fluid:	5	Raw Water		
Temp. Min/Max:	6	0-180 F		
PERFORMANCE				
Range:	7	0-180 F		
Sensor Accuracy:	8	±0.5 deg. F or ±0.5% of actual temp., greater of two from 32-1200 deg. F.		
Trans. Accuracy:	9	±0.2% of calibrated span, including repeatability and linearity.		
Stability:	10	<0.1 deg. F shift from initial calibration in 1 year.		
Resistance:	11	100 ohms at 32 degrees F; 0.22 ohms per degree F Change.		
SENSOR				
Type:	12	3 or 4-Wire RTD Type Standard Length Sensor Assembly.		
Element:	13	Platinum RTD element.		
Sheath:	14	316 S.S.; Sheath Length, Diameter and Grounding State as recommended by manufacturer.		
Thermowell:	15	(See Notes, Line 34).		
Enclosure/Housing:	16	Waterproof Housing.		
Mounting:	17	10" Sensor Insertion Length; Coordinate with process piping and installation requirements.		
Commun. Cable:	18	Cable to Transmitter; Length as Required.		
Additional Features:	19	Extension fittings.		
TRANSMITTER				
Type:	20	Solid-State Electronic Transmitter.		
Input:	21	Input isolation.		
Output:	22	4-20mADC direct acting isolated, 0-600 ohms.		
Power Supply:	23	24 VDC; (See Notes, Line 35).		
Relays:	24	As Required.		
Indication / Display:	25	3-1/2 digit LCD visible through enclosure window; Engineering Units.		
Enclosure/Housing:	26	NEMA 4X; Die cast, low copper aluminum enclosure.		
Mounting:	27	Pipe Stand Mount; Provide mounting brackets.		
Connections:	28	3/4 inch internal NPT; Barrier terminal strip wiring connections.		
Area Classification:	29	Not Applicable		
Additional Features:	30	Temperature Effect (See Notes, Line 36); Built-in EMI and RFI protection.		
NOTES				
Function:	31	Sensor shall create electrical resistance proportional to process medium temperature. Transmitter shall condition and convert resistance to provide a DC analog output signal linearly proportional to process medium temperature.		
Installation:	32	Refer to Contract Drawing Installation Details and manufacturer's recommendations for installation.		
Calibration:	33	Provide ISO Factory Calibration Certificate. Unit shall be factory calibrated for operating temperature and field adjustable for span and zero settings.		
Thermowell:	34	Thermowells provide isolation between temperature sensor and environment allowing removal/replacement of temperature sensor without compromising ambient region or process. Thermowell material shall be compatible with the process fluid. Refer to Materials Compatibility Chart.		
Power Supply	35	Transmitter Power Supply Effect: Maximum of ± 0.005% of span per one VDC change in power supply.		
Temperature Effect:	36	Transmitter Ambient Temperature Effect: Not more than ±0.5% span for a 50 deg. C change in ambient temperature within operative limits.		
	37			
MANUFACTURE		Provide products of one of the following, Or Equal:		
Manufacturer:	38	ABB	Rosemount - Division of Emerson	

DATA SHEETS - PRIMARY SENSORS AND FIELD INSTRUMENTS

PRODUCT		Temperature Transmitter - RTD Type		SHEET 2 OF 2	
PROJECT		GAC TREATMENT SYSTEM AT WASHINGTON LAKE FILTRATION PLANT		SPEC. NO. 40 60 05 - 3.5.C.80	ADDENDUM/C.O.
TAG NO.		**TIT - 056**	**TIT - 057**		
Ref. Dwg. No.:	1	I-02	I-02		
PROCESS					
Location:	2	GAC Building	GAC Building		
Service:	3	GAC Building Ambient Temperature	Electrical Room Ambient Temperature		
Vessel / Line No.:	4	-	-		
Pressure Min/Max:	5	0 - 50 PSI	0 - 50 PSI		
Temp. Min/Max:	6	10-120 F	10-120 F		
PERFORMANCE					
Range:	7	0-130 F	0-130 F		
Sensor Accuracy:	8	+/- 0.3 percent of Full Scale	+/- 0.3 percent of Full Scale		
Trans. Accuracy:	9	+/- 0.1 percent of Full Scale	+/- 0.1 percent of Full Scale		
Output Temperature Range:	10	User selectable between -30 to 250 degrees F with a minimum span of 40 degrees F	User selectable between -30 to 250 degrees F with a minimum span of 40 degrees F		
Response time:	11	250 ms	250 ms		
SENSOR					
Type:	12	RTD Type	RTD Type		
Element:	13	Platinum (Pt1000)	Platinum (Pt1000)		
Sheath:	14	Not Applicable	Not Applicable		
Thermowell:	15	Not Applicable	Not Applicable		
Enclosure/Housing:	16	Not Applicable	Not Applicable		
Mounting:	17	Integral Mount to the Transmitter	Integral Mount to the Transmitter		
Commun. Cable:	18	Not Applicable	Not Applicable		
Probe Length:	19	2" to 18", as required	2" to 18", as required		
TRANSMITTER					
Type:	20	Solid-State Electronic Transmitter.	Solid-State Electronic Transmitter.		
Input:	21	-	-		
Output:	22	4-20mA (2-wire loop powered)	4-20mA (2-wire loop powered)		
Power Supply:	23	24 VDC	24 VDC		
Relays:	24	As Required.	As Required.		
Indication / Display:	25	LCD visible; Engineering Units.	LCD visible; Engineering Units.		
Enclosure/Housing:	26	Weatherproof and Explosion-proof for Class I, Groups B, C, D; Class II, Groups E, F, G; Class III	Weatherproof and Explosion-proof for Class I, Groups B, C, D; Class II, Groups E, F, G; Class III		
Mounting:	27	Type 316 SS Bracket	Type 316 SS Bracket		
Conduit Connections:	28	1/2" female NPT	1/2" female NPT		
Area Classification:	29	Not Applicable	Not Applicable		
Additional Features:	30	Temperature Effect (See Notes, Line 36); Built-in EMI and RFI protection.	Temperature Effect (See Notes, Line 36); Built-in EMI and RFI protection.		
NOTES					
Function:	31	Sensor shall create electrical resistance proportional to process medium temperature. Transmitter shall condition and convert resistance to provide a DC analog output signal linearly proportional to process medium temperature.			
Installation:	32	Refer to Contract Drawing Installation Details and manufacturer's recommendations for installation.			
Calibration:	33	Provide ISO Factory Calibration Certificate. Unit shall be factory calibrated for operating temperature and field adjustable for span and zero settings.			
Thermowell:	34	Not Applicable			
Power Supply	35	Transmitter Power Supply Effect: Maximum of ± 0.005% of span per one VDC change in power supply.			
Temperature Effect:	36	Transmitter Ambient Temperature Effect: Not more than ±0.5% span for a 50 deg. C change in ambient temperature within operative limits.			
	37				
MANUFACTURE		Provide products of one of the following, Or Equal:			
Manufacturer:	38	Dwyer	Rosemount - Division of Emerson		

DATA SHEETS - PRIMARY SENSORS AND FIELD INSTRUMENTS

PRODUCT		**Flow Meter - Magnetic Insertion Type**		SHEET 1 OF 1
PROJECT		GAC TREATMENT SYSTEM AT WASHINGTON LAKE FILTRATION PLANT		SPEC. NO. 40 60 05 - 3.5.C.83 / ADDENDUM/C.O.
TAG NO.		**FE / FIT - 054**		
Ref. Dwg. No.:	1	I-03		
PROCESS				
Location:	2	FIT-054 Meter Vault		
Service:	3	Low Pressure Distribution		
Vessel / Line No.:	4	36"		
Fluid:	5	Water		
Temp. Min/Max:	6	33 to 80 F		
Press. Min/Max:	7	0 to 15 PSI		
Flow Min/Max:	8	0 - 8000 GPM		
PERFORMANCE				
Range:	9	0 - 8000 GPM		
Accuracy Velocity:	10	+/- 2% of Rate		
Temperature:	11	0 to 140 degrees F		
Repeatability:	12			
Fluid Conductivity:	13	> 50 µS/cm		
SENSOR				
Electrode:	14	Stainless Steel 316L		
Body:	15	Stainless Steel		
Seals:	16	Suitable for Potable Water (WRAS listed). Refer to Materials Compatibility table		
Flow Sensor Cable Length:	17	As Required		
	18			
	19			
TRANSMITTER				
Power Supply	20	120 V AC		
Output:	21	4 to 20 mA		
Digital Outputs:	22	As Required		
Environmental Protection:	23	IP67 (NEMA 4X)		
Additional Features:	24	Tamper-Proof Security		
Enclosure:	25	Powder-coated Aluminum with glass window		
	26			
NOTES	27			
	28			
	29			
	30			
	31			
	32			
MANUFACTURE		Provide products of one of the following, Or Equal:		
Manufacturer:	33	ABB AquaProbe		

DATA SHEETS - PRIMARY SENSORS AND FIELD INSTRUMENTS

PRODUCT		**Relative Humidty**	SHEET 1 OF 1	
PROJECT		GAC TREATMENT SYSTEM AT WASHINGTON LAKE FILTRATION PLANT	SPEC. NO. 40 60 05 - 3.5.C.84	ADDENDUM/C.O.
TAG NO.		**ME / MIT - 058**		
Ref. Dwg. No.:	1	I-03		
PROCESS				
Location:	2	GAC Building Room		
Service:	3	Ambient Space RH sensing		
Vessel / Line No.:	4	-		
Fluid:	5	Ambient Space		
Temp. Min/Max:	6	-40 to 140 F		
Relative Humidity Min/Max:	7	0 to 100% RH		
Level Min/Max:	8			
Transmitter				
Accuracy:	9	+/- 2% for 10-90% RH		
Repeatability:	10	+/- 0.1%		
Power Requirements:	11	24 VDC		
Output Signal:	12	4 - 20 mA Analog Output		
Response Time:	13	15 seconds		
Conduit Connection:	14	1/2 female NPT		
RH Sensor Type:	15	Capactiance Polymer		
Housing Material:	16	Aluminum		
Local Indication:	17	2 line alphanumeric LCD Display		
Protection Classification:	18	Rated for Explosion - Proof Area		
	19			
	20			
	21			
	22			
	23			
	24			
	25			
	26			
	27			
	28			
NOTES				
Agency Approvals:	29	FM, CE.		
	30			
	31			
	32			
	33			
	34			
MANUFACTURE		Provide products of one of the following, Or Equal:		
Manufacturer:	35	Dwyer		

DATA SHEETS - PRIMARY SENSORS AND FIELD INSTRUMENTS

PRODUCT		**Analyzer - Fluoride**	SHEET 1 OF 1	
PROJECT		GAC TREATMENT SYSTEM AT WASHINGTON LAKE FILTRATION PLANT	SPEC. NO. 40 60 05 - 3.5.C.85	ADDENDUM/C.O.
TAG NO.		**AIT-045**		
Ref. Dwg. No.:	1	I-04		
PROCESS				
Location:	2	GAC Building Mezz. Floor		
Service:	3	Distribution Water Monitoring		
Vessel / Line No.:	4	Chemical Monitoring System		
Fluid:	5	Potable Water		
Temp. Min/Max:	6	33 to 80 F		
Press. Min/Max:	7	0 to 40 psig		
RH Min/Max:	8	0 to 95% non-condensing		
Anlyzer				
Type:	9	Ion Selective Electrode (Formic Acid Reagent)		
Accuracy:	10	+/- 10%		
Range:	11	10 ppb to 200 ppm		
Inlet Pressure	12	8 to 100 psig		
Sample Flow Rate	13	40 mL/minute		
Response Time:	14	95% within 2 minutes of injecting a standard solution		
Enclosure Rating:	15	Waterproof; IP66; NEMA 4X		
Inlet Connection:	16	1/4" NPTF tube fitting		
Output:	17	4 to 20 mA		
Relay Details:	18	3 Relay output each rated at 5A		
Certifications:	19	CE, CSA, UL, FCC Class A limits		
Power Supply:	20	120V AC		
Local Indication:	21	Custom backlit LCD with temperautre, concentration, mV, error codes and menu driven prompts		
Drain Connection:	22	3/4" NPT male		
	23			
	24			
	25			
	26			
	27			
	28			
NOTES				
Consumables:	29	1 year supply of all required reagents for full functionality of the analzyer.		
Additional Features:	30	Unit shall be provided with an integral air pump for sampling.		
	31			
	32			
	33			
	34			
MANUFACTURE		Provide products of one of the following, Or Equal:		
Manufacturer:	35	Thermofisher Scientific		

REFERENCES: Materials Compatibility and Area Classification Charts

MATERIALS COMPATIBILITY CHART

Process Fluid	Diaphragm	O-Ring	Gasket			
Wastewater / Sludge	316 SS	Buna-N	Buna-N			
Potassium	Carpenter 20	Viton	Viton			
Sodium Hypochlorite	Teflon	Teflon	Teflon			
Polymer	316 SS	Buna-N	Buna-N			
Phosphoric Acid	316 SS	Buna-N	Buna-N			
Alum	316 SS	Teflon	Teflon			
Chlorine Gas	Teflon	Teflon	Teflon			
Chlorine Solution	Teflon	Teflon	Teflon			
Sodium Chloride	Teflon	Teflon	Teflon			
Ammonia	316 SS	Teflon	Teflon			
Methanol	316 SS	Teflon	Teflon			
Carbon	316 SS	Buna-N	Buna-N			
Lime	316 SS	Teflon	Teflon			
Ferric Chloride	Teflon	Teflon	Teflon			
Caustic Soda	Teflon	Teflon	Teflon			
Sodium Bisulfite	Teflon	Teflon	Teflon			
Sodium Hydroxide	Teflon	Teflon	Teflon			
Scrubber Solution	Teflon	Teflon	Teflon			
Fluoride	Hastelloy C	Viton	Viton			
Phosphate	316 SS	Teflon	Teflon			
Potable Water	316 SS	Buna-N	Buna-N			

AREA CLASSIFICATION CHART

Location	Description
Class 1	Class I locations are those in which flammable gases or vapors are or may be present in the air in quantities sufficient to produce explosive or ignitable mixtures.
Class 1, Division 1	A location (1) In which ignitable concentrations of flammable gases or vapors can exist under normal operating conditions; or (2) In which ignitable concentrations of such gases or vapors may exist frequently because of repair or maintenance operations or because of leakage; or (3) In which breakdown or faulty operation of equipment or processes might release ignitable concentrations of flammable gases or vapors and might also cause simultaneous failure of electrical equipment in such a way as to directly cause the electrical equipment to become a source of ignition.
Class 1, Division 2	A location (1) In which volatile flammable liquids or flammable gases are handled, processed, or used, but in which the liquids, vapors, or gases will normally be confined within closed containers or closed systems from which they can escape only in case of accidental rupture or breakdown of such containers or systems, or in case of abnormal operation of equipment; or (2) In which ignitable concentrations of gases or vapors are normally prevented by positive mechanical ventilation and might become hazardous through failure or abnormal operation of the ventilating equipment; or (3) That is adjacent to a Class I, Division 1 location, and to which ignitable concentrations of gases or vapors might occasionally be communicated unless such communication is prevented by adequate positive-pressure ventilation from a source of clean air and effective safeguards against ventilation failure are provided.
Class 2	Class II locations are those that are hazardous because of the presence of combustible dust.
Class 2, Division 1	A location (1) In which combustible dust is in the air under normal operating conditions in quantities sufficient to produce explosive or ignitable mixtures; or (2) Where mechanical failure or abnormal operation of machinery or equipment might cause such explosive or ignitable mixtures to be produced, and might also provide a source of ignition through simultaneous failure of electric equipment, through operation of protection devices, or from other causes; or (3) In which Group E combustible dusts may be present in quantities sufficient to be hazardous.
Class 2, Division 2	A location (1) In which combustible dusts due to abnormal operations may be present in the air in quantities sufficient to produce explosive or ignitable mixtures; or (2) Where combustible dust accumulations are present but are normally insufficient to interfere with the normal operation of electrical equipment or other apparatus, but could as a result of infrequent malfunctioning of handling or processing equipment become suspended in the air; or (3) In which combustible dust accumulations on , in, or in the vicinity of the electrical equipment could be sufficient to interfere with the safe dissipation of heat from electrical equipment, or could be ignitable by abnormal operation or failure of electrical equipment.
Class 3	Class III locations are those that are hazardous because of the presence of easily ignitable fibers or filings, but in which such fibers or filings are not likely to be in suspension in the air in quantities sufficient to produce ignitable mixtures.
Class 3, Division 1	A location in which easily ignitable fibers or materials producing filings are handled, manufactured or used.
Class 3, Division 2	A location in which easily ignitable fibers are stored or handled (except in the process of manufacture).

* Source: NEC 2005 Edition - Article 500

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SECTION 40 66 33

FIBER OPTIC CABLING AND APPURTENANCES

PART 1 – GENERAL

1.1 DESCRIPTION

A. CONTRACTOR shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish and install fiber optic cabling, including fiber testing procedures, accessories and splicing requirements.

B. The entire fiber optic system is considered to be one component and provided by a single source, hereafter referred to as the Supplier.

C. Related Sections:
   1. Section 40 60 05, Instrumentation and Control.
   2. Division 16, Electrical.

1.2 REFERENCES

A. Standards referenced in this Section are listed below:
   1. ASTM D 1248, Specification for Polyethylene Plastics Molding and Extrusion Materials.
   2. ASTM D 1603, Test Method for Carbon Black in Olefin Plastics.
   3. ASTM D 1765, Classification System for Carbon Blacks used in Rubber Products.
   4. ASTM D 3349, Test Method for Absorption Coefficient of Ethylene Polymer Material Pigmented with Carbon Black.

1.3 SUBMITTALS

A. Shop Drawings: Submit the following:
   1. Cut sheets and catalog literature for proposed fiber optic cable, and fiber optic cable accessories (terminations).
   2. Manufacturer specifications and data, which clearly and unambiguously shows that the fiber optic cable meets all the requirements specified herein.
   3. Physical dimension drawings of all fiber optic accessories.
   4. Proposed fiber identification sequence and labeling.
   5. Provide a Spare Parts List.

1.4 MAINTENANCE

A. Provide off-line maintenance aids and on-line diagnostics to check the performance of the communication links and interfaces of devices on the data highway.

B. Provide a list and include all special tools for fiber installation, testing and maintenance.

C. One hand-held optical light source with SC-type connectors, as manufactured by Corning or equal.

D. One hand-held optical power meter SC-type connectors, as manufactured by Corning or equal.

E. Provide two spare cables of each different bundle type with differing strand counts. Provide 100-foot reels.

F. Provide two spare Patch Cords in 10 and 20m lengths.

PART 2 – PRODUCTS

2.1 FIBER OPTIC CABLE SUMMARY SPECIFICATIONS

A. The fiber optic cable shall meet the following summary specifications:
   1. Fiber Type: Multimode.
   2. Core Diameter: 62.5 microns.
   3. Cladding Diameter: 125 microns.
   4. Nominal Cable Outside Diameter: 5.30-mm (0.21-in).
   5. Nominal Cable Weight: 29 kg/km (19 lbs/1000 ft).
   6. Maximum Attenuation: 3.5 dB/km at 850 nm, 1.0 dB/km at 1300 nm.
   7. Bandwidth: 200/500 (MHZ X km).
   8. Buffer Type: Tight buffer.
   9. Number of Fibers: 6
   10. Cable Central Strength Member: Dielectric.
   11. Outer Jacket: Flame-Retardant Jacket.
   12. Flame Resistance: NFPA 262
   13. Approval Requirement: NEC Article 770 with OFNP and FT-6 listing
   14. Maximum Pulling Load: 99 lbf (440 N).
   15. Operating Temperature Range: 0°C to +70°C.
   16. Quantity: As shown.
   17. Packaging: Spools/reels, protected from shipment.

B. Fibers within the cable shall be color-coded so that each fiber may be individually identified. The color sequence suggested is as follows: blue, orange, green, brown, slate, white, red, black, yellow and violet. Dashed versions of the same colors may be used to continue the sequence, depending on the cable structure and fiber count.

C. The outer jackets of the cable shall be continuous, free from holes, splits, blisters or inclusions. The same requirement holds for any inner jackets within a given cable structure as well as for fiber coatings.

D. Materials used for fiber optic cable shall present no environmental or toxicological hazards as defined by current industry standards and shall comply with OSHA and EPA standards or applicable federal or state laws or regulations.

E. The color of the polyethylene outer jacket material shall be black in accordance with ASTM D 1248, and contain a suitable antioxidant substance. The carbon black used shall be furnace-type conforming to designation N 110 in accordance with the requirements of ASTM D 1765. The carbon black content in the jacket material when measured in accordance with the requirements of ASTM D 1603 shall be 2.6 percent ±0.25 percent by weight. The light absorption coefficient of the jacket material shall be at least 400 when measured at a wavelength of 375 nm in accordance with the requirements of ASTM D 3349.
   1. Outer polyethylene jacket materials shall meet tensile strength and elongation minimum requirements for unaged and aged samples as follows:
      a. Tensile Strength at Break: 2800 psi (Unaged), 2100 psi (Aged).
      b. Elongation at Rupture: 400 percent (Unaged), 375 percent (Aged).

F. The cable jacket shrinkage test measures the shrinkage or expansion of a cable jacket exposed to temperature aging for a specified period of time. Maximum shrinkage shall be less than five percent for each specimen tested. The test procedure is described in EIA-RS-455, FOTP-86.

2.2 CABLE PACKAGING

A. The cable shall be permanently marked to identify the manufacturer, date of manufacture, length markings, a product identification code, and UL messages, where appropriate. The markings shall be printed at regular intervals of not more than two feet apart.

B. The cable shall be packaged on a reel with inner hub diameter greater than the recommended minimum bending diameter of the cable. The anchor holes on the reels shall admit a 2-1/2-inch diameter spindle without binding. The package shall be sturdy enough to endure reasonable handling in the process of shipping and storage. The package shall bear the name of the manufacturer, the product identification code and the total amount of product on the reel.

C. The following information shall be securely attached to the reel as a tag or clearly and permanently stenciled or labeled on each reel:
   1. Customer Order Number.
   2. Customer Job Number.
   3. Customer Reel Number.
   4. Termination.
   5. Ship Date.
   6. Manufacturer's Name.
   7. Factory Reel Number.
   8. Manufacturer's Cable Code (Type and Fiber count).
   9. Length of Cable.
   10. Weight of Cable and Reel.

11. Defect Tag.

D. The ends of all cable shall be sealed to prevent the escape of filling compound and to prevent the entry of moisture during shipping, handling, storage and installation.

2.3 FIBER OPTIC CABLE MANUFACTURER

A. Manufacturers: Provide products of one of the following:
   1. Corning Cable Systems.
   2. Or equal.

2.4 MANUFACTURER TEST DOCUMENTATION

A. Test documentation from the fiber optic cable manufacturer shall be delivered to ENGINEER upon delivery of the cable to the Site, as a prerequisite for cable installation.

B. The documentation shall include Optical Time Domain Reflectometer (OTDR) traces for each fiber of each reel at 850 nm and 1300 nm. Optical attenuation test data shall be furnished for each fiber of each reel, as measured at 850 nm and 1300 nm.

2.5 PRE-INSTALLATION TESTING

A. CONTRACTOR shall test the fiber optic cable prior to its installation. This testing shall be witnessed by ENGINEER. Expenses for meals, lodging, transportation and incidentals shall be included for up to two people witnessing the shop test for one day testing period.

B. Testing shall consist of making an OTDR trace of each fiber of each reel, at both 850 nm and 1300 nm. The test shall incorporate a one km long backscatter suppression cable inserted between the OTDR and the fiber end. Each trace shall include the optical length and average attenuation.

C. The results of the testing shall be submitted to ENGINEER prior to installation. Any cable that shows “out-of-spec” performance shall be replaced, at no additional cost to the DEPARTMENT or delay to the Project Schedule.

2.6 FIBER PATCH PANELS

A. General:
   1. All Fiber Optic Patch Panels shall be self-contained units.
   2. Two wall mounted fiber patch panel each shall be provided in the GAC building and the Head House, with designation FPP-1 & FPP-2 and FPP-3 & FPP-4 respectively. One wall mounted fiber patch panel shall be provided in the Chemical building, with designation FPP-5.
   3. Provide all necessary items for installation, including enclosure, mounting brackets, interconnecting cables, hardware and appurtenances.

B. Features:
   1. The fiber patch panel shall have provisions for terminating multiple fiber optic trunk and fiber patch cables. Actual quantity of cables shall be as shown and specified (see I-06 and Electrical Drawings). All fibers in each fiber optic trunk cable shall be terminated at the panel and connected to the fiber patch panel terminals. Panel size shall be suited to the number of fiber termination points required for both directions. Install dust caps on any fiber optic connector that is not actively in use.
   2. Patch panels shall accept fiber cable with SC connectors.
   3. The fiber patch panels shall be installed in enclosures and shall swing out for ease of use. Enclosures shall meet the following NEMA ratings:

Tag Name	Location	NEMA Rating
FPP-1	GAC Building Service Entrance	NEMA 4X
FPP-2	GAC Building Electrical Room	NEMA 4X
FPP-3	Head House Service Entrance	NEMA 4X
FPP-4	Head House Existing Control Room	NEMA 4X
FPP-5	Chemical Building Service Entrane	NEMA 4X

   4. Enclosures shall comply with Section 40 60 05, Panels construction section.
   5. Splice trays, strain relief cable attachment points, fiber organizers, and bend radius hardware shall be furnished within the enclosure.
   6. Enclosure shall be provided with a lock to prevent unauthorized entry. Provide two keys.
   7. The enclosure shall have a hinged front door that provides access to all splice trays and patch panels. The enclosure shall be sized to accept all required fiber cables and provide space for unstripped, coiled cable, each being up to 25 feet long.

C. Manufacturers: Provide products of one of the following:
   1. Corning Cable Systems.
   2. Or equal.

2.7 FIBER OPTIC JUMPER CABLE AND CONNECTORS

A. The fiber patch cable shall meet the following requirements:
   1. Type: Multimode, simplex fiber patch cable.
   2. Core Diameter: 62.5 microns.
   3. Maximum Tensile Load: 100 N/cm.
   4. Loaded Minimum Bend Radius: 5cm.
   5. Crush Resistance: 750 N/cm.
   6. Flex Resistance: 7500 cycles.
   7. Insertion Loss: 0.3 dB at 850nm typical; 0.5 at 850nm maximum.
   8. Quantity: As shown and specified.
   9. Length as required to accomplish terminations as indicated on Contract Drawings.

10. The outer jacket of the cable shall be continuous, free from holes, splits, blisters or inclusions. The same requirement holds for any inner jackets within a given cable structure as well as for fiber coatings.
11. Materials used for fiber optic cable shall present no environmental or toxicological hazards as defined by current industry standards and shall comply with OSHA and EPA standards or applicable federal or state laws or regulations.

B. Jumpers with SC connectors on both ends shall be furnished between FPP-001 and FPP-002. Jumpers with SC connectors on both ends shall be furnished between FPP-003 and FPP-004.

C. Jumpers with SC Connectors on opposite ends shall be furnished for connection from Patch Panels to Local Control Panel mounted Ethernet switches.

D. Fiber Patch Panels and their respective Control Panels shall be terminated with the SC end of the jumper at the panel mounted Ethernet Switch, with the SC connector at the Patch Panel.

E. All connectors shall be identical and shall be SC-type as specified.

F. Manufacturers: Provide products of one of the following:
1. Corning Cable Systems.
2. Belkin International, Inc.
3. Or equal.

2.8 PULLING GRIP

A. Provide a pulling grip to be used for installation of pre-terminated fiber cables. Pulling grip shall be sized to accommodate up to 24 strand fiber cables.

PART 3 – EXECUTION

3.1 CABLE INSTALLATION

A. All fiber optic cable shall be installed, terminated, and tested by the fiber subcontractor specified above.

B. In pulling the cable, strain-release, or other tension limiting devices shall be used to limit the pull tension to less than 600 pounds. ENGINEER shall witness the cable being pulled.

C. Minimum bend radius restrictions shall be satisfied both during and after cable installation.

D. All conduit and cabinet entrances shall be sealed with RTV or other re-enterable sealant material to prevent ingress of water, dust or other foreign materials.

E. Splices in the fiber optic cable shall only be made at termination points where connectorized pigtails are applied. Non-terminating field splices shall not be made, unless authorized by ENGINEER, in writing. If a field splice is required, it shall be fusion spliced and placed in a buried pull box. Closures shall be AT&T UCB1 with Type 2000 outer case, SIECOR SC5, or equal. Encapsulant shall be placed between inner and outer closures. Such splices shall meet the loss parameters/testing requirements specified elsewhere.

F. Fiber optic trunk cables, installed between the fiber patch panels, shall not have cable to cable splices except for pigtail splicing at the end of the cable for termination in the fiber patch panels.

G. Fiber optic branch cables shall not have cable to cable splices except for pigtail splicing at the end of the cable for termination in the fiber patch panels, Process Monitoring and Control System control panels, or security interface panels.

3.2 CABLE DAMAGE DURING INSTALLATION

A. If the cable becomes damaged during installation, CONTRACTOR shall stop their operations and notify ENGINEER, in writing, immediately. The DEPARTMENT and ENGINEER will decide whether to replace the entire reel of cable or to install a splice at the damaged section.

B. If the DEPARTMENT decides to replace the entire reel of cable, CONTRACTOR shall begin the installation at the last designated splice point. The damaged cable between these points shall be removed, coiled, tagged, and given to the CITY. Installation of new cable to replace damaged cable shall not be a basis of extra payment or Contract completion time. In addition to installation of the new cable, CONTRACTOR shall reimburse the DEPARTMENT and entire cost of the replacement reel of cable. This cost will be withheld from the Contract price.

C. If the DEPARTMENT decides to install a splice at the damaged point, and the cable is damaged a second time, the entire reel of damaged cable (and all subsequent damaged reels) shall be replaced with new reels at CONTRACTOR's expense.

3.3 CABLE ACCEPTANCE TESTING

A. Acceptance testing of the data highway (fiber and electronic equipment) shall be conducted as a part of integrated system field-testing, as specified elsewhere. Prior to such tests, however, the fiber optic cable shall be tested as specified herein.

B. The fiber optic subcontractor shall conduct fiber optic cable testing as specified below. All testing shall be witnessed by ENGINEER. A test plan shall be submitted at least one week prior to the proposed test date(s). The test plan and procedures shall be mutually agreed upon prior to conducting the tests.

C. Each optical fiber in every span shall be tested after installation and termination. For each fiber, an OTDR trace hardcopy is required. This end-to-end trace shall be

performed from BOTH ends of the fiber. The traces shall be made at 850 nm and 1300 nm. Also for each fiber, and end-to-end power attenuation (insertion loss) test shall be performed from BOTH ends of the fiber. The attenuation test shall use a stabilized optical source and an optical power meter calibrated to the appropriate operating wavelength (850 nm and 1300 nm).

D. For each installed fiber, the power attenuation shall not exceed the following, tested from connector to connector at the respective patch panels, at 850 nm and 1300 nm. For the 1300 nm test, substitute 0.0020 for 0.0035 in the first term of the equation.

$$(0.0035)L + (0.35)N + 3.0 \text{ dB}$$

where L = the length of the fiber in meters, and
N = the number of fusion splices in the fiber.

E. Any fiber optic cables containing one or more fibers not meeting this performance will not be accepted by the DEPARTMENT, and shall be repaired or replaced at no additional cost to the DEPARTMENT.

F. All fiber optic testing shall be documented on pre-approved test forms. Three copies of all documents (including OTDR traces) shall be submitted to ENGINEER upon successful completion of the testing.

G. Work at the termination cabinets shall be performed such that the fiber optic cables, and the fibers, are not subjected to undesirable bending both during the Work and when permanently fixed in place. The cables, fibers, pigtails, etc. shall be organized in a neat and orderly fashion within the enclosure. Inspection of the Work shall be performed by ENGINEER. Unsatisfactory Work shall be reworked by the CONTRACTOR.

+ + END OF SECTION + +

SECTION 41 22 23

HOISTS

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all professional services, labor, materials, tools, equipment, and incidentals as shown, specified, and required to furnish and install hoist systems complete and operational.

B. Coordination:
   1. Review installation procedures under this and other Sections and coordinate installation of items that must be installed with or before hoist systems Work.
   2. Notify other contractors in advance of the installation of hoisting equipment to provide them with sufficient time for installing items included in their contracts that must be installed with or before hoist systems Work.

C. Related Sections:
   1. Section 05 12 00, Structural Steel Framing.
   2. Section 09 91 00, Painting.

1.2 REFERENCES

A. Standards referenced in this Section are:
   1. ANSI/AGMA 6013-A, Standard for Industrial Enclosed Gear Drives.
   2. ANSI MH 27.1, Specifications for Underhung Cranes and Monorail Systems.
   3. AISC Specification for Structural Steel Buildings.
   4. AISC Code of Standard Practice for Steel Buildings and Bridges.
   5. ASME B30.11, Monorails and Underhung Cranes.
   6. ASME B30.16, Overhead Hoists (Underhung).
   7. ASME HST-1, Performance Standard for Electric Chain Hoists.
   8. ASME HST-2, Performance Standard For Hand Chain Manually Operated Chain Hoists.
   9. ASME HST-4, Performance Standard for Overhead Electric Wire Rope Hoists.
   10. ASTM A36/A36M, Specification for Carbon Structural Steel.
   11. ASTM A325, Specification for Structural Bolts, Steel, Heat-Treated, 120/105 KSI Minimum Tensile Strength.
   12. ASTM A563, Specification for Carbon and Alloy Steel Nuts.
   13. ASTM A572/A572M, Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel.
   14. ASTM F436, Specification for Hardened Steel Washers.
   15. AWS D1.1, Structural Welding Code – Steel.

16. AWS D14.1, Specification for Welding of Industrial and Mill Cranes and other Material Handling Equipment.
17. NFPA 820, Standard for Fire Protection in Wastewater Treatment and Collection Facilities.
18. Research Council on Structural Connections (RCSC), Specification for Structural Joints Using ASTM A325 or A490 Bolts.

1.3 QUALITY ASSURANCE

A. Qualifications:
   1. Manufacturer:
      a. Minimum of five years of experience producing substantially similar equipment and able to provide documentation of at least five installations in satisfactory operation for at least five years in the United States.
      b. Equipment shall be manufactured in the United States.
   2. Professional Engineer:
      a. Engage registered professional engineer legally qualified to practice in the same state as the Site and experienced in providing engineering services of the kind indicated.
      b. Submit qualifications data.
      c. Responsibilities include:
         1) Carefully reviewing monorail system performance and design criteria stated in the Contract Documents.
         2) Preparing written requests for clarifications or interpretations of performance or design criteria for submittal to ENGINEER by CONTRACTOR.
         3) Preparing or supervising preparation of design calculations and related drawings, Shop Drawings, and a comprehensive engineering analysis verifying compliance of monorail system with requirements of the Contract Documents.
         4) Signing and sealing all calculations and design drawings, and Shop Drawings.
         5) Certifying that:
            a) it has performed the design of the monorail system in accordance with performance and design criteria stated in the Contract Documents, and
            b) the said design conforms to all local, state and federal Laws and Regulations and to prevailing standards of practice.
   3. Installer Qualifications:
      a. Engage an experienced installer to perform the Work under this Section, who is experienced in installing hoisting equipment similar to that required for the Project, and is acceptable to hoisting equipment manufacturer.
      b. Submit name and qualifications, and the following information for at least three successful, completed projects:
         1) Names and telephone numbers of each owner and architect or engineer

responsible for project.
2) Approximate contract cost of hoisting equipment.
3) Number of installations.

B. Component Supply and Compatibility:
1. Obtain all equipment included in this Section regardless of component manufacturer, from single hoisting equipment manufacturer.
2. Hoisting equipment manufacturer shall review and approve or prepare all submittals for components furnished under this Section.
3. Components shall be specifically constructed for specified service conditions and shall be integrated into overall equipment assembly by hoisting equipment manufacturer.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:
1. Shop Drawings:
a. Complete description of materials and equipment in sufficient detail to allow comparison with requirements of this Section.
b. Drawing showing arrangement of system and clearances, including plan and sections.
c. Specialized wiring diagrams, if applicable.
2. Product Data:
a. Manufacturer's literature, illustrations, specifications identification of materials of construction, rated capacities, dimensions of individual components, and finishes.
b. Make, model, weight and horsepower of each component.
c. External power requirements for each component.
3. Testing Plans: Plan for load testing at the Site.

B. Delegated Design Submittals: Submit the following:
1. Detailed structural design drawings showing details of monorail and support systems, including:
a. Bracing details.
b. Member loads and design stresses.
c. Calculations used for determining member stresses.
d. Connection details.
e. Maximum allowable and calculated deflections.
2. Clearly show dimensions and assumptions on which design is based. Indicate referenced standards and codes. Information shall be project-specific.

C. Informational Submittals: Submit the following:
1. Certificates:
a. Manufacturer's installation certification.
b. Professional engineer's certification.
2. Manufacturer's Instructions:

a. Special shipping, storage and protection, and handling instructions.
b. Routine maintenance requirements prior to start-up.

3. Field Quality Control Submittals:
   a. Load test report, including copy of certifications of test weights.
4. Manufacturer's Reports: Submit written report of results of each visit to Site by Supplier's service technician, including purpose and time of visit, tasks performed, and results obtained.
5. Qualifications Statements:
   a. Manufacturer, when qualifications are requested by ENGINEER.
   b. Professional engineer.
   c. Installer, when qualifications are requested by ENGINEER.

D. Closeout Submittals: Submit the following:
1. Operation and Maintenance Data:
   a. Furnish operation and maintenance manuals in accordance with Section 01 78 23, Operations and Maintenance Data.
   b. Include acceptable test reports, maintenance data and schedules, description of operation, wiring diagrams, and list of spare parts recommended for one year of operation with current price list.

1.5 DELIVERY, STORAGE AND HANDLING

A. Packing, Shipping, Handling, and Unloading:
1. Deliver materials and equipment to Site to ensure uninterrupted progress of the Work. Deliver anchorage materials to be embedded in concrete in ample time to prevent delaying the Work.
2. Inspect all boxes, crates, and packages upon delivery to Site and notify ENGINEER in writing of loss or damage to materials or equipment. Promptly remedy loss and damage to new condition in accordance with manufacturer's instructions.
3. Conform to Section 01 65 00, Product Delivery Requirements.

B. Storage and Protection:
1. Keep materials and equipment off ground using pallets, platforms, or other supports. Protect steel, packaged materials, motors, and electronics from corrosion and deterioration.
2. Conform to Section 01 66 00, Product Storage and Handling Requirements.

1.6 WARRANTY

A. General Warranty: Special warranty specified in this Article shall not deprive DEPARTMENT of other rights or remedies DEPARTMENT may otherwise have under the Contract Documents and shall be in addition to and run concurrent with other warranties made by CONTRACTOR under the Contract Documents. Obligations of CONTRACTOR under the Contract Documents shall not be limited in any way by provisions of specified special warranty

PART 2 – PRODUCTS

2.1 SYSTEM PERFORMANCE

A. System Description:
   1. Hoists shall conform to headroom, hook elevation, and side clearance requirements shown and indicated in the Contract Documents, and shall provide required available lift height and capacity.

B. Design Criteria:
   1. Patented Track Monorail Systems:
      a. Patented track monorail systems, including bracing and attachment to supporting structure, shall conform to ANSI MH 27.1, AISC Specification for Structural Steel Buildings, and AISC Code of Standard Practice for Steel Buildings and Bridges, and shall conform to Specifications in Division 5, Metals.
      b. Monorail track, hangers, supports, plates and connection elements shall conform to ASTM A36 or A572 Grade 50 steel.
      c. Welding shall conform to AWS D1.1.
      d. Bolts shall conform to ASTM A325, with ASTM A563 nuts and ASTM F436 hardened washers. Connections shall conform to the RCSC Specification for Structural Joints Using ASTM A325 or A490 Bolts.
      e. Deflection of monorail track under rated load (not including impact) shall not exceed 1/450 of span.

C. Performance Criteria:
   1. Manually Operated Chain Hoists:

Designation:	**Monorail 1**
General Location:	GAC Treatment Building
Hoist Type:	Chain
Ambient Conditions (deg. F, Indoor/Outdoor):	Indoor, 50-80 deg. F
Number Required:	1
Capacity (tons):	2
Required Lift (feet):	12
Max Required Hook Elevation (feet):	18
Trolley Type:	Manual Geared

2.2 MANUFACTURERS

A. Manufacturers: Provide equipment of one of the following:
   1. Columbus McKinnon.
   2. Reliable, by Stanspec, a division of American Crane & Hoist Corp.
   3. Or equal.

2.3 DETAILS OF CONSTRUCTION

A. Manual Chain Hoists:
   1. Comply with ASME B30.16 and ASME HST-2. Welding shall comply with AWS D14.1.
   2. Design Stresses: Provide load bearing components so that stresses at rated load shall not exceed 20 percent of average ultimate strength of material.
   3. Hooks: Provide latch-type hooks, free to rotate through 360 degrees under all loading conditions. Hooks shall be heat-treated drop forged steel.
   4. Hoisting Chain: Hardened alloy steel.
   5. Lift Wheel: Machined and heat treated alloy steel with hardened steel chain guides.
   6. Gearing: Machined and heat treated spur gear system. Provide means for adequate lubrication of gearing.
   7. Bearings: Bearings shall be permanently lubricated type.
   8. Load Brake: Hoist shall include Weston-type load brake, providing instant brake and release action for positive control of load.
   9. Provide overload protection device that prevents lifting of loads beyond rated capacity.
   10. Housing and Covers: Cast aluminum.
   11. Provide supports, fasteners, brackets and all accessories required.

B. Manual Geared Trolleys:
   1. Trolley shall be constructed to accept specified hoist using lug-mounted suspension, and shall be of sufficient size and strength to transport rated load of associated hoist.
   2. Trolley frame shall have steel side plates that wrap around trolley to provide protective lug to prevent trolley from falling off monorail in event of wheel axle failure.
   3. Wheels: Wheels shall be fabricated of hardened steel or cast iron and shall be constructed to run on specified beam. Wheels shall have uniform surface hardness and be capable of carrying maximum applied load.
   4. Trolley shall be geared to provide hand chain driven locomotion.
   5. Gearing: Machined and heat-treated spur gear system. Provide means of adequate lubrication of gearing.
   6. Bearings: Bearings shall be ball or roller type, permanently lubricated.

2.4 FINISHING

A. Surface Preparation and Painting:
   1. Surface preparation and shop painting is required for ferrous metals, equipment, and accessories. Do not paint stainless steel and machined surfaces.
   2. Clean and apply in the shop prime coat in accordance with Section 09 91 00, Painting.
   3. Apply manufacturer's standard factory finish.

B. Gears, bearing surfaces, and other machined surfaces shall receive a heavy application of rust-inhibiting coating that shall be maintained during storage and until equipment is placed into operation.

2.5 IDENTIFICATION

A. Identify component subassemblies with stainless steel nameplates and each labeled with the following:
   1. Manufacturer and model number.
   2. Date of manufacture with pertinent ratings, operation, and maintenance information.
   3. Certification, stamp, or approval to applicable Laws and Regulations.

PART 3 – EXECUTION

3.1 INSPECTION

A. Examine conditions under which materials and equipment are to be installed and notify ENGINEER in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions have been corrected.

B. Inspect and verify that no part of the building, structure, piping, mechanical systems including ductwork, electrical systems including lighting and conduit, or other elements that will interfere with proper operation of hoist along the entire length of monorail track.

3.2 INSTALLATION

A. Install materials and equipment in conformance with Laws and Regulations, applicable standards, manufacturer's instructions and recommendations, and the Contract Documents.

B. Refer to Section 05 12 00, Structural Steel Framing, for requirements for hoisting system's supporting steel.

3.3 FIELD QUALITY CONTROL

A. Site Tests:
   1. After installing equipment and associated controls, perform at the Site running tests for hoisting equipment and appurtenances. Should testing indicate malfunction, make repairs and adjustments as required. Repeat testing and adjusting until, in ENGINEER's opinion, installation is complete and equipment is functioning properly and accurately, and is Substantially Complete.

2. Load Test:
   a. Perform load tests under supervision of manufacturer's factory-trained service technician, in presence of ENGINEER.
   b. Weights used in load testing shall be certified by a state or local bureau of weights and measures. Submit weight certification as part of the load test report.
   c. Load testing shall conform to ASME B30.11, ASME B30.16, and the following:
      1) Trolley travel full length of monorail with rated load, while verifying that all functions operate properly.
      2) Hoist brake drift test with rated load: Lift weight, measure distance to floor, allow five minutes to elapse, and re-measure. Record the results measured. Criteria for Acceptance: No difference in measurements.
      3) Upper/lower limit switch test with no load.
      4) Deflection Test: With hoist positioned at center of longest monorail span, and at tip of longest cantilever (if any), while hoisting rated load, measure distance from hook to floor. Remove load and measure distance from hook to floor. Criteria for Acceptance: Difference in measurements shall conform to manufacturer's specifications and Paragraph 2.1.B.1.d of this Section.
   d. Load Test Report: Submit results of load testing as report that lists tests performed, data collected, results of each test, and corrective actions taken (if any). Test report shall be signed by manufacturer's service technician present during testing.

B. Manufacturer's Services: Provide a qualified, factory-trained service technician to perform the following:
   1. Instruct CONTRACTOR in installing equipment and assist in the installation of equipment.
   2. Inspect and adjust equipment after installation and ensure proper operation, and supervise initial operations and load tests.
   3. Instruct CITY's personnel in operating and maintaining the equipment.
   4. Manufacturer's technician shall make a minimum of 3 visits, with minimum number of hours on-Site for each visit as specified.
      a. First visit shall be for instructing CONTRACTOR in proper equipment installation, and assisting in installing equipment. Minimum number of hours on-Site: 2 hours.
      b. Second visit shall be for checking completed installation, start-up of system; and performing field quality control testing. Minimum number of hours on-Site: 4 hours.
      c. Third visit shall be to instruct operations and maintenance personnel. Number of hours on-Site shall be in accordance with Section 01 79 23, Instruction of Operations and Maintenance Personnel.
      d. Technician shall revisit the Site as often as necessary until installation is acceptable.
   5. Manufacturer's Installation Certification: Submit certification that

manufacturer's technician has checked completed installation and equipment, as specified in the Contract Documents, has been provided in accordance with manufacturer's recommendations, and that operation of equipment is satisfactory. Certification shall be signed by manufacturer's technician present at the Site and CONTRACTOR.

6. Training: Furnish services of Supplier's qualified factory trained specialists to instruct CITY's operations and maintenance personnel in recommended operation and maintenance of equipment. Training requirements, duration of instruction, and qualifications shall be in accordance with Section 01 79 23, Instruction of Operations and Maintenance Personnel.
7. All costs, including expenses for travel, lodging, meals and incidentals, and cost of travel time, for visits to the Site shall be included in the Contract Price.

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SECTION 43 21 13.12

CENTRIFUGAL END SUCTION PUMPS DRY PIT

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish and install end suction dry pit centrifugal pumps complete and operational with motors, control equipment and accessories as shown and specified. Anchor bolts are included in this Section.

B. Coordination:
   1. Review installation procedures under this and other Sections and coordinate the installation of items that must be installed with, or before the centrifugal end suction pumps-dry pit Work.
   2. Notify other contractors in advance of the installation of the centrifugal end suction pumps-dry pit to provide them with sufficient time for the installation of items included in their contracts that must be installed with, or before, the centrifugal end suction pumps-dry pit Work.

C. Related Sections:
   1. Section 03 60 00, Grouting.
   2. Section 05 05 33, Anchor Systems.
   3. Section 26 29 23, Low-voltage Variable Frequency Drives.
   4. Section 40 05 93, Common Motor Requirements for Process Equipment.

1.2 REFERENCES

A. Standards referenced in this Section are listed below:
   1. American Gear Manufacturers' Association, (AGMA).
   2. American National Standards Institute, (ANSI).
   3. American Society for Testing Materials, (ASTM).
   4. Standards of American Water Works Association, (AWWA).
   5. Institute of Electrical and Electronic Engineers, (IEEE).
   6. Standards of the Hydraulic Institute, (HI).
   7. National Electrical Code, (NEC).
   8. Standards of the National Electrical Manufacturers Association, (NEMA).
   9. NSF International.

1.3 QUALITY ASSURANCE

A. Manufacturer's Qualifications:
   1. Manufacturer shall have a minimum of five years experience producing substantially similar equipment, and shall be able to show evidence of at least five installations in satisfactory operation for at least five years.

B. Component Supply and Compatibility:
   1. Obtain all equipment included in this Section regardless of the component manufacturer from a single centrifugal end suction pumps-dry pit manufacturer.
   2. The centrifugal end suction pumps-dry pit equipment manufacturer to review and approve or to prepare all Shop Drawings and other submittals for all components furnished under this Section.
   3. All components shall be specifically constructed for the specified service conditions and shall be integrated into the overall assembly by the centrifugal end suction pumps-dry pit equipment manufacturer.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Product Data:
      a. Manufacturer's literature, illustrations, specifications and engineering data including: dimensions, materials, size, weight, performance data and curves showing overall pump efficiencies, required net positive suction head, allowable suction lift, flow rate, head, brake horsepower, motor horsepower, speed, and shut-off head. Where variable speed units are specified, curves shall have at least five speeds plotted between maximum and minimum rpm.
      b. Motor tests and data as described in Part 2.
   2. Shop Drawings:
      a. Fabrication, assembly, installation and wiring diagrams.

B. Informational Submittals: Submit the following:
   1. Source Quality Control:
      a. Guarantee with proof of ability to maintain efficiency.
      b. Certified pump tests.

C. Closeout Submittals: Submit the following:
   1. Operation and Maintenance Data:
      a. Submit complete installation, operation and maintenance manuals including test reports, maintenance data and schedules, description of operation and spare parts information.
      b. Furnish Operation and Maintenance Manuals in conformance with the requirements of Section 01 78 23, Operations and Maintenance Data.

1.5 DELIVERY, STORAGE AND HANDLING

A. Packing, Shipping, Handling and Unloading:
   1. Deliver materials to the Site to ensure uninterrupted progress of the Work. Deliver anchor bolts and anchorage devices, which are to be embedded in cast-in-place concrete, in ample time to prevent delay of the Work.

B. Storage and Protection:
   1. Store materials to permit easy access for inspection and identification. Keep all material off the ground, using pallets, platforms, or other supports. Protect steel members and packaged materials from corrosion and deterioration.

C. Acceptance at Site:
   1. All boxes, crates and packages shall be inspected by CONTRACTOR upon delivery to the Site. CONTRACTOR shall notify ENGINEER, in writing, if any loss or damage exists to equipment or components. Replace loss and repair damage to new condition in accordance with manufacturer's instructions.

1.6 GUARANTEE

A. In addition to the manufacturer's standard guarantee, CONTRACTOR shall include the services of a factory-trained serviceman to provide repair service for the equipment for the period of one year commencing with the time the equipment is placed in continuous permanent operation. This service shall include the cost of all replacement parts required during the interval.

PART 2 - PRODUCTS

2.1 EQUIPMENT PERFORMANCE

A. Description:
   1. Pumps shall be end suction dry pit centrifugal type.

B. Performance Criteria:
   1. Pumps shall comply with the minimum design conditions specified below and shall be specially designed, constructed, and installed for the service intended:

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Design Conditions	Pump No. 1
Location:	GAC Treatment Building
Use:	High Lift Pumps 1, 2, 3
Number required:	3
Design Flow, (gpm):	2,000
Design TH, (ft.):	190
Maximum Hp at Shut-Off:	137
Efficiency at Design, (percent):	79
Motor, (Hp):	150
Maximum Speed, (rpm):	1,800
Suction Size, (in.):	8
Suction Lift, (ft.):	0
Available NPSH at Design, (ft.):	22
Flow at 2nd Design Point, (gpm):	2,300
TH at 2nd Design Point, (ft.):	170
Liquid Pumped:	Water
Temperature, (ºF):	33-70
Drive Type:	VFD

2.2 MANUFACTURERS

A. Products and Manufacturers:
   1. ITT Industries Inc., Goulds Model 3196 XLTi.
   2. Or equal.

2.3 DETAILS OF CONSTRUCTION

A. Pump Materials and Construction:
   1. Casing: Ductile-iron
   2. Impeller Type: Open, two port, non-clog, dynamically balanced
   3. Impeller Material: Type 316 stainless steel
   4. Impeller Wear Ring: Chrome steel, hardened.
   5. Suction Head Wear Ring: Chrome steel, hardened.
   6. Shaft Sleeve: Chrome steel, hardened.
   7. Shaft: Carbon steel.
   8. Seals: Mechanical.
   9. Bearings: Anti-friction, grease or oil lubricated with a minimum B-10 life of 100,000 hours.
   10. Baseplate: Structural steel or cast-iron provided with means for collecting and draining oil and water.
   11. Furnish with 125 pound ANSI connection flanges and handhole.
   12. Coupling: Shall have a minimum 1.5 service factor based on the drive rated horsepower and protected with an OSHA approved guard.
   13. Anchor bolts and inserts shall be furnished under this Section and shall be sized and installed in accordance with the manufacturer's recommendations.

14. All bolts, nuts and cap screws shall have hexagon heads.
15. Brass or stainless steel nameplates giving the manufacturer's model and serial number, rated capacity, head, speed and all other pertinent data shall be attached to the pump.

B. Motors:
1. Motors shall conform to the requirements of Section 40 05 93, Common Motor Requirements for Process Equipment.
2. Drip-proof, 3 phase, 60 Hz, 460 VAC, solid shaft, ball bearing type.
3. Motors shall be in accordance with all current applicable standards of NEMA, IEEE, AFBMA, NEC, and ANSI.
4. Motors shall be normal starting torque, normal slip, squirrel cage induction type.
5. Motors shall be capable of carrying full load current continuously without injurious temperature rise in an ambient temperature of 40°C.
6. Motors shall be provided with a service factor of 1.15.
7. Motors shall be of sufficient size so that there will be no overload on the motor above rated nameplate horsepower under any condition of operation from shut-off to zero head, unless otherwise specifically permitted in this Section.
8. Motor thrust bearings shall be adequate to carry continuous thrust loads under all conditions of pump operation from zero head to shut-off.
9. Locked rotor currents shall be as specified in NEMA standards.
10. Lubrication may be grease or oil type.
11. Motor Tests and Data:
    a. For each motor larger than ten horsepower, furnish a certified motor data sheet for the actual motor or for a previously manufactured electrically duplicate motor which was tested. Provide the following minimum data:
        1) Starting torque.
        2) Efficiency at 1/2, 3/4 and full load.
        3) Power factor at 1/2, 3/4 and full load.
        4) Percent slip.
        5) Running light, full load and locked rotor current.
        6) Current balance check.
        7) Vibration check.
        8) Temperature rises and results of dielectric tests.
        9) Motor type and frame size.
        10) Bearing type and lubrication medium.
        11) Insulation and enclosure type.
12. Job Motor Shop Tests:
    a. Each motor shall be given a complete initial shop test.
    b. If the shop tests results indicate that a motor does not conform to specified or guaranteed performance, the motor shall be modified and retested, at no additional cost to the DEPARTMENT, until full compliance with specified and guaranteed performance can be demonstrated.
    c. No motor shall be shipped from the motor manufacturer's plant until all test data have been approved by the ENGINEER.

2.4 CONTROLS AND ACCESSORIES

A. Pumps shall be furnished with the following accessories and controls:
   1. Variable Frequency Drive System in accordance with Section 26 29 23, Low-Voltage Variable Frequency Drives.
   2. Shaft grounding ring.
   3. Insulated/isolated NDE motor bearing.
   4. Other controls and accessories as shown.

2.5 TOOLS AND SPARE PARTS

A. Each pump shall be furnished with the following:
   1. One mechanical seal or packing for each gland.
   2. One set of gaskets.
   3. One shaft sleeve.
   4. Two sets of special tools required for normal maintenance or operation.

B. Spare parts shall be packed in sturdy containers with clear indelible identification markings and shall be stored in a dry, warm location until transferred to the CITY at the conclusion of the project.

2.6 PAINTING

A. Pumps, motors, drives, frames, baseplates, appurtenances, etc., shall receive manufacturer's standard finish paint system prior to shipment.

B. Machined, polished, and non-ferrous surfaces shall be coated with corrosion prevention compound.

C. Field painting shall conform to the requirements of Section 09 91 00, Painting.

2.7 SOURCE QUALITY CONTROL

A. Shop Tests:
   1. Pump casings shall be hydrostatically tested to twice the discharge head or 1-1/2 times the shutoff head, whichever is greater.
   2. Running Test: Pump assembly shall be operated from zero to maximum capacity as shown on the approved curve. Results of the test shall be shown in a plot of test curves showing head, flow, horsepower, efficiency, and current. Readings shall be taken at a minimum of five evenly spaced capacity points including shut-off, design point and minimum head for which pump is designed to operate.
   3. Each test shall be witnessed by a Registered Professional Engineer, who may be an employee of the manufacturer. The Registered Professional Engineer shall sign and seal all copies of curves and shall certify that hydrostatic tests were performed. Tests shall be conducted in conformance with applicable methods described in Section A6 of AWWA E101.

4. Pumps shall not be shipped until the ENGINEER has approved the test reports.

PART 3 - EXECUTION

3.1 INSPECTION

A. CONTRACTOR shall verify that structures, pipes and equipment are compatible.

B. Make adjustments required to place system in proper operating condition.

3.2 INSTALLATION

A. Manufacturer's representative shall check and approve the installation prior to operation. Manufacturer's representative shall field test and calibrate the equipment to assure that the system operates to the ENGINEER's satisfaction.

B. All pumping units shall be installed on concrete bases and secured with anchor bolts in accordance with the manufacturer's recommendations and as shown. The concrete bases shall be poured up to 1 inch below the metal bases or soleplates. Concrete work and grout shall be in accordance with Division 03, Concrete. The base with the equipment mounted thereon, or the soleplate, shall then be accurately shimmed to grade and the spaces between filled with an approved non-shrink grout. After the grout has reached its initial set, exposed edges shall be cut back ½ inch and the edges neatly finished with 1 to 2 cement mortar. Where channel baseplates are used, the void inside the channel shall be filled with non-shrink grout and the open ends plastered with 1 to 2 cement mortar.

C. Neatly placed 1-inch hard copper pipe shall be provided for each non-submersible pump to convey leakage to nearest drainage inlet.

D. Installation shall include furnishing and applying an initial supply of grease and oil, recommended by the manufacturer.

E. Support piping independent of pump.

F. Check and align all pump, motor and flexible shafting.

3.3 START-UP AND TEST

A. CONTRACTOR shall verify that structures, pipes and equipment are compatible.

B. Make adjustments required to place system in proper operating condition.

3.4 FIELD QUALITY CONTROL

A. All equipment will be given running tests by CONTRACTOR at the job Site following installation of the equipment and controls. Should the tests indicate any malfunction, CONTRACTOR shall make any necessary repairs and adjustments. Such tests and adjustments shall be repeated until, in the opinion of the ENGINEER, the installation is complete and the equipment is functioning properly and accurately, and is ready for permanent operation.

B. A factory trained representative shall be provided for installation supervision, start-up and test services and operation and maintenance personnel training services. The representative shall make a minimum of 3 visits, minimum 4 hours on-Site for each visit, to the Site. The first visit shall be for assistance in the installation of equipment. Subsequent visits shall be for checking the completed installation, start-up and training of the system. Manufacturer's representative shall test operate the system in the presence of the ENGINEER and verify that the equipment conforms to the requirements. Representative shall revisit the Site as often as necessary until all trouble is corrected and the installation is entirely satisfactory.

C. All costs, including travel, lodging, meals and incidentals, shall be considered as included in CONTRACTOR's bid price.

+ + END OF SECTION + +

SECTION 43 21 13.23

CENTRIFUGAL AXIAL SPLIT CASE PUMPS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment and incidentals required to furnish and install centrifugal axial split case pumps complete and operational with motors, control equipment and accessories as shown and specified. Anchor bolts are included in this Section.

B. Coordination:
   1. Review installation procedures under this and other Sections and coordinate the installation of items that must be installed with, or before the centrifugal axial split case pumps Work.
   2. Notify other contractors in advance of the installation of the centrifugal axial split case pumps to provide them with sufficient time for the installation of items included in their contracts that must be installed with, or before, the centrifugal axial split case pumps Work.

C. Related Sections:
   1. Section 03 30 00, Cast-In-Place Concrete.
   2. Section 03 60 00, Grouting.
   3. Section 05 05 33, Anchor Systems.
   4. Section 09 91 00, Painting.
   5. Section 26 29 23, Low-voltage Variable Frequency Drives.
   6. Section 40 05 93, Common Motor Requirements for Process Equipment.

1.2 REFERENCES

A. Standards referenced in this Section are listed below:
   1. American Bearing Manufacturers Association, (ABMA).
   2. American National Standards Institute, (ANSI).
   3. American Water Works Association, (AWWA).
   4. Hydraulic Institute, (HI).
   5. Institute of Electrical and Electronic Engineers, (IEEE).
      a. IEEE 85, Airborne Sound Measurements - Rotating Electrical Machinery.
   6. National Electrical Code, (NEC).
   7. National Electrical Manufacturers Association, (NEMA).
   8. NSF International.

1.3 QUALITY ASSURANCE

A. Manufacturer's Qualifications:
   1. Manufacturer shall have a minimum of five years experience producing substantially similar equipment and shall be able to show evidence of at least five installations in satisfactory operation for at least five years.

B. Component Supply and Compatibility:
   1. Obtain all equipment included in this Section regardless of the component manufacturer from a single centrifugal axial split case pumps manufacturer.
   2. The centrifugal axial split case pumps equipment manufacturer to review and approve or to prepare all Shop Drawings and other submittals for all components furnished under this Section.
   3. All components shall be specifically constructed for the specified service conditions and shall be integrated into the overall assembly by the centrifugal axial split case pumps equipment manufacturer.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Product Data:
      a. Manufacturer's literature, illustrations, specifications and engineering data including: dimensions, materials, size, weight, performance data and curves showing overall pump efficiencies, required net positive suction head, allowable suction lift, flow rate, head, brake horsepower, motor horsepower, speed, and shut-off head. Where variable speed units are specified, curves shall have at least five speeds plotted between maximum and minimum rpm.
      b. Motor tests and data as described in Part 2.
   2. Shop Drawings:
      a. Fabrication, assembly, installation and wiring diagrams.

B. Informational Submittals: Submit the following:
   1. Source Quality Control:
      a. Guarantee.
      b. Certified pump tests.

C. Closeout Submittals: Submit the following:
   1. Operation and Maintenance Data:
      a. Submit complete installation, operation and maintenance manuals including test reports, maintenance data and schedules, description of operation and spare parts information.
      b. Furnish Operation and Maintenance Manuals in conformance with the requirements of Section 01 78 23, Operations and Maintenance Data.

1.5 DELIVERY, STORAGE AND HANDLING

A. Packing, Shipping, Handling and Unloading:
   1. Deliver materials to the Site to ensure uninterrupted progress of the Work. Deliver anchor bolts and anchorage devices which are to be embedded in cast-in-place concrete in ample time to prevent delay of that Work.

B. Storage and Protection:
   1. Store materials to permit easy access for inspection and identification. Keep all material off the ground, using pallets, platforms, or other supports. Protect steel members and packaged materials from corrosion and deterioration.

C. Acceptance at Site:
   1. All boxes, crates and packages shall be inspected by CONTRACTOR upon delivery to the Site. CONTRACTOR shall notify ENGINEER, in writing, if any loss or damage exists to equipment or components. Replace loss and repair damage to new condition in accordance with manufacturer's instructions.

1.6 GUARANTEE

A. In addition to the manufacturer's standard guarantee, CONTRACTOR shall include the services of a factory-trained serviceman to provide repair service for the equipment for the period of one year commencing with the time the equipment is placed in continuous permanent operation. This service shall include the cost of all replacement parts required during the interval.

PART 2 - PRODUCTS

2.1 SERVICE CONDITIONS

A. Description:
   1. Pumps shall be the axial split case single stage, double suction, double volute, horizontal centrifugal type. They shall be specially designed, constructed, and installed for the service intended and shall comply with the following minimum conditions:

B. Design Criteria:

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Design Conditions	Pump No. 1
Location:	Head House Basement
Use:	GAC Feed Pumps 1, 2, 3
Number Required:	3
Design Flow, (gpm):	3,100
Design TH, (ft.):	70
Maximum HP at Shut-off:	69
Efficiency at Design, (percent):	85
Motor, (Hp):	75
Maximum Speed, (rpm):	1,200
Suction Size, (in.):	12
Suction Lift, (ft.):	0
Available NPSH at Design, (ft):	30
Flow at 2nd Design Point, (gpm):	3,750
TH at 2nd Design Point, (ft.):	60
Liquid Pumped:	Filtered Water
Liquid, (pH):	6.5-8.5
Temperature, (°F):	33-70
Drive Type:	VFD

2.2 MANUFACTURERS

A. Products and Manufacturers:
   1. ITT Industries, Inc., Goulds Model 3410 XL.
   2. Or equal.

2.3 DETAILS OF CONSTRUCTION

A. Pump Materials and Construction:
   1. Casing: Cast-iron. Provide the casing joint with dowels for accurate reassembly. The casing shall be furnished with valve openings for venting the high points of the casing and for draining. Pressure instrument taps shall be provided at suction and discharge flanges.
   2. Impeller Type: Enclosed, statically and dynamically balanced.
   3. Impeller Material: Bronze.
   4. Impeller Wear Ring: Bronze.
   5. Casing Head Wear Ring: Bronze.
   6. Shaft Sleeve: Bronze.
   7. Shaft: Steel.
   8. Seals: Mechanical.
   9. Bearings: Anti-friction, regreasable bearings as specified by the manufacturer.
   10. Baseplate: Structural steel or cast-iron provided with means for collecting and draining oil and water.
   11. Furnish with 125 pound ANSI connection flanges.
   12. Coupling: Shall have a minimum 1.5 service factor based on the drive rated horsepower and protected with an approved guard.

13. Type 316 stainless steel anchor bolts and inserts shall be furnished under this Section and shall be sized and installed in accordance with the manufacturer's recommendations. Anchor bolts shall conform to the requirements of Section 05 05 33, Anchor Systems.
14. All bolts, nuts and cap screws shall have hexagon heads.
15. Stainless steel nameplates providing the manufacturer's model and serial number, rated capacity, head, speed and all other pertinent data shall be attached to the pump.

B. Motors:
1. Motors shall conform to the requirements of Section 40 05 93, Common Motor Requirements for Process Equipment.
2. Motors shall be in accordance with all current applicable standards of NEMA, IEEE, ABMA, NEC, and ANSI.
3. Motor shall be 3 phase, 60Hz, 460 volts.
4. Motor shall be equipped with Class F insulation
5. Motor shall have a Service Factor of 1.15
6. Motors shall be equipped with insulated/isolated NDE bearings and furnished with a shaft grounding ring as specified by the manufacturer
7. Motors shall be normal starting torque, normal slip, squirrel cage induction type.
8. Motors shall be capable of carrying full load current continuously without injurious temperature rise in an ambient temperature of 40ºC.
9. Motors shall be of sufficient size so that there will be no overload on the motor above rated nameplate horsepower under any condition of operation from shut-off to zero head, unless otherwise specifically permitted in this Section.
10. Locked rotor currents shall be as specified in NEMA Standards.
11. Lubrication shall be grease or oil type.
12. Motor Tests and Data:
    a. For each motor larger than ten horsepower, furnish a certified motor data sheet for the actual motor or for a previously manufactured electrically duplicate motor which was tested. Provide the following minimum data:
        1) Starting torque.
        2) Efficiency at 1/2, 3/4 and full load.
        3) Power factor at 1/2, 3/4 and full load.
        4) Percent slip.
        5) Running light, full load and locked rotor current.
        6) Current balance check.
        7) Vibration check.
        8) Temperature rises and results of dielectric tests.
        9) Motor type and frame size.
        10) Bearing type and lubrication medium.
        11) Insulation and enclosure type.
13. Job Motor Shop Tests:
    a. Each motor shall be given a complete initial shop test.
    b. If the shop tests results indicate that a motor does not conform to specified or guaranteed performance, the motor shall be modified and

retested, at no additional cost to the DEPARTMENT, until full compliance with specified and guaranteed performance can be demonstrated.

c. Certified test data covering each witness shop test shall be submitted to the ENGINEER for approval.

d. No motor shall be shipped from the motor manufacturer's plant until all test data have been approved by the ENGINEER.

2.4 CONTROLS AND ACCESSORIES

A. Pumps shall be furnished with the following accessories and controls:
   1. As shown.

B. Pumps shall operate with and be controlled by existing variable frequency drives located in the Head House that currently serve the existing High Lift Pumps. Existing drives are Allen-Bradley Power Flex 400 (Allen- Bradley Model No. 23C-D-170A 103NNBANN-S S5-774-1-PF-125, 460V, 156A).

2.5 TOOLS, SPARE PARTS AND MAINTENANCE MATERIALS

A. Each pump shall be furnished with the following:
   1. One mechanical seal or packing for each gland.
   2. One set of gaskets.
   3. One shaft sleeve.
   4. Two sets of special tools required for normal maintenance or operation.

B. Spare parts shall be packed in sturdy containers with clear indelible identification markings and shall be stored in a dry, warm location until transferred to the OWNER at the conclusion of the Project.

2.6 SURFACE PREPARATION AND PAINTING

A. Pumps, motors, frames, baseplates, appurtenances, etc., shall receive shop primer coating conforming to the requirements of Section 09 91 00, Painting.

B. Surface preparation and painting shall conform to the requirements of Section 09 91 00, Painting.

C. All gears, bearing surfaces, machined surfaces and other surfaces which are to remain unpainted shall receive a heavy application of grease or other rust-resistant coating. This coating shall be maintained during storage and until the equipment is placed into operation.

D. CONTRACTOR shall certify, in writing, that the shop primer and finish coating system conforms to the requirements of Section 09 91 00, Painting.

E. Field painting shall conform to the requirements of Section 09 91 00, Painting.

2.7 SOURCE QUALITY CONTROL

A. Shop Tests:
   1. Pump casings shall be hydrostatically tested to twice the discharge head or 1-1/2 times the shutoff head, whichever is greater.
   2. Running Test: Pump assembly shall be operated from zero to maximum capacity as shown on the approved curve. Results of the test shall be shown in a plot of test curves showing head, flow, horsepower, efficiency, and current. Readings shall be taken at a minimum of five evenly spaced capacity points including shut-off, design point and minimum head for which pump is designed to operate.
   3. Each test shall be witnessed by a Registered Professional Engineer, who may be an employee of the manufacturer. The Registered Professional Engineer shall sign and seal all copies of curves and shall certify that hydrostatic tests were performed. Tests shall be conducted in conformance with the methods described in Section A6 of AWWA E101.
   4. Pumps shall not be shipped until the ENGINEER has approved the test reports.

PART 3 - EXECUTION

3.1 INSPECTION

A. CONTRACTOR shall verify that structures, pipes and equipment are compatible.

B. Make adjustments required to place system in proper operating condition.

3.2 INSTALLATION

A. Manufacturer's representative shall check and approve the installation prior to operation. Manufacturer's representative shall field test and calibrate the equipment to assure that the system operates to the ENGINEER's satisfaction.

B. All pumping units shall be installed on concrete bases and secured with anchor bolts in accordance with the manufacturer's recommendations and as shown. The concrete bases shall be poured up to 1-inch below the metal bases or soleplates. Concrete work and grout are in Division 03, Concrete. The base with the equipment mounted thereon, or the soleplate, shall then be accurately shimmed to grade and the spaces between filled with an approved non-shrink grout. After the grout has reached its initial set, exposed edges shall be cut back 1/2-inch and the edges neatly finished with 1 to 2 cement mortar. Where channel baseplates are used, the void inside the channel shall be filled with non-shrink mortar and the open ends plastered with 1 to 2 cement mortar.

C. Neatly placed 1/2-inch hard copper pipe shall be provided on each pump to convey leakage to nearest acceptable drainage inlet.

D. Installation shall include furnishing and applying an initial supply of grease and oil, recommended by the manufacturer.

E. Support piping independent of pump.

F. Check and align all pumps, motor and drive shafting, to the standards of the Hydraulic Institute.

3.3 FIELD QUALITY CONTROL

A. All equipment will be given running tests by CONTRACTOR at the job Site following installation of the equipment and controls. Should the tests indicate any malfunction, CONTRACTOR shall make any necessary repairs and adjustments. Such tests and adjustments shall be repeated until, in the opinion of the ENGINEER, the installation is complete and the equipment is functioning properly and accurately, and is ready for permanent operation.

B. A factory trained representative shall be provided for installation supervision, start-up and test services and operation and maintenance personnel training services. The representative shall make a minimum of 3 visits, minimum 4 hours on-Site for each visit, to the Site. The first visit shall be for assistance in the installation of equipment. Subsequent visits shall be for checking the completed installation, start-up and training of the system. Manufacturer's representative shall test operate the system in the presence of the ENGINEER and verify that the equipment conforms to the requirements. Representative shall revisit the Site as often as necessary until all trouble is corrected and the installation is entirely satisfactory.

C. All costs, including travel, lodging, meals and incidentals, for additional visits shall be at no additional cost to the DEPARTMENT.

+ + END OF SECTION + +

SECTION 46 61 22

GAC CONTACTOR SYSTEMS INSTALLATION

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:

1. CONTRACTOR shall provide all labor, equipment, incidentals, and materials required to unload, install, place into operation, and perform field testing for the DEPARTMENT furnished GAC Contactor Systems (Contactors). The DEPARTMENT has an agreement with Calgon Corporation (GAC CONTACTOR SYSTEM MANUFACTURER) to manufacture, deliver and assist in system testing and startup of the DEPARTMENT furnished GAC Contactor Systems. CONTRACTOR shall review CONTRACT No. OP10261, Specification Section 46 61 21, GAC Pressure Contactors, for information on the scope of supply by GAC CONTACTOR SYSTEM MANUFACTURER
2. DEPARTMENT furnished GAC Media for the GAC Contactor Systems will be under a separate contract anticipated to Bid in November 2016 and CONTRACTOR shall also coordinate delivery, installation, flushing, and testing of DEPARTMENT furnished GAC Media. DEPARTMENT furnished GAC Media will be supplied by the GAC MEDIA SUPPLIER.
3. A copy of CONTRACT No. OP10261 is provided for reference in the Limited Site Use Data.
4. CONTRACTOR shall have the complete responsibilities of the "Installation Contractor" as specified in CONTRACT No. OP10261.
5. CONTRACTOR shall be responsible for coordination of all interfaces with other contractors and GAC CONTACTOR SYSTEM MANUFACTURER to achieve the operation of the completed system as required by the Contract Documents.
6. Contract Drawings show approximate sizes and locations of the system equipment to be installed. They do not necessarily contain or show all minor components required. All equipment furnished by GAC CONTACTOR SYSTEM MANUFACTURER shall be installed complete with all minor elements and components. ENGINEER will provide CONTRACTOR with approved shop drawings of DEPARTMENT furnished Contactors submittals.
7. CONTRACTOR shall review installation procedures under other Sections and coordinate the installation of items that must be installed with, or before, DEAPARTMENT furnished Contactors.
8. Refer to Specification Section 01 13 13, Milestones, for detailed information regarding availability and receipt of DEPARTMENT furnished Contactors and DEPARTMENT furnished GAC Media.

B. Related Sections:
   1. Section 01 45 29.13, Testing Laboratory Services Furnished by Contractor.
   2. Section 01 45 53, Cleaning, Testing and Disinfecting Hydraulic Structures.
   3. Section 01 64 00, Department Furnished Products.
   4. Division 3, Concrete.
   5. Division 40, Process Integration.

1.2 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Shop Drawings:
      a. Dimensioned layout and section drawings showing installation of DEPARTMENT furnished Contactors, all piping, and piping supports.
      b. CONTRACTOR shall assist GAC CONTACTOR SYSTEM MANUFACTURER with information related to equipment and piping provided by CONTRACTOR that may be required by GAC CONTACTOR SYSTEM MANUFACTURER to develop a complete testing plan.

B. Closeout Submittals:
      a. CONTRACTOR shall assist GAC CONTACTOR SYSTEM MANUFACTURER with preparation of a report detailing the results of system testing as it pertains to CONTRACTOR-provided equipment and systems.

1.3 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Delivery of Materials
   1. CONTRACTOR shall coordinate delivery of Contactors with GAC CONTACTOR SYSTEM MANUFACTURER, ENGINEER, CITY, and DEPARTMENT in accordance with Specification 01 64 00, Department Furnished Products.

PART 2 - PRODUCTS

2.1 GENERAL

A. Equipment for installation shall be as described in this specification and CONTRACT No. OP10261. CONTRACTOR shall provide all required anchorage devices and other accessories and appurtenances required to install, place in operation, and test the GAC CONTACTOR SYSTEM MANUFACTURER equipment, which are not furnished by GAC CONTACTOR SYSTEM MANUFACTURER or assigned to another contractor, as described in the Contract Documents.

PART 3 - EXECUTION

3.1 EQUIPMENT INSTALLATION

A. Installation, placing in operation, and testing of equipment shall be in complete accordance with GAC CONTACTOR SYSTEM MANUFACTURER's instructions and recommendations and the Contract Documents.

B. CONTRACTOR shall install DEPARTMENT furnished Contactors and appurtenances as shown and in accordance with GAC CONTACTOR SYSTEM MANUFACTURER's standards and recommendations. DEPARTMENT furnished Contactors shall be installed level in accordance with GAC CONTACTOR SYSTEM MANUFACTURER's recommended tolerances. Each GAC Contactor shall be provided with a concrete equipment pad for each of the leg supports and a concrete equipment pad with suitable pipe support for valves and pipes furnished by GAC CONTACTOR SYSTEM MANUFACTURER so as to match the correct elevation of the Contactors after installation.

C. CONTRACTOR shall coordinate and adjust all piping based on GAC CONTACTOR SYSTEM MANUFACTURER's approved shop drawings to result in properly positioned connections between pipe fittings supplied by GAC CONTACTOR SYSTEM MANUFACTURER and piping provided by CONTRACTOR. All piping shall be supported independent of the DEPARTMENT furnished Contactors.

3.2 CLEANING, PRESSURE TESTING, AND DISINFECTION

A. Water for cleaning, flushing, pressure testing, and disinfecting DEPARTMENT furnished Contactors will be provided in accordance with Specification Section 01 45 53, Cleaning, Testing and Disinfecting Hydraulic Structures. CONTRACTOR shall provide all temporary piping, hoses, valves, pumps, backflow protection devices, equipment, and chemicals to complete cleaning, flushing, pressure testing, and disinfecting DEPARTMENT furnished Contactors.

B. Cleaning: CONTRACTOR shall clean the interior of each GAC Contactor by removing all visible dirt and debris that may have entered the GAC Contactor during construction/installation and also flush all piping and valves appurtenant to the GAC Contactors with potable water. Coordinate flushing activities with CITY and ENGINEER to account for CITY operations. Flushing of DEPARTMENT furnished Contactors shall be limited to occur between the hours of 10 pm and 6 am.

C. Hydrostatic Pressure Testing: After cleaning, GAC CONTACTOR SYSTEM MANUFACTURER and CONTRACTOR shall pressure test the DEPARTMENT furnished Contactors and appurtenant piping as a system. GAC CONTACTOR SYSTEM MANUFACTURER shall assist CONTRACTOR with operation of GAC CONTACTOR SYSTEM MANUFACTURER's equipment. Test pressure

shall be 125 psig for a minimum of two hours and test shall be conducted in the presence of ENGINEER. All leaks, failures, and malfunctions detected during the testing shall be immediately repaired. Testing shall be repeated until the treatment system can maintain the required pressure for the specified duration without any leakage, failures, or malfunctions. GAC CONTACTOR SYSTEM MANUFACTURER and CONTRACTOR shall provide written certification of hydrostatic testing and results to ENGINEER within 24 hours of satisfactory completion of testing.

D. Disinfection: After completion of hydrostatic pressure testing, CONTRACTOR shall disinfect DEPARTMENT furnished Contactors and appurtenant piping in accordance with Section 01 45 53, Cleaning, Testing, and Disinfecting Hydraulic Structures. After each disinfection activity, CONTRACTOR shall perform two bacteriological analyses, collected no less than 24 hours apart. Bacteriological sampling shall be witnessed by the ENGINEER.

3.3 GAC MEDIA INSTALLATION

A. Adequate functional testing shall be completed prior to installing DEPARTMENT furnished GAC Media to ensure the system, including the pumps, piping, valves, and appurtenances are functioning properly.

B. CONTRACTOR shall coordinate and assist GAC MEDIA SUPPLIER with installation of GAC Media.

C. For each System, after GAC Media is installed, CONTRACTOR shall flush GAC Media with a minimum of 70,000 gallons of potable water, or as recommended by the GAC MEDIA SUPPLIER. After the flush is complete, CONTRACTOR shall perform two bacteriological analyses and one turbidity analysis, collected no less than 30 minutes apart. Bacteriological sampling shall be witnessed by the ENGINEER. ENGINEER will perform NYS Part 5 analysis as required by NYS DOH.

3.4 START-UP AND FIELD TESTING

A. Prior to GAC Media installation, functional testing of the overall GAC treatment system shall be completed by GAC CONTACTOR SYSTEM MANUFACTURER and CONTRACTOR including piping, valves, and appurtenances, to ensure the entire system is functioning properly before DEPARTMENT furnished GAC Media is installed. Functional testing proposed shall be defined in the field testing plan developed by GAC CONTACTOR SYSTEM MANUFACTURER with CONTRACTOR's assistance.

B. After equipment installation is complete and field testing plan has been approved, CONTRACTOR, GAC CONTACTOR SYSTEM MANUFACTURER, and GAC feed pump manufacturer shall perform operating tests of each GAC Contactor System and GAC feed pump and associated

controls, in presence of ENGINEER. Testing shall include at minimum the following conditions:

1. All duty Contactors online at minimum feed pump flow (partial treatment mode), tested with each installed pump. Test shall be repeated or otherwise modified to ensure that the standby Contactor is also tested.
2. Peak flow testing of each Contactor system (lead/lag) and pump.

C. If equipment does not comply with the Contract Documents and does not pass the tests, CONTRACTOR shall adjust, modify, and retest the equipment as often as necessary until tests are successfully passed.

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SECTION XII

Measurement for Payment

SECTION XII

MEASUREMENT FOR PAYMENT

PART 1 - GENERAL

1.1 DESCRIPTION

A. This section covers the methods and procedures that the Department will use to measure the CONTRACTOR's Work and provide payment. This description of the measurement and payment features will not, in any way, limit the responsibility of the CONTRACTOR for making a thorough investigation of the Contract Documents and Site conditions to determine the scope of the work included in each bid item.

B. Items listed starting in Article 1.7 of this Section refer to and are the same pay items listed in the Bid Form and constitute all pay items for completing the Work. No direct or separate payment will be made for providing miscellaneous temporary or accessory works, plant services, CONTRACTOR or ENGINEER's field offices, sanitary services, security, temporary controls, supervision, project sign, testing, safety provisions and safety devices, submittals and record drawings, power and fuel, traffic maintenance, removal of waste, coordination with CITY's operations, information technology (including hardware, software, and services) required during construction, bonds, insurance, or other requirements of the General Conditions, Supplementary Conditions, General Requirements, and other requirements of the Contract Documents. Payment will constitute complete compensation for all Work required by the Contract Documents, including all costs of accepting the general risks, liabilities and obligations, expressed or implied. Compensation for providing, as required, all supervision, labor, equipment, overhead, profit, material, tests, required services, applicable taxes, and for performing all other related Work items, shall be included in prices stipulated for lump sum and unit price pay items listed in this Section and included in the Contract.

C. Payment will be made to the CONTRACTOR in accordance with the specified methods of measurement and the unit or lump sum prices stipulated in the acceptance of the bid. Payment will constitute complete compensation for all work required by the Contract Documents including all costs of accepting the general risks, liabilities and obligations, expressed or implied. Payment under all tasks will include, but necessarily be limited to, compensation for furnishing all supervision, labor, equipment overhead, profit, material, services, applicable taxes, and for performing all other related work required. No other payment will be made.

D. Each lump sum and unit bid price shall include an amount considered by CONTRACTOR to be adequate to cover CONTRACTOR's overhead and profit for each separately identified item.

E. For unit price items, the CONTRACTOR shall be paid for the actual amount of work accepted and for the actual amount of materials in place during the period of construction. After the work is completed and before final payment is made, the ENGINEER or CONTRACTOR as specified in the pay items will make final measurements to determine the quantities of the various items of work accepted as the basis for final payment. The CONTRACTOR shall accept compensation as herein provided, in full payment for furnishing all materials, labor, tools, equipment, and incidentals

necessary to the completed work and for performing all work contemplated and embraced by the Contract.

F. For lump sum items, the CONTRACTOR will be paid on the basis of actual work accepted until the work is completed. Upon completion of the item, 100 percent of the lump sum price may be paid, subject to the terms of the Agreement. The pay items listed below describe the measurement of and payment for the Work to be done under respective items listed in the Bid as outlined in the approved schedule of values.

G. No payment will be made for work performed by the CONTRACTOR to replace defective work, work which is not required by the Contract Documents, work outside the limits of the Contract and additional work necessary due to actions of the CONTRACTOR.

H. All units of measurement shall be standard United States convention, as applied to the specific items of work by tradition and as interpreted by the ENGINEER. Each unit or lump sum price stated in the Bid shall constitute full compensation, as herein specified, for each item of Work completed.

1.2 ENGINEER'S ESTIMATE OF QUANTITIES

A. The estimated quantities for Unit Price Items, as listed in the Bid Schedule, are approximate only and are included solely for purpose of the comparison of Bids. The ENGINEER does not expressly, or by implication, agree that nature of materials encountered or required shall correspond therewith and reserves the right to increase or decrease any such quantities or to eliminate quantities as the ENGINEER may deem necessary.

1.3 RELATED PROVISIONS

A. Payments to CONTRACTOR: Refer to Section VI Agreement Articles 9 and 14, Section VIII General Conditions and Section IX Supplementary Conditions.

B. Changes in Contract Price: Refer to Section VIII General Conditions, Section XI Supplementary Conditions and Section XI 01 26 00, Contract Modification Procedures.

C. Schedule of Values: Refer to Section VIII General Conditions, Section IX Supplementary Conditions, and Section XI 01 29 73, Schedule of Values.

1.4 QUANTITIES

A. The Estimated quantities indicated in the Bid Schedule are the quantities for the evaluation of bids. The actual quantities of items to be paid for on a unit price basis may vary significantly from the quantities indicated in the Bid Schedule.

1.5 SUBMITTALS

A. Schedule of Values (Bid Breakdown): Submit in accordance with Section VIII General Conditions Articles 1.4, 1.6 and 13.1.

1.6 INCIDENTAL ITEMS

A. Except for the items designated hereunder for Measurement and Payment, the costs of items necessary to complete the work as specified are considered incidental to the items specified for Measurement and Payment. The costs of incidental items shall be included in the prices of items specified for Measurement and Payment.

PART 2 - MEASUREMENT

A. Under this Contract, the CONTRACTOR shall provide all labor, equipment, and materials and shall complete all Work as shown and described in the Contract Documents and as directed by the ENGINEER, in accordance with the expressed intent of the Contract to secure a complete construction of a functionally complete Project. The bid items described in this Section shall together include all work set forth in the Contract Documents or required to properly complete the Work. Any necessary Work that is not explicitly described shall be considered included in the item to which it properly belongs. Where used in the Contract Documents, the word "including" ("includes", "include") shall mean "including (includes, include) but not limited to". Each item includes:

1. All tools, labor, material, equipment, plant services, bonds and insurance, tests, adjustments, warranties, overhead, supervision and other expenses required to perform the Work.

2. All accessories, manuals, and services pertinent to the proper installation of materials and equipment.

3. All accessories, manuals, and services pertinent to the proper start-up, operation, and maintenance of materials and equipment.

B. Lump Sum Items: Measurement of all Lump Sum Items will be on a total job basis.

4. The quantities of Work performed under lump sum items will not be measured except for the purpose of determining reasonable interim payments. Interim payments will be made in accordance with the estimated value of Work performed and found acceptable as determined by the ENGINEER, or as specified in this Section.

5. For each lump sum bid item, the CONTRACTOR shall provide a schedule of values per Subpart 1.5 of this Section. The schedule of values shall include a breakdown of major cost items included within the lump sum in sufficient detail to document the specific costs of all items included in the lump sum bid item. The schedule of values shall be provided prior to initiation of the Work.

6. Measurement for Progress Payments of all lump sum items will be on a percent complete basis as established in the Contract Documents.

C. Unit Price Items: For each unit price bid item, the CONTRACTOR shall provide a schedule of values per Subpart 1.5 of this Section. The schedule of values shall include a breakdown of major cost items included within the unit price in sufficient detail to document the specific costs of all items included in the unit price bid item. The schedule of values shall be provided prior to initiation

of the Work. Where items are specified to be measured on a unit basis, measurement will be of each particular unit as specified.

1. Volumetric Basis - Where solid or semi-solid items (e.g. sludge and sediment) are specified to be measured on a volumetric basis, the volume will be determined on an in-place basis (prior to excavation for excavation or after placement and compaction for imported fill) between the existing and final ground surfaces as measured by land surveys. If no tolerance is specified, the tolerance shall be interpreted to be 0.00 foot. Where liquid items are specified to be measured on a volumetric basis, the volume will be determined by direct readings obtained from a graduated container containing the liquid or from a calibrated meter designed to measure the quantity of liquid passing an established point or boundary (e.g. flow meter).

2. Area Basis - Where items are specified to be measured on an areal basis, the area will be measured as the actual surface area within the specified limits. If a specified width of an item is indicated, the area will be determined by the actual length along the centerline multiplied by the specified width. No adjustments will be made for the overlap of materials.

3. Length Basis - Where items are specified to be measured on a length basis, the length will be measured as the actual length along the centerline within specified limits. No adjustments will be made for the overlap of materials

4. Weight Basis - Where items are specified to be measured on a weight basis, the weight will be measured based on certified weigh scale tickets obtained from a weigh scale certified by the County Office of Weights and Measures and approved by the ENGINEER. The weights shall be taken in the presence of a Department representative. When the weight is per ton, trucks shall be weighed prior to loading and after loading. The measured tonnage will be the difference between the prior- and post-loading measured truck weights.

D. Measurement and payment will be made only for Work that has been acceptably performed within the limits shown on the Contract Documents and in conformance with the Contract Documents, as specified, or ordered by the ENGINEER.

PART 3 – BID ITEMS

Electric Construction Contract No. D010310

A. Bid Item LS-1 – GAC Treatment System Construction

1. Measurement and Payment: The bid lump sum price for Bid Item LS-1 – All Work required for the construction of the GAC Treatment System Construction, except for Work as required under other Bid Items, shall be the amount paid to the CONTRACTOR to demolish the 1 million gallon buried concrete storage tank, other demolition, site work, GAC Treatment Building, pavements, yard piping, tanks, installation of DEPARTMENT furnished equipment, site restoration and ancillary work at the Site in accordance with the requirements of the Contract Documents. Payments will be made based on percentage of work completed.

B. Bid Item UP-1 – Bedrock Excavation and Disposal

1. Payment: Bid Item UP-1 shall be bid unit cost price per cubic yard, as quantified by the in place measure and comparison of before and after surveys as approved by the Department's Representative. Provide all labor, materials, equipment and incidentals necessary to excavate, load, transport and dispose of bedrock at an acceptable location required for foundations, yard piping and site grading.
2. Measurement for payment of Bid Item UP-1 – Bedrock Excavation and Disposal shall be the actual number of cubic yards approved by the Department's Representative.

C. Bid Item UP-2 – Select Granular Fill

1. Payment: Bid Item UP-2 shall be bid unit cost price per cubic yard, as quantified by the in place measure and comparison of before and after surveys as approved by the Department's Representative. Provide all labor, materials, equipment and incidentals necessary to furnish, place, and compact select granular fill for the tank foundation.
2. Measurement for payment of Bid Item UP-2 – Select Granular Fill shall be the actual number of cubic yards approved by the Department's Representative.

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SECTION XIII

Wage Rates and Associated Contract Requirements

Andrew M. Cuomo, Governor

Roberta Reardon, Commissioner

NYSDEC

Dana Bryant, Engineer
Arcadis
855 Route 146 - Suite 210
Clifton Park NY 12065

Schedule Year	2016 through 2017
Date Requested	10/18/2016
PRC#	2016010464

Location	Filtration Plant
Project ID#	
Project Type	Water treatment plant upgrade consisting of tank demolition, construction of a new building housing pumps and GAC contactors, electrical and instrumentation upgrades, and piping changes.

PREVAILING WAGE SCHEDULE FOR ARTICLE 8 PUBLIC WORK PROJECT

Attached is the current schedule(s) of the prevailing wage rates and prevailing hourly supplements for the project referenced above. A unique Prevailing Wage Case Number (PRC#) has been assigned to the schedule(s) for your project.

The schedule is effective from July 2016 through June 2017. All updates, corrections, posted on the 1st business day of each month, and future copies of the annual determination are available on the Department's website www.labor.state.ny.us. Updated PDF copies of your schedule can be accessed by entering your assigned PRC# at the proper location on the website.

It is the responsibility of the contracting agency or its agent to annex and make part, the attached schedule, to the specifications for this project, when it is advertised for bids and /or to forward said schedules to the successful bidder(s), immediately upon receipt, in order to insure the proper payment of wages.

Please refer to the "General Provisions of Laws Covering Workers on Public Work Contracts" provided with this schedule, for the specific details relating to other responsibilities of the Department of Jurisdiction.

Upon completion or cancellation of this project, enter the required information and mail **OR** fax this form to the office shown at the bottom of this notice, **OR** fill out the electronic version via the NYSDOL website.

NOTICE OF COMPLETION / CANCELLATION OF PROJECT

Date Completed: _____ Date Cancelled: _____

Name & Title of Representative: _____

Phone: (518) 457-5589 Fax: (518) 485-1870
W. Averell Harriman State Office Campus, Bldg. 12, Room 130, Albany, NY 12240

General Provisions of Laws Covering Workers on Article 8 Public Work Contracts

Introduction

The Labor Law requires public work contractors and subcontractors to pay laborers, workers, or mechanics employed in the performance of a public work contract not less than the prevailing rate of wage and supplements (fringe benefits) in the locality where the work is performed.

Responsibilities of the Department of Jurisdiction

A Department of Jurisdiction (Contracting Agency) includes a state department, agency, board or commission: a county, city, town or village; a school district, board of education or board of cooperative educational services; a sewer, water, fire, improvement and other district corporation; a public benefit corporation; and a public authority awarding a public work contract.

The Department of Jurisdiction (Contracting Agency) awarding a public work contract MUST obtain a Prevailing Rate Schedule listing the hourly rates of wages and supplements due the workers to be employed on a public work project. This schedule may be obtained by completing and forwarding a "Request for wage and Supplement Information" form (PW 39) to the Bureau of Public Work. The Prevailing Rate Schedule MUST be included in the specifications for the contract to be awarded and is deemed part of the public work contract.

Upon the awarding of the contract, the law requires that the Department of Jurisdiction (Contracting Agency) furnish the following information to the Bureau: the name and address of the contractor, the date the contract was let and the approximate dollar value of the contract. To facilitate compliance with this provision of the Labor Law, a copy of the Department's "Notice of Contract Award" form (PW 16) is provided with the original Prevailing Rate Schedule.

The Department of Jurisdiction (Contracting Agency) is required to notify the Bureau of the completion or cancellation of any public work project. The Department's PW 200 form is provided for that purpose.

Both the PW 16 and PW 200 forms are available for completion online.

Hours

No laborer, worker, or mechanic in the employ of a contractor or subcontractor engaged in the performance of any public work project shall be permitted to work more than eight hours in any day or more than five days in any week, except in cases of extraordinary emergency. The contractor and the Department of Jurisdiction (Contracting Agency) may apply to the Bureau of Public Work for a dispensation permitting workers to work additional hours or days per week on a particular public work project.

There are very few exceptions to this rule. Complete information regarding these exceptions is available on the "4 Day / 10 Hour Work Schedule" form (PW 30R).

Wages and Supplements

The wages and supplements to be paid and/or provided to laborers, workers, and mechanics employed on a public work project shall be not less than those listed in the current Prevailing Rate Schedule for the locality where the work is performed. If a prime contractor on a public work project has not been provided with a Prevailing Rate Schedule, the contractor must notify the Department of Jurisdiction (Contracting Agency) who in turn must request an original Prevailing Rate Schedule form the Bureau of Public Work. Requests may be submitted by: mail to NYSDOL, Bureau of Public Work, State Office Bldg. Campus, Bldg. 12, Rm. 130, Albany, NY 12240; Fax to Bureau of Public Work (518) 485-1870; or electronically at the NYSDOL website www.labor.state.ny.us.

Upon receiving the original schedule, the Department of Jurisdiction (Contracting Agency) is REQUIRED to provide complete copies to all prime contractors who in turn MUST, by law, provide copies of all applicable county schedules to each subcontractor and obtain from each subcontractor, an affidavit certifying such schedules were received. If the original schedule expired, the contractor may obtain a copy of the new annual determination from the NYSDOL website www.labor.state.ny.us.

The Commissioner of Labor makes an annual determination of the prevailing rates. This determination is in effect from July 1st through June 30th of the following year. The annual determination is available on the NYSDOL website www.labor.state.ny.us.

Payrolls and Payroll Records

Every contractor and subcontractor MUST keep original payrolls or transcripts subscribed and affirmed as true under penalty of perjury. Payrolls must be maintained for at least three (3) years from the project's date of completion. At a minimum, payrolls must show the following information for each person employed on a public work project: Name, Address, Last 4 Digits of Social Security Number, Classification(s) in which the worker was employed, Hourly wage rate(s) paid, Supplements paid or provided, and Daily and weekly number of hours worked in each classification.

Every contractor and subcontractor shall submit to the Department of Jurisdiction (Contracting Agency), within thirty (30) days after issuance of its first payroll and every thirty (30) days thereafter, a transcript of the original payrolls, subscribed and affirmed as true under penalty of perjury. The Department of Jurisdiction (Contracting Agency) shall collect, review for facial validity, and maintain such payrolls.

In addition, the Commissioner of Labor may require contractors to furnish, with ten (10) days of a request, payroll records sworn to as their validity and accuracy for public work and private work. Payroll records include, by are not limited to time cards, work description sheets, proof that supplements were provided, cancelled payroll checks and payrolls. Failure to provide the requested information within the allotted ten (10) days will result in the withholding of up to 25% of the contract, not to exceed $100,000.00. If the contractor or subcontractor does not maintain a place of business in New York State and the amount of the contract exceeds $25,000.00, payroll records and certifications must be kept on the project worksite.

The prime contractor is responsible for any underpayments of prevailing wages or supplements by any subcontractor.

All contractors or their subcontractors shall provide to their subcontractors a copy of the Prevailing Rate Schedule specified in the public work contract as well as any subsequently issued schedules. A failure to provide these schedules by a contractor or subcontractor is a violation of Article 8, Section 220-a of the Labor Law.

All subcontractors engaged by a public work project contractor or its subcontractor, upon receipt of the original schedule and any subsequently issued schedules, shall provide to such contractor a verified statement attesting that the subcontractor has received the Prevailing Rate Schedule and will pay or provide the applicable rates of wages and supplements specified therein. (See NYS Labor Laws, Article 8 . Section 220-a).

Determination of Prevailing Wage and Supplement Rate Updates Applicable to All Counties

The wages and supplements contained in the annual determination become effective July 1st whether or not the new determination has been received by a given contractor. Care should be taken to review the rates for obvious errors. Any corrections should be brought to the Department's attention immediately. It is the responsibility of the public work contractor to use the proper rates. If there is a question on the proper classification to be used, please call the district office located nearest the project. Any errors in the annual determination will be corrected and posted to the NYSDOL website on the first business day of each month. Contractors are responsible for paying these updated rates as well, retroactive to July 1st.

When you review the schedule for a particular occupation, your attention should be directed to the dates above the column of rates. These are the dates for which a given set of rates is effective. To the extent possible, the Department posts rates in its possession that cover periods of time beyond the July 1st to June 30th time frame covered by a particular annual determination. Rates that extend beyond that instant time period are informational ONLY and may be updated in future annual determinations that actually cover the then appropriate July 1st to June 30th time period.

Withholding of Payments

When a complaint is filed with the Commissioner of Labor alleging the failure of a contractor or subcontractor to pay or provide the prevailing wages or supplements, or when the Commissioner of Labor believes that unpaid wages or supplements may be due, payments on the public work contract shall be withheld from the prime contractor in a sufficient amount to satisfy the alleged unpaid wages and supplements, including interest and civil penalty, pending a final determination.

When the Bureau of Public Work finds that a contractor or subcontractor on a public work project failed to pay or provide the requisite prevailing wages or supplements, the Bureau is authorized by Sections 220-b and 235.2 of the Labor Law to so notify the financial officer of the Department of Jurisdiction (Contracting Agency) that awarded the public work contract. Such officer MUST then withhold or cause to be withheld from any payment due the prime contractor on account of such contract the amount indicated by the Bureau as sufficient to satisfy the unpaid wages and supplements, including interest and any civil penalty that may be assessed by the Commissioner of Labor. The withholding continues until there is a final determination of the underpayment by the Commissioner of Labor or by the court in the event a legal proceeding is instituted for review of the determination of the Commissioner of Labor.

The Department of Jurisdiction (Contracting Agency) shall comply with this order of the Commissioner of Labor or of the court with respect to the release of the funds so withheld.

Summary of Notice Posting Requirements

The current Prevailing Rate Schedule must be posted in a prominent and accessible place on the site of the public work project. The prevailing wage schedule must be encased in, or constructed of, materials capable of withstanding adverse weather conditions and be titled "PREVAILING RATE OF WAGES" in letters no smaller than two (2) inches by two (2) inches.

The "Public Work Project" notice must be posted at the beginning of the performance of every public work contract, on each job site.

Every employer providing workers. compensation insurance and disability benefits must post notices of such coverage in the format prescribed by the Workers. Compensation Board in a conspicuous place on the jobsite.

Every employer subject to the NYS Human Rights Law must conspicuously post at its offices, places of employment, or employment training centers, notices furnished by the State Division of Human Rights.

Employers liable for contributions under the Unemployment Insurance Law must conspicuously post on the jobsite notices furnished by the NYS Department of Labor.

Apprentices

Employees cannot be paid apprentice rates unless they are individually registered in a program registered with the NYS Commissioner of Labor. The allowable ratio of apprentices to journeyworkers in any craft classification can be no greater than the statewide building trade ratios promulgated by the Department of Labor and included with the Prevailing Rate Schedule. An employee listed on a payroll as an apprentice who is not registered as above or is performing work outside the classification of work for which the apprentice is indentured, must be paid the prevailing journeyworker's wage rate for the classification of work the employee is actually performing.

NYSDOL Labor Law, Article 8, Section 220-3, require that only apprentices individually registered with the NYS Department of Labor may be paid apprenticeship rates on a public work project. No other Federal or State Agency of office registers apprentices in New York State.

Persons wishing to verify the apprentice registration of any person must do so in writing by mail, to the NYSDOL Office of Employability Development / Apprenticeship Training, State Office Bldg. Campus, Bldg. 12, Albany, NY 12240 or by Fax to NYSDOL Apprenticeship Training (518) 457-7154. All requests for verification must include the name and social security number of the person for whom the information is requested.

The only conclusive proof of individual apprentice registration is written verification from the NYSDOL Apprenticeship Training Albany Central office. Neither Federal nor State Apprenticeship Training offices outside of Albany can provide conclusive registration information.

It should be noted that the existence of a registered apprenticeship program is not conclusive proof that any person is registered in that program. Furthermore, the existence or possession of wallet cards, identification cards, or copies of state forms is not conclusive proof of the registration of any person as an apprentice.

Interest and Penalties

In the event that an underpayment of wages and/or supplements is found:

- Interest shall be assessed at the rate then in effect as prescribed by the Superintendent of Banks pursuant to section 14-a of the Banking Law, per annum from the date of underpayment to the date restitution is made.
- A Civil Penalty may also be assessed, not to exceed 25% of the total of wages, supplements, and interest due.

Debarment

Any contractor or subcontractor and/or its successor shall be ineligible to submit a bid on or be awarded any public work contract or subcontract with any state, municipal corporation or public body for a period of five (5) years when:

- Two (2) willful determinations have been rendered against that contractor or subcontractor and/or its successor within any consecutive six (6) year period.
- There is any willful determination that involves the falsification of payroll records or the kickback of wages or supplements.

Criminal Sanctions

Willful violations of the Prevailing Wage Law (Article 8 of the Labor Law) may be a felony punishable by fine or imprisonment of up to 15 years, or both.

Discrimination

No employee or applicant for employment may be discriminated against on account of age, race, creed, color, national origin, sex, disability or marital status.

No contractor, subcontractor nor any person acting on its behalf, shall by reason of race, creed, color, disability, sex or national origin discriminate against any citizen of the State of New York who is qualified and available to perform the work to which the employment relates (NYS Labor Law, Article 8, Section 220-e(a)).

No contractor, subcontractor, nor any person acting on its behalf, shall in any manner, discriminate against or intimidate any employee on account of race, creed, color, disability, sex, or national origin (NYS Labor Law, Article 8, Section 220-e(b)).

The Human Rights Law also prohibits discrimination in employment because of age, marital status, or religion.

There may be deducted from the amount payable to the contractor under the contract a penalty of $50.00 for each calendar day during which such person was discriminated against or intimidated in violation of the provision of the contract (NYS Labor Law, Article 8, Section 220-e(c)).

The contract may be cancelled or terminated by the State or municipality. All monies due or to become due thereunder may be forfeited for a second or any subsequent violation of the terms or conditions of the anti-discrimination sections of the contract (NYS Labor Law, Article 8, Section 220-e(d)).

Every employer subject to the New York State Human Rights Law must conspicuously post at its offices, places of employment, or employment training centers notices furnished by the State Division of Human Rights.

Workers' Compensation

In accordance with Section 142 of the State Finance Law, the contractor shall maintain coverage during the life of the contract for the benefit of such employees as required by the provisions of the New York State Workers' Compensation Law.

A contractor who is awarded a public work contract must provide proof of workers' compensation coverage prior to being allowed to begin work.

The insurance policy must be issued by a company authorized to provide workers' compensation coverage in New York State. Proof of coverage must be on form C-105.2 (Certificate of Workers' Compensation Insurance) and must name this agency as a certificate holder.

If New York State coverage is added to an existing out-of-state policy, it can only be added to a policy from a company authorized to write workers' compensation coverage in this state. The coverage must be listed under item 3A of the information page.

The contractor must maintain proof that subcontractors doing work covered under this contract secured and maintained a workers' compensation policy for all employees working in New York State.

Every employer providing worker's compensation insurance and disability benefits must post notices of such coverage in the format prescribed by the Workers' Compensation Board in a conspicuous place on the jobsite.

Unemployment Insurance

Employers liable for contributions under the Unemployment Insurance Law must conspicuously post on the jobsite notices furnished by the New York State Department of Labor.

Andrew M. Cuomo, Governor

Roberta Reardon, Commissioner

NYSDEC

Dana Bryant, Engineer
Arcadis
855 Route 146 - Suite 210
Clifton Park NY 12065

Schedule Year	2016 through 2017
Date Requested	10/18/2016
PRC#	2016010464

Location	Filtration Plant
Project ID#	
Project Type	Water treatment plant upgrade consisting of tank demolition, construction of a new building housing pumps and GAC contactors, electrical and instrumentation upgrades, and piping changes.

Notice of Contract Award

New York State Labor Law, Article 8, Section 220.3a requires that certain information regarding the awarding of public work contracts, be furnished to the Commissioner of Labor. One "Notice of Contract Award" (PW 16, which may be photocopied), **MUST** be completed for **EACH** prime contractor on the above referenced project.

Upon notifying the successful bidder(s) of this contract, enter the required information and mail **OR** fax this form to the office shown at the bottom of this notice, **OR** fill out the electronic version via the NYSDOL website.

Contractor Information

All information must be supplied

Federal Employer Identification Number: _____

Name: _____

Address: _____

_____

City: _____ State: _____ Zip: _____

Amount of Contract: $_____

Approximate Starting Date: ____/____/____

Approximate Completion Date: ____/____/____

Contract Type:

[ ] (01) General Construction
[ ] (02) Heating/Ventilation
[ ] (03) Electrical
[ ] (04) Plumbing
[ ] (05) Other : _____

Phone: (518) 457-5589 Fax: (518) 485-1870
W. Averell Harriman State Office Campus, Bldg. 12, Room 130, Albany, NY 12240

IMPORTANT NOTICE

FOR

CONTRACTORS & CONTRACTING AGENCIES

Social Security Numbers on Certified Payrolls

The Department of Labor is cognizant of the concerns of the potential for misuse or inadvertent disclosure of social security numbers. Identity theft is a growing problem and we are sympathetic to contractors' concerns with regard to inclusion of this information on payrolls if another identifier will suffice.

For these reasons, ***the substitution of the use of the last four digits of the social security number on certified payrolls submitted to contracting agencies on public work projects is now acceptable to the Department of Labor.***

NOTE: This change does not affect the Department's ability to request and receive the entire social security number from employers during the course of its public work / prevailing wage investigations.

To all State Departments, Agency Heads and Public Benefit Corporations
IMPORTANT NOTICE REGARDING PUBLIC WORK ENFORCEMENT FUND

Budget Policy & Reporting Manual

B-610

Public Work Enforcement Fund

effective date December 7, 2005

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1. Purpose and Scope:

This Item describes the Public Work Enforcement Fund (the Fund, PWEF) and its relevance to State agencies and public benefit corporations engaged in construction or reconstruction contracts, maintenance and repair, and announces the recently-enacted increase to the percentage of the dollar value of such contracts that must be deposited into the Fund. This item also describes the roles of the following entities with respect to the Fund:

- New York State Department of Labor (DOL),
- The Office of the State of Comptroller (OSC), and
- State agencies and public benefit corporations.

2. Background and Statutory References:

DOL uses the Fund to enforce the State's Labor Law as it relates to contracts for construction or reconstruction, maintenance and repair, as defined in subdivision two of Section 220 of the Labor Law. State agencies and public benefit corporations participating in such contracts are required to make payments to the Fund.

Chapter 511 of the Laws of 1995 (as amended by Chapter 513 of the Laws of 1997, Chapter 655 of the Laws of 1999, Chapter 376 of the Laws of 2003 and Chapter 407 of the Laws of 2005) established the Fund.

3. Procedures and Agency Responsibilities:

The Fund is supported by transfers and deposits based on the value of contracts for construction and reconstruction, maintenance and repair, as defined in subdivision two of Section 220 of the Labor Law, into which all State agencies and public benefit corporations enter.

Chapter 407 of the Laws of 2005 increased the amount required to be provided to this fund to .10 of one-percent of the total cost of each such contract, to be calculated at the time agencies or public benefit corporations enter into a new contract or if a contract is amended. The provisions of this bill became effective August 2, 2005.

To all State Departments, Agency Heads and Public Benefit Corporations
IMPORTANT NOTICE REGARDING PUBLIC WORK ENFORCEMENT FUND

OSC will report to DOL on all construction-related ("D") contracts approved during the month, including contract amendments, and then DOL will bill agencies the appropriate assessment monthly. An agency may then make a determination if any of the billed contracts are exempt and so note on the bill submitted back to DOL. For any instance where an agency is unsure if a contract is or is not exempt, they can call the Bureau of Public Work at the number noted below for a determination. Payment by check or journal voucher is due to DOL within thirty days from the date of the billing. DOL will verify the amounts and forward them to OSC for processing.

For those contracts which are not approved or administered by the Comptroller, monthly reports and payments for deposit into the Public Work Enforcement Fund must be provided to the Administrative Finance Bureau at the DOL within 30 days of the end of each month or on a payment schedule mutually agreed upon with DOL.

Reports should contain the following information:

- Name and billing address of State agency or public benefit corporation;
- State agency or public benefit corporation contact and phone number;
- Name and address of contractor receiving the award;
- Contract number and effective dates;
- Contract amount and PWEF assessment charge (if contract amount has been amended, reflect increase or decrease to original contract and the adjustment in the PWEF charge); and
- Brief description of the work to be performed under each contract.

Checks and Journal Vouchers, payable to the "New York State Department of Labor" should be sent to:

Department of Labor
Administrative Finance Bureau-PWEF Unit
Building 12, Room 464
State Office Campus
Albany, NY 12240

Any questions regarding billing should be directed to NYSDOL's Administrative Finance Bureau-PWEF Unit at (518) 457-3624 and any questions regarding Public Work Contracts should be directed to the Bureau of Public Work at (518) 457-5589.

Construction Industry
Fair Play Act

Required Posting For Labor Law
Article 25-B § 861-d

Construction industry employers must post the "Construction Industry Fair Play Act" notice in a prominent and accessible place on the job site.

Failure to post the notice can result in penalties of up to $1,500 for a first offense and up to $5,000 for a second offense.

The posting is included as part of this wage schedule. Additional copies may be obtained from the NYS DOL website, www.labor.ny.gov.

If you have any questions concerning the Fair Play Act, please call the State Labor Department toll-free at 1-866-435-1499 or email us at: dol.misclassified@labor.state.ny.us .

New York State Department of Labor
Required Notice under Article 25-B of the Labor Law

ATTENTION ALL EMPLOYEES, CONTRACTORS AND SUBCONTRACTORS:
YOU ARE COVERED BY THE
CONSTRUCTION INDUSTRY FAIR PLAY ACT

The law says that you are an employee unless:

- You are free from direction and control in performing your job AND
- You perform work that is not part of the usual work done by the business that hired you AND
- You have an independently established business

Your employer cannot consider you to be an independent contractor unless all three of these facts apply to your work.

IT IS AGAINST THE LAW FOR AN EMPLOYER TO MISCLASSIFY EMPLOYEES AS INDEPENDENT CONTRACTORS OR PAY EMPLOYEES OFF-THE-BOOKS.

Employee rights. If you are an employee:

- You are entitled to state and federal worker protections such as
  - unemployment benefits, if unemployed through no fault of your own, able to work, and otherwise qualified
  - workers' compensation benefits for on-the-job injuries
  - payment for wages earned, minimum wage, and overtime (under certain conditions)
  - prevailing wages on public work projects
  - the provisions of the National Labor Relations Act and
  - a safe work environment
- It is a violation of this law for employers to retaliate against anyone who asserts their rights under the law. Retaliation subjects an employer to civil penalties, a private lawsuit or both.

Independent Contractors: If you are an independent contractor*:*

- You must pay all taxes required by New York State and Federal Law.

Penalties for paying off-the-books or improperly treating employees as independent contractors:

- **Civil Penalty** — First Offense: up to $2,500 per employee.
  Subsequent Offense(s): up to $5,000 per employee.

- **Criminal Penalty** — First Offense: Misdemeanor - up to 30 days in jail, up to a $25,000 fine and debarment from performing Public Work for up to one year.
  Subsequent Offense(s): Misdemeanor - up to 60 days in jail, up to a $50,000 fine and debarment from performing Public Work for up to 5 years.

If you have questions about your employment status or believe that your employer may have violated your rights and you want to file a complaint, call the Department of Labor at 1(866)435-1499 or send an email to dol.misclassified@labor.state.ny.us. All complaints of fraud and violations are taken seriously and you can remain anonymous.

Employer Name:

IA 999 (09/10)

WORKER NOTIFICATION

(Labor Law §220, paragraph a of subdivision 3-a)

Effective February 24, 2008

This provision is an addition to the existing prevailing wage rate law, Labor Law §220, paragraph a of subdivision 3-a. It requires contractors and subcontractors to provide written notice to all laborers, workers or mechanics of the *prevailing wage rate* for their particular job classification *on each pay stub**. It also requires contractors and subcontractors to *post a notice* at the beginning of the performance of every public work contract *on each job site* that includes the telephone number and address for the Department of Labor and a statement informing laborers, workers or mechanics of their right to contact the Department of Labor if he/she is not receiving the proper prevailing rate of wages and/or supplements for his/her particular job classification. The required notification will be provided with each wage schedule, may be downloaded from our website www.labor.state.ny.us or made available upon request by contacting the Bureau of Public Work at 518-457-5589.

* In the event that the required information will not fit on the pay stub, an accompanying sheet or attachment of the information will suffice.

(11.11)

New York State Department of Labor
Bureau of Public Work

Attention Employees

THIS IS A:

PUBLIC WORK PROJECT

If you are employed on this project as a **worker, laborer, or mechanic** you are entitled to receive the **prevailing wage and supplements rate** for the classification at which you are working.

Chapter 629 of the Labor Laws of 2007:

These wages are set by law and must be posted at the work site. They can also be found at: www.labor.ny.gov

If you feel that you have not received proper wages or benefits, please call our nearest office.*

Albany	(518) 457-2744	Patchogue	(631) 687-4882
Binghamton	(607) 721-8005	Rochester	(585) 258-4505
Buffalo	(716) 847-7159	Syracuse	(315) 428-4056
Garden City	(516) 228-3915	Utica	(315) 793-2314
New York City	(212) 932-2419	White Plains	(914) 997-9507
Newburgh	(845) 568-5156		

* For New York City government agency construction projects, please contact the Office of the NYC Comptroller at (212) 669-4443, or www.comptroller.nyc.gov – click on Bureau of Labor Law.

Contractor Name: _____

Project Location: _____

OSHA 10-hour Construction

Safety and Health Course – S1537-A

Effective July 18, 2008

This provision is an addition to the existing prevailing wage rate law, Labor Law §220, section 220-h. It requires that on all public work projects of at least $250,000.00, all laborers, workers and mechanics working on the site, be certified as having successfully completed the OSHA 10-hour construction safety and health course. It further requires that the advertised bids and contracts for every public work contract of at least $250,000.00, contain a provision of this requirement.

NOTE: ***The OSHA 10 Legislation only applies to workers on a public work project that are required, under Article 8, to receive the prevailing wage.***

Where to find OSHA 10-hour Construction Course

1. NYS Department of Labor website for scheduled outreach training at:

   www.labor.state.ny.us/workerprotection/safetyhealth/DOSH_ONSITE_CONSULTATION.shtm

2. OSHA Training Institute Education Centers:

   Rochester Institute of Technology OSHA Education Center
   Rochester, NY
   Donna Winter
   Fax (585) 475-6292
   e-mail: dlwtpo@rit.edu
   (866) 385-7470 Ext. 2919
   www.rit.edu/~outreach/course.php3?CourseID=54

   Atlantic OSHA Training Center
   UMDNJ – School of Public Health
   Piscataway, NJ
   Janet Crooks
   Fax (732) 235-9460
   e-mail: crooksje@umdnj.edu
   (732) 235-9455
   https://ophp.umdnj.edu/wconnect/ShowSchedule.awp?~~GROUP~AOTCON~10~

   Atlantic OSHA Training Center
   University at Buffalo
   Buffalo, New York
   Joe Syracuse
   Fax (716) 829-2806
   e-mail:mailto:japs@buffalo.edu
   (716) 829-2125
   http://www.smbs.buffalo.edu/CENTERS/trc/schedule_OSHA.php

   Keene State College
   Manchester, NH
   Leslie Singleton
   e-mail: lsingletin@keene.edu
   (800) 449-6742
   www.keene.edu/courses/print/courses_osha.cfm

3. List of trainers and training schedules for OSHA outreach training at:

   www.OutreachTrainers.org

Requirements for OSHA 10 Compliance

Chapter 282 of the Laws of 2007, codified as Labor Law 220-h took effect on July 18, 2008. The statute provides as follows:

The advertised specifications for every contract for public work of $250,000.00 or more must contain a provision requiring that every worker employed in the performance of a public work contract shall be certified as having completed an OSHA 10 safety training course. The clear intent of this provision is to require that all employees of public work contractors, required to be paid prevailing rates, receive such training "prior to the performing any work on the project."

The Bureau will enforce the statute as follows:

All contractors and sub contractors must attach a copy of proof of completion of the OSHA 10 course to the first certified payroll submitted to the contracting agency and on each succeeding payroll where any new or additional employee is first listed.

Proof of completion may include but is not limited to:

- Copies of bona fide course completion card (*Note: Completion cards do not have an expiration date.*)
- Training roster, attendance record of other documentation from the certified trainer pending the issuance of the card.
- Other valid proof

**A certification by the employer attesting that all employees have completed such a course is not sufficient proof that the course has been completed.

Any questions regarding this statute may be directed to the New York State Department of Labor, Bureau of Public Work at 518-485-5696.

WICKS Reform 2008

(For all contracts advertised or solicited for bid on or after 7/1/08)

- Raises the threshold for public work projects subject to the Wicks Law requiring separate specifications and bidding for the plumbing, heating and electrical work. The total project's threshold would increase from $50,000 to: $3 million in Bronx, Kings, New York, Queens and Richmond counties; $1.5 million in Nassau, Suffolk and Westchester counties; and $500,000 in all other counties.

- For projects below the monetary threshold, bidders must submit a sealed list naming each subcontractor for the plumbing, HVAC and electrical work and the amount to be paid to each. The list may not be changed unless the public owner finds a legitimate construction need, including a change in specifications or costs or use of a Project Labor Agreement (PLA), and must be open to public inspection.

- Allows the state and local agencies and authorities to waive the Wicks Law and use a PLA if it will provide the best work at the lowest possible price. If a PLA is used, all contractors shall participate in apprentice training programs in the trades of work it employs that have been approved by the Department of Labor (DOL) for not less than three years. They shall also have at least one graduate in the last three years and use affirmative efforts to retain minority apprentices. PLA's would be exempt from Wicks, but deemed to be public work subject to prevailing wage enforcement.

- The Commissioner of Labor shall have the power to enforce separate specification requirements on projects, and may issue stop-bid orders against public owners for non-compliance.

- Other new monetary thresholds, and similar sealed bidding for non-Wicks projects, would apply to certain public authorities including municipal housing authorities, NYC Construction Fund, Yonkers Educational Construction Fund, NYC Municipal Water Finance Authority, Buffalo Municipal Water Finance Authority, Westchester County Health Care Association, Nassau County Health Care Corp., Clifton-Fine Health Care Corp., Erie County Medical Center Corp., NYC Solid Waste Management Facilities, and the Dormitory Authority.

- Reduces from 15 to 7 days the period in which contractors must pay subcontractors.

IMPORTANT INFORMATION

Regarding Use of Form PW30R

"Employer Registration for Use of 4 Day / 10 Hour Work Schedule"

To use the '4 Day / 10 Hour Work Schedule':

There MUST be a *Dispensation of Hours (PW30)* in place on the project

AND

You MUST register your intent to work 4 / 10 hour days, by completing the PW30R Form.

REMEMBER…

The '4 Day / 10 Hour Work Schedule' applies ONLY to Job Classifications and Counties listed on the PW30R Form.

Do not write in any additional Classifications or Counties.

(**Please note** : For each Job Classification check the individual wage schedule for specific details regarding their 4/10 hour day posting.)

Instructions for Completing Form PW30R

"Employer Registration for Use of 4 Day / 10 Hour Work Schedule"

Before completing Form PW30R check to be sure …

- There is a *Dispensation of Hours* in place on the project.
- The 4 Day / 10 Hour Work Schedule applies to the Job Classifications you will be using.
- The 4 Day / 10 Hour Work Schedule applies to the County / Counties where the work will take place.

Instructions (Type or Print legibly):

Contractor Information:

- Enter the Legal Name of the business, FEIN, Street Address, City, State, Zip Code; the Company's Phone and Fax numbers; and the Company's email address (if applicable)
- Enter the Name of a Contact Person for the Company along with their Phone and Fax numbers, and the personal email address (if applicable)

Project Information:

- Enter the Prevailing Rate Case number (PRC#) assigned to this project
- Enter the Project Name / Type (i.e. Smithtown CSD – Replacement of HS Roof)
- Enter the Exact Location of Project (i.e. Smithtown HS, 143 County Route #2, Smithtown,NY; Bldgs. 1 & 2)
- If you are a Subcontractor, enter the name of the Prime Contractor for which you work
- On the Checklist of Job Classifications -
  - Go to pages 2 and 3 of the form
  - Place a checkmark in the box to the right of the Job Classification you are choosing
  - Mark all Job Classifications that apply

    ****Do not write in any additional Classifications or Counties.****

Requestor Information:

- Enter the name of the person submitting the registration, their title with the company , and the date the registration is filled out

Return Completed Form:

- **Mail** the completed PW30R form (3 pages) to: NYSDOL Bureau of Public Work, SOBC – Bldg.12 – Rm.130, Albany, NY 12240 -***OR -***
- **Fax** the completed PW30R form (3 pages) to: NYSDOL Bureau of Public Work at (518)485-1870

Bureau of Public Work
Harriman State Office Campus
Building 12 - Room 130
Albany, New York 12240
Phone - (518) 457-5589 Fax - (518) 485-1870

Employer Registration for Use of 4 Day / 10 Hour Work Schedule

Before completing Form PW30R check to be sure …
There is a *Dispensation of Hours* in place on the project.
The 4 Day / 10 Hour Work Schedule applies to the Job Classifications you will be using.
The 4 Day / 10 Hour Work Schedule applies to the County / Counties where the work will take place.

Please Type or Print the Requested Information

When completed …
Mail to NYSDOL Bureau of Public Work, SOBC, Bldg. 12, Rm.130, Albany, NY 12240
-or-
Fax to NYSDOL Bureau of Public Work at (518) 485-1870

Contractor Information

Company Name: _____ FEIN: _____

Address: _____

City: _____ State: _____ Zip Code: _____

Phone Number _____ Fax Number: _____ Email Address: _____

Contact Person: _____

Phone No: _____ Fax No: _____ Email: _____

Project Information

Project PRC#: _____ Project Name/Type: _____

Exact Location of Project: _____ County: _____

(If you are Subcontractor)
Prime Contractor Name: _____

Job Classification(s) to Work 4/10 Schedule: *(Choose all that apply on Job Classification Checklist - Pages 3 -7)*
**** Do not write in any additional Classifications or Counties****

Requestor Information

Name: _____

Title: _____ Date : _____

Please use the list below with the number assigned to each county as a reference to the corresponding numbers listed in the following pages under "Entire Counties" & "Partial Counties".

1. Albany County
2. Allegany County
3. Bronx County
4. Broome County
5. Cattaraugus County
6. Cayuga County
7. Chautauqua County
8. Chemung County
9. Chenango County
10. Clinton County
11. Columbia County
12. Cortland County
13. Delaware County
14. Dutchess County
15. Erie County
16. Essex County
17. Franklin County
18. Fulton county
19. Genesee County
20. Greene County
21. Hamilton County
22. Herkimer County
23. Jefferson County
24. Kings County (Brooklyn)
25. Lewis County
26. Livingston County
27. Madison County
28. Monroe County
29. Montgomery County
30. Nassau County
31. New York County (Manhattan)
32. Niagara County
33. Oneida County
34. Onondaga County
35. Ontario County
36. Orange County
37. Orleans County
38. Oswego County
39. Otsego County
40. Putnam County
41. Queens County
42. Rensselaer County
43. Richmond County (Staten Island)
44. Rockland County
45. Saint Lawrence County
46. Saratoga County
47. Schenectady County
48. Schoharie County
49. Schuyler County
50. Seneca County
51. Steuben County
52. Suffolk County
53. Sullivan County
54. Tioga County
55. Tompkins County
56. Ulster County
57. Warren county
58. Washington County
59. Wayne County
60. Westchester County
61. Wyoming County
62. Yates County

Job Classification Checklist

(Place a checkmark by all classifications that will be using the 4/10 schedule)

**** Do not write in any additional Classifications or Counties****

Job Classification	Tag #	Entire Counties	Partial Counties	Check Box
Carpenter-Building	276B-All	7	2 ,5	☐
Carpenter-Building	276B-Cat	15	5	☐
Carpenter - Building	276-B--LIV	26, 28, 35, 59	61	☐
Carpenter-Building	276B-Gen	19, 32, 37	61	☐
Carpenter-Floor Layers	276B-FL-Liv	26, 28, 35, 59	61	☐
Carpenter-Heavy&Highway	276HH-All	2, 5, 7		☐
Carpenter-Heavy&Highway	276HH-Erie	15		☐
Carpenter-Heavy&Highway	276HH- Gen	19, 32, 37, 61		☐
Carpenter-Heavy&Highway	276HH-Liv	26, 28, 35, 59		☐
Carpenter-Residential	276R-All	7	2, 5	☐
Carpenter - Building	277B-Bro	4, 54		☐
Carpenter - Building	277B-CAY	6, 50, 62		☐
Carpenter - Building	277B-CS	8, 12, 49, 51, 55	2	☐
Carpenter - Building	277 JLS	23, 25, 45		☐
Carpenter - Building	277 omh	22, 27, 33		☐
Carpenter - Building	277 On	34		☐
Carpenter - Building	277 Os	38		☐
Carpenter - Building	277CDO Bldg	9, 13, 39		☐
Carpenter - Heavy&Highway	277CDO HH	9, 13, 39		☐
Carpenter - Heavy&Highway	277HH-BRO	4, 6, 8, 12, ,22, 23, 25, 27, 33, 34, 38, 45, 49, 50, 51, 54, 55, 62		☐
Carpenter - Building	291B-Alb	1, 18, 20, 29, 42, 47, 48		☐
Carpenter - Building	291B-Cli	10, 16, 17		☐
Carpenter - Building	291B-Ham	21, 57, 58		☐
Carpenter - Building	291B-Sar	46		☐
Carpenter - Heavy&Highway	291HH-Alb	1, 10, 16, 17,18, 20, 21, 29, 42, 46, 47, 48, 57, 58		☐
Electrician	25m	30, 52		☐
Electrician-Teledata Cable Splicer	43	12, 22, 27, 33, 38	6, 9, 34, 39, 55, 59	☐

Job Classification Checklist

(Place a checkmark by all classifications that will be using the 4/10 schedule)

**** Do not write in any additional Classifications or Counties****

Job Classification	Tag #	Entire Counties	Partial Counties	Check Box
Electrician	86	26, 28	19, 35, 37, 59, 61	☐
Electrician	840Teledata and 840 Z1	62	6, 34, 35, 50, 59	☐
Electrician	910	10, 16, 17, 23, 25, 45		☐
Electrician Lineman	1049Line/Gas	30, 41, 52		☐
Electrician Lineman	1249a	1, 2, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 25, 26, 27, 28, 29, 32, 33, 34, 35, 36, 37, 38, 39, 40, 42, 44, 46, 47, 48, 49, 50, 45, 51, 53, 54, 55, 56, 57, 58, 59, 61, 62		☐
Electrical Lineman	1249a West	60		☐
Electrical Lineman	1249a-LT	1, 2, 4, 5, 6, 7, 8, 9, 10, 12, 13, 15, 16, 17, 18, 19, 20, 21, 22, 23, 25, 26, 27, 28, 29, 32, 33, 34, 35, 37, 38, 39, 42, 46, 47, 48, 49, 50, 45, 51, 53, 54, 55, 57, 58, 59, 61, 62		☐
Electrical Lineman	1249aREG8LT	11, 14, 36, 40, 44, 56		☐
Electrical Lineman	1249aWestLT	60		☐
Elevator Constructor	138	11, 14, 20, 36, 40, 53, 56	13, 44, 60	☐
Elevator Constructor	14	2, 5, 7, 15, 19, 32, 37, 61		☐
Elevator Constructor	27	8, 26, 28, 35, 49, 50, 51, 59, 62		☐
Elevator Constructor	35	1, 10, 16, 18, 21, 22, 29, 39, 42, 46, 47, 48, 57, 58		☐
Elevator Constructor	62.1	4, 6, 9, 12, 23, 25, 27, 33, 34, 38, 45, 54, 55	13	☐
Glazier	201	1, 10, 11, 16, 17, 18, 20, 21, 29, 42, 46, 47, 48, 57, 58		☐
Glazier	660r	2, 5, 7, 15, 19, 32, 37, 61		☐
Glazier	660	2, 5, 7, 15, 19, 32, 37, 61		☐
Glazier	677.1	23, 25, 26, 28, 35, 45, 50, 59, 62		☐
Glazier	677Z-2	6, 12, 22, 27, 33, 34, 38		☐
Glazier	677z3	4, 8, 9, 13, 39, 49, 51, 54, 55		☐
Glazier	677r.2	6, 12, 22, 27, 33, 34, 38		☐
Insulator - Heat & Frost	30-Syracuse	4, 6, 8, 9, 12, 22, 23, 25, 27, 33, 34, 38, 39, 49, 50, 45, 54, 55		☐
Laborers- Tunnel	157	47	18, 29, 46	☐
Laborers- Heavy & Highway	157h/h	47	18, 29, 46	☐

Job Classification Checklist

(Place a checkmark by all classifications that will be using the 4/10 schedule)

**** Do not write in any additional Classifications or Counties****

Job Classification	Tag #	Entire Counties	Partial Counties	Check Box
Laborers- Heavy & Highway	1822/2h	10,16,57		☐
Laborers- Heavy & Highway	1822/2h(2)	17, 23, 25, 45		☐
Laborers- Tunnel	1822T	10, 16 57		☐
Laborers- Tunnel	1822T(2)	17, 23, 25, 45		☐
Laborers- Tunnel	35T	21, 22, 27, 33	18, 29	☐
Laborers- Tunnel	190	1, 42, 58	11, 20, 46	☐
Laborers- Heavy & Highway	190 h/h	1, 42, 58	11, 20, 46	☐
Laborers- Heavy & Highway	35/2h	21, 22, 27, 33	18, 29	☐
Laborers- Tunnel	35T	21, 22, 27, 33	18, 29	☐
Laborers- Heavy & Highway	633hON	34		☐
Laborers- Heavy & Highway	633hOS	38		☐
Laborers- Heavy & Highway	633h Cay	6		☐
Laborers- building	633 bON	34		☐
Laborers- building	633b Cay	6		☐
Laborers- building	633bOS	38		☐
Laborers- Tunnel	633T (Cay)	6		☐
Laborers- Tunnel	633T (ON)	34		☐
Laborers- Tunnel	633T (OS)	38		☐
Laborers- Heavy & Highway	785h	12, 55	49, 54	☐
Laborers-Tunnel	785T	12, 55		☐
Laborers - Building	785(7)	4	9, 13, 54	☐
Laborers - Building	785B-CS	8, 51	49	☐
Laborers- Heavy & Highway	7-785b	12, 55	49, 54	☐
Laborers Heavy & Highway	785(7)	4	9, 13, 54	☐
Laborer - Heavy & Highway	785HH-CS	8, 51	49	☐
Laborer - Building	621b	2, 7	5	☐
Laborer - Residential	621r	2, 7	5	☐

Job Classification Checklist

(Place a checkmark by all classifications that will be using the 4/10 schedule)

**** Do not write in any additional Classifications or Counties****

Job Classification	Tag #	Entire Counties	Partial Counties	Check Box
Mason-Building	2TS.1	1, 10,11, 16, 17, 18, 20, 21, 29, 42, 46, 47, 48, 57, 58		☐
Mason-Building	2TS.2	22, 23, 25, 33, 45	27	☐
Mason-Building	2TS.3	6, 34, 38	27	☐
Mason-Building	2b-on	34		☐
Mason-Building	2b.1	1, 11, 18, 20, 21, 29, 42, 46, 47, 48, 58	57	☐
Mason-Building	2b.2	22, 33	25	☐
Mason-Building	2b.3	6, 34	27	☐
Mason-Building	2b.4	38		☐
Mason-Building	2b.5	23	25	☐
Mason-Building	2b.6	45		☐
Mason-Building	2b.8	10, 16, 17	57	☐
Mason-Building	2b.5	23	25	☐
Mason-Building	2b.6	45		☐
Mason-Building	2b.8	10, 16, 17	57	☐
Mason-Building	3b-Co-Z2	8, 49, 51	2	☐
Mason-Building	3B-Z1	19, 26, 28, 35, 50, 59, 61, 62		☐
Mason-Building-Residential	3B-Z1R	19, 26, 28, 35, 50, 59, 61, 62		☐
Mason-Building	3B-Bing-Z2	4, 9, 13, 39, 54		☐
Mason-Building	3B-Ith-Z2	12, 55		☐
				☐
				☐
				☐
				☐
				☐
				☐

Job Classification Checklist

(Place a checkmark by all classifications that will be using the 4/10 schedule)

**** Do not write in any additional Classifications or Counties****

Job Classification	Tag #	Entire Counties	Partial Counties	Check Box
Mason-Building	3B-Jam-Z2	7	2, 5	☐
Mason-Building-Residential	3B-Jam-Z2R	2, 4, 8, 7, 9, 12, 39, 13, 49, 51, 54, 55	5	☐
Mason-Building	3B-Z3	15, 32	5	☐
Mason-Building	3B-Z3.Orleans	37		☐
Mason-Residential	3B-Z3R	15, 32	5	☐
Mason-Residential	3B-Z3R.Orleans	37		☐
Mason-Heavy Highway	3h	2, 4, 8, 7, 9, 12, 13, 19, 26, 28, 35, 37, 39, 49, 50, 51, 54, 55, 59, 61, 62	5, 15, 32	☐
Mason-Tile Finisher	3TF-Z1	19, 26, 28, 35, 50, 59, 61, 62		☐
Mason-Tile Finisher	3TF-Z2	2, 4, 8, 7, 9, 12, 13, 39, 49, 51, 54, 55	5	☐
Mason-Tile Finisher	3TF-Z3	15, 32, 37	5	☐
Mason-Tile Finisher	3TF-Z1R	19, 26, 28, 35, 50, 59, 61, 62		☐
Mason-Tile Finisher	3TF-Z2R	2, 4, 7, 9, 12, 13, 39, 49, 51, 54, 55	5	☐
Mason-Tile Finisher	3TF-Z3R	15, 32, 37	5	☐
Mason-Tile Setter	3TS-Z1	19, 26, 28, 35, 50, 59, 61, 62		☐
Mason-Tile Setter Residential	3TS-Z1R	19, 26, 28, 35, 50, 59, 61, 62		☐
Mason-Tile Setter	3TS-Z2	2, 4, 7, 8, 9, 12, 13, 39, 49, 51, 54, 55	5	☐
Mason-Tile Setter Residential	3TS-Z2R	2, 4, 7, 8, 9, 12, 13, 39, 49, 51, 54, 55	5	☐
Mason-Tile Setter Residential	3TS-Z3R	15, 32, 37	5	☐
Mason - Building/Heavy&Highway	780	3, 24, 30, 31, 41, 43, 52		☐
Operating Engineer - Heavy/Highway	137H/H	40, 60	14	☐
Operating Engineer - Heavy& Highway	158-832H	2, 8, 26, 28, 35, 49, 51, 59, 62	19	☐
Operating Engineer - Heavy& Highway	158-H/H	1, 4, 9, 10, 11, 14, 16, 17, 18, 20, 21, 22, 29, 39, 42, 46, 47, 48, 54, 57, 58		☐
Operating Engineer - Heavy& Highway	158-545h	6, 12, 23, 25, 27, 33, 38, 45, 50, 55		☐
Painter	1456-LS	1, 3, 10, 11, 14, 16, 17, 18, 20, 21, 24, 29, 30, 31, 36, 40, 41, 42, 43, 44, 46, 47, 48, 52, 53, 56, 57, 58, 60		☐
Painter	150	28, 59, 62	26, 35	☐

Job Classification Checklist

(Place a checkmark by all classifications that will be using the 4/10 schedule)

**** Do not write in any additional Classifications or Counties****

Job Classification	Tag #	Entire Counties	Partial Counties	Check Box
Painter	178 B	4, 9, 54		☐
Painter	178 E	8, 49	51	☐
Painter	178 I	12, 55		☐
Painter	178 O	13, 39		☐
Painter	31	6, 22, 27, 33, 34, 50	25, 35, 38	☐
Painter	38.O		38	☐
Painter	38.W	23, 45	25	☐
Painter	4-Buf,Nia,Olean	2, 15, 19, 32, 37, 61	5, 7, 26, 51	☐
Painter	4-Jamestown		5, 7	☐
Painter	38.O		38	☐
Painter	38.W	23, 45	25	☐
Painter	4-Buf,Nia,Olean	2, 15, 19, 32, 37, 61	5, 7, 26, 51	☐
Painter	4-Jamestown		5, 7	☐
Sheetmetal Worker	46	26, 28, 35, 50, 59, 62		☐
Sheetmetal Worker	46r	26, 28, 35, 50, 59, 62		☐
Teamsters-Heavy&Highway	294h/h	1, 11, 18, 20, 29, 42, 46, 47, 48, 58	57	☐
Teamsters-Heavy&Highway	317bhh	6, 12, 50, 51, 55, 62	2	☐
Teamsters-Building/Heavy&Highway	456	40, 60		☐

Introduction to the Prevailing Rate Schedule

Information About Prevailing Rate Schedule

This information is provided to assist you in the interpretation of particular requirements for each classification of worker contained in the attached Schedule of Prevailing Rates.

Classification

It is the duty of the Commissioner of Labor to make the proper classification of workers taking into account whether the work is heavy and highway, building, sewer and water, tunnel work, or residential, and to make a determination of wages and supplements to be paid or provided. It is the responsibility of the public work contractor to use the proper rate. If there is a question on the proper classification to be used, please call the district office located nearest the project. District office locations and phone numbers are listed below.

Prevailing Wage Schedules are issued separately for "General Construction Projects" and "Residential Construction Projects" on a county-by-county basis.

General Construction Rates apply to projects such as: Buildings, Heavy & Highway, and Tunnel and Water & Sewer rates.

Residential Construction Rates generally apply to construction, reconstruction, repair, alteration, or demolition of one family, two family, row housing, or rental type units intended for residential use.

Some rates listed in the Residential Construction Rate Schedule have a very limited applicability listed along with the rate. Rates for occupations or locations not shown on the residential schedule must be obtained from the General Construction Rate Schedule. Please contact the local Bureau of Public Work office before using Residential Rate Schedules, to ensure that the project meets the required criteria.

Paid Holidays

Paid Holidays are days for which an eligible employee receives a regular day's pay, but is not required to perform work. If an employee works on a day listed as a paid holiday, this remuneration is in addition to payment of the required prevailing rate for the work actually performed.

Overtime

At a minimum, all work performed on a public work project in excess of eight hours in any one day or more than five days in any workweek is overtime. However, the specific overtime requirements for each trade or occupation on a public work project may differ. Specific overtime requirements for each trade or occupation are contained in the prevailing rate schedules.

Overtime holiday pay is the premium pay that is required for work performed on specified holidays. It is only required where the employee actually performs work on such holidays.

The applicable holidays are listed under HOLIDAYS: OVERTIME. The required rate of pay for these covered holidays can be found in the OVERTIME PAY section listings for each classification.

Supplemental Benefits

Particular attention should be given to the supplemental benefit requirements. In most cases the payment or provision of supplements is for each hour worked (noted in the schedule as 'Per hour worked'). Some classifications require the payment or provision of supplements for each hour paid (noted in the schedule as 'Per hour paid'), which require supplements to be paid or provided at a premium rate for premium hours worked. Some classifications may also require the payment or provision of supplements for paid holidays on which no work is performed.

Effective Dates

When you review the schedule for a particular occupation, your attention should be directed to the dates above the column of rates. These are the dates for which a given set of rates is effective. The rate listed is valid until the next effective rate change or until the new annual determination which takes effect on July 1 of each year. All contractors and subcontractors are required to pay the current prevailing rates of wages and supplements. If you have any questions please contact the Bureau of Public Work or visit the New York State Department of Labor website (www.labor.state.ny.us) for current wage rate information.

Apprentice Training Ratios

The following are the allowable ratios of registered Apprentices to Journey-workers.

For example, the ratio 1:1,1:3 indicates the allowable initial ratio is one Apprentice to one Journeyworker. The Journeyworker must be in place on the project before an Apprentice is allowed. Then three additional Journeyworkers are needed before a second Apprentice is allowed. The last ratio repeats indefinitely. Therefore, three more Journeyworkers must be present before a third Apprentice can be hired, and so on.

Please call Apprentice Training Central Office at (518) 457-6820 if you have any questions.

Title (Trade)	Ratio
Boilermaker (Construction)	1:1,1:4
Boilermaker (Shop)	1:1,1:3
Carpenter (Bldg.,H&H, Pile Driver/Dockbuilder)	1:1,1:4
Carpenter (Residential)	1:1,1:3

Electrical (Outside) Lineman	1:1,1:2
Electrician (Inside)	1:1,1:3
Elevator/Escalator Construction & Modernizer	1:1,1:2
Glazier	1:1,1:3
Insulation & Asbestos Worker	1:1,1:3
Iron Worker	1:1,1:4
Laborer	1:1,1:3
Mason	1:1,1:4
Millwright	1:1,1:4
Op Engineer	1:1,1:5
Painter	1:1,1:3
Plumber & Steamfitter	1:1,1:3
Roofer	1:1,1:2
Sheet Metal Worker	1:1,1:3
Sprinkler Fitter	1:1,1:2

If you have any questions concerning the attached schedule or would like additional information, please contact the nearest BUREAU of PUBLIC WORK District Office or write to:

New York State Department of Labor
Bureau of Public Work
State Office Campus, Bldg. 12
Albany, NY 12240

District Office Locations:	Telephone #	FAX #
Bureau of Public Work - Albany	518-457-2744	518-485-0240
Bureau of Public Work - Binghamton	607-721-8005	607-721-8004
Bureau of Public Work - Buffalo	716-847-7159	716-847-7650
Bureau of Public Work - Garden City	516-228-3915	516-794-3518
Bureau of Public Work - Newburgh	845-568-5287	845-568-5332
Bureau of Public Work - New York City	212-932-2419	212-775-3579
Bureau of Public Work - Patchogue	631-687-4882	631-687-4902
Bureau of Public Work - Rochester	585-258-4505	585-258-4708
Bureau of Public Work - Syracuse	315-428-4056	315-428-4671
Bureau of Public Work - Utica	315-793-2314	315-793-2514
Bureau of Public Work - White Plains	914-997-9507	914-997-9523
Bureau of Public Work - Central Office	518-457-5589	518-485-1870

Orange County General Construction

Boilermaker 10/01/2016

JOB DESCRIPTION Boilermaker **DISTRICT** 4

ENTIRE COUNTIES
Bronx, Dutchess, Kings, Nassau, New York, Orange, Putnam, Queens, Richmond, Rockland, Suffolk, Sullivan, Ulster, Westchester

WAGES

Per Hour:	07/01/2016
Boilermaker	$ 51.56
Repairs & Renovations	$ 51.56

SUPPLEMENTAL BENEFITS

Per Hour:	07/01/2016
Boilermaker	32% of hourly
Repairs & Renovations	Wage Paid
	+ $25.19

NOTE: "Hourly Wage Paid" shall include any and all premium(s) pay.

Repairs & Renovation Includes replacement of parts and repairs & renovation of existing unit.

OVERTIME PAY
OVERTIME PAY
See (D, O) on OVERTIME PAGE
HOLIDAY
Paid: See (8, 16, 23, 24) on HOLIDAY PAGE
Overtime: See (5, 6, 11, 12, 15, 25) on HOLIDAY PAGE
NOTE: *Employee must work in pay week to receive Holiday Pay.
**Boilermarker gets 4 times the hourly wage rate for working on Labor Day.
***Repairs & Renovation see (B,E,Q) on HOLIDAY PAGE

HOLIDAY

REGISTERED APPRENTICES
Wage per hour:
(1/2) Year Terms at the following pecentage of Boilermaker's Wage

1st	2nd	3rd	4th	5th	6th	7th	8th
65%	65%	70%	75%	80%	85%	90%	95%

Supplemental Benefits Per Hour:

	07/01/2016
Apprentice(s)	32% of Hourly Wage Paid Plus Amount Below
1st Term	$ 19.27
2nd Term	20.11
3rd Term	20.95
4th Term	21.80
5th Term	22.65
6th Term	23.49
7th Term	24.33

NOTE: "Hourly Wage Paid" shall include any and all premium(s)

4-5

Carpenter 10/01/2016

JOB DESCRIPTION Carpenter **DISTRICT** 8

ENTIRE COUNTIES
Bronx, Dutchess, Kings, Nassau, New York, Putnam, Queens, Richmond, Rockland, Suffolk, Westchester

PARTIAL COUNTIES

Orange: The area lying on Southern side of Orange County demarcated by a line drawn from the Bear Mountain Bridge continuing east to the Bear Mountain Circle, continue North on 9W to the town of Cornwall where County Road 107 (also known as Quaker Rd) crosses under 9W, then east on County Road 107 to Route 32, then north on Route 32 to Orrs Mills Rd, then west on Orrs Mills Rd to Route 94, continue west and south on Route 94 to the Town of Chester, to the intersection of Kings Highway, continue south on Kings Highway to Bellvale Rd, west on Bellvale Rd to Bellvale Lakes Rd, then south on Bellvale Lakes Rd to Kain Rd, southeast on Kain Rd to Route 17A, then north and southeast along Route 17A to Route 210, then follow Route 210 to NJ Border.

WAGES

Per hour:	07/01/2016
Carpet/Resilient Floor Coverer	$ 50.50

INCLUDES HANDLING & INSTALLATION OF ARTIFICIAL TURF AND SIMILAR TURF INDOORS/OUTDOORS.

SUPPLEMENTAL BENEFITS

Per hour paid:

Floor Coverer	$ 45.85

OVERTIME PAY

See (B, E, Q) on OVERTIME PAGE

HOLIDAY

Paid:	See (18, 19)on HOLIDAY PAGE.
Paid: for 1st & 2nd yr. Apprentices	See (5,6,11,13,16,18,19,25)
Overtime:	See (5,6,11,13,16,18,19,25) on HOLIDAY PAGE.

REGISTERED APPRENTICES

Wage per hour is Pecentage of Journeyworkers Wage

(1) year terms:

1st.	2nd.	3rd.	4th.
$20.20	$25.25	$32.83	$40.40

Supplemental benefits per hour:

$ 31.11

8-2287

Carpenter 10/01/2016

JOB DESCRIPTION Carpenter **DISTRICT** 8

ENTIRE COUNTIES

Bronx, Dutchess, Kings, Nassau, New York, Orange, Putnam, Queens, Richmond, Rockland, Suffolk, Westchester

WAGES

Per Hour:	07/01/2016
Marine Construction:	
Marine Diver	$ 65.38
Marine Tender	46.44

SUPPLEMENTAL BENEFITS

Per Hour Paid:

Journeyman	$ 48.62

OVERTIME PAY

See (B, E, E2, Q) on OVERTIME PAGE

HOLIDAY

Paid:	See (18, 19) on HOLIDAY PAGE
Overtime:	See (5, 6, 10, 11, 13, 16, 18, 19) on HOLIDAY PAGE

8-1456MC

Carpenter 10/01/2016

JOB DESCRIPTION Carpenter **DISTRICT** 8

ENTIRE COUNTIES
Bronx, Kings, Nassau, New York, Queens, Richmond, Rockland, Westchester

PARTIAL COUNTIES
Orange: South of but including the following, Waterloo Mills, Slate Hill, New Hampton, Goshen, Blooming Grove, Mountainville, east to the Hudson River.
Putnam: South of but including the following, Cold Spring, TompkinsCorner, Mahopac, Croton Falls, east to Connecticut border.
Suffolk: West of Port Jefferson and Patchogue Road to Route 112 to the Atlantic Ocean.

WAGES

Per hour:	07/01/2016	10/17/2016 Additional
Core Drilling:		
Driller	$ 37.82	$ 2.21
Driller Helper	$ 30.17	$ 1.94

Additional Helpers: One (1) year increments. This is not an apprenticeship for Driller:

Helper 1st year	$ 21.12
Helper 2nd year	24.14
Helper 3rd year	27.15
Helper 4th year	30.17

Note: Hazardous Waste Pay Differential:
For Level C, an additional 10% above wage rate per hour
For Level B, an additional 10% above wage rate per hour
For Level A, an additional 10% above wage rate per hour
Note: When required to work on water: an additional $ 0.50 per hour.

SUPPLEMENTAL BENEFITS

Per hour paid:	07/01/2016	10/17/2016
Driller and All Helpers	$ 24.00	$ 24.00

OVERTIME PAY
OVERTIME: See (B,E,K*,P,R**) on OVERTIME PAGE.

HOLIDAY
Paid: See (5,6) on HOLIDAY PAGE.
Overtime: * See (5,6) on HOLIDAY PAGE.
** See (8,10,11,13) on HOLIDAY PAGE.

8-1536-CoreDriller

Carpenter 10/01/2016

JOB DESCRIPTION Carpenter **DISTRICT** 8

ENTIRE COUNTIES
Dutchess, Orange

WAGES

Per hour:	07/01/2016
Building:	
Millwright	$ 40.89

SUPPLEMENTAL BENEFITS

Per hour paid:	
Journeyman	$ 39.04

OVERTIME PAY
See (B, E, E2, Q) on OVERTIME PAGE

HOLIDAY
HOLIDAY:
Paid: See (18,19) on HOLIDAY PAGE.
Paid: See (5,6,11,13,16,18,19,25) for 1st & 2nd yr.Apprentices
Overtime: See (5,6,11,13,16,18,19,25) on HOLIDAY PAGE.

REGISTERED APPRENTICES
Wages per hour:

(1) year terms at the following percentage of Journeyman's wage.

1st	2nd	3rd	4th
$22.49	$26.58	$30.67	$38.85

Supplemental benefits per hour:

1st	2nd	3rd	4th
$27.30	$29.58	$32.36	$36.43

8-740.2

Carpenter - Building / Heavy&Highway 10/01/2016

JOB DESCRIPTION Carpenter - Building / Heavy&Highway **DISTRICT** 2

ENTIRE COUNTIES
Albany, Allegany, Broome, Cattaraugus, Cayuga, Chautauqua, Chemung, Chenango, Clinton, Columbia, Cortland, Delaware, Erie, Essex, Franklin, Fulton, Genesee, Greene, Hamilton, Herkimer, Jefferson, Lewis, Livingston, Madison, Monroe, Montgomery, Niagara, Oneida, Onondaga, Ontario, Orleans, Oswego, Otsego, Rensselaer, Saratoga, Schenectady, Schoharie, Schuyler, Seneca, St. Lawrence, Steuben, Sullivan, Tioga, Tompkins, Ulster, Warren, Washington, Wayne, Wyoming, Yates

PARTIAL COUNTIES
Orange: The area lying on Northern side of Orange County demarcated by a line drawn from the Bear Mountain Bridge continuing east to the Bear Mountain Circle, continue North on 9W to the town of Cornwall where County Road 107 (also known as Quaker Rd) crosses under 9W, then east on County Road 107 to Route 32, then north on Route 32 to Orrs Mills Rd, then west on Orrs Mills Rd to Route 94, continue west and south on Route 94 to the Town of Chester, to the intersection of Kings Highway, continue south on Kings Highway to Bellvale Rd, west on Bellvale Rd to Bellvale Lakes Rd, then south on Bellvale Lakes Rd to Kain Rd, southeast on Kain Rd to Route 17A, then north and southeast along Route 17A to Route 210, then follow Route 210 to NJ Border.

WAGES
Wages per hour:

	07/01/2016	07/01/2017	07/01/2018
Carpenter - ONLY for Artificial Turf/Synthetic Sport Surface	$ 29.10	Additional $ 1.50	Additional $ 1.50

Note - Does not include the operation of equipment. Please see Operating Engineers rates.

SUPPLEMENTAL BENEFITS
Per hour worked plus paid holidays:

Journeyman $ 20.73

OVERTIME PAY
See (B, E, Q) on OVERTIME PAGE

HOLIDAY
Paid: See (2, 17) on HOLIDAY PAGE
Overtime: See (5, 6, 16) on HOLIDAY PAGE
Notes:
When a holiday falls upon a Saturday, it shall be observed on the preceding Friday. Whan a holiday falls upon a Sunday, it shall be observed on the following Monday.
An employee taking an unexcused day off the regularly scheduled day before or after a paid Holiday shall not receive Holiday pay.

REGISTERED APPRENTICES
Wages per hour:

One year terms at the following percentage of Journeyman's wage:

1st	2nd	3rd	4th
50%	60%	70%	80%

Supplemental Benefits per hour paid:

1st year term	$ 10.70
2nd year term	10.70
3rd year term	13.30
4th year term	13.30

2-42AtSS

Carpenter - Building / Heavy&Highway 10/01/2016

JOB DESCRIPTION Carpenter - Building / Heavy&Highway **DISTRICT** 11

ENTIRE COUNTIES
Columbia, Dutchess, Orange, Sullivan, Ulster

WAGES
WAGES:(per hour)

	07/01/2016	01/01/2017 Additional
Carpenter	$ 34.69	$ 0.80**
Carpenter-Floor Coverer*	34.69	
Dockbuilder/Piledriver	34.69	
Diver Tender	34.69	
Diver(WET)	50.00	
Diver(DRY)	34.69	

**To be allocated at a later date.

SHIFT DIFFERENTIAL: When mandated by a Government Agency irregular or off shift can be worked. The Carpenter shall receive an additional fifteen (15) percent of wage plus applicable benefits.
* Note: Rate DOES NOT apply in Orange or Dutchess County.
On projects for removal and/or abatement of asbestos or any toxic or hazardous material and it is required by the employer or mandated by NYS or Federal Regulation to wear protective equipment an additional two (2) hours pay per day including benefits on all classifications including apprentices. For work on smokestacks, silos, or steeples more than fifty (50) feet high, an additional $2.00 per hour, payable from the ground up.

SUPPLEMENTAL BENEFITS
Per hour paid:
Journeyworker $ 26.63

OVERTIME PAY
See (B, E, Q) on OVERTIME PAGE

HOLIDAY
BUILDING:
Paid: See (1) on HOLIDAY PAGE.
Overtime: See (5, 6, 16, 25) on HOLIDAY PAGE.
HEAVY/HIGHWAY:
Paid: See (5, 6, 16, 25) on HOLIDAY PAGE including benefits.
Overtime: See (5*, 6*, 16**, 25**) on HOLIDAY PAGE.
* NOTE: For Holidays 5 and 6 code T applies, with benefits at straight time rate.
** NOTE: For Holidays 16 and 25 code Q applies, with benefits at straight time rate.

REGISTERED APPRENTICES
1 Year terms at the following wage rates.

1st	2nd	3rd	4th
$17.65	$20.66	$23.68	$26.70

Supplemental Benefits per hour paid:

Apprentices
All terms $ 15.70

11-279.2B/H&H

Electrician 10/01/2016

JOB DESCRIPTION Electrician **DISTRICT** 11

ENTIRE COUNTIES
Orange, Putnam, Rockland

PARTIAL COUNTIES
Dutchess: Towns of Fishkill, East Fishkill, and Beacon.

WAGES
Per hour:

	07/01/2016	04/01/2017
Electrician Wireman/Technician	$ 42.00	$ 42.50

*SHIFT DIFFERENTIAL: On Public Work in New York State when shift work is mandated either in the job specifications or by the contracting agency, the following rates apply:

Shift worked between 4:30pm & 12:30am	$ 49.28*	$ 49.87*

Shift worked between 12:30am & 8:30am	$ 55.20*	$ 55.86*

On jobs where employees are required to work from boatswain chairs, swinging scaffolds, etc.,forty (40) feet or more above the ground, or under compressed air, using Scottair packs, gas masks or in shafts or tunnels, they shall receive an additional $2.00 per hour above the regular straight time rate.
On jobs where a CDL, Asbestos License, Welding Certificate or Cable Splicing is required an additional $1.00 above the Journeyman rate is to be paid.

SUPPLEMENTAL BENEFITS
Per hour worked:

	07/01/2016	04/01/2017
Journeyman	$ 24.82 plus 6% of wage	$ 25.32 plus 6% of wage

OVERTIME PAY
See (B, E, Q) on OVERTIME PAGE

HOLIDAY
Paid: See (1) on HOLIDAY PAGE
Overtime: See (5, 6, 13, 15, 16, 25) on HOLIDAY PAGE

REGISTERED APPRENTICES
Wages:

(1)year terms at the following percentage of Journeyman's wage.*

1st	2nd	3rd	4th	5th	6th
30%	40%	50%	60%	70%	75%

* Denotes average Journeyman Wireman rate of all wage zones

Supplemental Benefits per hour worked:

	07/01/2016
1st term	$ 11.42 plus 6% of wage
2nd term	$ 12.92 plus 6% of wage
3rd term	$ 14.92 plus 6% of wage
4th term	$ 16.92 plus 6% of wage
5th & 6th term	$ 19.92 plus 6% of wage

11-363/1

Elevator Constructor 10/01/2016

JOB DESCRIPTION Elevator Constructor **DISTRICT** 1

ENTIRE COUNTIES
Columbia, Dutchess, Greene, Orange, Putnam, Sullivan, Ulster

PARTIAL COUNTIES
Delaware: Towns of Andes, Bovina, Colchester, Davenport, Delhi, Harpersfield, Hemdon, Kortright, Meredith, Middletown, Roxbury, Hancock & Stamford
Rockland: Only the Township of Stony Point.
Westchester: Only the Townships of Bedford, Lewisboro, Cortland, Mt. Kisco, North Salem, Pound Ridge, Somers and Yorktown.

WAGES

Per Hour	07/01/2016
Mechanic	$ 53.72
Helper	70% of Mechanic Wage Rate

Four (4), ten (10) hour days may be worked at straight time during a week, Monday thru Thursday.

NOTE - In order to use the '4 Day/10 Hour Work schedule', as your normal schedule, you must submit an 'Employer Registration for Use of 4 Day/10 Hour Work Schedule,' form PW30R; and there must be a dispensation of hours in place on the project. If the PW30R is not submitted you may be liable for overtime payments for work over 8 hours per day.

SUPPLEMENTAL BENEFITS
Per hour worked

07/01/2016

Journeyman/Helper
$ 29.985*

(*)Plus 6% of gross wages if less than 5 years service
(*)Plus 8% of gross wages if more than 5 years service

OVERTIME PAY
See (D, O) on OVERTIME PAGE

HOLIDAY
Paid: See (5, 6, 15, 16) on HOLIDAY PAGE
Overtime: See (5, 6, 15, 16) on HOLIDAY PAGE
Note: When a paid holiday falls on Saturday, it shall be observed on Friday. When a paid holiday falls on Sunday, it shall be observed on Monday.

REGISTERED APPRENTICES
Wages per hour:

0-6 mo*	6-12 mo	2nd yr	3rd yr	4th yr
50 %	55 %	65 %	70 %	80 %

*No supplemental benefits

Supplemental Benefits per hour worked:

Same as Journeyman/Helper

1-138

Glazier 10/01/2016

JOB DESCRIPTION Glazier **DISTRICT** 8

ENTIRE COUNTIES
Bronx, Dutchess, Kings, Nassau, New York, Orange, Putnam, Queens, Richmond, Rockland, Suffolk, Sullivan, Ulster, Westchester

WAGES

Per hour:	07/01/2016	11/01/2016 + additional $.85
Glazier	$ 53.55	
Scaffolding	$ 54.55	

Scafolding includes swing scaffold, mechanical equipment, scissor jacks, man lifts, booms & buckets 24' or more, but not pipe scaffolding.

Repair & Maintenance $ 26.88

Repair & Maintenance- All repair & maintenance work on a particular building,whenever performed, where the total cumulative contract value is under $121,550

SUPPLEMENTAL BENEFITS

Per hour paid:	07/01/2016	11/01/2016
Journeyworker	$ 28.94	$ 28.94
Repair & Maintenance	17.26	17.26

OVERTIME PAY
OVERTIME: Premium is applied to the respective base wage only.
See (C*,D* E2, O) on OVERTIME PAGE.

* If an optional 8th hour is required to complete the entire project, the same shall be paid at the regular rate of pay. If a 9th hour is worked, then both hours or more (8th & 9th or more) will be paid at double time rate of pay.

For Repair & Maintenance see (B,B2, F, P) on overtime page.

HOLIDAY
Paid: See (1) on HOLIDAY PAGE
Overtime: See (4, 6, 16, 25) on HOLIDAY PAGE
Paid for the Repair & Maintenance (5, 6, 16 & 25)

REGISTERED APPRENTICES
Wage per hour:
(1) year terms at the following wage rates:

	07/01/2016	11/01/2016

1st term	$ 18.20	$ 18.20
2nd term	26.44	26.44
3rd term	31.89	31.89
4th term	42.69	42.69

Supplemental Benefits:
(Per hour worked)

1st term	$ 14.24	$ 14.24
2nd term	19.67	19.67
3rd term	21.58	21.58
4th term	25.12	25.12

8-1281 (DC9 NYC)

Insulator - Heat & Frost 10/01/2016

JOB DESCRIPTION Insulator - Heat & Frost **DISTRICT** 8

ENTIRE COUNTIES
Dutchess, Orange, Putnam, Rockland, Westchester

WAGES

Per hour:	07/01/2016
Insulator	$ 49.45
Discomfort & Additional Training**	$ 52.41
Fire Stop Work*	$ 25.79

* Applies on all exclusive Fire Stop Work (When contract is for Fire Stop work only). No apprentices on these contracts only.

**Applies to work requiring; garb or equipment worn against the body not customarily worn by insulators;psychological evaluation;special training, including but not limited to "Yellow Badge" radiation training

Note: Additional $0.50 per hour for work 30 feet or more above floor or ground level.

SUPPLEMENTAL BENEFITS
(Per hour paid)

Journeyworker	$ 31.90
Discomfort & Additional Training	$ 33.89
Fire Stop Work:	
Journeyworker	$ 16.07

OVERTIME PAY
See (B, E, E2, Q, *T) on OVERTIME PAGE

HOLIDAY
Paid: See (1) on HOLIDAY PAGE.
Note: Last working day preceding Christmas and New Years day, workers shall work no later than 12:00 noon and shall receive 8 hrs pay.

Overtime: See (2*, 4, 6, 16, 25) on HOLIDAY PAGE.
*Note: Labor Day triple time if worked.

REGISTERED APPRENTICES
(1) year terms.

Insulator Apprentices:

1st	2nd	3rd	4th
$ 21.49	$ 26.15	$ 35.47	$ 40.14

Discomfort & Additional Training Apprentices:

1st	2nd	3rd	4th
$ 22.66	$ 27.62	$ 37.53	$ 42.49

Supplemental Benefits paid per hour paid:

Insulator Apprentices:

1st term	$ 13.19
2nd term	16.30
3rd term	22.55
4th term	25.68

Discomfort & Additional Training Apprentices:

1st term	$ 13.97
2nd term	17.30
3rd term	23.94
4th term	27.26

8-91

Ironworker 10/01/2016

JOB DESCRIPTION Ironworker **DISTRICT** 11

ENTIRE COUNTIES
Dutchess, Orange, Putnam, Rockland, Sullivan, Ulster

WAGES
Per hour:

	07/01/2016
Structural	$ 46.17
Reinforcing*	$ 46.17
Ornamental	$ 46.17
Chain Link Fence	$ 46.17

*NOTE: For Reinforcing classification ONLY, Ironworker 4-46Reinf rates apply in Rockland county's southern section (south of Convent Road and east of Blue Hills Road).

SUPPLEMENTAL BENEFITS
Per hour paid:

Journeyman	$ 34.24

OVERTIME PAY
OVERTIME:.....See (B*, E**, Q, V) on OVERTIME PAGE.
*Note: Double Time after 10 hours Monday thru Friday.
**Note: On Saturdays, double time after 8 hours.

HOLIDAY

Paid:	See (1) on HOLIDAY PAGE
Overtime:	See (5, 6, 16) on HOLIDAY PAGE

REGISTERED APPRENTICES
Wages:

(1) year terms at the following wage.

1st	2nd	3rd	4th
$ 23.09	$ 27.70	$ 32.32	$ 36.94

Supplemental Benefits per hour worked:

1st year	$ 29.15
2nd year	$ 30.17
3rd year	$ 31.18
4th year	$ 32.20

11-417

Laborer - Building 10/01/2016

JOB DESCRIPTION Laborer - Building **DISTRICT** 11

ENTIRE COUNTIES
Orange, Sullivan, Ulster

PARTIAL COUNTIES

Delaware: Only the Townships of Andes, Bovina, Davenport, Delhi, Franklin, Hamden, Harpersfield, Kortright, Meredith, Middletown, Roxbury, and Stamford.
Greene: Only the Township of Catskill.

WAGES

GENERAL LABORER: Flag person, portable generator tender, portable pump tender, pitman and dumpman, temporary heat tender, traffic control, air chipping hammer, acoustic pump, mixer, concrete laborer, demolition, excavation, gunite, general cleanup, grading, backfilling,landscaping, mason tender, jackhammer, pavement breaker, tampers, walk behind roller, pressure blasting, signalperson, buggies, wrecking, asphalt, blaster, chain saw, chipping machine, corrugate pipe, cleaning machine, cutting torch, discharge pipe, drill chuck tender, explosive handler, hydraulic splitter, mega mixer, power brush cutter, pump crete machine, rip rap, Drilling Equipment Only Where a Separate Air Compressor Unit Supplies Power, assembling and placing of gabion baskets.
PREMIUM LABORER: Asbestos abatement work, toxic and hazardous abatement, lead abatement work, environmental work.

WAGES:(per hour)

	07/01/2016
General	$ 33.25
Premium	37.80

These rates will cover all work within five feet of the building foundation line.

Shift Differential: On all Governmental mandated irregular or off shift work, an additional 25% of wage and benefits are required. The 25% shift differential will be paid on public works contract for shifts or irregular workdays outside the normal working hours for 2nd and 3rd shifts or irregular work day or when mandated or required by state, federal, county, local or other governmental agency contracts.

SUPPLEMENTAL BENEFITS

Per hour worked:
Journeyman $ 26.40

OVERTIME PAY

See (B, E, Q) on OVERTIME PAGE
Double time after the eigth hour on Saturday

HOLIDAY

Paid: See (1) on HOLIDAY PAGE
Overtime: See (5, 6) on HOLIDAY PAGE

REGISTERED APPRENTICES

(1) year terms at the following wage rates.

	07/01/2016
1st term	$ 18.29
2nd term	21.61
3rd term	24.94
4th term	28.26

Supplemental Benefits per hour worked:

Apprentices $ 20.85

11-17.BA

Laborer - Heavy&Highway 10/01/2016

JOB DESCRIPTION Laborer - Heavy&Highway **DISTRICT** 11

ENTIRE COUNTIES

Orange, Sullivan, Ulster

PARTIAL COUNTIES

Delaware: Only the Townships of Andes, Bovina, Middletown, Roxbury,Franklin, Hamden, Stamford, Delhi, Kortright, Harpersfield,Meredith, and Davenport.
Greene: Only the Township of Catskill.

WAGES

CLASS 1: Flagperson, gateperson.

CLASS 2: General laborer, chuck tender, nipper,powder carrier, magazine tender, concrete men, vibrator men, mason tender, mortar men, traffic control, custodial work, temporary heat, pump men, pit men, dump men, asphalt men, joint setter, signalman, pipe men, riprap, dry stone layers, jack hammer, bush hammer, pavement breaker, gunnite nozzle, men on mulching & seeding machines all seeding & sod laying, landscape work, walk behind self-prop, powers saws, grinder, groover, walk behind rollers and tampers of all types, burner men, filling and wiring of baskets for gabion walls, chain saw operator, railroad track laborers, power buggy & pumpcrete opers. fireproof sprayer, plaster & acoustic pumps, **(asbestos, toxic, lead or hazardous materials when protective clothing & equipment is not required), power brush cutter, retention liners, walk behind surface planer, chipping hammer, manhole and catch basin on inlet building, mortar mixer, laser men.
*Micropaving and crack sealing.

CLASS 3: Asbestos, toxic, bio remediation and phyto remediation, lead or hazardous materials abatement when protective clothing and equipment are required, blaster, Drilling Equipment Only Where a Separate Air Compressor Unit Supplies Power.

CLASS 4: Blaster, all laborers involved in pipejacking, and boring operations, asphalt screedman.

WAGES:(per hour)

	07/01/2016
CLASS 1	$ 31.15
CLASS 2	$ 35.90
CLASS 3	$ 40.15
CLASS 4	$ 44.25

*NOTE: Micropaving and crack sealing laborers shall receive $2.50 per hour over the CLASS 2 rate.
**NOTE: Asbestos, toxic, lead or hazardous materials when protective clothing & equipment is not required shall receive $ 2.00 per hour over the CLASS 2 rate.
SHIFT DIFFERENTIAL: On all NYS D.O.T. or other Governmental mandated irregular or off shift work, an additional 15% of wage on straight time pay.

SUPPLEMENTAL BENEFITS
Per hour paid:

Journeyman	$ 26.05

SHIFT DIFFERENTIAL: $ 27.62 for irregular or off shift work

OVERTIME PAY
See (B, E, P, *S) on OVERTIME PAGE

HOLIDAY
Paid: See (5, 6, 15, 25) on HOLIDAY PAGE
Overtime: See (*1) on HOLIDAY PAGE
*Note: If Saturday Holiday is worked code S applies.

REGISTERED APPRENTICES
(1)year 1000 hour terms at the following wage rates.

1st term	$ 18.29
2nd term	$ 21.61
3rd term	$ 24.94
4th term	$ 28.26

Supplemental Benefits per hour paid:

Apprentices	$ 20.85

11-17.1H/H

Laborer - Tunnel 10/01/2016

JOB DESCRIPTION Laborer - Tunnel **DISTRICT** 8

ENTIRE COUNTIES
Dutchess, Orange, Otsego, Sullivan, Ulster

PARTIAL COUNTIES
Chenango: Townships of Columbus, Sherburne and New Berlin
Columbia: Townships of Ancram, Claverack, Claremont, Copake, Galatin, Germantown, Greenport, Hillsdale, Hudson, Livingston, Philmont and Taconic
Delaware: Townships of Andes, Bovina, Middletown, Roxbury, Franklin, Hamden, Stamford, Delhi, Kortright, Harpersfield, Merideth and Davenport
Greene: Township of Catskill

WAGES
Per hour:

Class 1: All support laborers/ sandhogs working above the shaft or tunnel
Class 2: All laborers/sandhogs working in the shaft or tunnel
Class 4: Safety Miners

	07/01/2016	07/01/2017
Class 1	$ 45.50	$ 46.80
Class 2	$ 47.50	$ 48.85
Class 4	$ 53.50	$ 55.05

Toxic and hazardous waste, lead abatement and asbestos abatement work will be paid an additional $3.00 an hour

SUPPLEMENTAL BENEFITS
Per hour paid:

Journeyman	07/01/2016	07/01/2017
Straight Time:	$ 27.15	$ 28.40
Premium Time, Irregular Shifts, Saturday, Sunday, Holidays:	$ 40.35	$ 42.40

OVERTIME PAY
See (B, E, Q, V) on OVERTIME PAGE

HOLIDAY
Paid: See (5, 6, 15, 25) on HOLIDAY PAGE
Overtime: See (5, 6, 15, *16, 25) on HOLIDAY PAGE
* Double wages and benefits if worked
NOTE: Whenever a holidays falls on Sunday, it will be observed on the following Monday

8-17/235Tun

Laborer - Tunnel 10/01/2016

JOB DESCRIPTION Laborer - Tunnel **DISTRICT** 11

ENTIRE COUNTIES
Dutchess, Orange, Otsego, Sullivan, Ulster

PARTIAL COUNTIES
Chenango: Townships of Columbus, Sherburne and New Berlin.
Columbia: Townships of Ancram, Claverack, Claremont, Copake, Galatin, Germantown, Greenport, Hillsdale, Hudson, Livingston, Philmont and Taconic.
Delaware: Townships of Andes, Bovina, Middletown, Roxbury, Franklin, Hamden, Stamford, Delhi, Kortright, Harpersfield, Merideth and Davenport.
Greene: Township of Catskill

WAGES
Class 1: All support laborers/ sandhogs working above the shaft or tunnel.

Class 2: All laborers/sandhogs working in the shaft or tunnel.

Class 4: Safety Miners

WAGES: (per hour)

	07/01/2016	07/01/2017
Class 1	$45.50	$ 46.80
Class 2	$47.50	$ 48.85
Class 4	$53.50	$ 55.05

Toxic and hazrdous waste, lead abatementand asbestos abatement work will be paid an additional $ 3.00 an hour.

SHIFT DIFFERENTIAL: 2nd and 3rd shift or an irregular shift shall be paid at time and one half the regular rate Monday through Friday.
Saturday shall be paid at 1.65 times the regular rate.
Sunday shall be paid at 2.15 times the regular rate.

SUPPLEMENTAL BENEFITS
Per hour paid:

Journeyman	$ 27.15 on straight hours	$ 28.40 on straight hours
	$ 40.60 on shift work, overtime, irregular work, Saturday, Sunday and Holiday hours.	

OVERTIME PAY

See (B, E, Q, V) on OVERTIME PAGE

HOLIDAY
Paid: See (5, 6, 15, 25) on HOLIDAY PAGE
Overtime: See (5, 6, 15, *16, 25) on HOLIDAY PAGE
* Double rate and benefits if worked

11-17Tun

Lineman Electrician 10/01/2016

JOB DESCRIPTION Lineman Electrician **DISTRICT** 6

ENTIRE COUNTIES
Albany, Allegany, Broome, Cattaraugus, Cayuga, Chautauqua, Chemung, Chenango, Clinton, Columbia, Cortland, Delaware, Dutchess, Erie, Essex, Franklin, Fulton, Genesee, Greene, Hamilton, Herkimer, Jefferson, Lewis, Livingston, Madison, Monroe, Montgomery, Niagara, Oneida, Onondaga, Ontario, Orange, Orleans, Oswego, Otsego, Putnam, Rensselaer, Rockland, Saratoga, Schenectady, Schoharie, Schuyler, Seneca, St. Lawrence, Steuben, Sullivan, Tioga, Tompkins, Ulster, Warren, Washington, Wayne, Wyoming, Yates

WAGES
Per hour:

NOTE: Includes Teledata Work within ten (10) feet of High Voltage Transmission Lines

Below rates applicable on all overhead and underground distribution and maintenance work, and all overhead and underground transmission line work and the installation of fiber optic cable where no other construction trades are or have been involved. (Ref #14.01.01)

	07/01/2016
Lineman, Technician	$ 47.95
Crane, Crawler Backhoe	47.95
Welder, Cable Splicer	47.95
Digging Machine Operator	43.16
Tractor Trailer Driver	40.76
Groundman, Truck Driver	38.36
Equipment Mechanic	38.36
Flagman	28.77

Additional $1.00 per hour for entire crew when a helicopter is used.

Below rates applicable on all electrical sub-stations, switching structures, fiber optic cable and all other work not defined as "Utility outside electrical work". (Ref #14.02.01-A)

Lineman, Technician	$ 47.95
Crane, Crawler Backhoe	47.95
Cable Splicer	52.75
Cert. Welder-Pipe Type Cable	50.35
Digging Machine Operator	43.16
Tractor Trailer Driver	40.76
Groundman, Truck Driver	38.36
Equipment Mechanic	38.36
Flagman	28.77

Additional $1.00 per hour for entire crew when a helicopter is used.

Below rates apply on switching structures, maintenance projects, railroad catenary install/maintenance third rail installation, bonding of rails and pipe type cable and installation of fiber optic cable. (Ref #14.02.01-B)

Lineman, Technician, Welder	$ 49.27
Crane, Crawler Backhoe	49.27
Cable Splicer	54.20
Cert. Welder-Pipe Type Cable	51.73
Digging Machine Operator	44.34
Tractor Trailer Driver	41.88
Groundman, Truck Driver	39.42
Equipment Mechanic	39.42
Flagman	29.56

Additional $1.00 per hour for entire crew when a helicopter is used.

Below rates applicable on all overhead and underground transmission line work & fiber optic cable where other construction trades are or have been involved. This applies to transmission line work only, not other construction. (Ref #14.03.01)

Lineman, Technician, Welder	$ 50.46
Crane, Crawler Backhoe	50.46
Cable Splicer	50.46
Digging Machine Operator	45.41
Tractor Trailer Driver	42.89
Groundman, Truck Driver	40.37
Equipment Mechanic	40.37
Flagman	30.28

Additional $1.00 per hour for entire crew when a helicopter is used.

NOTE: THE FOLLOWING RATES WILL APPLY ON ALL CONTRACTING AGENCY MANDATED MULTIPLE SHIFTS OF AT LEAST FIVE (5) DAYS DURATION WORKED BETWEEN THE HOURS LISTED BELOW:

1ST SHIFT	8:00 AM to 4:30 PM REGULAR RATE
2ND SHIFT	4:30 PM to 1:00 AM REGULAR RATE PLUS 17.3 %
3RD SHIFT	12:30 AM to 9:00 AM REGULAR RATE PLUS 31.4 %

** IMPORTANT NOTICE **
Four (4), ten (10) hour days may be worked at straight time during a week, Monday thru Thursday. Friday may be used as a make-up day.
*Effective 05/06/2013, Tuesday thru Friday may be worked with no make-up day.

NOTE - In order to use the '4 Day/10 Hour Work schedule', as your normal schedule, you must submit an 'Employer Registration for Use of 4 Day/10 Hour Work Schedule,' form PW30R; and there must be a dispensation of hours in place on the project. If the PW30R is not submitted you may be liable for overtime payments for work over 8 hours per day.

SUPPLEMENTAL BENEFITS
Per hour worked (but also required on non-worked holidays):

The following SUPPLEMENTAL BENEFITS apply to all classification categories of CONSTRUCTION, TRANSMISSION and DISTRIBUTION.

Journeyman	$ 21.75 *plus 7.25% of hourly wage

*The 7.25% is based on the hourly wage paid, straight time rate or premium rate.

OVERTIME PAY
See (B, E, Q,) on OVERTIME PAGE. *Note* Double time for all emergency work designated by the Dept. of Jurisdiction.

HOLIDAY

Paid	See (5, 6, 8, 13, 25) on HOLIDAY PAGE plus Governor of NYS Election Day.
Overtime	See (5, 6, 8, 13, 25) on HOLIDAY PAGE plus Governor of NYS Election Day.

NOTE: All paid holidays falling on Saturday shall be observed on the preceding Friday. All paid holidays falling on Sunday shall be observed on the following Monday. Supplements for holidays paid at straight time.

REGISTERED APPRENTICES
WAGES: 1000 hour terms at the following percentage of the Journeyman Lineman wage.

1st	2nd	3rd	4th	5th	6th	7th
60%	65%	70%	75%	80%	85%	90%

SUPPLEMENTAL BENEFITS: Same as Journeyman

6-1249a

Lineman Electrician - Teledata **10/01/2016**

JOB DESCRIPTION Lineman Electrician - Teledata **DISTRICT** 6

ENTIRE COUNTIES

Albany, Allegany, Broome, Cattaraugus, Cayuga, Chautauqua, Chemung, Chenango, Clinton, Columbia, Cortland, Delaware, Dutchess, Erie, Essex, Franklin, Fulton, Genesee, Greene, Hamilton, Herkimer, Jefferson, Lewis, Livingston, Madison, Monroe, Montgomery, Niagara, Oneida, Onondaga, Ontario, Orange, Orleans, Oswego, Otsego, Putnam, Rensselaer, Rockland, Saratoga, Schenectady, Schoharie, Schuyler, Seneca, St. Lawrence, Steuben, Sullivan, Tioga, Tompkins, Ulster, Warren, Washington, Wayne, Westchester, Wyoming, Yates

WAGES
Per hour:

FOR OUTSIDE WORK.

	07/01/2016	01/01/2017
Cable Splicer	$ 30.29	$ 30.90
Installer, Repairman	28.75	29.33
Teledata Lineman	28.75	29.33
Technician, Equipment Operator	28.75	29.33
Groundman	15.25	15.56

NOTE: EXCLUDES Teledata work within ten (10) feet of High Voltage (600 volts and over) transmission lines. For this work please see LINEMAN.

SUPPLEMENTAL BENEFITS
Per hour worked:

Journeyman	$ 4.43 *plus 3% of wage paid	$ 4.43 *plus 3% of wage paid

*The 3% is based on the hourly wage paid, straight time rate or premium rate.

OVERTIME PAY
See (B, E, Q) on OVERTIME PAGE

HOLIDAY
Paid: See (1) on HOLIDAY PAGE
Overtime: See (5, 6, 16) on HOLIDAY PAGE

6-1249LT - Teledata

Lineman Electrician - Traffic Signal Lighting 10/01/2016

JOB DESCRIPTION Lineman Electrician - Traffic Signal Lighting **DISTRICT** 6

ENTIRE COUNTIES
Columbia, Dutchess, Orange, Putnam, Rockland, Ulster

WAGES
Lineman/Technician shall perform all overhead aerial work. A Lineman/Technician on the ground will install all electrical panels, connect all grounds, install and connect all electrical conductors which includes, but is not limited to road loop wires; conduit and plastic or other type pipes that carry conductors, flex cables and connectors, and to oversee the encasement or burial of such conduits or pipes.

A Groundman/Groundman Truck Driver shall: Build and set concrete forms, handle steel mesh, set footer cages, transport concrete in a wheelbarrow, hand or machine concrete vibrator, finish concrete footers, mix mortar, grout pole bases, cover and maintain footers while curing in cold weather, operate jack hammer, operate hand pavement breaker, tamper, concrete and other motorized saws, as a drill helper, operate and maintain generators, water pumps, chain saws, sand blasting, operate mulching and seeding machine, air tools, electric tools, gas tools, load and unload materials, hand shovel and/or broom, prepare and pour mastic and other fillers, assist digger operator equipment operator in ground excavation and restoration, landscape work and painting. Only when assisting a lineman technician, a ground man/truck driver may assist in installing conduit, pipe, cables and equipment.

A flagger's duties shall consist of traffic control only.

(Ref #14.01.02)

Per hour:

	07/01/2016
Lineman, Technician	$ 42.93
Crane, Crawler Backhoe	42.93
Certified Welder	45.08
Digging Machine	38.64
Tractor Trailer Driver	36.49
Groundman, Truck Driver	34.34
Equipment Mechanic	34.34

Flagman	25.76

Above rates applicable on all Lighting and Traffic Signal Systems and the installation, testing, operation, maintenance and repair of all traffic control and illumination projects, traffic monitoring systems, road weather information systems and the installation of Fiber Optic Cable.

NOTE: THE FOLLOWING RATES WILL APPLY ON ALL CONTRACTING AGENCY MANDATED MULTIPLE SHIFTS OF AT LEAST FIVE (5) DAYS DURATION WORKED BETWEEN THE HOURS LISTED BELOW:

1ST SHIFT	8:00 AM TO 4:30 PM REGULAR RATE
2ND SHIFT	4:30 PM TO 1:00 AM REGULAR RATE PLUS 17.3%
3RD SHIFT	12:30 AM TO 9:00 AM REGULAR RATE PLUS 31.4%

** IMPORTANT NOTICE **
Four (4), ten (10) hour days may be worked at straight time during a week, Monday thru Thursday. Friday may be used as a make-up day.
*Effective 05/06/2013, Tuesday thru Friday may be worked with no make-up day.

NOTE - In order to use the '4 Day/10 Hour Work schedule', as your normal schedule, you must submit an 'Employer Registration for Use of 4 Day/10 Hour Work Schedule,' form PW30R; and there must be a dispensation of hours in place on the project. If the PW30R is not submitted you may be liable for overtime payments for work over 8 hours per day.

SUPPLEMENTAL BENEFITS
Per hour worked (but also required on non-worked holidays):

Journeyman	$ 21.75 *plus 7.25% of hourly wage

* The 7.25% is based on the hourly wage paid, straight time rate or premium rate.
Supplements paid at STRAIGHT TIME rate for holidays.

OVERTIME PAY
See (B, E, Q) on OVERTIME PAGE. *Note* Double time for all emergency work designated by the Dept. of Jurisdiction.

HOLIDAY
Paid: See (5, 6, 8, 13, 25) on HOLIDAY PAGE and Governor of NYS Election Day.
Overtime: See (5, 6, 8, 13, 25) on HOLIDAY PAGE and Governor of NYS Election Day.

NOTE: All paid holidays falling on Saturday shall be observed on the preceding Friday. All paid holidays falling on Sunday shall be observed on the following Monday. Supplements for holidays paid at straight time.

REGISTERED APPRENTICES
WAGES: Per hour. 1000 hour terms.

1st	2nd	3rd	4th	5th	6th	7th
$ 25.76	$ 27.90	$ 30.05	$ 32.20	$ 34.34	$ 36.49	$ 38.64

SUPPLEMENTAL BENEFITS: Same as Journeyman

6-1249aReg8LT

Lineman Electrician - Tree Trimmer 10/01/2016

JOB DESCRIPTION Lineman Electrician - Tree Trimmer **DISTRICT** 6

ENTIRE COUNTIES
Albany, Allegany, Broome, Cattaraugus, Cayuga, Chautauqua, Chemung, Chenango, Clinton, Columbia, Cortland, Delaware, Dutchess, Erie, Essex, Franklin, Fulton, Genesee, Greene, Hamilton, Herkimer, Jefferson, Lewis, Livingston, Madison, Monroe, Montgomery, Niagara, Oneida, Onondaga, Ontario, Orange, Orleans, Oswego, Otsego, Putnam, Rensselaer, Rockland, Saratoga, Schenectady, Schoharie, Schuyler, Seneca, St. Lawrence, Steuben, Sullivan, Tioga, Tompkins, Ulster, Warren, Washington, Wayne, Wyoming, Yates

WAGES
Per hour:

Applies to line clearance, tree work and right-of-way preparation on all new or existing energized overhead or underground electrical, telephone and CATV lines. This also would include stump removal near underground energized electrical lines, including telephone and CATV lines.

	07/01/2016	01/01/2017
Tree Trimmer	$ 23.37	$ 23.95
Equipment Operator	20.61	21.13

Equipment Mechanic	20.61	21.13
Truck Driver	17.26	17.52
Groundman	14.15	14.36
Flag person	10.08	10.23

SUPPLEMENTAL BENEFITS
Per hour worked (but also required on non-worked holidays):

Journeyman	$ 9.56 *plus 3% of hourly wage	$ 9.98 *plus 3% of hourly wage

* The 3% is based on the hourly wage paid, straight time rate or premium rate.

OVERTIME PAY
See (B, E, Q) on OVERTIME PAGE

HOLIDAY
Paid: See (5, 6, 8, 15, 16, 25) on HOLIDAY PAGE
Overtime: See (5, 6, 8, 15, 16, 25) on HOLIDAY PAGE
NOTE: All paid holidays falling on a Saturday shall be observed on the preceding Friday.
All paid holidays falling on a Sunday shall be observed on the following Monday.

6-1249TT

Mason - Building 10/01/2016

JOB DESCRIPTION Mason - Building **DISTRICT** 11

ENTIRE COUNTIES
Dutchess, Sullivan, Ulster

PARTIAL COUNTIES
Orange: Entire county except the Township of Tuxedo.

WAGES
Per hour:

	07/01/2016
Bricklayer	$ 39.89
Cement Mason Bldg*	39.89
Plasterer/Stone Mason	39.89
Pointer/Caulker	39.89

Additional $1.00 per hour for power saw work
Additional $0.50 per hour for swing scaffold or staging work

SHIFT DIFFERENTIAL: When shift work is mandated or required by state, federal, county, local or other governmental agency contracts, the following rates apply:
Second shift an additional 15% of wage plus benefits to be paid
Third shift an additional 25% of wage plus benefits to be paid

* Overtime paid at one and one half times wages and benefits

SUPPLEMENTAL BENEFITS
Per hour paid:

Journeyman $ 31.56

OVERTIME PAY
Cement Mason See (B, E2, H, V) on OVERTIME PAGE.
All Others See (B, E, E2, Q) on OVERTIME PAGE.

HOLIDAY
Paid: See (1) on HOLIDAY PAGE
Overtime: See (5, 6) on HOLIDAY PAGE

REGISTERED APPRENTICES
Wages per hour:

750 hour terms at the following percentage of Journeyman's wage

1st	2nd	3rd	4th	5th	6th	7th	8th
50%	55%	60%	65%	70%	75%	80%	85%

Supplemental Benefits per hour paid

750 hour terms at the following percentage of journeyman supplements

1st	2nd	3rd	4th	5th	6th	7th	8th
50%	55%	60%	65%	70%	75%	80%	85%

Apprentices indentured before September 1, 2009 receive full journeyman benefits

11-5du-b

Mason - Building 10/01/2016

JOB DESCRIPTION Mason - Building **DISTRICT** 9

ENTIRE COUNTIES
Dutchess, Orange, Putnam, Sullivan, Ulster

WAGES
Per hour:

	07/01/2016	12/05/2016 An Additional
Building:		
Tile, Marble,& Terrazzo Mechanic/Setter	$ 48.06	$0.95

SUPPLEMENTAL BENEFITS
Per Hour:
Journeyman: $ 23.10*per hour paid
plus $6.80 per hour worked

* This portion of the benefits is per hour paid; and subject to same premium as overtime wages.

OVERTIME PAY
See (B, *E, Q) on OVERTIME PAGE
*Double time rate applies after 10 hours

HOLIDAY
Paid: See (1) on HOLIDAY PAGE
Overtime: See (5, 6, 11, 15, 16, 25) on HOLIDAY PAGE

REGISTERED APPRENTICES
Wages per hour:

(750 hour) terms at the following wages:

1st	2nd	3rd	4th	5th	6th	7th	8th
$23.72	$27.55	$30.59	$33.66	$36.46	$38.80	$39.08	$43.92

Supplemental Benefits (per Hour):

1st	2nd	3rd	4th	5th	6th	7th	8th
$14.35*	$14.35*	$14.85*	$15.60*	$16.35*	$17.85*	$17.35*	$19.85*
+$.66	+$.70	+$1.04	+$1.08	+$1.41	+$1.44	+$5.52	+$5.94

*This portion of the benefits is per hour paid; and subject to the same premium as overtime wages. The additional benefit amount is per hour worked.

9-7/52B

Mason - Building 10/01/2016

JOB DESCRIPTION Mason - Building **DISTRICT** 9

ENTIRE COUNTIES
Dutchess, Orange, Putnam, Sullivan, Ulster

WAGES

Per hour:	07/01/2016	12/05/2016 An Additional
Building		
Tile, Marble, & Terrazzo Finisher	$ 41.23	$ 0.70

SUPPLEMENTAL BENEFITS
Journeyman:

Per Hour. $ 18.35* per hour paid
plus $ 6.68 per hour worked

* This portion of benefit subject to same premium as wages

OVERTIME PAY
See (A, *E, Q) on OVERTIME PAGE
* Double time rate applies after 10 hours on Saturdays.

HOLIDAY
Paid: See (1) on HOLIDAY PAGE
Overtime: See (5, 6, 11, 15, 16, 25) on HOLIDAY PAGE

9-7/88B-tf

Mason - Building 10/01/2016

JOB DESCRIPTION Mason - Building **DISTRICT** 11

ENTIRE COUNTIES
Putnam, Rockland, Westchester

PARTIAL COUNTIES
Orange: Only the Township of Tuxedo.

WAGES
Per hour:

	07/01/2016
Bricklayer	$ 40.68
Cement Mason Bldg*	40.68
Plasterer/Stone Mason	40.68
Pointer/Caulker	40.68

Additional $1.00 per hour for power saw work
Additional $0.50 per hour for swing scaffold or staging work

SHIFT DIFFERENTIAL: When shift work is mandated or required by state, federal, county, local or other governmental contracts, the following rates apply:

Second shift an additional 15% of wage plus benefits to be paid
Third shift an additional 25% of wage plus benefits to be paid

* Overtime paid at one and one half wage and benefits

SUPPLEMENTAL BENEFITS
Per hour paid:

Journeyman $ 32.11

OVERTIME PAY
OVERTIME:
Cement Mason See (B, E2, H, V) on OVERTIME PAGE.
All Others See (B, E, E2, Q) on OVERTIME PAGE.

HOLIDAY
Paid: See (1) on HOLIDAY PAGE
Overtime: See (5, 6) on HOLIDAY PAGE

REGISTERED APPRENTICES
Wages per hour:

750 hour terms at the following percentage of Journeyman's wage

1st	2nd	3rd	4th	5th	6th	7th	8th
50%	55%	60%	65%	70%	75%	80%	85%

Supplemental Benefits per hour paid

750 hour terms at the following percentage of journeyman supplements

1st	2nd	3rd	4th	5th	6th	7th	8th
50%	55%	60%	65%	70%	75%	80%	85%

Apprentices indentured before September 1 2009 receive full journeyman benefits

11-5wp-b

Mason - Building 10/01/2016

JOB DESCRIPTION Mason - Building **DISTRICT** 9

ENTIRE COUNTIES
Bronx, Dutchess, Kings, Nassau, New York, Orange, Putnam, Queens, Richmond, Rockland, Suffolk, Sullivan, Ulster, Westchester

WAGES

Wages:	07/01/2016	01/01/2017
Marble Cutters& Setters	$ 57.32	$ 57.74

SUPPLEMENTAL BENEFITS
Per Hour:

Journeyworker	$ 33.08	$ 34.11

OVERTIME PAY
See (B, E, Q, V) on OVERTIME PAGE

HOLIDAY
Paid: See (1) on HOLIDAY PAGE
Overtime: See (5, 6, 8, 11, 15, 16, 25) on HOLIDAY PAGE

REGISTERED APPRENTICES
Wage Per Hour:

750 hour terms at the following wage.

1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th
1-750	751-1500	1501-2250	2251-3000	3001-3750	3751-4500	4501-5250	5251-6000	6001-6751	6751-7500
07/01/2016									
$22.93	$25.79	$28.66	$31.53	$34.39	$37.26	$40.12	$42.99	$48.72	$54.45

01/01/2017: Apprentices will receive an increase per the journeyman's wage increase.

Supplemental Benefits per hour paid at the following term:

1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th
07/01/2016									
$23.52	$24.27	$25.08	$25.84	$26.60	$27.37	$28.13	$28.91	$30.43	$31.96

9-7/4

Mason - Heavy&Highway 10/01/2016

JOB DESCRIPTION Mason - Heavy&Highway **DISTRICT** 11

ENTIRE COUNTIES
Dutchess, Sullivan, Ulster

PARTIAL COUNTIES
Orange: Entire county except the Township of Tuxedo.

WAGES
Per hour:

	07/01/2016
Bricklayer	$ 40.39
Cement Mason*	40.39
Marble/Stone Mason	40.39
Plasterer	40.39
Pointer/Caulker	40.39

Additional $1.00 per hour for power saw work
Additional $0.50 per hour for swing scaffold or staging work

SHIFT DIFFERENTIAL: When shift work is mandated or required by state, federal, county, local or other governmental contracts, the following rates apply:

Second shift an additional 15% of wage plus benefits to be paid
Third shift an additional 25% of wage plus benefits to be paid

* Overtime paid at one and one half times wage and benefits

SUPPLEMENTAL BENEFITS

Per hour paid:
Journeyman $ 31.56

OVERTIME PAY
See (B, O) on OVERTIME PAGE
Cement Mason See (B, H, V)

HOLIDAY
Paid: See (5, 6, 15, 25) on HOLIDAY PAGE
Overtime: See (5, 6, 15, 25) on HOLIDAY PAGE

REGISTERED APPRENTICES
Wages per hour:

750 hour terms at the following percentage of Journeyman's wage

1st	2nd	3rd	4th	5th	6th	7th	8th
50%	55%	60%	65%	70%	75%	80%	85%

Supplemental Benefits per hour paid

750 hour terms at the following percentage of journeyman supplements

1st	2nd	3rd	4th	5th	6th	7th	8th
50%	55%	60%	65%	70%	75%	80%	85%

Apprentices indentured before September 1, 2009 receive full journeyman benefits

11-5du-H/H

Mason - Heavy&Highway 10/01/2016

JOB DESCRIPTION Mason - Heavy&Highway **DISTRICT** 11

ENTIRE COUNTIES
Putnam, Rockland, Westchester

PARTIAL COUNTIES
Orange: Only the Township of Tuxedo.

WAGES
Per hour:

	07/01/2016
Bricklayer	$ 41.18
Cement Mason*	41.18
Marble/Stone Mason	41.18
Plasterer	41.18
Pointer/Caulker	41.18

Additional $1.00 per hour for power saw work
Additional $0.50 per hour for swing scaffold or staging work

SHIFT DIFFERENTIAL: When shift work is mandated or required by state, federal, county, local or other governmental contracts, the following rates apply:
Second shift an additional 15% of wage plus benefits to be paid
Third shift an additional 25% of wage plus benefits to be paid

* Overtime paid at one and one half times wage and benefits

SUPPLEMENTAL BENEFITS
Per hour paid:

Journeyman $ 32.11

OVERTIME PAY
See (B, O) on OVERTIME PAGE
*Cement Mason See (B, H, V)

HOLIDAY
Paid: See (5, 6, 15, 25) on HOLIDAY PAGE
Overtime: See (5, 6, 15, 25) on HOLIDAY PAGE

REGISTERED APPRENTICES
Wages per hour:

750 hour terms at the following percentage of Journeyman's wage

1st	2nd	3rd	4th	5th	6th	7th	8th
50%	55%	60%	65%	70%	75%	80%	85%

Supplemental Benefits per hour paid

750 hour terms at the following percentage of journeyman supplements

1st	2nd	3rd	4th	5th	6th	7th	8th
50%	55%	60%	65%	70%	75%	80%	85%

Apprentices indentured before September 1, 2009 receive full journeyman benefits

11-5WP-H/H

Operating Engineer - Building / Heavy&Highway 10/01/2016

JOB DESCRIPTION Operating Engineer - Building / Heavy&Highway **DISTRICT** 11

ENTIRE COUNTIES
Delaware, Orange, Rockland, Sullivan, Ulster

WAGES
CLASS A5: Cranes, Derricks and Pile Drivers 100tons or more and Tower Cranes, with 140ft boom and over.
CLASS A4: Cranes, Derricks and Pile Drivers 100 tons or more and Tower Cranes, with 100ft to 139ft boom.
CLASS A3: Cranes, Derricks and Pile Drivers less than 100 tons with a 140ft boom and over.
CLASS A2: Cranes, Derricks and Pile Drivers 100 tons or more and Tower Cranes, with a boom under 100ft.
CLASS A1: Cranes, Derricks and Piler Drivers less than 100 tons with a 100ft to 139ft boom.
CLASS A: Cranes, Derricks and Pile Drivers less than 100 tons with a boom under 100ft.1Autograde-Combn. Subgrader, Base Material Spreader and Base Trimmer (CMI and Similar Types), Autograde Placer-Trimmer-Spreader Comb. (CMI & Similar types), Autograde Slipform Paver (CMI & Similar Types), Backhoe, Central Power Plants (all types),Chief of Party, Concrete Paving Machines, Cranes (all types, incl. Overhead & Straddle Traveling Type), Cranes-Gantry, Derricks (Land or Floating), Drillmaster, Quarrymaster (Down the Hole Drill), Rotary Drill, Self-Propelled Hydraulic Drill, Self-Powered Drill, Draglines, Elevator Graders, Excavator, Front End Loaders (5 yds.and over), Gradalls, Grader-Rago, Helicopters (Co-Pilot), Helicopters (Communications Engineer), Locomotive (Large), Mucking Machines, Pavement & Concrete Breaker, i.e., Superhammer & Hoe Ram, Piledriver (length of boom including lead length shall determine premium rate applicable), Roadway Surface Grinder, Prentice Truck, Scooper (Loader and Shovel), Shovels, Tree Chopper with Boom and Trench Machines.

CLASS B: "A" Frame, Backhoe (Combination), Boom Attachment on Loaders (Rate based on size Bucket-not applicable to pipehook), Boring and Drilling Machines, Brush Chopper, Shredder and Tree Shredder, Bulldozer(Fine Grade), Cableways, Carryalls, Concrete Pump, Concrete Pumping System, Pump Concrete and Similar Types, Conveyors (125 ft. and over), Drill Doctor (duties incl. Dust Collector Maintenance), Front End Loaders (2 yds. but less than 5 yds.), Graders (all), Groove Cutting Machine (Ride on Type), Heater Planer, Hoists (all type Hoists, shall also include Steam, Gas, Diesel, Electric, Air Hydraulic, Single and Double Drum, Concrete, Brick Shaft Caisson, Snorkel Roof, and/or any other Similar Type Hoisting Machines, portable or stationary, except Chicago Boom Type), Long Boom Rate to be applied if Hoist is "Outside Material Tower Hoist," Hoists (Chicago Boom Type), Hydraulic Cranes-10 tons and under, Hydro-Axe, Hydro Blaster, Jacks-Screw Air Hydraulic
Power Operated Unit or Console Type (not hand Jack or Pile Load Test Type), Log Skidder, Pans, Pavers (all) concrete,Pumpcrete Machines,Squeeze-crete & Concrete Pumping (regardless of size), Scrapers, Side Booms, "Straddle"Carrier-Ross and similar types, Winch Trucks (Hoisting), Vacuum Truck, Whip Hammer.

CLASS C: Asphalt Curbing Machine, Asphalt Plant Engineer, Asphalt Spreaders, Autograde Tube Finisher and Texturing Machine (CMI & Similar types), Autograde curecrete machine (CMI & Similar Types), Autograde Curb Trimmer & Sidewalk, Shoulder, Slipform (CMI & Similar Types), Bar Bending Machines(Power),Batchers, Batching Plant and Crusher on Site, Belt Conveyor Systems, Boom Type Skimmer Machines, Bridge Deck Finisher, Bulldozer(except fine grade), Car Dumpers (Railroad), Compressor and Blower Type Units (used independently or mounted on dual purpose Trucks, on Job Site or in conjunction with jobsite, in Loading and Unloading of Concrete, Cement, Fly Ash, Instacrete, or Similar Type Materials), Compressors (2 or 3 in Battery), Concrete Breaking Machines, Concrete Finishing Machines,Concrete cleaning decontamination machine operator, Concrete Saws and Cutters (Ride-on type) Concrete Spreaders (Hetzel, Rexomatic and Similar Types), Concrete Vibrators, Conveyors (under 125 feet), Crushing Machines,Directional Boring Machines, Ditching Machine-small (Ditch-witch, Vermeer, or Similar type), Dope Pots (Mechanical with or without pump), Dumpsters, Elevator, Fireman, ForkLifts (Economobile, Lull and Similar Types of Equipment), Front End Loaders (1 yd.and over but under 2 yds.), Generators (2 or 3 in Battery), Giraffe Grinders, Gunnite Machines (excluding nozzle), Hammer Vibrator (in conjunction with Generator), Heavy Equipment Robotics Operator Technician, Hoists-Roof, Tugger, Aerial Platform Hoist & House Cars), Hoppers, Hopper Doors (power operated), Hydro Blaster, Hydralic Jacking Trailer, Ladders (motorized), Laddervator, Locomotive-dinky type, Maintenance -Utility Man, Master environmental maintenance technician, Mechanics, Mixers (Excepting Paving Mixers), Pavement Breakers (small self propelled ride on type-also maintains compressor hydraulic unit), Pavement Breaker-truck mounted, Pipe Bending Machine (Power), Pitch Pump, Plaster Pump (regardless of size), Post Hole Digger (Post Pounder & Auger), Rod Bending Machines (Power), Roller-Black Top, Scales (Power), Seaman pulverizing mixer, Shoulder widener, Silos, Skidsteer (all attachments), Skimmer Machines (boom-type),Steel Cutting Machine (service & maintain), Tam Rock Drill, Tractor, Tug Captain,Power Boats, Tug Master (powerboats), Ultra High Pressure Waterjet Cutting Tool System,operator/maintenance technician, Vacuum Blasting Machine, Vibrating Plants (used inconjunction with unloading), Welder and Repair Mechanics.

CLASS D: Brooms and Sweepers, Chippers, Compressor (single), Concrete Spreaders (small type), Conveyor Loaders (not including Elevator Graders), Engines-large diesel (1620 HP) and Staging Pump, Farm Tractors, Fertilizing Equipment (Operation & Maint. of), Fine Grade Machine (small type), Form Line Graders (small type), Front End Loader (under 1 yard), Generator (single), Grease, Gas, Fuel and Oil supply trucks, Heaters (Nelson or other type incl. Propane, Natural Gas or Flowtype Units), Lights, Portable Generating Light Plants, Mixers (Concrete, small), Mulching Equipment (Operation and Maintenance of), Pumps (4 inch.suction & over incl. submersible pumps), Pumps (2 inch or less than four (4) inches such incl. submersible pumps), Pumps (Diesel Engine and Hydraulic-immaterial of power, Road Finishing Machines (small type), Rollers-grade, fill or stone base, Seeding Equip. (Operation and Maintenance of), Sprinkler & Water Pump Trucks (used on jobsite or in conjunction with jobsite), Steam Jennies and Boilers-irrespective of use, Stone Spreader, Tamping Machines Machines, Vibrating Ride-on, Temporary Heating Plant (Nelson or other type, incl. Propane, Natural Gas or Flow Type Units), Water & Sprinkler Trucks (used on or in conjunction with jobsite), Welding Machines (Gas, Diesel, and/or Electric Converters of any type, single, two, or three in a battery), Wellpoint Systems (including installation by Bull Gang and Maintenance of).

CLASS E: Assistant Engineer/Oiler, Maintenance Apprentice (Deck Hand), Maintenance Apprentice (Oiler), Mechanics' Helper, Tire Repair and Maintenance, Transit/Instrument Man.

WAGES:(per hour)

	07/01/2016
Class A5	$ 53.82
Class A4	52.82
Class A3	50.07
Class A2	51.82
Class A1	49.07
Class A	48.07
Class B	46.48
Class C	44.57
Class D	42.94
Class E	41.23
Helicopter:	
Pilot/Engineer	49.89
Lead/Safety Engineer	48.81
Surveying:	
Chief of Party	48.07
Transit/Instrument Man	41.23
Rod/Chainman	38.65

SHIFT WORK: On all Government mandated irregular or off shift work, an additional 15% on straight time hours.

Additional 20% per hour for DEC or EPA certified toxic or hazardous waste work.

SUPPLEMENTAL BENEFITS
Per hour paid:

Journeyman	$ 30.63

SHIFT WORK: On all Government mandated irregular or off shift work, an additional 15% on straight time hours.

OVERTIME PAY
See (B, E, Q, V) on OVERTIME PAGE

HOLIDAY

Paid:	See (5, 6, 10, 15) on HOLIDAY PAGE
Overtime:	See (5, 6, 10, 15) on HOLIDAY PAGE

REGISTERED APPRENTICES
(1) year terms at the following percentage of journeyman's wage.

1st	2nd	3rd	4th
60%	70%	80%	90%

Supplemental Benefits per hour paid:

Apprentices	$ 30.63

11-825

Operating Engineer - Marine Dredging **10/01/2016**

JOB DESCRIPTION Operating Engineer - Marine Dredging **DISTRICT** 4

ENTIRE COUNTIES
Albany, Bronx, Cayuga, Chautauqua, Clinton, Columbia, Dutchess, Erie, Essex, Franklin, Greene, Jefferson, Kings, Monroe, Nassau, New York, Niagara, Orange, Orleans, Oswego, Putnam, Queens, Rensselaer, Richmond, Rockland, St. Lawrence, Suffolk, Ulster, Washington, Wayne, Westchester

WAGES
These wages do not apply to Operating Engineers on land based construction projects. For those projects, please see the Operating Engineer Heavy/Highway Rates. The wage rates below for barge mounted cranes and other equipment are only for marine dredging work in navigable waters found in the counties listed above.

Per Hour:

DREDGING OPERATIONS	07/01/2016
CLASS A	
Operator, Leverman, Lead Dredgeman	$ 35.63
CLASS A1 Dozer,Front Loader Operator	To conform to Operating Engineer Prevailing Wage in locality where work is being performed including benefits.
CLASS B	
Spider/Spill Barge Operator, Tug Operator(over1000hp), OperatorII, Fill Placer, Derrick Operator, Engineer, Chief Mate, Electrician, Chief Welder, Maintenance Engineer	$ 30.81
Certified Welder, Boat Operator(licensed)	$ 29.01
CLASS C	
Drag Barge Operator, Steward, Mate, Assistant Fill Placer,	$ 28.22
Welder (please add)	$ 0.06
Boat Operator	$ 27.30
CLASS D	
Shoreman, Deckhand, Rodman, Scowman, Cook, Messman, Porter/Janitor	$ 22.68
Oiler(please add)	$ 0.09

SUPPLEMENTAL BENEFITS
Per Hour:
THE FOLLOWING SUPPLEMENTAL BENEFITS APPLY TO ALL CATEGORIES

	07/01/2016
All Classes A & B	$ 9.99 plus 8% of straight time wage, Overtime hours add $ 0.63
All Class C	$ 9.69 plus 8% of straight time wage, Overtime hours add $ 0.48
All Class D	$ 9.39 plus 8% of straight time wage, Overtime hours add $ 0.33

OVERTIME PAY
See (B, F, R) on OVERTIME PAGE

HOLIDAY
Paid: See (1) on HOLIDAY PAGE
Overtime: See (5, 6, 8, 15, 26) on HOLIDAY PAGE

4-25a-MarDredge

Operating Engineer - Steel Erectors 10/01/2016

JOB DESCRIPTION Operating Engineer - Steel Erectors **DISTRICT** 11

ENTIRE COUNTIES
Delaware, Orange, Rockland, Sullivan, Ulster

WAGES
CLASS A3: Cranes, Derricks and Pile Drivers 100 tons or more and Tower Cranes, with a 140 ft. boom and over.

CLASS A2: Cranes, Derricks and Pile Drivers 100 tons or more and Tower Cranes, with up to a 139 ft. boom and under.

CLASS A1: Cranes, Derricks and Pile Drivers less than 100 tons with a 140 ft. boom and over.

CLASS A: Cranes, Derricks and Pile Drivers less than 100 tons with up to a 139 ft. boom and under.

CLASS B: "A" Frame, Cherry Pickers(10 tons and under), Hoists (all type Hoists, shall also include Steam, Gas, Diesel, Electric, Air Hydraulic, Single and Double Drum, Concrete, Brick Shaft Caisson, Snorkel Roof, and/or any other Similar Type Hoisting Machines, portable or stationary, except Chicago Boom Type), Jacks-Screw Air Hydraulic Power Operated Unit or Console Type (not hand Jack or Pile Load Test Type), Side Booms, Straddle Carrier, Vacuum Truck.

CLASS C: Aerial Platform used as Hoist, Compressors (2 or 3 in Battery), Concrete cleaning/ decontamination machine operator, Directional Boring Machines, Elevator or House Cars,Conveyers and Tugger Hoists, Fireman, ForkLifts, Generators (2 or 3 in Battery),Heavy equipment robotics operator/technician, Master environmental maintenance technician, Maintenance -Utility Man, Rod Bending Machines (Power),Captain(powerboat), Tug Master, Ultra High Pressure Waterjet Cutting Tool System, Vacuum Blasting Machine, Welding Machines(gas or electric,2 or 3 in battery, including diesels), Transfer Machine, Apprentice Engineer/Oiler with either one compressor or one welding machine when used for decontamination and remediation.

CLASS D: Compressor (single), Welding Machines (Gas, Diesel, and/or Electric Converters of any type), Welding System Multiple (Recitifier Transformer type).

CLASS E: Assistant Engineer/Oiler, Maintenance Apprentice (Deck Hand), Maintenance Apprentice (Oiler), Mechanics' Helper, Transit/Instrument Man.

WAGES:(per hour)

	07/01/2016
Class A3	$ 55.84
Class A2	54.18
Class A1	52.09
Class A	50.43
Class B	47.64
Class C	44.98
Class D	43.45
Class E	41.69
Helicopter:	
Pilot/Engineer	51.70
Lead/Safety Engineer	49.26
Surveying:	
Chief of Party	48.40
Transit/Instrument man	41.69
Rod/Chainman	38.65

SHIFT WORK: On all Government mandated irregular or off shift work, an additional 15% on straight time hours.

Additional 20% per hour for DEC or EPA certified toxic or hazardous waste work.

SUPPLEMENTAL BENEFITS
Per hour paid:

Journeyman	$ 30.63

SHIFT WORK: On all Government mandated irregular or off shift work, an additional 15% on straight time hours.

OVERTIME PAY
See (B, E, Q, V) on OVERTIME PAGE

HOLIDAY

Paid:	See (5, 6, 10, 15) on HOLIDAY PAGE
Overtime:	See (5, 6, 10, 15) on HOLIDAY PAGE

REGISTERED APPRENTICES
(1) year terms at the following percentage of journeyman's wage.

1st	2nd	3rd	4th
60%	70%	80%	90%

Supplemental Benefits per hour paid:

Apprentices	$ 29.48	$ 30.63

11-825SE

Painter 10/01/2016

JOB DESCRIPTION Painter **DISTRICT** 1

ENTIRE COUNTIES
Columbia, Dutchess, Greene, Orange, Sullivan, Ulster

WAGES
Per hour

	07/01/2016	05/01/2017 Additional	05/01/2018 Additional
Brush/Paper Hanger	$ 31.44	$1.65	$1.65
Dry Wall Finisher	31.44		
Lead Abatement	31.44		
Sandblaster-Painter	31.44		
Spray Rate	32.44		

See Bridge Painting rates for the following work:
Structural Steel , all work performed on tanks, ALL BRIDGES, towers, smoke stacks, flag poles. Rate shall apply to all of said areas from the ground up.

SUPPLEMENTAL BENEFITS
Per hour worked

Journeyman	$ 21.14

OVERTIME PAY
See (B, E, E2, Q) on OVERTIME PAGE

HOLIDAY

Paid:	See (1) on HOLIDAY PAGE
Overtime:	See (5, 6) on HOLIDAY PAGE

REGISTERED APPRENTICES
Wages per hour

Six (6) month terms at the following percentage of Journeyman's wage

1st	2nd	3rd	4th	5th	6th
40%	50%	60%	70%	80%	90%

Supplemental Benefits per hour worked

1st term	$ 9.64
All others	21.14

1-155

Painter - Bridge & Structural Steel 10/01/2016

JOB DESCRIPTION Painter - Bridge & Structural Steel **DISTRICT** 8

ENTIRE COUNTIES
Albany, Bronx, Clinton, Columbia, Dutchess, Essex, Franklin, Fulton, Greene, Hamilton, Kings, Montgomery, Nassau, New York, Orange, Putnam, Queens, Rensselaer, Richmond, Rockland, Saratoga, Schenectady, Schoharie, Suffolk, Sullivan, Ulster, Warren, Washington, Westchester

WAGES
Per Hour Worked:
STEEL:

Bridge Painting:	07/01/2016
From May 1st to Nov. 15th -	
	$ 49.00
	+ 6.13*
From Nov. 16th to April 30th -	
	$ 49.00
	+ 6.13*

*Not subject to overtime and limited to first 40 hours
NOTE: All premium wages are to be calculated on $48.00 or $49.00 per hour only.

EXCEPTION: During the period of May 1st to November 15th, for the first and last week of employment on the project, and for the weeks of Memorial Day, Independence Day and Labor Day, this rate shall be paid for the actual number of hours worked.

Power Tool/Spray is an additional $6.00 per hour above hourly rate, whether straight time or overtime

NOTE: Generally, for Bridge Painting Contracts, ALL WORKERS on and off the bridge (including Flagmen) are to be paid Painter's Rate; the contract must be ONLY for Bridge Painting.

SUPPLEMENTAL BENEFITS
Per Hour Worked:

Journeyworker:	07/01/2016
From May 1st to Nov. 15th -	
Hourly Rate up to 40 hours	$ 29.95
Hourly Rate after 40 hours	7.50
From Nov. 16th to April 30th -	
Hourly Rate up to 50 hours	29.70
Hourly Rate after 50 hours	7.50

EXCEPTION: During the period of May 1st to November 15th, for the first and last week of employment on the project, and for the weeks of Memorial Day, Independence Day and Labor Day, this rate shall be paid for the actual number of hours worked.

OVERTIME PAY
See (A, F, R) on OVERTIME PAGE

HOLIDAY
Paid: See (1) on HOLIDAY PAGE
Overtime: See (4, 6) on HOLIDAY PAGE

REGISTERED APPRENTICES
(Wage per hour Worked):

Apprentices: (1) year terms

	07/01/2016
1st 90 days	$ 22.05
1st year after 90 days	22.05
2nd year	33.08
3rd year	44.10

Supplemental Benefits per hour worked:

	07/01/2016
1st 90 days	$ 9.23
1st year after 90 days	11.98
2nd year	17.97
3rd year	23.96

8-DC-9/806/155-BrSS

Painter - Line Striping **10/01/2016**

JOB DESCRIPTION Painter - Line Striping **DISTRICT** 8

ENTIRE COUNTIES
Albany, Bronx, Clinton, Columbia, Dutchess, Essex, Franklin, Fulton, Greene, Hamilton, Kings, Montgomery, Nassau, New York, Orange, Putnam, Queens, Rensselaer, Richmond, Rockland, Saratoga, Schenectady, Schoharie, Suffolk, Sullivan, Ulster, Warren, Washington, Westchester

WAGES
Per hour:

Painter (Striping-Highway):	07/01/2016
Striping-Machine Operator*	$ 27.11
Linerman Thermoplastic	$ 32.37

Note: * Includes but is not limited to: Positioning of cones and directing of traffic using hand held devices. Excludes the Driver/Operator of equipment used in the maintenance and protection of traffic safety

Four (4), ten (10) hour days may be worked at straight time during a week, Monday thru Thursday. Friday may be used as a make-up day.

NOTE - In order to use the '4 Day/10 Hour Work Schedule,' as your normal schedule, you must submit an 'Employer Registration for Use of 4 Day/10 Hour Work Schedule,' form PW30R; and there must be a dispensation of hours in place on the project. If the PW30R is not submitted you may be liable for overtime payments for work over 8 hours per day.

SUPPLEMENTAL BENEFITS
Per hour paid: 07/01/2016
Journeyworker:

Striping-Machine operator	$ 14.18
Linerman Thermoplastic	$ 14.55

OVERTIME PAY
See (B, E, E2, F, S) on OVERTIME PAGE

HOLIDAY
Paid: See (5, 20) on HOLIDAY PAGE
Overtime: See (5, 8, 11, 12, 15, 16, 17, 20, 21, 22) on HOLIDAY PAGE

8-1456-LS

Painter - Metal Polisher 10/01/2016

JOB DESCRIPTION Painter - Metal Polisher **DISTRICT** 8

ENTIRE COUNTIES
Albany, Allegany, Bronx, Broome, Cattaraugus, Cayuga, Chautauqua, Chemung, Chenango, Clinton, Columbia, Cortland, Delaware, Dutchess, Erie, Essex, Franklin, Fulton, Genesee, Greene, Hamilton, Herkimer, Jefferson, Kings, Lewis, Livingston, Madison, Monroe, Montgomery, Nassau, New York, Niagara, Oneida, Onondaga, Ontario, Orange, Orleans, Oswego, Otsego, Putnam, Queens, Rensselaer, Richmond, Rockland, Saratoga, Schenectady, Schoharie, Schuyler, Seneca, St. Lawrence, Steuben, Suffolk, Sullivan, Tioga, Tompkins, Ulster, Warren, Washington, Wayne, Westchester, Wyoming, Yates

WAGES

	07/01/2016	06/01/2017
Metal Polisher	$ 28.88	$ 29.73
Metal Polisher**	29.83	30.68
Metal Poilsher***	32.38	33.23

**Note: Applies on New Construction & complete renovation
*** Note: Applies when working on scaffolds over 34 feet.

SUPPLEMENTAL BENEFITS

Per Hour:	07/01/2016	06/01/2017
Journeyworker:		
All classification	$ 9.26	$ 9.41

OVERTIME PAY
See (B, E, E2, P, T) on OVERTIME PAGE

HOLIDAY
Paid: See (5, 6, 11, 15, 16, 25, 26) on HOLIDAY PAGE
Overtime: See (5, 6, 9, 11, 15, 16, 25, 26) on HOLIDAY PAGE

REGISTERED APPRENTICES
Wages per hour:
One (1) year term at the following wage rates:

	07/01/2016
1st year	$ 11.75
2nd year	13.00
3rd year	15.75

Supplentals benefits:
Per hour paid:

1st year	$ 6.26
2nd year	6.37
3rd year	6.51

8-8A/28A-MP

Plumber 10/01/2016

JOB DESCRIPTION Plumber **DISTRICT** 11

ENTIRE COUNTIES
Orange, Rockland, Sullivan

PARTIAL COUNTIES
Ulster: Only the Townships of Plattekill, Marlboro, Wawarsing, and Shawangunk (except for Wallkill and Shawangunk Prisons).

WAGES
REFRIGERATION/AIR COOLING/AIR CONDITIONING: For all commercial plumbing/HVAC service and maintenance refrigeration where combined compressor tonnage does not exceed 40 tons. For water-cooled air conditioning where units do not exceed 25 tons, including piping of the component system and erection of water tower. For air-cooled air conditioning where units do not exceed 50 tons.

WAGES: (per hour)

	07/01/2016
Plumber/Steamfitter	$ 32.99

SUPPLEMENTAL BENEFITS
Per hour paid:

Journeyman	$ 27.13

OVERTIME PAY
See (B, G, P) on OVERTIME PAGE

HOLIDAY

Paid:	See (5, 6, 13, 15, 25) on HOLIDAY PAGE
Overtime:	See (5, 6, 13, 15, 25) on HOLIDAY PAGE

REGISTERED APPRENTICES
(1)year terms at the following wage.

1st term	$ 11.54
2nd term	14.84
3rd term	18.14
4th term	21.44
5th term	28.04

Supplemental Benefits per hour paid:

Apprentices

1st term	$ 9.50
2nd term	9.26
3rd term	14.97
4th term	17.67
5th term	23.37

11-373 Refrig

Plumber 10/01/2016

JOB DESCRIPTION Plumber **DISTRICT** 11

ENTIRE COUNTIES
Orange, Rockland, Sullivan

PARTIAL COUNTIES
Ulster: Only the Townships of Plattekill, Marlboro, Wawarsing, and Shawangunk (except for Wallkill and Shawangunk Prisons).

WAGES

WAGES:(per hour)	07/01/2016
Plumber/Steamfitter	$ 42.70

Note: For all work 40-60 feet above ground add $ 0.25 per hour,
over 60 feet add $ 0.50 per hour.

SUPPLEMENTAL BENEFITS
Per hour worked:

Journeyman	$ 36.14

OVERTIME PAY
OVERTIME: (B, E, Q, V) on OVERTIME PAGE

HOLIDAY

Paid:	See (1) on HOLIDAY PAGE
Overtime:	See (5, 6, 15, 16) on HOLIDAY PAGE

REGISTERED APPRENTICES
(1) year terms at the following wages.

1st term	$ 14.95
2nd term	19.22
3rd term	23.49
4th term	27.76
5th term	36.30

Supplemental Benefits per hour worked:

1st term	12.72
2nd term	16.32
3rd term	19.91
4th term	23.49
5th term	32.59

11-373 SF

Roofer 10/01/2016

JOB DESCRIPTION Roofer **DISTRICT** 9

ENTIRE COUNTIES
Bronx, Dutchess, Kings, New York, Orange, Putnam, Queens, Richmond, Rockland, Sullivan, Ulster, Westchester

WAGES

Per Hour:	07/01/2016
Roofer/Waterproofer	$ 42.20

Note: Abatement/Removal of Asbestos containing roofs and roofing material is classified as Roofer.

SUPPLEMENTAL BENEFITS

Journeyworker	$ 28.93

OVERTIME PAY
See (B, H) on OVERTIME PAGE
Note: An observed holiday that falls on a Sunday will be observed the following Monday.

HOLIDAY

Paid:	See (1) on HOLIDAY PAGE
Overtime:	See (5, 6) on HOLIDAY PAGE

REGISTERED APPRENTICES
(1) year terms at the following percentage of Journeyworkers hourly wage.

1st	2nd	3rd	4th
35%	50%	60%	75%

Supplements per hour paid at the following rates:

1st	2nd	3rd	4th
$ 2.70	$ 14.76	$ 17.59	$ 21.85

9-8R

Sheetmetal Worker 10/01/2016

JOB DESCRIPTION Sheetmetal Worker **DISTRICT** 8

ENTIRE COUNTIES
Dutchess, Orange, Putnam, Rockland, Sullivan, Ulster, Westchester

WAGES

	07/01/2016
SheetMetal Worker	$ 43.16

SHIFT WORK
For all NYS D.O.T. and other Governmental mandated off-shift work:
10% increase for additional shifts for a minimum of five (5) days

SUPPLEMENTAL BENEFITS

Journeyworker	$ 37.87

OVERTIME PAY
OVERTIME:.. See (B, E, Q,) on OVERTIME PAGE.
*Note: For Sundays or Holidays worked, HOURLY WAGE is double the total of the hourly wage plus the hourly benefit paid all in wages. (Benefits are included in the wages).

HOLIDAY

Paid:	See (1) on HOLIDAY PAGE
Overtime:	See (5, 6, 8, 15, 16, 23) on HOLIDAY PAGE

REGISTERED APPRENTICES

1st	2nd	3rd	4th	5th	6th	7th	8th
$15.97	$17.96	$ 19.96	$ 21.95	$ 23.94	$ 25.95	$ 28.42	$ 30.88

Supplemental Benefits per hour:

Apprentices	
1st term	$ 16.00
2nd term	18.11
3rd term	20.18
4th term	22.26
5th term	24.38
6th term	26.46
7th term	28.08
8th term	29.70

8-38

Sprinkler Fitter 10/01/2016

JOB DESCRIPTION Sprinkler Fitter **DISTRICT** 1

ENTIRE COUNTIES
Dutchess, Orange, Putnam, Rockland, Sullivan, Ulster, Westchester

WAGES
Per hour

	07/01/2016
Sprinkler Fitter	$ 41.47

SUPPLEMENTAL BENEFITS
Per hour worked

Journeyman	$ 21.30

OVERTIME PAY
See (B, E, Q) on OVERTIME PAGE

HOLIDAY

Paid:	See (1) on HOLIDAY PAGE
Overtime:	See (5, 6) on HOLIDAY PAGE

Note: When a holiday falls on Sunday, the following Monday shall be considered a holiday and all work performed on either day shall be at the double time rate. When a holiday falls on Saturday, the preceding Friday shall be considered a holiday and all work performed on either day shall be at the double time rate.

REGISTERED APPRENTICES
Wages per hour

For Apprentices HIRED PRIOR TO 04/01/2010:

One Half Year terms at the following percentage of journeyman's wage.

1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th
50%	50%	55%	60%	65%	70%	75%	80%	85%	90%

Supplemental Benefits per hour worked

1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th
$ 8.15	$ 8.15	$ 15.12	$ 15.12	$21.30	$21.30	$21.30	$21.30	$21.30	$21.30

For Apprentices HIRED ON OR AFTER 04/01/2010:

One Half Year terms at the following percentage of journeyman's wage.

1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th
45%	50%	55%	60%	65%	70%	75%	80%	85%	90%

Supplemental Benefits per hour worked

1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th
$ 8.68	$ 8.74	$ 15.52	$ 15.58	$ 16.04	$ 16.20	$ 16.26	$ 16.31	$ 16.37	$ 16.43

For Apprentices HIRED ON OR AFTER 04/01/2013:

One Half Year terms at the following percentage of journeyman's wage.

1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th
45%	50%	55%	60%	65%	70%	75%	80%	85%	90%

Supplemental Benefits per hour worked

1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th
$ 7.90	$ 7.90	$ 15.12	$ 15.12	$ 15.37	$ 15.37	$ 15.37	$ 15.37	$ 15.37	$ 15.37

1-669.2

Teamster - Building / Heavy&Highway 10/01/2016

JOB DESCRIPTION Teamster - Building / Heavy&Highway **DISTRICT** 11

ENTIRE COUNTIES
Dutchess, Orange, Rockland, Sullivan, Ulster

WAGES
GROUP 1: LeTourneau Tractors, Double Barrel Euclids, Athney Wagons and similar equipment (except when hooked to scrapers), I-Beam and Pole Trailers, Tire Trucks and Tractor and Trailers with 5 axles and over, Articulated Back Dumps and Road Oil Distributors, Articulated Water Trucks and Fuel Trucks, positions requiring a HAZMAT CDL endorsement.

GROUP 1A: Drivers on detachable Gooseneck Low Bed Trailers rated over 35 tons.

GROUP 2: All equipment 25 yards and up to and including 30 yard bodies and cable Dump Trailers and Powder and Dynamite Trucks.

GROUP 3: All Equipment up to and including 24-yard bodies, Mixer Trucks, Dump Crete Trucks and similar types of equipment, Fuel Trucks and Batch Trucks and all other Tractor Trailers.

GROUP 4: Tri-Axles, Ten Wheelers, Grease Trucks, Tillerman, Pattern Trucks, Intinuator Trucks. Water Trucks.

GROUP 5: Straight Trucks.

GROUP 6: Pick-up Trucks for hauling materials, parts, and Escort Man over-the-road.

WAGES: (per hour)	07/01/2016
GROUP 1	$ 30.75

GROUP 1A	31.89
GROUP 2	30.19
GROUP 3	29.97
GROUP 4	29.86
GROUP 5	29.74
GROUP 6	29.74

NOTE: additional 20% premium above the hourly wage for hazardous and toxic waste removal. This applies to all groups.

Shift Work: A shift premium of 10% on 2ND Shift and 15% on 3RD Shift will be paidwhen mandated by the NYS DOT or other governmental agency contracts.All irregular and offshift work is to be paid a 10% premium.

SUPPLEMENTAL BENEFITS

Per hour paid:

First 40 hours	$ 32.68
Over 40 hours	$ 26.50

OVERTIME PAY

OVERTIME:... See (B, E, P,T*,U**) on OVERTIME PAGE.

HOLIDAY

HOLIDAY:
Paid:..... See (5, 6, 15, 25) on HOLIDAY PAGE.
Overtime:.. See (5, 6, 15, 25) on HOLIDAY PAGE.
NOTE: Holidays worked Monday to Friday receive straight time wage for working, plus Holiday Pay.
*Holidays worked on Saturday, code T applies.
**Holidays worked on Sunday, code U applies.

11-445B/HH

Welder 10/01/2016

JOB DESCRIPTION Welder **DISTRICT** 1

ENTIRE COUNTIES

Albany, Allegany, Bronx, Broome, Cattaraugus, Cayuga, Chautauqua, Chemung, Chenango, Clinton, Columbia, Cortland, Delaware, Dutchess, Erie, Essex, Franklin, Fulton, Genesee, Greene, Hamilton, Herkimer, Jefferson, Kings, Lewis, Livingston, Madison, Monroe, Montgomery, Nassau, New York, Niagara, Oneida, Onondaga, Ontario, Orange, Orleans, Oswego, Otsego, Putnam, Queens, Rensselaer, Richmond, Rockland, Saratoga, Schenectady, Schoharie, Schuyler, Seneca, St. Lawrence, Steuben, Suffolk, Sullivan, Tioga, Tompkins, Ulster, Warren, Washington, Wayne, Westchester, Wyoming, Yates

WAGES

Per hour 07/01/2016

Welder: To be paid the same rate of the mechanic performing the work.*

*EXCEPTION: If a specific welder certification is required, then the 'Certified Welder' rate in that trade tag will be paid.

OVERTIME PAY

HOLIDAY

1-As Per Trade

Overtime Codes

Following is an explanation of the code(s) listed in the OVERTIME section of each classification contained in the attached schedule. Additional requirements may also be listed in the HOLIDAY section.

NOTE: Supplemental Benefits are 'Per hour worked' (for each hour worked) unless otherwise noted

(AA)	Time and one half of the hourly rate after 7 and one half hours per day
(A)	Time and one half of the hourly rate after 7 hours per day
(B)	Time and one half of the hourly rate after 8 hours per day
(B1)	Time and one half of the hourly rate for the 9th & 10th hours week days and the 1st 8 hours on Saturday. Double the hourly rate for all additional hours
(B2)	Time and one half of the hourly rate after 40 hours per week
(C)	Double the hourly rate after 7 hours per day
(C1)	Double the hourly rate after 7 and one half hours per day
(D)	Double the hourly rate after 8 hours per day
(D1)	Double the hourly rate after 9 hours per day
(E)	Time and one half of the hourly rate on Saturday
(E1)	Time and one half 1st 4 hours on Saturday; Double the hourly rate all additional Saturday hours
(E2)	Saturday may be used as a make-up day at straight time when a day is lost during that week due to inclement weather
(E3)	Between November 1st and March 3rd Saturday may be used as a make-up day at straight time when a day is lost during that week due to inclement weather, provided a given employee has worked between 16 and 32 hours that week
(E4)	Saturday and Sunday may be used as a make-up day at straight time when a day is lost during that week due to inclement weather
(E5)	Double time after 8 hours on Saturdays
(F)	Time and one half of the hourly rate on Saturday and Sunday
(G)	Time and one half of the hourly rate on Saturday and Holidays
(H)	Time and one half of the hourly rate on Saturday, Sunday, and Holidays
(I)	Time and one half of the hourly rate on Sunday
(J)	Time and one half of the hourly rate on Sunday and Holidays
(K)	Time and one half of the hourly rate on Holidays
(L)	Double the hourly rate on Saturday
(M)	Double the hourly rate on Saturday and Sunday
(N)	Double the hourly rate on Saturday and Holidays
(O)	Double the hourly rate on Saturday, Sunday, and Holidays
(P)	Double the hourly rate on Sunday
(Q)	Double the hourly rate on Sunday and Holidays
(R)	Double the hourly rate on Holidays
(S)	Two and one half times the hourly rate for Holidays, if worked

(S1) Two and one half times the hourly rate the first 8 hours on Sunday or Holidays One and one half times the hourly rate all additional hours.

(T) Triple the hourly rate for Holidays, if worked

(U) Four times the hourly rate for Holidays, if worked

(V) Including benefits at SAME PREMIUM as shown for overtime

(W) Time and one half for benefits on all overtime hours.

Holiday Codes

PAID Holidays:

Paid Holidays are days for which an eligible employee receives a regular day's pay, but is not required to perform work. If an employee works on a day listed as a paid holiday, this remuneration is in addition to payment of the required prevailing rate for the work actually performed.

OVERTIME Holiday Pay:

Overtime holiday pay is the premium pay that is required for work performed on specified holidays. It is only required where the employee actually performs work on such holidays. The applicable holidays are listed under HOLIDAYS: OVERTIME. The required rate of pay for these covered holidays can be found in the OVERTIME PAY section listings for each classification.

Following is an explanation of the code(s) listed in the HOLIDAY section of each classification contained in the attached schedule. The Holidays as listed below are to be paid at the wage rates at which the employee is normally classified.

(1)	None
(2)	Labor Day
(3)	Memorial Day and Labor Day
(4)	Memorial Day and July 4th
(5)	Memorial Day, July 4th, and Labor Day
(6)	New Year's, Thanksgiving, and Christmas
(7)	Lincoln's Birthday, Washington's Birthday, and Veterans Day
(8)	Good Friday
(9)	Lincoln's Birthday
(10)	Washington's Birthday
(11)	Columbus Day
(12)	Election Day
(13)	Presidential Election Day
(14)	1/2 Day on Presidential Election Day
(15)	Veterans Day
(16)	Day after Thanksgiving
(17)	July 4th
(18)	1/2 Day before Christmas
(19)	1/2 Day before New Years
(20)	Thanksgiving
(21)	New Year's Day
(22)	Christmas
(23)	Day before Christmas
(24)	Day before New Year's
(25)	Presidents' Day
(26)	Martin Luther King, Jr. Day
(27)	Memorial Day

New York State Department of Labor - Bureau of Public Work
State Office Building Campus
Building 12 - Room 130
Albany, New York 12240

REQUEST FOR WAGE AND SUPPLEMENT INFORMATION

As Required by Articles 8 and 9 of the NYS Labor Law

Fax (518) 485-1870 or mail this form for new schedules or for determination for additional occupations.

This Form Must Be Typed

Submitted By: (Check Only One) ☐ Contracting Agency ☐ Architect or Engineering Firm ☐ Public Work District Office Date:

A. Public Work Contract to be let by: (Enter Data Pertaining to Contracting/Public Agency)

1. Name and complete address ☐ (Check if new or change)

Telephone: ( ) Fax: ( )
E-Mail:

2. NY State Units (see Item 5)

- ☐ 01 DOT
- ☐ 02 OGS
- ☐ 03 Dormitory Authority
- ☐ 04 State University Construction Fund
- ☐ 05 Mental Hygiene Facilities Corp.
- ☐ 06 OTHER N.Y. STATE UNIT
- ☐ 07 City
- ☐ 08 Local School District
- ☐ 09 Special Local District, i.e., Fire, Sewer, Water District
- ☐ 1O Village
- ☐ 11 Town
- ☐ 12 County
- ☐ 13 Other Non-N.Y. State (Describe)

3. SEND REPLY TO (☐ check if new or change)
Name and complete address:

Telephone:( ) Fax: ( )
E-Mail:

4. SERVICE REQUIRED. Check appropriate box and provide project information.

- ☐ New Schedule of Wages and Supplements.

APPROXIMATE BID DATE :

- ☐ Additional Occupation and/or Redetermination

PRC NUMBER ISSUED PREVIOUSLY FOR THIS PROJECT :

OFFICE USE ONLY

B. PROJECT PARTICULARS

5. Project Title _____

Description of Work _____

Contract Identification Number _____

Note: For NYS units, the OSC Contract No. _____

6. Location of Project:
Location on Site _____

Route No/Street Address _____

Village or City _____

Town _____

County _____

7. Nature of Project - Check One:

- ☐ 1. New Building
- ☐ 2. Addition to Existing Structure
- ☐ 3. Heavy and Highway Construction (New and Repair)
- ☐ 4. New Sewer or Waterline
- ☐ 5. Other New Construction (Explain)
- ☐ 6. Other Reconstruction, Maintenance, Repair or Alteration
- ☐ 7. Demolition
- ☐ 8. Building Service Contract

8. OCCUPATION FOR PROJECT :

- ☐ Construction (Building, Heavy Highway/Sewer/Water)
- ☐ Tunnel
- ☐ Residential
- ☐ Landscape Maintenance
- ☐ Elevator maintenance
- ☐ Exterminators, Fumigators
- ☐ Fire Safety Director, NYC Only
- ☐ Guards, Watchmen
- ☐ Janitors, Porters, Cleaners, Elevator Operators
- ☐ Moving furniture and equipment
- ☐ Trash and refuse removal
- ☐ Window cleaners
- ☐ Other (Describe)

9. Has this project been reviewed for compliance with the Wicks Law involving separate bidding? YES ☐ NO ☐

10. Name and Title of Requester

Signature

SEE PAGE TWO FOR LAWS RELATING TO PUBLIC WORK CONTRACTS

NEW YORK STATE DEPARTMENT OF LABOR
Bureau of Public Work - Debarment List

LIST OF EMPLOYERS INELIGIBLE TO BID ON OR BE AWARDED ANY PUBLIC WORK CONTRACT

Under Article 8 and Article 9 of the NYS Labor Law, a contractor, sub-contractor and/or its successor shall be debarred and ineligible to submit a bid on or be awarded any public work or public building service contract/sub-contract with the state, any municipal corporation or public body for a period of five (5) years from the date of debarment when:

- Two (2) final determinations have been rendered within any consecutive six-year (6) period determining that such contractor, sub-contractor and/or its successor has WILLFULLY failed to pay the prevailing wage and/or supplements
- One (1) final determination involves falsification of payroll records or the kickback of wages and/or supplements

NOTE: The agency issuing the determination and providing the information, is denoted under the heading 'Fiscal Officer'. DOL = NYS Dept. of Labor; NYC = New York City Comptroller's Office; AG = NYS Attorney General's Office; DA = County District Attorney's Office.

A list of those barred from bidding, or being awarded, any public work contract or subcontract with the State, under section 141-b of the Workers' Compensation Law, may be obtained at the following link, on the NYS DOL Website:

https://dbr.labor.state.ny.us/EDList/searchPage.do

NYSDOL Bureau of Public Work Debarment List 09/28/2016

Article 8

AGENCY	Fiscal Officer	FEIN	EMPLOYER NAME	EMPLOYER DBA NAME	ADDRESS	DEBARMENT START DATE	DEBARMENT END DATE
DOL	DOL		4618 FOSTER AVE LLC		C/O KAHAN & KAHAN 225 BROADWAY-SUITE 715NEW YORK NY 10007	02/05/2013	02/05/2018
DOL	DOL	*****0996	A-1 CONSTRUCTION & RENOVATION INC		1973 81ST ST - SUITE A-5 BROOKLYN NY 11214	01/08/2015	01/08/2020
DOL	NYC	*****4486	ABBEY PAINTING CORP		21107 28TH AVENUE BAYSIDE NY 11360	07/02/2012	07/02/2017
DOL	DOL	*****9095	ABDO TILE CO		6179 EAST MOLLOY ROAD EAST SYRACUSE NY 13057	06/25/2010	07/02/2017
DOL	DOL	*****9095	ABDO TILE COMPANY		6179 EAST MOLLOY ROAD EAST SYRACUSE NY 13057	06/25/2010	07/02/2017
DOL	NYC		ABDUL KARIM		C/O NORTH AMERICAN IRON W 1560 DECATUR STREETRIDGEWOOD NY 11385	05/15/2015	05/15/2020
DOL	DOL	*****8488	ABELCRAFT OF NEW YORK CORP		640 ASHFORD AVENUE ARDSLEY NY 10502	08/27/2013	08/27/2018
DOL	DOL	*****1219	ABSOLUTE GENERAL CONTRACTING INC		1229 AVENUE U BROOKLYN NY 11229	01/28/2013	01/28/2018
DOL	DOL	*****4539	ACCOMPLISHED WALL SYSTEMS INC		112 OSCAWANA HEIGHTS ROAD PUTNAM VALLEY NY 10542	08/27/2013	08/27/2018
DOL	DOL	*****8018	ACCURATE MECHANICAL LLC		9547 BUSTLETON AVENUE PHILADELPHIA PA 19115	02/05/2014	02/05/2019
DOL	DOL		ACCURATE MECHANICAL OF PHILADELPHIA LLC		9547 BUSTLETON AVENUE PHILADELPHIA PA 19115	02/05/2014	02/05/2019
DOL	DOL	*****3344	ACT INC		6409 LAND O LAKES BLVD LAND O LAKES FL 34638	11/10/2015	11/10/2020
DOL	DOL	*****7584	ADAM'S FLOOR COVERING LLC		2718 CURRY ROAD SCHENECTADY NY 12303	07/08/2010	02/15/2017
DOL	DOL		ADESUWA UWUIGBE		P O BOX 21-1022 BROOKLYN NY 11221	05/16/2012	05/16/2017
DOL	NYC		ADRIANA SELA	C/O COLONIAL ROOFING COMPANY INC	247 48TH STREET BROOKLYN NY 11220	02/05/2014	02/05/2019
DOL	DOL	*****6367	ADVANCED METALS		387 RIVERSIDE DRIVE JOHNSON CITY NY 13790	10/01/2012	10/01/2017
DOL	DOL	*****1687	ADVANCED SAFETY SPRINKLER INC		261 MILL ROAD P O BOX 296EAST AURORA NY 14052	07/29/2015	07/29/2020
DOL	DOL	*****2538	AGG MASONRY INC		160 72ND ST - SUITE 721 BROOKLYN NY 11209	03/19/2013	03/19/2018
DOL	DOL		AJ TORCHIA		10153 ROBERTS RD SAUQUOIT NY 13456	08/22/2016	08/22/2021
DOL	DOL		ALISHER KARIMOV		C/O AGG MASONRY INC 7105 3RD AVENUEBROOKLYN NY 11209	03/19/2013	03/19/2018
DOL	DOL	*****3344	ALL CATASTROPHE CONSTRUCTION TEAM INC	ACT INC	6409 LAND O LAKES BLVD LAND O LAKES FL 34638	11/10/2015	11/10/2020
DOL	DOL	*****8740	ALLSTATE ENVIRONMENTAL CORP		C/O JOSE MONTAS 27 BUTLER PLACEYONKERS NY 10710	03/18/2011	03/19/2020
DOL	DOL		AMADEO J TORCHIA	TORCHIA'S HOME IMPROVEMEN T	10153 ROBERTS RD SAUQUOIT NY 13456	08/22/2016	08/22/2021
DOL	DOL	*****4274	AMERICAN STEEL MECHANICAL INC		693 PAINTER STREET MEDIA PA 19063	02/20/2013	02/20/2018
DOL	DOL		ANDREW DIPAUL		C/O CONSOLIDATED INDUSTRI 2051 ROUTE 44/55MODENA NY 12548	12/11/2012	12/11/2017
DOL	NYC		ANDRZEJ WROBEL		24 CONGRESS LANE SOUTH RIVER NJ 08882	05/01/2013	05/01/2018
DOL	NYC		ANISUL ISLAM		C/O RELIANCE GENERAL CONS 644 OCEAN PARKWAYBROOKLYN NY 11230	09/02/2015	09/02/2020
DOL	DOL	*****7004	ANNEX CONTRACTING LTD		3005 WYNSUM AVENUE MERRICK NY 11566	08/18/2014	08/18/2019
DOL	DOL	*****7004	ANNEX GENERAL CONTRACTING INC		3005 WYNSUM AVENUE MERRICK NY 11566	08/18/2014	08/18/2019
DOL	DA		ANTHONY CARDINALE		58-48 59TH STREET MASPETH NY 11378	05/16/2012	05/08/2020

DOL	DOL		ANTHONY J MINGARELLI JR		C/O T & T CONCRETE INC 2560 HAMBURG TURNPIKELACKAWANNA NY 14218	07/08/2015	07/08/2020
DOL	DOL	*****3020	APCO CONTRACTING CORP		24 SOUTH MARYLAND AVENUE PORT WASHINGTON NY 11050	09/24/2012	09/02/2020
DOL	DOL	*****3219	APOLLO CONSTRUCTION SERVICES CORP	APOLLO PAINTING CO	157 TIBBETTS ROAD YONKERS NY 10705	03/12/2014	03/12/2019
DOL	DOL		APOLLO PAINTING CO		157 TIBBETTS ROAD YONKERS NY 10705	03/12/2014	03/12/2019
DOL	DOL	*****3295	APOLLO PAINTING CORP		3 ALAN B SHEPART PLACE YONKERS NY 10705	03/12/2014	03/12/2019
DOL	AG	*****0194	APPLIED CONSTRUCTION INC		46 RUGBY ROAD WESTBURY NY 11590	11/20/2013	11/20/2018
DOL	NYC	*****8403	AQUA JET PAINTING CORP		10 VIKING DRIVE WEST ISLIP NY 11795	04/16/2014	04/16/2019
DOL	NYC	*****9232	ARKAY CONSTRUCTION INC		102-104 GREYLOCK AVENUE BELLEVILLE NJ 07109	07/15/2015	07/15/2020
DOL	DOL	*****3953	ASCAPE LANDSCAPE & CONSTRUCTION CORP		634 ROUTE 303 BLAUVELT NY 10913	07/26/2012	11/19/2018
DOL	NYC	*****4779	ASTORIA GENERAL CONTRACTING CORP		35-34 31ST STREET LONG ISLAND CITY NY 11106	09/02/2015	09/02/2020
DOL	NYC	*****7217	ASTRO COMMUNICATIONS OF NY CORP		79 ALEXANDER AVE- STE 36A BRONX NY 10454	10/30/2015	10/30/2020
DOL	NYC	*****6046	ATLANTIC SUN CONTRUCTION CORP		58-46 59TH AVENUE MASPETH NY 11378	05/08/2015	05/08/2020
DOL	NYC		AUDLEY O'BRIEN		1273 NORTH AVENUE/#1 CP NEW ROCHELLE NY 10804	04/07/2015	04/07/2020
DOL	DOL		AVIS R HILL		3510 HICKORY WALK LANE ELLENWOOD GA 32094	01/22/2015	01/22/2020
DOL	AG		AVTAR SINGH		116-24 127TH STREET SOUTH OZONE PARK NY 11420	12/22/2015	12/22/2020
DOL	AG		BALDEV SINGH		116-24 127TH STREET SOUTH OZONE PARK NY 11420	12/22/2015	12/22/2020
DOL	DOL		BARBARA CASSIDY		7 BLENIS PLACE VALHALLA NY 10595	04/02/2015	04/02/2020
DOL	DOL		BARRY KINNEY		6409 LAND O LAKES BLVD LAND O LAKES FL 34638	11/10/2015	11/10/2020
DOL	NYC	*****3915	BEACON RESTORATION INC		SUITE B-8 782 PELHAM PARKWAY SOUTHBRONX NY 10462	04/21/2016	04/21/2021
DOL	DOL	*****2294	BEDELL CONTRACTING CORP		2 TINA LANE HOPEWELL JUNCTION NY 12533	01/06/2012	01/06/2017
DOL	DOL		BEVERLY F WILLIAMS		1238 PRESIDENT STREET BROOKLYN NY 11225	11/18/2013	11/18/2018
DOL	DOL		BIAGIO CANTISANI		200 FERRIS AVENUE WHITE PLAINS NY 10603	12/04/2009	05/04/2017
DOL	DOL	*****8551	BRANDY'S MASONRY		216 WESTBROOK STREET P O BOX 304SAYRE PA 18840	08/09/2016	08/09/2021
DOL	NYC	*****6555	BROOKLYN WELDING CORP		1273 NORTH AVENUE/ #1 CP NEW ROCHELLE NY 10804	04/07/2015	04/07/2020
DOL	DOL		BRUCE MORSEY		C/O KENT HOLLOW SIDING LL 29A BRIDGE STREETNEW MILFORD CT 06776	01/15/2016	01/15/2021
DOL	DOL	*****6156	C & J LANDSCAPING & MAINTENANCE INC		520 PINE HILL ROAD CHESTER NY 10940	06/23/2014	06/23/2019
DOL	DOL		CANTISANI & ASSOCIATES LTD		442 FERRIS AVENUE WHITE PLAINS NY 10603	12/04/2009	05/04/2017
DOL	DOL		CANTISANI HOLDING LLC		220 FERRIS AVENUE WHITE PLAINS NY 10603	05/04/2012	05/04/2017
DOL	DOL		CARIBBEAN POOLS		C/O DOUGLAS L MALARKEY 64 VICTORIA DRIVEBINGHAMTON NY 13904	02/04/2016	02/04/2021
DOL	DOL	*****1143	CARMODY BUILDING CORP		442 ARMONK ROAD MOUNT KISCO NY 10549	05/04/2012	05/04/2017
DOL	DOL	*****3368	CARMODY CONCRETE CORP		442 ARMONK ROAD MOUNT KISCO NY 10549	12/04/2009	05/04/2017
DOL	DOL		CARMODY CONTRACTING CORP		220 FERRIS AVENUE WHITE PLAINS NY 10603	05/04/2012	05/04/2017
DOL	DOL	*****6215	CARMODY CONTRACTING INC		220 FERRIS AVENUE WHITE PLAINS NY 10603	05/04/2012	05/04/2017
DOL	DOL		CARMODY ENTERPRISES LTD		220 FERRIS AVENUE WHITE PLAINS NY 10603	12/04/2009	05/04/2017

DOL	DOL	*****3812	CARMODY INC		442 ARMONK ROAD MOUNT KISCO NY 10549	12/04/2009	05/04/2017
DOL	DOL	*****3812	CARMODY INDUSTRIES INC		442 FERRIS AVENUE WHITE PLAINS NY 10603	05/04/2012	05/04/2017
DOL	DOL		CARMODY MAINTENANCE CORP		105 KISCO AVENUE MOUNT KISCO NY 10549	05/04/2012	05/04/2017
DOL	DOL	*****0324	CARMODY MASONRY CORP		442 ARMONK ROAD MOUNT KISKO NY 10549	12/04/2009	05/04/2017
DOL	DOL	*****3812	CARMODY"2" INC		220 FERRIS AVENUE WHITE PLAINS NY 10603	12/04/2009	05/04/2017
DOL	NYC	*****9172	CASSIDY EXCAVATING INC		14 RAILROAD AVENUE VALHALLA NY 10595	05/15/2014	04/02/2020
DOL	DOL	*****1683	CATONE CONSTRUCTION COMPANY INC		294 ALPINE ROAD ROCHESTER NY 14423	03/09/2012	03/09/2017
DOL	DOL		CATONE ENTERPRISES INC		225 DAKOTA STREET ROCHESTER NY 14423	03/09/2012	03/09/2017
DOL	DOL	*****6745	CATSKILL FENCE INSTALLATIONS INC		5445 ROUTE 32 CATSKILL NY 12414	08/22/2014	08/22/2019
DOL	DOL	*****8530	CAZ CONTRACTING CORP		37-11 35TH AVENUE LONG ISLAND CITY NY 11101	08/26/2013	08/26/2018
DOL	DOL	*****5556	CERTIFIED INSTALLERS INC		113 N MAPLE AVENUE GREENSBURG PA 15601	02/21/2013	02/21/2018
DOL	DOL	*****7655	CHAMPION CONSTRUCTION SERVICES CORP		2131 SCHENECTADY AVENUE BROOKLYN NY 11234	11/18/2015	11/18/2020
DOL	NYC		CHARLES CASSIDY JR		14 RAILROAD AVENUE VALHALLA NY 10595	05/15/2014	04/02/2020
DOL	DOL		CHARLES ZIMMER JR		216 WESTBROOK STREET P O BOX 304SAYRE PA 18840	08/09/2016	08/09/2021
DOL	DOL	*****1416	CHEROMINO CONTROL GROUP LLC		61 WILLET ST - SUITE 14 PASSAIC NJ 07055	12/03/2009	02/23/2017
DOL	DOL		CHRIS SAVOURY		44 THIELLS-MT IVY ROAD POMONA NY 10970	10/14/2011	10/14/2016
DOL	DOL		CHRISTINE J HEARNE		C/O CJ-HEARNE CONSTRUCTIO 131 PONCE DE LEON AVE NEATLANTA GA 30308	12/01/2015	12/01/2020
DOL	DOL		CHRISTOF PREZBYL		2 TINA LANE HOPEWELL JUNCTION NY 12533	01/06/2012	01/06/2017
DOL	DOL	*****3360	CITY LIMITS GROUP INC		2279 HOLLERS AVENUE BRONX NY 10475	01/07/2014	06/23/2019
DOL	DOL	*****0671	CJ-HEARNE CONSTRUCTION CO		SUITE 204 131 PONCE DE LEON AVENUEATLANTA GA 30308	12/01/2015	12/01/2020
DOL	NYC	*****2905	COLONIAL ROOFING COMPANY INC		247 48TH STREET BROOKLYN NY 11220	02/05/2014	02/05/2019
DOL	NYC	*****3182	COLORTECH INC		5990 58TH AVENUE MASPETH NY 11378	11/18/2013	11/18/2018
DOL	DOL	*****2703	CONKLIN'S TECH-MECHANICAL INC		5 PARKER AVENUE POUGHKEEPSIE NY 12601	03/25/2014	03/25/2019
DOL	DOL	*****4175	CONSOLIDATED INDUSTRIAL SERVICES INC		2051 ROUTE 44/55 MODENA NY 12548	12/11/2012	01/28/2018
DOL	DOL		CONSTANTINOS ZERVAS		37-11 35TH AVENUE LONG ISLAND CITY NY 11101	08/26/2013	08/26/2018
DOL	NYC	*****4468	CRAFT CONTRACTING GROUP INC		3256 BRUNER AVENUE BRONX NY 10469	07/29/2014	07/29/2019
DOL	NYC	*****8507	CRAFT FENCE INC		3256 BRUNER AVENUE BRONX NY 10469	07/29/2014	07/29/2019
DOL	NYC	*****2164	CREATIVE TRUCKING INC		58-83 54TH STREET MASPETH NY 11378	02/26/2016	02/26/2021
DOL	DOL	*****0810	D & G PAINTING & DECORATING INC		53 LITTLE COLLABAR ROAD MONTGOMERY NY 12549	04/19/2012	04/19/2017
DOL	DOL	*****7761	D L MALARKEY CONSTRUCTION		64 VICTORIA DRIVE BINGHAMTON NY 13904	02/04/2016	02/04/2021
DOL	DOL	*****7888	D L MALARKEY CONSTRUCTION INC		64 VICTORIA DRIVE BINGHAMTON NY 13904	02/04/2016	02/04/2021
DOL	DOL	*****5629	DAKA PLUMBING AND HEATING LLC		2561 ROUTE 55 POUGHQUAG NY 12570	02/19/2016	02/19/2021
DOL	DOL		DARYL T RIEKS		C/O RIEKS CONTRACTING LLC 4804 GAHWILER ROADAUBURN NY 13021	05/01/2015	05/01/2020
DOL	NYC	*****7707	DASSLE CONTRACTING INC		213-37 39TH AVE/SUITE 120 BAYSIDE NY 11360	05/08/2015	05/08/2020
DOL	DOL		DAVID MARTINEZ		C/O EMPIRE TILE INC 6 TREMONT COURTHUNTINGTON STATION NY 11746	03/08/2016	03/08/2021

DOL	NYC		DAWN AVILA AKA DAWN BECHTOLD		1ST FLOOR STORE FRONT 88-10 LITTLE NECK PARKWAYFLORAL PARK NY 11001	06/24/2014	06/24/2019
DOL	NYC		DAWN BECHTOLD AKA DAWN AVILA		1ST FLOOR STORE FRONT 88-10 LITTLE NECK PARKWAYFLORAL PARK NY 11001	06/24/2014	06/24/2019
DOL	DOL		DEAN ROBBINS III		212 OXFORD WAY SCHENECTADY NY 12309	12/11/2012	09/16/2018
DOL	NYC	*****3865	DECOMA BUILDING CORPORATION		134 EVERGREEN PL/STE 101 EAST ORANGE NJ 07018	12/30/2013	12/30/2018
DOL	DOL		DEDA GAZIVODAN		C/O DAKA PLUMBING AND H 2561 ROUTE 55POUGHQUAG NY 12570	02/19/2016	02/19/2021
DOL	DOL	*****1446	DELTA CONTRACTING PAINTING AND DECORATING INC		437 SUNRISE HIGHWAY WEST BABYLON NY 11707	08/12/2013	08/12/2018
DOL	DOL	*****3538	DELTA CONTRACTING PAINTING AND DESIGN INC		75 MCCULLOCH DRIVE DIX HILLS NY 11746	10/19/2010	08/12/2018
DOL	DOL		DEMETRIOS KOUTSOURAS		530 BEECH STREET NEW HYDE PARK NY 11040	07/02/2012	07/02/2017
DOL	DOL		DENNIS SCHWANDTNER		C/O YES SERVICE AND REPAI 325 RABRO DRIVE - SUITE 1HAUPPAUGE NY 11788	08/18/2016	08/18/2021
DOL	DOL	*****9868	DESANTIS ENTERPRISES		161 OSWEGO RIVER ROAD PHOENIX NY 13135	09/24/2013	11/18/2018
DOL	NYC	*****8234	DEWATERS PLUMBING AND HEATING LLC		30 COLUMBUS CIRCLE EASTCHESTER NY 10709	08/21/2012	08/21/2017
DOL	DOL	*****9252	DI BERNARDO TILE AND MARBLE CO INC		15 WALKER WAY ALBANY NY 12205	03/21/2014	03/21/2019
DOL	DOL		DIANE DEAVER		731 WARWICK TURNPIKE HEWITT NJ 07421	06/25/2012	12/11/2017
DOL	NYC		DIMITRIOS KOUTSOUKOS		C/O ASTORIA GENERAL CONTR 35-34 31ST STREETLONG ISLAND CITY NY 11106	09/02/2015	09/02/2020
DOL	DOL		DORIS SKODA		C/O APCO CONTRACTING CORP 24 SOUTH MARYLAND AVENUEPORT WASHINGTON NY 11050	09/24/2012	09/02/2020
DOL	NYC	*****7404	DOSANJH CONSTRUCTION CORP		9439 212TH STREET QUEENS VILLAGE NY 11428	02/25/2016	02/25/2021
DOL	DOL		DOUGLAS L MALARKEY	MALARKEY CONSTRUCTI ON	64 VICTORIA DRIVE B INGHAMTON NY 13904	02/04/2016	02/04/2021
DOL	DOL	*****6982	DUFOUR GROUP INC	DUFOUR MASONRY	353 WEST 56TH STREET #7M NEW YORK NY 10019	06/10/2014	06/10/2019
DOL	DOL		DUFOUR MASONRY		353 WEST 56TH ST #7M NEW YORK NY 10019	06/10/2014	06/10/2019
DOL	DOL		DUFOUR MASONRY & RESTORATION INC		353 WEST 56TH STREET #7M NEW YORK NY 10019	06/10/2014	06/10/2019
DOL	DOL	*****5840	DYNA CONTRACTING INC		363 88TH STREET BROOKLYN NY 11209	11/18/2013	11/18/2018
DOL	DOL		E C WEBB		6409 LAND O LAKES BLVD LAND O LAKES FL 34638	11/10/2015	11/10/2020
DOL	DOL		EARL GALBREATH		640 ASHFORD AVENUE ARDSLEY NY 10502	08/27/2013	08/27/2018
DOL	DOL		EARL L WILSON	WILSON BROTHER DRYWALL CONTRACTOR S	36 ABERSOLD STREET ROCHESTER NY 14621	08/31/2015	08/31/2020
DOL	DOL	*****1496	EAST COAST DRYWALL INC		1238 PRESIDENT STREET BROOKLYN NY 11225	11/18/2013	11/18/2018
DOL	DOL	*****8011	ECOA CLEANING CONTRACTORS INC		P O BOX 21-1022 BROOKLYN NY 11221	05/16/2012	05/16/2017
DOL	DOL		EDWARD L GAUTHIER		C/O IMPERIAL MASONRY REST 141 ARGONNE DRIVEKENMORE NY 14217	10/03/2012	10/03/2017
DOL	NYC		EDWARD MENKEN		C/O AQUA JET PAINTING 10 VIKING DRIVEWEST ISLIP NY 11795	04/16/2014	04/16/2019
DOL	NYC	*****0900	EF PRO CONTRACTING INC		147 BROOME AVENUE ATLANTIC BEACH NY 11509	03/03/2014	03/03/2019
DOL	NYC		EFSTRATIOS BERNARDIS		23-73 48TH STREET LONG ISLAND CITY NY 11103	04/24/2014	04/24/2019

DOL	NYC	*****6260	EL TREBOL SPECIAL CLEANING INC		95-26 76TH STREET OZONE PARK NY 11416	10/12/2011	10/12/2016
DOL	DOL		ELIZABETH RAMADANI		C/O RAMADA CONSTRUCTION 80 SAVO LOOPSTATEN ISLAND NY 10309	01/07/2014	01/07/2019
DOL	DOL		ELLEN DESANTIS	DESANTIS ENTERPRISES	161 OSWEGO RIVER ROAD PHOENIX NY 13135	09/24/2013	11/18/2018
DOL	DOL	*****0780	EMES HEATING & PLUMBING CONTR		5 EMES LANE MONSEY NY 10952	01/20/2002	01/20/3002
DOL	AG		EMILIO FRANZA		90 JUNIUS STREET BROOKLYN NY 11212	01/23/2014	01/23/2019
DOL	DOL		EMPIRE CONCRETE SERVICES LLC		101 SULLYS TRAIL/SUITE 20 PITTSFORD NY 14534	11/18/2013	01/07/2019
DOL	DOL	*****0511	EMPIRE CONCRETE SYSTEMS LLC		101 SULLYS TRAIL/ SUITE 2 PITTSFORD NY 14534	11/18/2013	01/07/2019
DOL	DOL	*****2353	EMPIRE CONSTRUCTORS LLC		101 SULLYS TRAIL/SUITE 20 PITTSFORD NY 14534	11/18/2013	01/07/2019
DOL	DOL		EMPIRE PRECAST LLC		101 SULLYS TRAIL/SUITE 20 PITTSFORD NY 14534	11/18/2013	01/07/2019
DOL	DOL	*****3270	EMPIRE TILE INC		6 TREMONT COURT HUNTINGTON STATION NY 11746	03/08/2016	03/08/2021
DOL	DOL		ERIKA BARNETT		253 BEACH BREEZE LANE UNIT BARVERNE NY 11692	02/05/2013	02/05/2018
DOL	DOL		ESTEVES & FRAGA CONSTRUCTION CO INC		986 MADISON AVENUE PATERSON NJ 07501	01/03/2013	01/03/2018
DOL	DOL		ESTEVES & FRAGA INC		986 MADISON AVENUE PATERSON NJ 07501	01/03/2013	01/03/2018
DOL	DOL		EVELIO ELLEDIAS		114 PEARL STREET PORT CHESTER NY 10573	08/15/2012	08/15/2017
DOL	NYC		EVERTON CARLESS		134 EVERGREEN PL/STE 101 EAST ORANGE NJ 07018	12/30/2013	12/30/2018
DOL	DOL		F KALAFATIS		2279 HOLLERS AVENUE BRONX NY 10475	01/07/2014	06/23/2019
DOL	DOL		FANTASTIC PAINTING		493 LANSING ROAD FULTONVILLE NY 12072	11/18/2013	11/18/2018
DOL	DOL		FAY MATTHEW		C/O CHAMPION CONSTRUCTION 2131 SCHENECTADY AVENUEBROOKLYN NY 11234	11/18/2015	11/18/2020
DOL	DOL		FAZIA GINA ALI-MOHAMMED	C/O CHAMPION CONSTRUCTI ON	2131 SCHENECTADY AVENUE BROOKLYN NY 11234	11/18/2015	11/18/2020
DOL	DOL	*****5867	FJM-FERRO INC		6820 14TH AVENUE BROOKLYN NY 11219	10/27/2011	10/27/2016
DOL	DOL	*****1311	FLOZ-ON PAINTING & DECORATING INC		12 DUNDERBERG ROAD TOMKINS NY 10986	10/16/2013	10/16/2018
DOL	DOL	*****8961	FLOZ-ON PAINTING INC		12 DUNDERBERG ROAD TOMKINS NY 10986	10/16/2013	10/16/2018
DOL	DOL		FMS		4 LEGHORN COURT NEW YORK NY 11746	11/28/2012	11/28/2017
DOL	DOL	*****8067	FORTH SPORT FLOORS INC		P O BOX 74 EAST GREENBUSH NY 12061	02/28/2012	10/01/2017
DOL	DOL		FRAN MICELI		2279 HOLLERS AVENUE BRONX NY 10475	01/07/2014	06/23/2019
DOL	DOL		FRANCES KALAFATIS		2279 HOLLERS AVENUE BRONX NY 10475	01/07/2014	06/23/2019
DOL	DOL		FRANCES KALAFATIS-MICELI		2279 HOLLERS AVENUE BRONX NY 10475	01/07/2014	06/23/2019
DOL	DOL		FRANK J MERCANDO		134 MURRAY AVENUE YONKERS NY 10704	12/11/2009	02/03/2019
DOL	DOL		FRANK MICELI JR	C/O FRANK MICELI JR CONTRACTIN G INC	19 CLIFF STREET NEW ROCHELLE NY 10801	10/16/2013	10/16/2018
DOL	DOL	*****1321	FRANK MICELI JR CONTRACTING INC		19 CLIFF STREET NEW ROCHELLE NY 10801	10/16/2013	10/16/2018
DOL	DOL		FRED ABDO	ABDO TILE COMPANY AKA ABDO TILE CO	6179 EAST MOLLOY ROAD EAST SYRACUSE NY 13057	06/25/2010	07/02/2017
DOL	DOL	*****2724	FRESH START PAINTING CORP		157 TIBBETS ROAD YONKERS NY 10705	03/12/2014	03/12/2019
DOL	DOL		G FUCCI CONSTRUCTION SERVICES		3 ALAN B SHEPARD PLACE YONKERS NY 10705	03/12/2014	03/12/2019

DOL	DOL	*****6767	G FUCCI PAINTING INC		C/O SPIEGEL & UTRERA 1 MAIDEN LANE - 5TH FLNEW YORK NY 10038	03/12/2014	03/12/2019
DOL	DOL	*****4546	GAF PAINTING LLC		157 TIBBETS ROAD YONKERS NY 10705	03/12/2014	03/12/2019
DOL	DOL		GALINDA ROTENBERG		C/O GMDV TRANS INC 67-48 182ND STREETFRESH MEADOWS NY 11365	06/28/2016	06/28/2021
DOL	DOL		GARDEN STATE PAINTING		157 TIBBETTS ROAD YONKERS NY 10705	03/12/2014	03/12/2019
DOL	DOL		GARY MCDOWELL	GM CONSTRUCTI ON & LAWN CARE SERVICE	76 PLEASANT STREET WELLSVILLE NY 14895	06/11/2013	06/11/2018
DOL	DOL		GEORGE DI BERNARDO		C/O DI BERNARDO TILE 15 WALKER WAYALBANY NY 12205	03/21/2014	03/21/2019
DOL	NYC		GEORGE LUCEY		150 KINGS STREET BROOKLYN NY 11231	01/19/1998	01/19/2998
DOL	DOL	*****1075	GLOBAL TANK CONSTRUCTION LLC		P O BOX 1238 SALINA OK 74365	11/28/2012	11/28/2017
DOL	DOL	*****0878	GM CONSTRUCTION & LAWN CARE SERVICE		76 PLEASANT STREET WELLSVILLE NY 14895	06/11/2013	06/11/2018
DOL	DOL	*****5674	GMDV TRANS INC		67-48 182ND STREET FRESH MEADOWS NY 11365	06/28/2016	06/28/2021
DOL	DOL	*****0090	GOLDS FLOORING INSTALLATIONS INC		25 HAMILTON ROAD MONTICELLO NY 12701	10/16/2013	10/16/2018
DOL	DOL		GREGORY A FUCCI		C/O PAF PAINTING SERVICES 157 TIBBETTS ROADYONKERS NY 10705	03/12/2014	03/12/2019
DOL	DOL		GREGORY FUCCI JR		C/O APOLLO CONSTRUCTION 157 TIBBETTS ROADYONKERS NY 10705	03/12/2014	03/12/2019
DOL	DOL		GRETCHEN SULLIVAN		P O BOX 130 CRETE IL 60417	11/10/2011	11/10/2016
DOL	DOL	*****9456	GUILLO CONTRACTING CORP		P O BOX 229 CALVERTON NY 11933	07/08/2013	07/08/2018
DOL	DOL		GUS PAPASTEFANOU		C/O D & G PAINTING & DECO 53 LITTLE COLLABAR ROADMONTGOMERY NY 12549	04/19/2012	04/19/2017
DOL	NYC	*****0346	H N H CONTRACTORS CORP		4558 BROADWAY # 6 NEW YORK NY 10040	08/04/2014	08/04/2019
DOL	DOL		HALSSAM FOSTOK		5 HANSEN PLACE WAYNE NJ 07470	09/18/2013	09/18/2018
DOL	NYC		HAMEEDUL HASAN		240 HOME STREET TEANECK NJ 07666	08/04/2014	08/04/2019
DOL	AG	*****9918	HARA ELECTRIC CORP		2461 47TH STREET ASTORIA NY 11103	09/26/2013	09/26/2018
DOL	DOL	*****5405	HARD LINE CONTRACTING INC		89 EDISON AVENUE MOUNT VERNON NY 10550	10/28/2011	10/28/2016
DOL	NYC		HARMEL SINGH		15 CLINTON LANE HICKSVILLE NY 11801	02/25/2016	02/25/2021
DOL	NYC		HAROLD KUEMMEL		58-83 54TH STREET MASPETH NY 11378	02/26/2016	02/26/2021
DOL	AG		HARVINDER SINGH PAUL		90 JUNIUS STREET BROOKLYN NY 11212	01/23/2014	01/23/2019
DOL	DOL		HENRY VAN DALRYMPLE		2663 LANTERN LANE ATLANTA GA 30349	12/01/2015	12/01/2020
DOL	DOL		HI-TECH CONTRACTING CORP		114 PEARL STREET PORT CHESTER NY 10573	08/15/2012	08/15/2017
DOL	DOL	*****6370	HILLIANO CONSTRUCTION & ELECTRICAL INC		354 MAGNOLIA STREET ROCHESTER NY 14611	01/22/2015	01/22/2020
DOL	DOL	*****8282	IDEMA DEVELOPMENT INC		91 COLLEGE AVENUE POUGHKEEPSIE NY 12603	12/04/2015	12/04/2020
DOL	DOL	*****8282	IDEMA GENERAL CONTRACTORS INC		91 COLLEGE AVENUE POUGHKEEPSIE NY 12603	12/04/2015	12/04/2020
DOL	DOL	*****8426	IMPERIAL MASONRY RESTORATION INC		141 ARGONNE DRIVE KENMORE NY 14217	10/03/2012	10/03/2017
DOL	DOL	*****7001	INTEGRATED CONSTRUCTION & POWER SYSTEMS INC		SUITE 100 2105 W GENESEE STREETSYRACUSE NY 13219	01/06/2016	01/06/2021
DOL	DOL		ISABEL FRAGA		C/O THREE FRIENDS CONSTR 986 MADISON AVENUEPATERSON NJ 07501	01/03/2013	01/03/2018

DOL	AG	*****0000	J A M CONSTRUCTION CORP		SUITE 125 265 SUNRISE HIGHWAYROCKVILLE CENTRE NY 10457	04/07/2016	04/07/2021
DOL	DOL	*****7598	J M RICH LLC		P O BOX 268 STILLWATER NY 12170	09/16/2013	03/21/2019
DOL	DOL	*****3478	J N P CONSTRUCTION CORP		50 LOUIS COURT P O BOX 1907SOUTH HACKENSACK NY 07606	03/21/2014	03/21/2019
DOL	DOL		J N RICH LLC		P O BOX 268 STILLWATER NY 12170	09/16/2013	03/21/2019
DOL	DOL	*****9368	J TECH CONSTRUCTION		PO BOX 64782 ROCHESTER NY 14624	09/24/2012	09/24/2017
DOL	DOL		J THE HANDYMAN			09/24/2012	09/24/2017
DOL	DOL	*****4910	J V MAGIC TOUCH CORPORATION		94-25 57TH AVENUE, APT 5G ELMHURST NY 11373	01/12/2015	01/12/2020
DOL	DOL		JACQUELINE HOWE		C/O FLOZ-ON PAINTING INC 12 DUNDERBERG ROADTOMKINS NY 10986	10/16/2013	10/16/2018
DOL	DOL	*****8627	JAG I LLC		635 LUZERNE ROAD QUEENSBURY NY 12804	09/16/2013	09/16/2018
DOL	DOL	*****2868	JAG INDUSTRIES INC		175 BROAD ST - SUITE 320 GLENS FALLS NY 12801	09/16/2013	09/16/2018
DOL	DOL		JAMES B RHYNDERS		91 COLLEGE AVENUE POUGHKEEPSIE NY 12603	12/04/2015	12/04/2020
DOL	DOL		JAMES BOYCE		C/O EMPIRE CONCRETE SYST 101 SULLYS TRAIL/SUITE 20PITTSFORD NY 14534	11/18/2013	01/07/2019
DOL	DOL		JAMES E RHYNDERS		91 COLLEGE AVENUE POUGHKEEPSIE NY 12603	12/04/2015	12/04/2020
DOL	AG		JAMES FALCONE		SUITE 125 265 SUNRISE HIGHWAYROCKVILLE CENTRE NY 10457	04/07/2016	04/07/2021
DOL	DOL		JAMES RHYNDERS SR		91 COLLEGE AVENUE POUGHKEEPSIE NY 12603	12/04/2015	12/04/2020
DOL	DOL		JAMES SICKAU		3090 SHIRLEY ROAD NORTH COLLINS NY 14111	04/19/2011	07/08/2020
DOL	DOL		JAMES WALSH		89 EDISON AVENUE MOUNT VERNON NY 10550	10/28/2011	10/28/2016
DOL	DOL		JASON M RICH		P O BOX 268 STILLWATER NY 12170	09/16/2013	03/21/2019
DOL	DOL		JASON W MILLIMAN		C/O ROCHESTER ACOUSTICAL P O BOX 799HILTON NY 14468	02/19/2016	02/19/2021
DOL	DOL		JAY PRESUTTI		C/O CONSOLIDATED INDUSTRI 2051 ROUTE 44/55MODENA NY 12548	01/28/2013	01/28/2018
DOL	DOL		JEFF P BRADLEY		520 PINE HILL ROAD CHESTER NY 10940	06/23/2014	06/23/2019
DOL	NYC		JEFFREY CASSIDY		14 RAILROAD AVENUE VALHALLA NY 10595	05/15/2014	04/02/2020
DOL	DOL		JERALD HOWE		C/O FLOZ-ON PAINTING INC 12 DUNDERBERG ROADTOMKINS NY 10986	10/16/2013	10/16/2018
DOL	DOL		JEROME LACITIGNOLA		C/O CATSKILL FENCE INSTAL 5445 ROUTE 32 CATSKILL NY 12414	08/22/2014	08/22/2019
DOL	NYC		JERRY DEWATERS		30 COLUMBUS CIRCLE EASTCHESTER NY 10709	08/21/2012	08/21/2017
DOL	DOL		JOHN CATONE		C/O CATONE CONSTRUCTION 294 ALPINE ROADROCHESTER NY 14612	03/09/2012	03/09/2017
DOL	DOL		JOHN DESCUL		437 SUNRISE HIGHWAYA WEST BABYLON NY 11704	08/12/2013	08/12/2018
DOL	DOL		JOHN H LEE	JOHN LEE QUALITY PAVING	67 WILER ROAD HILTON NY 14468	01/28/2013	01/28/2018
DOL	DOL	*****1749	JOHN LEE QUALITY PAVING		67 WILER ROAD HILTON NY 14468	01/28/2013	01/28/2018
DOL	DOL		JON E DEYOUNG		261 MILL ROAD P O BOX 296EAST AURORA NY 14052	07/29/2015	07/29/2020
DOL	DOL	*****9368	JORGE I DELEON	J TECH CONSTRUCTI ON	PO BOX 64782 ROCHESTER NY 14624	09/24/2012	09/24/2017
DOL	DOL		JORGE OUVINA		344 SOUNDVIEW LANE COLLEGE POINT NY 11356	11/22/2011	11/22/2016

DOL	DOL		JORGE VILLALOBOS		94-25 57TH AVENUE - APT 5 ELMHURST NY 11373	01/12/2015	01/12/2020
DOL	DOL		JOSE MONTAS		27 BUTLER PLACE YONKERS NY 10710	03/18/2011	03/19/2020
DOL	DOL		JOSEPH CASUCCI		6820 14TH AVENUE BROOKLYN NY 11219	10/27/2011	10/27/2016
DOL	AG		JOSEPH FALCONE		SUITE 125 265 SUNRISE HIGHWAYROCKVILLE CENTRE NY 10457	04/07/2016	04/07/2021
DOL	DOL		JOSEPH MARTONE		112 OSCAWANA HEIGHTS ROAD PUTNAM VALLEY NY 10542	08/27/2013	08/27/2018
DOL	DOL		JOSHUA DEBOWSKY		9547 BUSTLETON AVENUE PHILADELPHIA PA 19115	02/05/2014	02/05/2019
DOL	DOL		JOYA MUSCOLINO		10 ST CHARLES STREET THORNWOOD NY 10594	09/03/2013	09/03/2018
DOL	DOL		JUANA MARTINEZ		C/O LEAD CONSTRUCTION 27 BUTLER PLACEYONKERS NY 10710	03/19/2015	03/19/2020
DOL	DOL	*****4340	JUBCO SITE DEVELOPMENT LLC		462 LAKEVIEW AVENUE VALHALLA NY 10595	12/16/2013	12/16/2018
DOL	DOL		JULIUS AND GITA BEHREND		5 EMES LANE MONSEY NY 10952	11/20/2002	11/20/3002
DOL	DOL		KAREN HARTMAN		C/O GUILLO CONTRACTING P O BOX 229CALVERTON NY 11933	07/08/2013	07/08/2018
DOL	NYC		KATHLEEN SELA	C/O COLONIAL ROOFING COMPANY INC	247 48TH STREET BROOKLYN NY 11220	02/05/2014	02/05/2019
DOL	DOL		KEITH SCHEPIS		C/O KJS HAULING AND HOME 95 MAPLE AVENUENEW CITY NY 10956	04/15/2013	04/15/2018
DOL	DOL		KEN DEAVER		731 WARWICK TURNPIKE HEWITT NJ 07421	06/25/2012	12/11/2017
DOL	DOL	*****9732	KENT HOLLOW SIDING LLC		29A BRIDGE STREET NEW MILFORD CT 06776	01/15/2016	01/15/2021
DOL	DOL		KEVIN BABCOCK JR		P O BOX 46 THOMPSON RIDGE NY 10985	08/22/2014	08/22/2019
DOL	DOL		KEVIN M BABCOCK		P O BOX 46 THOMPSON RIDGE NY 10985	08/22/2014	08/22/2019
DOL	DOL		KIM SOROCENSKI		C/O SOLUTION MATTERS INC 198 NORWOOD ROADPORT JEFFERSON NY 11776	11/19/2015	11/19/2020
DOL	DOL	*****2463	KJS HAULING AND HOME IMPROVEMENT INC		95 MAPLE AVENUE NEW CITY NY 10956	04/15/2013	04/15/2018
DOL	AG		KOSTAS "GUS" ANDRIKOPOULOS		2461 47TH STREET ASTORIA NY 11103	09/26/2013	09/26/2018
DOL	DOL		KRZYSZTOF PRXYBYL		2 TINA LANE HOPEWELL JUNCTION NY 12533	01/06/2012	01/06/2017
DOL	DOL	*****6033	KUSNIR CONSTRUCTION		2677 ANAWALK ROAD KATONAH NY 10536	08/03/2012	08/03/2017
DOL	NYC	*****8816	LAKE CONSTRUCTION AND DEVELOPMENT CORPORATION		150 KINGS STREET BROOKLYN NY 11231	08/19/1998	08/19/2998
DOL	DOL	*****6224	LAKESIDE FIRE SPRINKLERS LLC		125 CHAUTAUQUA AVENUE LAKEWOOD NY 14750	06/24/2015	06/24/2020
DOL	DOL		LARRY DOMINGUEZ		114 PEARL STREET PORT CHESTER NY 10573	08/15/2012	08/15/2017
DOL	DOL		LAURA A. GAUTHIER		C/O IMPERIAL MASONRY REST 141 ARGONNE DRIVEKENMORE NY 14217	10/03/2012	10/03/2017
DOL	DOL		LAURI MARTONE		112 OSCAWANA HEIGHTS ROAD PUTNAM VALLEY NY 10542	08/27/2013	08/27/2018
DOL	DOL		LAVERN GLAVE		C/O RAW POWER ELECTRIC 3 PARK CIRCLEMIDDLETOWN NY 10940	09/15/2014	09/15/2019
DOL	DOL		LAWRENCE J RUGGLES		P O BOX 371 ROUND LAKE NY 12151	05/12/2014	05/12/2019
DOL	DOL	*****1364	LEAD CONSTRUCTION SERVICES INC		3 ALAN B SHEPARD PLACE YONKERS NY 10705	03/19/2015	03/19/2020
DOL	DOL	*****0597	LEED INDUSTRIES CORP	HI-TECH CONTRACTIN G CORP	114 PEART STREET PORT CHESTER NY 10573	08/15/2012	08/15/2017
DOL	DOL	*****4388	LEN J CONSTRUCTION LLC		P O BOX 10007 ALBANY NY 12201	07/08/2016	07/08/2021

DOL	AG		LEONID FRIDMAN		APT 5 200 BRIGHTON, 15TH STBROOKLYN NY 11235	01/23/2014	01/23/2019
DOL	DOL		LEROY NELSON JR		C/O LEN J CONSTRUCTION LL P O BOX 10007ALBANY NY 12201	07/08/2016	07/08/2021
DOL	DOL		LINDSEY R CRILL		143 FILLMORE AVENUE BUFFALO NY 14210	01/08/2015	01/08/2020
DOL	DOL	*****8453	LINPHILL ELECTRICAL CONTRACTORS INC		523 SOUTH 10TH AVENUE MOUNT VERNON NY 10553	01/07/2011	04/15/2018
DOL	DOL		LINVAL BROWN		523 SOUTH 10TH AVENUE MOUNT VERNON NY 10553	01/07/2011	04/15/2018
DOL	NYC	*****2850	M A 2 FLAGS CONTRACTING CORP		25-18 100TH STREET EAST ELMHURST NY 11369	08/21/2013	08/21/2018
DOL	AG	*****6957	M B DIN CONSTRUCTION INC		8831 20TH AVENUE/SUITE 6E BROOKLYN NY 11214	11/17/2015	11/17/2020
DOL	NYC	*****6317	M S QUALITY CONSTRUCTION LLC		27 MAPLEWOOD AVENUE COLONIA NJ 07067	02/04/2015	02/04/2020
DOL	NYC		MACIEJ SONTOWSKI		27 MAPLEWOOD AVENUE COLONIA NJ 07067	02/04/2015	02/04/2020
DOL	NYC	*****9590	MACK GLASSNAUTH IRON WORKS INC		137 LIBERTY AVENUE BROOKLYN NY 11212	12/21/2015	12/21/2020
DOL	NYC	*****3141	MACKEY REED ELECTRIC INC		1ST FLOOR STORE FRONT 88-10 LITTLE NECK PARKWAYFLORAL PARK NY 11001	06/24/2014	06/24/2019
DOL	DOL		MALARKEY'S BAR & GRILL LLC		64 VICTORIA DRIVE BINGHAMTON NY 13904	02/04/2016	02/04/2021
DOL	DOL	*****0705	MALARKEY'S PUB & GRUB LLC		64 VICTORIA DRIVE BINGHAMTON NY 13904	02/04/2016	02/04/2021
DOL	NYC		MANUEL P TOBIO		150 KINGS STREET BROOKLYN NY 14444	08/19/1998	08/19/2998
DOL	NYC		MANUEL TOBIO		150 KINGS STREET BROOKLYN NY 11231	08/19/1998	08/19/2998
DOL	DOL		MAR CONTRACTING CORP		620 COMMERCE STREET THORNWOOD NY 10594	09/24/2012	09/24/2017
DOL	DOL		MARGARET FORTH		P O BOX 74 EAST GREENBUSH NY 12061	02/28/2012	10/01/2017
DOL	DOL		MARIA ESTEVES AKA MARIA MARTINS		C/O THREE FRIENDS CONSTR 986 MADISON AVENUEPATERSON NJ 07501	01/03/2013	01/03/2018
DOL	DOL		MARIA MARTINS AKA MARIA ESTEVES		C/O THREE FRIENDS CONSTR 986 MADISON AVENUEPATERSON NJ 07501	01/03/2013	01/03/2018
DOL	DOL		MARIACHI'S PIZZERIA		C/O DOUGLAS L MALARKEY 64 VICTORIA DRIVEBINGHAMTON NY 13904	02/04/2016	02/04/2021
DOL	DOL		MARIO LUIS		31 DURANT AVENUE BETHEL CT 06801	07/02/2012	07/02/2017
DOL	DOL		MARK MIONIS		6409 LAND O LAKES BLVD LAND O LAKES FL 34638	11/10/2015	11/10/2020
DOL	DOL	*****5533	MARQUISE CONSTRUCTION & DEVELOPMENT CORP		10 ST CHARLES STREET THORNWOOD NY 10594	09/03/2013	09/03/2018
DOL	DOL	*****8810	MARQUISE CONSTRUCTION ASSOCIATES INC		20 BOSWELL ROAD PUTNAM VALLEY NY 10579	09/03/2013	09/03/2018
DOL	DOL	*****1134	MARQUISE CONSTRUCTION CORP		10 ST CHARLES STREET THORNWOOD NY 10594	09/03/2013	09/03/2018
DOL	NYC	*****4314	MASCON RESTORATION INC		129-06 18TH AVENUE COLLEGE POINT NY 11356	02/09/2012	02/09/2017
DOL	NYC	*****4314	MASCON RESTORATION LLC		129-06 18TH AVENUE COLLEGE POINT NY 11356	02/09/2012	02/09/2017
DOL	DOL	*****0845	MASONRY CONSTRUCTION INC		442 ARMONK ROAD MOUNT KISCO NY 10549	12/04/2009	05/04/2017
DOL	DOL	*****3333	MASONRY INDUSTRIES INC		442 ARMONK ROAD MOUNT KISKO NY 10549	12/04/2009	05/04/2017
DOL	DOL		MATTHEW IDEMA GENERAL CONTRACTORS INC		91 COLLEGE AVENUE POUGHKEEPSIE NY 12603	12/04/2015	12/04/2020
DOL	DOL	*****6416	MCCALL MASONRY		P O BOX 304 SAYRE PA 18840	08/09/2016	08/09/2021
DOL	DOL	*****9028	MCINTOSH INTERIORS LLC		8531 AVENUE B BROOKLYN NY 11236	02/05/2013	02/05/2018
DOL	DOL	*****4259	MERCANDO CONTRACTING CO INC		134 MURRAY AVENUE YONKERS NY 10704	12/11/2009	02/03/2019
DOL	DOL	*****0327	MERCANDO INDUSTRIES LLC		134 MURRAY AVENUE YONKERS NY 10704	12/11/2009	02/03/2019
DOL	NYC	*****5330	METRO DUCT SYSTEMS INC		1219 ASTORIA BOULEVARD LONG ISLAND CITY NY 11102	04/16/2014	11/19/2020

DOL	DOL	*****3368	MICEK CONSTRUCTION CO INC		20 CROSS STREET FALCONER NY 14733	12/02/2014	12/02/2019
DOL	DOL		MICHAEL A PASCARELLA		SUITE 100 2105 WEST GENESEE STREET SYRACUSE NY 13219	01/06/2016	01/06/2021
DOL	DOL	*****9198	MICHAEL CZECHOWICZ	OCTAGON CO	37-11 35TH AVENUE-2ND FL LONG ISLAND CITY NY 11101	01/08/2013	01/08/2018
DOL	DOL		MICHAEL F LEARY JR		3813 SNOWDEN HILL ROADNEW HARTFORD NY 13413	06/19/2013	06/19/2018
DOL	DOL		MICHAEL F LEARY JR METAL STUD & DRYWALL		3813 SNOWDEN HILL ROAD NEW HARTFORD NY 13413	06/19/2013	06/19/2018
DOL	NYC		MICHAEL HIRSCH		C/O MZM CORP 163 S MAIN STREETNEW CITY NY 10956	01/28/2016	01/28/2021
DOL	DOL		MICHAEL KTISTAKIS		363 88TH STREET BROOKLYN NY 11209	11/18/2013	11/18/2018
DOL	DOL	*****6033	MICHAEL KUSNIR	KUSNIR CONSTRUCTI ON	2677 ANAWALK ROAD KATONAH NY 10536	08/03/2012	08/03/2017
DOL	DOL		MICHAEL MARGOLIN		4 LEGHORN COURT NEW YORK NY 11746	11/28/2012	11/28/2017
DOL	DOL		MICHAEL WILSON	WILSON BROTHER DRYWALL CONTRACTOR S	36 ABERSOLD STREET ROCHESTER NY 14621	08/31/2015	08/31/2020
DOL	DOL		MICHELLE L BARBER		635 LUZERNE ROAD QUEENSBURY NY 12804	09/16/2013	09/16/2018
DOL	DOL	*****2635	MIDLAND CONSTRUCTION OF CEDAR LAKE INC		13216 CALUMET AVENUE CEDAR LAKE IL 46303	11/10/2011	11/10/2016
DOL	NYC		MIGUEL ACOSTA		25-18 100TH STREET EAST ELMHURST NY 11369	08/21/2013	08/21/2018
DOL	NYC		MILANCE HADZIC		22 CALIFORNIA AVE - STE 1 PATERSON NJ 07503	03/11/2015	03/11/2020
DOL	AG		MOHAMMAD RIAZ		46 RUGBY ROAD WESTBURY NY 11590	11/20/2013	11/20/2018
DOL	AG		MOHAMMED N CHATHA		8831 20TH AVENUE/SUITE 6E BROOKLYN NY 11214	11/17/2015	11/17/2020
DOL	DOL	*****2737	MOUNTAIN'S AIR INC		2471 OCEAN AVENUE- STE 7A BROOKLYN NY 11229	09/24/2012	09/18/2020
DOL	DOL		MUHAMMAD PERVAIZ		C/O CHAMPION CONSTRUCTION 2131 SCHENECTADY AVENUEBROOKLYN NY 11234	11/18/2015	11/18/2020
DOL	NYC		MUHAMMAD ZULFIQAR		129-06 18TH AVENUE COLLEGE POINT NY 11356	02/09/2012	02/09/2017
DOL	DOL		MURRAY FORTH		P O BOX 74 EAST GREENBUSH NY 12061	02/28/2012	10/01/2017
DOL	DOL		MUZAFFAR HUSSAIN		C/O ABSOLUTE GENERAL CONT 1129 AVENUE UBROOKLYN NY 11229	01/28/2013	01/28/2018
DOL	NYC	*****3613	MZM CORP		163 S MAIN STREET NEW CITY NY 10956	01/28/2016	01/28/2021
DOL	NYC	*****1284	NEW AMERICAN RESTORATION INC		22 CALIFORNIA AVE - STE 1 PATERSON NJ 07503	03/11/2015	03/11/2020
DOL	DA	*****6988	NEW YORK INSULATION INC		58-48 59TH STREET MASPETH NY 11378	05/16/2012	05/08/2020
DOL	NYC	*****4839	NEW YORK RIGGING CORP		58-83 54TH STREET MASPETH NY 11378	02/26/2016	02/26/2021
DOL	DOL		NICHOLAS DEGREGORY JR	NJ DEGREGORY & COMPANY	1698 ROUTE 9 GLENS FALLS NY 12801	05/23/2013	05/23/2018
DOL	NYC		NICHOLAS PROVENZANO		147 BROOME AVENUE ATLANTIC BEACH NY 11509	03/03/2014	03/03/2019
DOL	NYC		NICHOLAS PROVENZANO		147 BROOME AVENUE ATLANTIC BEACH NY 11509	03/03/2014	03/03/2019
DOL	DOL	*****5279	NJ DEGREGORY & COMPANY		1698 ROUTE 9 GLENS FALLS NY 12801	05/23/2013	05/23/2018
DOL	DOL		NJ DEGREGORY & SONS CONSTRUCTION		1698 ROUTE 9 GLENS FALLS NY 12801	05/23/2013	05/23/2018
DOL	NYC	*****1968	NORTH AMERICAN IRON WORKS INC		1560 DECATUR STREET RIDGEWOOD NY 11385	05/15/2015	05/15/2020
DOL	DOL	*****9198	OCTAGON CO		37-11 35TH AVENUE-2ND FL LONG ISLAND CITY NY 11101	01/08/2013	01/08/2018
DOL	DOL		OKBY ELSAYED		1541 EAST 56TH STREET BROOKLYN NY 11234	05/04/2012	05/04/2017

DOL	NYC		OLIVER HOLGUIN		95-26 76TH STREET OZONE PARK NY 11416	10/12/2011	10/12/2016
DOL	NYC	*****8337	OPTIMUM CONSTRUCTION INC		23-73 48TH STREET LONG ISLAND CITY NY 11103	04/24/2014	04/24/2019
DOL	NYC		ORSON ARROYO		C/O METRO DUCT SYSTEMS 12-19 ASTORIA BOULEVARDLONG ISLAND CITY NY 11102	04/16/2014	11/19/2020
DOL	DOL	*****4546	PAF PAINTING CORP		161 TIBBETTS ROAD YONKERS NY 10705	03/12/2014	03/12/2019
DOL	DOL	*****5242	PAF PAINTING SERVICES INC	GARDEN STATE PAINTING	157 TIBBETTS ROAD YONKERS NY 10103	03/12/2014	03/12/2019
DOL	DOL		PAF PAINTING SERVICES OF WESTCHESTER INC		C/O SPIEGEL & UTRERA 1 MAIDEN LANE - 5TH FLNEW YORK NY 10038	03/12/2014	03/12/2019
DOL	DOL	*****8802	PAT'S HEATING AND AIR CONDITIONING LTD		P O BOX 371 ROUND LAKE NY 12151	05/12/2014	05/12/2019
DOL	DOL		PATRICIA M RUGGLES		P O BOX 371 ROUND LAKE NY 12151	05/12/2014	05/12/2019
DOL	DOL		PAUL VERNA		C/O AMERICAN STEEL MECHA 693 PAINTER STREETMEDIA PA 19063	02/20/2013	02/20/2018
DOL	DOL	*****9569	PERFORM CONCRETE INC		31 DURANT AVENUE BETHEL CT 06801	07/02/2012	07/02/2017
DOL	NYC		PETER LUSTIG		30 COLUMBUS CIRCLE EASTCHESTER NY 10709	08/21/2012	08/21/2017
DOL	NYC		PETER TRITARIS		5990 58TH AVENUE MASPETH NY 11378	11/18/2013	11/18/2018
DOL	DOL	*****7914	PRECISION SITE DEVELOPMENT INC		89 EDISON AVENUE MOUNT VERNON NY 10550	10/28/2011	10/28/2016
DOL	DOL	*****2989	PROFESSIONAL ESTIMATING & BUSINESS CORP		157 TIBBETS ROAD YONKERS NY 10705	03/12/2014	03/12/2019
DOL	DOL	*****6895	PROLINE CONCRETE OF WNY INC		3090 SHIRLEY ROAD NORTH COLLINS NY 14111	04/19/2011	07/08/2020
DOL	DOL	*****0015	RAMADA CONSTRUCTION CORP		80 SAVO LOOP STATEN ISLAND NY 10309	01/07/2014	01/07/2019
DOL	NYC		RAMESHWAR ASU		137 LIBERTY AVENUE BROOKLYN NY 11212	12/21/2015	12/21/2020
DOL	DOL		RANA A KAHN		1973 81ST ST - SUITE A-5 BROOKLYN NY 11214	01/08/2015	01/08/2020
DOL	NYC		RANTIK PARIKH		13 LORIANN ROAD WARREN NJ 07059	07/15/2015	07/15/2020
DOL	DOL	*****2633	RAW POWER ELECTRIC CORP		3 PARK PLACE MIDDLETOWN NY 10940	09/16/2013	09/15/2019
DOL	NYC		RAYMOND PEARSON		P O BOX 957 PORT JEFFERSON STA NY 11776	03/12/2014	03/12/2019
DOL	DOL		REBECCA THORNE		113 N MAPLE AVENUE GREENSBURG PA 15601	02/21/2013	02/21/2018
DOL	DOL		REGINALD WARREN		C/O RAW POWER ELECTRIC 3 PARK CIRCLEMIDDLETOWN NY 10940	09/15/2014	09/15/2019
DOL	NYC	*****3461	RELIANCE GENERAL CONSTRUCTION INC		644 OCEAN PARKWAY BROOKLYN NY 11230	09/02/2015	09/02/2020
DOL	DOL		REVOLUTIONARY FLOORS LLC		P O BOX 268 STILLWATER NY 12170	09/16/2013	03/21/2019
DOL	DOL		RHINO CONCRETE LLC		101 SULLYS TRAIL/SUITE 20 PITTSFORD NY 14534	11/18/2013	01/07/2019
DOL	DOL		RICHARD WILSON		C/O DUFOUR GROUP INC 353 WEST 56TH STREET #7MNEW YORK NY 10019	06/10/2014	06/10/2019
DOL	DOL	*****8618	RIEKS CONTRACTING LLC		4804 GAHWILER ROAD AUBURN NY 13021	05/01/2015	05/01/2020
DOL	DOL		ROBBYE BISSESAR		89-51 SPRINGFIELD BLVD QUEENS VILLAGE NY 11427	01/11/2003	01/11/3003
DOL	DOL	*****1855	ROBERT D BISHOP JR	ROBERT D BISHOP JR	P O BOX 112 MORRISSONVILLE NY 12962	07/15/2014	07/15/2019
DOL	DOL		ROBERT D BISHOP JR		P O BOX 112 MORRISONVILLE NY 12962	07/15/2014	07/15/2019
DOL	NYC		ROBERT GUIDO		3256 BRUNER AVENUE BRONX NY 10469	07/29/2014	07/29/2019
DOL	DOL		ROBERT L EVANS		128A NORTH STAMFORD ROAD STAMFORD CT 06903	05/23/2013	05/23/2018
DOL	DOL		ROBERT TORDELLA		125 CHAUTAUQUA AVENUE LAKEWOOD NY 14750	06/24/2015	06/24/2020

DOL	DOL		ROCCO ESPOSITO		C/O ROCMAR CONTRACTING CO 620 COMMERCE STREETTHORNWOOD NY 10594	09/24/2012	09/24/2017
DOL	DOL	*****3859	ROCHESTER ACOUSTICAL CORP		P O BOX 799 HILTON NY 14468	02/19/2016	02/19/2021
DOL	DOL		ROCMAR CONSTRUCTION CORP		620 COMMERCE STREET THORNWOOD NY 10594	09/24/2012	09/24/2017
DOL	DOL	*****7083	ROCMAR CONTRACTING CORP		620 COMMERCE STREET THORNWOOD NY 10594	09/24/2012	09/24/2017
DOL	NYC		RODNEY SCOTT		201 HEMPSTEAD AVENUE WEST HEMPSTEAD NY 11552	10/30/2015	10/30/2020
DOL	DOL		ROMEO WARREN		C/O RAW POWER ELECTR CORP 3 PARK PLACEMIDDLETOWN NY 10940	09/16/2013	09/15/2019
DOL	DOL		ROSEANNE CANTISANI		11 TATAMUCK ROAD POUND RIDGE NY 10576	05/04/2012	05/04/2017
DOL	DOL		ROSS J MUSCOLINO		10 ST CHARLES STREET THORNWOOD NY 10594	09/03/2013	09/03/2018
DOL	DOL		S & S ELECTRIC		235 BROADWAY SCHENECTADY NY 12306	06/19/2013	06/19/2018
DOL	NYC		SABIR MUHAMMED		SUITE B-8 782 PELHAM PARKWAY SOUTHBRONX NY 10462	04/21/2016	04/21/2021
DOL	NYC		SAEED HASAN		4558 BROADWAY #6 NEW YORK NY 10040	08/04/2014	08/04/2019
DOL	DOL	*****4923	SCHENLEY CONSTRUCTION INC		731 WARWICK TURNPIKE HEWITT NJ 07421	06/25/2012	12/11/2017
DOL	NYC	*****2117	SCOTT ELECTRICAL LLC		201 HEMPSTEAD AVENUE WEST HEMPSTEAD NY 11552	10/30/2015	10/30/2020
DOL	DOL		SCOTT LEONARD	GLOBAL TANK CONSTRUCTI ON LLC	P O BOX 1238 SALINA OK 74365	11/28/2012	11/28/2017
DOL	DOL		SEAKCO CONSTRUCTION COMPANY LLC		128A NORTH STAMFORD ROAD STAMFORD CT 06903	05/23/2013	05/23/2018
DOL	DOL	*****9030	SEAKCO NEW YORK LLC	SEAKCO CONSTRUCTI ON COMPANY	128A NORTH STAMFORD ROAD STAMFORD CT 06903	05/23/2013	05/23/2018
DOL	DOL		SEAN BURBAGE	C/O SEAN BURBAGE CORP	445 ROOSA GAP ROAD BLOOMINGBURG NY 12721	04/14/2014	04/14/2019
DOL	DOL	*****6586	SEAN BURBAGE CORP		445 ROOSA GAP ROAD BLOOMINGBURG NY 12721	04/14/2014	04/14/2019
DOL	NYC		SHAHZAD ALAM		21107 28TH AVE BAYSIDE NY 11360	07/02/2012	07/02/2017
DOL	DOL	*****6904	SIGNING STAR LIMITED LIABILITY COMPANY		5 HANSEN PLACE WAYNE NJ 07470	09/18/2013	09/18/2018
DOL	DOL	*****4025	SOLUTION MATTERS INC		198 NORWOOD ROAD PORT JEFFERSON NY 11776	11/19/2015	11/19/2020
DOL	DOL		SPASOJE DOBRIC		61 WILLET STREET - SUITE PASSAIC NJ 07055	07/09/2010	02/23/2017
DOL	NYC	*****4934	SPHINX CONTRACTING CORP		240 HOME STREET TEANECK NJ 07666	08/04/2014	08/04/2019
DOL	DOL		SPORTSCRAFTERS INC		113 N MAPLE AVENUE GREENSBURG PA 15601	02/21/2013	02/21/2018
DOL	DOL	*****3539	SPOTLESS CONTRACTING	IMPACT INDUSTRIAL SERVICES INC	44 THIELLS-MT IVY ROAD POMONA NY 10970	10/14/2011	10/14/2016
DOL	DOL	*****3496	STAR INTERNATIONAL INC		89-51 SPRINGFIELD BLVD QUEENS VILLAGE NY 11427	08/11/2003	08/11/3003
DOL	DOL		STEPHEN BIANCHI		462 LAKEVIEW AVENUE VALHALLA NY 10595	12/16/2013	12/16/2018
DOL	DOL		STEPHEON SHELDON	FANTASTIC PAINTING	493 LANSING ROAD FULTONVILLE NY 12072	11/18/2013	11/18/2018
DOL	DOL		STEVEN P SUCATO		15-68 208TH STREET BAYSIDE NY 11360	06/23/2016	06/23/2021
DOL	DOL		STEVEN SAGGESE		3005 WYNSUM AVENUE MERRICK NY 11566	08/18/2014	08/18/2019
DOL	DOL		STUART CHAITIN		634 ROUTE 303 BLAUVET NY 10913	07/26/2012	11/19/2018
DOL	NYC	*****9432	SUBLINK LTD		346 THIRD AVENUE PELHAM NY 10803	11/19/2015	11/19/2020
DOL	DOL	*****3210	SUPER SWEEP	FMS	4 LEGHORN COURT NEW YORK NY 11746	11/28/2012	11/28/2017

DOL	DOL		SUZANNE G GOLD	C/O GOLDS FLOORING INSTALLATIONS INC	25 HAMILTON ROAD MONTICELLO NY 12701	10/16/2013	10/16/2018
DOL	DOL	*****7441	T & T CONCRETE INC		2560 HAMBURG TURNPIKE P O BOX 367LACKAWANNA NY 14218	07/08/2015	07/08/2020
DOL	DOL	*****9676	T D CONTRACTORS CORP	T D CONTRACTORS INC	113 N MAPLE AVENUE GREENSBURG PA 15601	02/21/2013	02/21/2018
DOL	DOL		T D CONTRACTORS INC		113 N MAPLE AVENUE GREENSBURG PA 15601	02/21/2013	02/21/2018
DOL	DOL		TAMMY LACITIGNOLA		C/O CATSKILL FENCE INSTAL 5445 ROUTE 32CATSKILL NY 12414	08/22/2014	08/22/2019
DOL	DOL	*****9852	TAP STEEL INC		ROUTE 26 3101 P O BOX 457CONSTABLEVILLE NY 13325	01/28/2016	01/28/2021
DOL	DOL		TECH-MECHANICAL FAB DC INC		5 PARKER AVENUE POUGHKEEPSIE NY 12601	03/25/2014	03/25/2019
DOL	DOL	*****0887	THE BRINSON PAINTING CORPORATION		72 TAUNTON PLACE BUFFALO NY 14216	04/14/2015	04/14/2020
DOL	DOL	*****8174	THE DALRYMPLE CORPORATION		UNIT 278 541 10TH STREET NWATLANTA GA 30318	12/01/2015	12/01/2020
DOL	DOL	*****8174	THE DALRYMPLE GROUP LLC		289 JONESBORO RD/ STE 216 MCDONOUGH GA 30253	12/01/2015	12/01/2020
DOL	DOL	*****4293	THE J OUVINA GROUP LLC		344 SOUNDVIEW LANE COLLEGE POINT NY 11356	11/22/2011	11/22/2016
DOL	DOL		THE THORNE GROUP INC		113 N MAPLE AVENUE GREENSBURG PA 15601	02/21/2013	02/21/2018
DOL	DOL	*****2070	THE UNIVERSAL GROUP OF NEW YORK INC		212 OXFORD WAY SCHENECTADY NY 12309	12/11/2012	09/16/2018
DOL	DOL	*****9243	THE WELCOME MAT PROPERTY MANAGEMENT LLC		P O BOX 268 STILLWATER NY 12170	09/16/2013	03/21/2019
DOL	DOL		THOMAS DESANTIS	DESANTIS ENTERPRISES	161 OSWEGO RIVER ROAD PHOENIX NY 13135	09/24/2013	11/18/2018
DOL	NYC		THOMAS SCARINCI		130-43 92ND AVENUE RICHMOND HILLS NY 11418	11/27/2013	11/27/2018
DOL	DOL	*****2734	THREE FRIENDS CONSTRUCTION CORP		986 MADISON AVENUE PATERSON NJ 07501	01/03/2013	01/03/2018
DOL	NYC	*****6253	THUNDER BROTHERS CORP		24 CONGRESS LANE SOUTH RIVER NJ 08882	05/01/2013	05/01/2018
DOL	DOL		TIMOTHY A PALUCK		C/O TAP STEEL INC RTE 26 3101/ P O BOX 457CONSTABLEVILLE NY 13325	01/28/2016	01/28/2021
DOL	DOL		TIMOTHY F BARBER		635 LUZERNE ROAD QUEENSBURY NY 12804	09/16/2013	09/16/2018
DOL	NYC	*****1523	TM MECHANICAL CORP		130-43 92ND AVENUE RICHMOND HILLS NY 11418	11/27/2013	11/27/2018
DOL	DOL	*****0600	TOMSON ALLOYS RECYCLING INC		143 FILLMORE AVENUE BUFFALO NY 14210	01/08/2015	01/08/2020
DOL	DOL	*****3453	TORCHIA'S HOME IMPROVEMENT		10153 ROBERTS RD SAUQUOIT NY 13456	08/22/2016	08/22/2021
DOL	DOL	*****8176	TOURO CONTRACTING CORP		1541 EAST 56TH STREET BROOKLYN NY 11234	05/04/2012	05/04/2017
DOL	DOL	*****6914	TRI-COUNTY RESTORATIONS & CONSTRUCTION INC		13 SUMMERSET DRIVE WALLKILL NY 12589	08/22/2014	08/22/2019
DOL	DOL		TRI-COUNTY RESTORATIONS INC		392 ROCK CUT ROAD WALDEN NY 12586	08/22/2014	08/22/2019
DOL	DOL		TROY D CLARKE	ADVANCED METALS	387 RIVERSIDE DRIVE JOHNSON CITY NY 13790	10/01/2012	10/01/2017
DOL	DOL	*****9407	TURBO GROUP INC		15-68 208TH STREET BAYSIDE NY 11360	06/23/2016	06/23/2021
DOL	AG	*****6490	UNIVERSAL STEEL FABRICATORS INC		90 JUNIUS STREET BROOKLYN NY 11212	01/23/2014	01/23/2019
DOL	NYC	*****7174	V&R CONTRACTING		P O BOX 957 PORT JEFFERSON STA NY 11776	03/12/2014	03/12/2019
DOL	NYC		VALERIE VISCONTI		346 THIRD AVENUE PELHAM NY 10803	11/19/2015	11/19/2020
DOL	NYC		VEAP SELA	C/O COLONIAL ROOFING COMPANY INC	247 48TH STREET BROOKLYN NY 11220	02/05/2014	02/05/2019
DOL	DOL	*****3270	VEZANDIO CONTRACTING CORP		530 BEECH STREET NEW HYDE PARK NY 11040	07/02/2012	07/02/2017

DOL	NYC		VICK CONSTRUCTION		21 DAREWOOD LANE VALLEY STREAM NY 11581	12/31/2013	12/31/2018
DOL	NYC		VICKRAM MANGRU	VICK CONSTRUCTI ON	21 DAREWOOD LANE VALLEY STREAM NY 11581	12/31/2013	12/31/2018
DOL	DOL		VICTOR ROTENBERG		C/O GMDV TRANS INC 67048 182ND STREETFRESH MEADOWS NY 11365	06/28/2016	06/28/2021
DOL	NYC		VINCENT PIZZITOLA		P O BOX 957 PORT JEFFERSON STA NY 11776	03/12/2014	03/12/2019
DOL	DOL		WESLEY J STAROBA		206 TALLY HO COURT SCHENECTADY NY 12303	06/19/2013	06/19/2018
DOL	DOL	*****0078	WESLEY J STAROBA INC	S & S ELECTRIC	235 BROADWAY SCHENECTADY NY 12306	06/19/2013	06/19/2018
DOL	DOL	*****7617	WHITE PLAINS CARPENTRY CORP		P O BOX 309 WHITE PLAINS NY 10603	12/04/2009	05/04/2017
DOL	DOL		WILLIAM CONKLIN		5 PARKER AVENUE POUGHKEEPSIE NY 12601	03/25/2014	03/25/2019
DOL	DOL		WILLIAM MAZZELLA		134 MURRAY AVENUE YONKERS NY 10704	02/03/2014	02/03/2019
DOL	DOL		WILLIAM THORNE		113 N MAPLE AVENUE GREENSBURG PA 15601	02/21/2013	02/21/2018
DOL	DOL		WILLIE BRINSON		72 TAUNTON PLACE BUFFALO NY 14216	04/14/2015	04/14/2020
DOL	DOL	*****6195	WILSON BROTHER DRYWALL CONTRACTORS		36 ABERSOLD STREET ROCHESTER NY 14621	08/31/2015	08/31/2020
DOL	DOL	*****7345	YES SERVICE AND REPAIRS CORPORATION		325 RABRO DRIVE - SUITE 1 HAUPPAUGE NY 11788	08/18/2016	08/18/2021
DOL	DOL		YURIY IVANIN		C/O MOUNTAIN'S AIR INC 2471 OCEAN AVENUE-STE 7ABROOKLYN NY 11229	09/24/2012	09/18/2020