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SECTION 260573 - POWER SYSTEM STUDIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes a computer-based study for:
 - 1. Short circuit report.
 - 2. Protective device coordination report.
 - 3. Arc flash report.
- B. Study encompasses the power distribution system of the Collier County Well 19 and the new loads to be fed off of Well 19 power distribution system from Well house 18 and 20 located in Collier County, Florida.
- C. Study includes the electric utility company's protective devices, portable emergency generators, service entrance equipment and distribution. All power distribution to that point whether existing or new is included. Equipment included, but not limited to:
 - 1. Main distribution panelboards.
 - 2. Motor control centers.
 - 3. Variable frequency controllers.
 - 4. Disconnect switches.
 - 5. Transfer switches.
 - 6. 480V control panels.
 - 7. Transformer panel assemblies.
- D. The local electric utility is Florida Power and Light (FPL).
- E. Obtain all data necessary to perform the study. Data included, but not limited to:
 - 1. Up to date one-line diagrams.
 - 2. Equipment data.
 - 3. Cable sizes and lengths.
 - 4. Existing protective device settings.
 - 5. Electric utility information: available fault current, protective device equipment information and settings, X/R ratios, transformer impedances and ratings.

1.3 DEFINITIONS

- A. Boundary, Arc Flash: When an arc flash hazard exists, an approach limit from an arc source at which the incident energy equals 1.2 cal/cm^2 .
- B. Boundary, Limited Approach: An approach limit at a distance from an exposed energized electrical conductor or circuit part within which a shock hazard exists.
- C. Boundary, Restricted Approach: An approach limit at a distance from an exposed energized electrical conductor or circuit part within which there is an increased likelihood of electric shock, due to electrical arc-over combined with inadvertent movement.
- D. Existing to Remain: Existing items of construction that are not to be removed and that are not otherwise indicated to be removed and salvaged, or removed and reinstalled. Existing to remain items shall remain functional throughout the construction period.
- E. Field Adjusting Agency: An independent electrical testing agency with full-time employees and the capability to adjust devices and conduct testing indicated and that is a member company of NETA.
- F. One-Line Diagram: A diagram that shows, by means of single lines and graphic symbols, the course of an electric circuit or system of circuits and the component devices or parts used therein.
- G. Power System Analysis Software Developer: An entity that commercially develops, maintains, and distributes computer software used for power system studies.
- H. Power Systems Analysis Specialist: Professional engineer in charge of performing the study and documenting recommendations, licensed in the state where Project is located.
- I. Preliminary Short Circuit Report: Report that includes the maximum available utility fault current, proposed equipment, and existing equipment to determine if new equipment may be released for manufacturing and existing equipment is adequate for the calculated short circuit levels.
- J. Protective Device: A device that senses when an abnormal condition or current flow exists and then removes the affected portion of the circuit from the system.
- K. SCCR: Short-circuit current rating.
- L. Service: The conductors and equipment for delivering electric energy from the serving utility to the wiring system of the premises served.
- M. Single-Line Diagram: See "One-Line Diagram."
- N. Supplier: The person, firm or corporation identified as such to provide the power system study and means the Supplier or its authorized agent. See also Power Systems Analysis Specialist.
- O. VFD: Variable frequency drive. Interchangeable with variable frequency controller.

1.4 ACTION SUBMITTALS

- A. Supplier qualifications per Quality Assurance paragraph. Submit prior to starting study. Include the following:
 - 1. Brief description of each qualifying study.
 - 2. Name of owner of installation on which study was performed with address, telephone number, and contact person.
 - 3. Date of study.
 - 4. Any other information indicating the firm's experiences and ability to perform the work and business status.
- B. Final Power System Study Report. Report must be approved prior to energization of new major electrical equipment. Revise study as required for changes during construction.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data:
 - 1. For Power Systems Analysis Software Developer.
 - 2. For Power System Analysis Specialist.
 - 3. For Field Adjusting Agency.
- B. If requested, Product Certificates: For power system study software, certifying compliance with IEEE 399, IEEE 1584 and NFPA 70E.
- C. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

- A. Final power system study updated with any changes made after equipment start-up.
- B. Digital computer files with full read-write access of the complete power system model and library.

1.7 QUALITY ASSURANCE

- A. Perform Study using commercially developed and distributed software designed specifically for power system analysis.
- B. Software algorithms shall comply with requirements of standards and guides specified in this Section.
- C. Manual calculations are unacceptable.
- D. Power System Analysis Software Qualifications:
 - 1. Design computer program to perform short-circuit studies or have a function, component, or add-on module designed to perform short-circuit studies.

2. Develop computer program under the charge of a licensed professional engineer who holds IEEE Computer Society's Certified Software Development Professional certification.
 3. Complies with IEEE 399, IEEE 141, IEEE 242, IEEE 519, IEEE 1015, and IEEE 1584 as applicable to the project scope.
- E. Power Systems Analysis Specialist Qualifications: Professional engineer licensed in the state where Project is located and has regularly engaged in this electrical engineering study specialty for minimum of five years and has performed at least three projects of similar complexity to this project within the last three years. Perform all elements of the study under the direct supervision and control of this professional engineer.
- F. Power System Study Certification: Report shall be signed and sealed by Power Systems Analysis Specialist.
- G. Field Adjusting Agency Qualifications:
1. Employer of NETA ETT-Certified Technician Level III or NICET Electrical Power Testing Level III certification responsible for all field adjusting of the Work.
 2. A member company of NETA.
 3. Acceptable to authorities having jurisdiction.

PART 2 - PRODUCTS

2.1 POWER SYSTEM ANALYSIS SOFTWARE DEVELOPERS

- A. Acceptable Software:
1. SKM System Analysis, Inc.: Power*Tools.
 2. Operation Technology, Inc.: ETAP (Electrical Transient Analyzer Program).
 3. EasyPower, Inc.: EasyPower.
 4. Or equal.

2.2 POWER SYSTEM STUDY REPORT GENERAL REQUIREMENTS

- A. Except for one-line diagrams, standard 8 1/2-inch by 11-inch pages, with total pages numbered.
- B. Electronic PDF format copy with electronic bookmarks for each section.
- C. Signed and sealed by a professional engineer registered in the state in which the project is located.
- D. Organized in the following order:
1. Executive Summary.
 2. Short Circuit Analysis.
 3. Short Circuit Computer Printout.
 4. Protective Device Coordination.
 5. Arc Flash Hazard Analysis.

6. Utility Data.
 7. Modeled One Line Diagrams.
- E. Information on one-line diagrams, legible when printed at 11-inch x 17-inch. Show the following:
1. Protective device designations and ampere ratings.
 2. Conductor types, sizes, and lengths.
 3. Transformer kilovolt ampere (kVA), impedance, and voltage ratings.
 4. Motor and generator designations and kVA ratings.
 5. Switchgear, switchboard, motor-control center, and panelboard designations and ratings.
 6. Derating factors and environmental conditions.
 7. Any revisions to electrical equipment required by the study.
- F. Identifiers between the one-line diagram, short circuit study, coordination study, and arc flash study to be the same.
- G. Include copies of correspondence with electric utility under utility data section of report. Correspondence to include names and contact information.

2.3 EXECUTIVE SUMMARY

- A. Include summary of distribution system, information received from electric utility, major assumptions, adequacy of equipment to safely clear or close on any fault, identify problem areas and recommendations for resolving problem areas.

2.4 SHORT CIRCUIT

- A. Comply with IEEE 399 and IEEE 551 (new 3002 series).
- B. Include normal utility powered configuration, on-site generation configuration, and alternate modes of operation (i.e. alternate utility configuration, bus ties closed).
- C. Include minimum and maximum possible fault conditions. Address three-phase bolted as well as ground fault conditions.
- D. Consider the fault contribution of all motors operating during the maximum demand condition of the motors.
- E. Calculate short-circuit momentary duties and interrupting duties based on an assumed bolted three-phase short circuit at each high and medium voltage switchgear bus and controller, low voltage switchgear bus, switchboard, motor control center, distribution panelboard, pertinent branch circuit panelboard and other significant locations throughout the systems. Include the X/R ratios, asymmetry factors, KVA and symmetrical fault-current in the short circuit tabulations. Provide ground fault current study for the same system areas. Include in tabulations fault impedance, X/R ratios, asymmetry factors, motor contribution, short circuit KVA, and symmetrical and asymmetrical fault-currents.

- F. Include representation of the site power system, the base quantities selected, impedance source data, calculation methods and tabulations, one-line diagrams, conclusions and recommendations.
- G. Identify available fault current at each bus and evaluate system elements including but not limited to equipment, protective devices, and cables.
- H. Base current transformers' ratio and burden calculations on a 10 percent maximum ratio error per IEEE C57.13. Identify current transformers that will not allow the protective devices to operate within acceptable IEEE error margins and recommend corrective action.
- I. List momentary, interrupting, and/or withstand rating of all key elements of the distribution system along with the maximum available fault current in tabular form and clearly indicate the adequacy of the element with PASS / FAIL designation.
- J. Short Circuit Computer Printout:
 - 1. Calculations shall be in sufficient detail for easy review.
 - 2. Back up calculations shall become part of the final report.

2.5 PROTECTIVE DEVICE COORDINATION

- A. Comply with IEEE 242 (new 3004 series).
- B. Utilize results from the short circuit study and balance the competing objectives of protection and continuity of service for the system specified, considering the basic factors of sensitivity, selectivity and speed. Include all system protective devices in the coordination analysis, not just overcurrent protective devices. This includes, but is not limited to under and over voltage protective relays, frequency relays, differential relays and reverse power relays.
- C. Show graphic indication of coordination between protective devices in the form of full color time-current coordination (TCC) plots with each protective device curve in a unique color for easy review.
- D. Provide separate TCC plots for each mode of operation. Provide separate TCC plots for "normal" and "stand by" operation. Show maximum fault values in each case. Both power sources shown on one plot is unacceptable.
- E. Provide separate TCC for phase over-current and ground fault.
- F. Show no more than six devices on one TCC. Of these six curves, two (the largest upstream device and the smallest downstream device) shall repeat curves shown on other coordination plots to provide cross-reference. Designate each TCC with a unique identifier and include each TCC identifier and descriptive title in the study's table of contents.
- G. Include in each TCC the following as applicable:
 - 1. TCC name and description.
 - 2. One-line diagram.
 - 3. Identifiers on one-line diagram and curves.

4. Significant motor starting characteristics.
 5. Appropriate NEC protection points.
 6. Appropriate ANSI/IEEE protection points.
 7. Magnetizing inrush points of transformers.
 8. Transformer damage curves.
 9. Complete operating bands for low voltage circuit breaker trip devices and fuses.
 10. Relay coil taps, time-dial settings and pickup settings.
 11. Significant symmetrical and asymmetrical fault currents.
 12. Power cable withstand curves.
 13. Generator short circuit decrement and thermal limit curves.
- H. Terminate device characteristic curve on TCC at a point reflecting the maximum symmetrical or asymmetrical fault current to which that device is exposed, based on the short circuit study.
- I. Select each primary protective device for a delta-to-wye-connected transformer so the characteristic or operating band is within the transformer parameters; where feasible, include a parameter equivalent to 58 percent of the ANSI C37.91 withstand curve to afford protection for secondary line-to-ground faults.
- J. Separate low voltage power circuit breakers from each other and the associated primary protective device, by a 16 percent current margin for coordination and protection in the event of line-to-line faults.
- K. Separate protective relays by a 0.3-second time margin for the maximum 3 phase fault conditions to assure proper selectivity.
- L. Optimize settings for breakers and relays to provide the most effective protection practicable for all modes and power sources.
- M. Include at least all devices down to largest branch circuit and largest feeder circuit breaker in each motor control center and/or power distribution panelboard. Include all adjustable setting ground fault protective devices.
- N. Provide tabulations of recommended settings for all protective devices. Where devices are existing, highlight any changes from the existing setting to the proposed recommended setting.
- O. Provide all information required to program/set multifunction solid state relays.

2.6 ARC FLASH HAZARD

- A. Comply with IEEE 1584, NFPA 70, and NFPA 70E as applicable.
- B. Utilize short circuit and protective device coordination results to provide arc flash hazard analysis. Perform calculations in accordance with IEEE 1584 or NFPA 70E with the method identified within the report.
- C. Calculate the incident energy levels at each faulted bus for each mode of operation and for both maximum and minimum fault currents.
- D. Include calculations at line side and load side of main breakers, where applicable.

- E. Provide tabular report for all modes and conditions and include “worst case” summary. Use the “worst case” to generate the arc flash labels. Include:
 - 1. Fault location.
 - 2. Arcing fault magnitude.
 - 3. Protective device clearing time.
 - 4. Duration of the arc.
 - 5. Arc flash boundary.
 - 6. Working distance.
 - 7. Incident energy.
 - 8. Electrode configuration.
- F. Highlight any available incident energy over 40 cal/cm² and provide recommendations to mitigate the hazard.
- G. Arc Flash Labels:
 - 1. Machine printed, 4-inches x 4-inches (nominal), thermal transfer, high adhesion polyester.
 - 2. Provide UV resistant laminate for outdoor labels.
- H. Arc Flash Label Information:
 - 1. Equipment name.
 - 2. Identifier LINE or LOAD where equipment has potential different energy levels.
 - 3. Arc flash hazard information: arc flash boundary and incident energy in cal/cm².
 - 4. Shock hazard information: limited approach and restricted approach boundaries.
 - 5. Personal Protective Equipment (PPE) requirements.
 - 6. Study Supplier, project number, and date.
- I. Provide arc flash label sample with preliminary report.
- J. Do not print labels until equipment is energized and protective devices set according to the approved final protective device coordination study.

PART 3 - EXECUTION

3.1 POWER SYSTEM DATA

- A. Obtain all data necessary for conduct of the study.
 - 1. Verify completeness of data supplied on one-line diagram. Call any discrepancies to Engineer's attention.
 - 2. For equipment included as Work of this Project, use characteristics submitted under provisions of action submittals and information submittals for this Project.
- B. Gather and tabulate the required input data to support the power system study.
- C. Field data gathering for existing systems shall be under direct supervision and control of the engineer in charge of performing the study and shall be by the engineer or its representative

who holds NETA ETT-Certified Technician Level III or NICET Electrical Power Testing Level III certification.

D. Data included, but are not limited to, the following:

1. Product data for overcurrent protective devices and existing settings.
2. Electrical power utility impedance at the service and upstream protective device data.
3. Power sources and ties.
4. For switchgear, switchboards, panelboards, and motor control centers, ampacity and SCCR in amperes RMS symmetrical.
5. For transformers, kVA, primary and secondary voltages, connection type, impedance, X/R ratio, taps measured in percent, and phase shift.
6. For reactors, manufacturer and model designation, voltage rating, and impedance.
7. For circuit breakers, trip units, fuses, and manufacturer and model designation. List type of breaker, type of trip, SCCR, current rating, and breaker settings.
8. For generators, short-circuit current contribution data, including short-circuit reactance, rated kVA, rated voltage, and X/R ratio.
9. For busways, manufacturer and model designation, current rating, impedance, lengths, and conductor material.
10. For motors, horsepower and NEMA MG 1 code letter designation.
11. Conductor sizes, lengths, number, conductor material, shield parameters for medium voltage cable, and conduit material (magnetic or nonmagnetic).
12. For relays, manufacturer and model designation, current transformer ratios, potential transformer ratios, and relay settings.
13. For transfer switches, withstand and closing ratings (WCR) with time duration.
14. Derating factors.

3.2 FIELD QUALITY CONTROL

- A. Do all testing and adjustment prior to the energization of new equipment.
- B. Test existing adjustable protective devices in accordance with NETA MTS.
- C. Test new adjustable protective devices in accordance with NETA ATS.
- D. Adjust existing and new protective devices according to approved coordination study.
- E. Testing and adjusting shall be by full-time employee of the Field Adjusting Agency, who holds NETA ETT-Certified Technician Level III or NICET Electrical Power Testing Level III certification.
- F. After successful testing and adjustment, install calibration sticker with Field Adjusting Agency name, employee initials, and date of calibration at each relay or protective device.
- G. After energization, minor adjustments to settings may be required to commission the equipment.
- H. Submit field report and list any changes made during field adjustment or commissioning for update for record submittal of study.

- I. For adjustable breakers, install sticker listing final adjusted settings, i.e. LTPU, LTD, STPU, STD, INST, GFPU, and GFD.

3.3 ARC FLASH LABELING

- A. After the field adjustment of relays and protective devices, apply arc flash study labels.
- B. Apply arc flash labels on front covers of the following equipment:
 1. Main distribution panelboards.
 2. Motor control centers.
 3. Variable frequency controllers.
 4. Disconnect switches.
 5. Transfer switches.
 6. 480V control panels.
 7. Transformer panel assemblies.
- C. Apply arc-flash labels at each section for large equipment such as switchgear and motor control centers.
- D. Install LINE and LOAD arc-flash labels as applicable.
- E. Remove any previous arc flash study labels as applicable and install new labels under the direction of the Power System Analysis Specialist.

END OF SECTION 260573

SECTION 262213 - LOW-VOLTAGE DISTRIBUTION TRANSFORMERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes:
 - 1. Drive isolation dry-type transformers.
 - 2. Transformer panel assemblies.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type and size of transformer.
 - 2. Include rated nameplate data, capacities, weights, dimensions, minimum clearances, installed devices and features, and performance for each type and size of transformer.
- B. Shop Drawings:
 - 1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 2. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment.
 - 3. Include diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For testing agency.
- B. Source quality-control reports.
- C. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For transformers to include in emergency, operation, and maintenance manuals.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Inspection: On receipt, inspect for and note any shipping damage to packaging and transformer.
 - 1. If manufacturer packaging is removed for inspection, and transformer will be stored after inspection, re-package transformer using original or new packaging materials that provide protection equivalent to manufacturer's packaging.
- B. Storage: Store in warm, dry, and temperature-stable location in original shipping packaging.
- C. Temporary Heating: Apply temporary heat according to manufacturer's written instructions within the enclosure of each ventilated-type unit, throughout periods during which equipment is not energized and when transformer is not in a space that is continuously under normal control of temperature and humidity.
- D. Handling: Follow manufacturer's instructions for lifting and transporting transformers.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - 1. ABB, Electrification Business (General Electric).
 - 2. Eaton.
 - 3. Square D; Schneider Electric USA.
- B. Source Limitations: Obtain each transformer type from single source from single manufacturer.

2.2 DRIVE ISOLATION TRANSFORMERS

- A. Comply with the following Standards:
 - 1. NEMA ST 20.
 - 2. UL 1561.
 - 3. US Department of Energy Efficiency Standards for Low Voltage Distribution Transformers.
- B. General Description:
 - 1. Dry type, two winding. Configuration, kVA, and voltage shown on Drawings.
 - 2. Windings: Copper.
 - 3. Temperature Rise: 80 degrees C.

- C. Taps for transformers 15 kVA and larger: Full capacity, two 2.5 percent above and four 2.5 percent below.
- D. Grounding: Provide ground-bar kit or a ground bar installed on the inside of the transformer enclosure.
- E. Enclosures:
 - 1. Indoor: NEMA 250, Type 1 or 2, ventilated. Standard enclosure type.
 - 2. Outdoor Enclosure or identified for NEMA 4X enclosures on Drawings: TENV, stainless steel enclosure. All stainless steel hardware.

2.3 TRANSFORMER PANEL ASSEMBLY (TPA)

- A. Comply with UL 1062 for unit substations.
- B. General Description: Unit assembly with combination of two winding dry type transformer and panel. Includes main primary circuit breaker and secondary panel section with main circuit breaker. Configuration, kVA, and voltage shown on Drawings. Also referred to on Drawings as MPZ (Mini-Power-Zone).
 - 1. Windings: Copper, epoxy-resin encapsulated.
 - 2. Temperature Rise: 115 degrees C.
 - 3. Taps: Full capacity, two 5 percent below.
- C. Grounding: Include provisions for connection to grounding electrode system. Include copper equipment ground bar in panel distribution section.
- D. Provide ground-bar kit or a ground bar installed on the inside of the transformer enclosure.
- E. Enclosures:
 - 1. Indoor: Standard enclosure type NEMA 3R, painted steel.
 - 2. Outdoor Enclosure or identified for NEMA 4X enclosures on Drawings: NEMA 3R, stainless steel.
- F. Circuit Breakers and Panel Section:
 - 1. Copper bus.
 - 2. Plug-on type circuit breakers.
 - 3. Main primary breaker sized per manufacturer's standard, minimum 18kA interrupting rating at 480V.
 - 4. Secondary main breaker sized per manufacturer's standard, minimum 10kA interrupting rating at 240V.

2.4 IDENTIFICATION

- A. Nameplates: Engraved, laminated-acrylic or melamine plastic signs for each distribution transformer, mounted with corrosion-resistant screws.

2.5 SOURCE QUALITY CONTROL

- A. Test and inspect transformers according to IEEE C57.12.01 and IEEE C57.12.91.
 - 1. Resistance measurements of all windings at rated voltage connections and at all tap connections.
 - 2. Ratio tests at rated voltage connections and at all tap connections.
 - 3. Phase relation and polarity tests at rated voltage connections.
 - 4. No load losses, and excitation current and rated voltage at rated voltage connections.
 - 5. Impedance and load losses at rated current and rated frequency at rated voltage connections.
 - 6. Applied and induced tensile tests.
 - 7. Regulation and efficiency at rated load and voltage.
 - 8. Insulation-Resistance Tests:
 - a. High-voltage to ground.
 - b. Low-voltage to ground.
 - c. High-voltage to low-voltage.
 - 9. Temperature tests.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine conditions for compliance with enclosure- and ambient-temperature requirements for each transformer.
- B. Verify that field measurements are as needed to maintain working clearances required by NFPA 70 and manufacturer's written instructions.
- C. Examine walls, floors, roofs, and concrete bases for suitable mounting conditions where transformers will be installed.
- D. Verify that ground connections are in place and requirements in Section 260510 "Limited Electrical for Small Projects" have been met. Maximum ground resistance shall be 5 ohms at location of transformer.
- E. Environment: Enclosures shall be rated for the environment in which they are located. Covers for NEMA 250, Type 4X enclosures shall not cause accessibility problems.
- F. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install wall-mounted transformers level and plumb with wall brackets fabricated by transformer manufacturer.

1. Coordinate installation of wall-mounted and structure-hanging supports with actual transformer provided.
- B. Install transformers level and plumb on concrete base with vibration-dampening supports. Locate transformers away from corners and not parallel to adjacent wall surface.
- C. Construct concrete bases and anchor floor-mounted transformers according to manufacturer's written instructions.
 1. Coordinate size and location of concrete bases with actual transformer provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.
- D. Secure transformer to concrete base according to manufacturer's written instructions.
- E. Secure covers to enclosure and tighten all bolts to manufacturer-recommended torques to reduce noise generation.
- F. Remove shipping bolts, blocking, and wedges.

3.3 CONNECTIONS

- A. Ground equipment in accordance with the National Electric Code and as indicated on the Drawings.
- B. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.
- C. Provide flexible connections at all conduit and conductor terminations and supports to eliminate sound and vibration transmission to the building structure.

3.4 IDENTIFICATION

- A. Identify equipment by name designation and fed from source with nameplates.
- B. Color code wiring.
- C. Identify panel branch circuit numbers at TPA at circuit breakers and neutral terminals.
- D. Provide as built typed panel directory at TPA.

3.5 FIELD QUALITY CONTROL

- A. Perform tests and inspections.

B. Dry-Type Transformer Field Tests:

1. Visual and Mechanical Inspection.

- a. Inspect physical and mechanical condition.
- b. Inspect anchorage, alignment, and grounding.
- c. Verify that resilient mounts are free and that any shipping brackets have been removed.
- d. Verify the unit is clean.
- e. Perform specific inspections and mechanical tests recommended by manufacturer.
- f. Verify that as-left tap connections are as specified.

2. Electrical Tests:

- a. Measure resistance at each winding, tap, and bolted connection.
- b. Perform insulation-resistance tests winding-to-winding and each winding-to-ground. Apply voltage according to manufacturer's published data. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.5.
- c. Verify correct secondary voltage, phase-to-phase and phase-to-neutral, after energization and prior to loading.

C. Remove and replace units that do not pass tests or inspections and retest as specified above.

D. Infrared Scanning: Two months after Substantial Completion, perform an infrared scan of transformer connections.

1. Use an infrared-scanning device designed to measure temperature or detect significant deviations from normal values. Provide documentation of device calibration.
2. Perform follow-up infrared scans of transformers at 11 months after Substantial Completion.
3. Prepare certified report identifying transformer checked and describing results of scanning. Include notation of deficiencies detected, remedial action taken, and scanning observations after remedial action.

E. Test Labeling: On completion of satisfactory testing of each unit, attach a dated and signed "Satisfactory Test" label to tested component.

3.6 ADJUSTING

A. Record transformer secondary voltage at each unit for at least 48 hours of typical occupancy period. Adjust transformer taps to provide optimum voltage conditions at secondary terminals. Optimum is defined as not exceeding nameplate voltage plus 5 percent and not being lower than nameplate voltage minus 3 percent at maximum load conditions. Submit recording and tap settings as test results.

B. Output Settings Report: Prepare written report recording output voltages and tap settings.

3.7 CLEANING

- A. Vacuum dirt and debris; do not use compressed air to assist in cleaning.

END OF SECTION 262213

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SECTION 262505 – 480V CONTROL PANELS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes well pump control panels (PCP) with the following features:
 - 1. Enclosure.
 - 2. Main circuit breaker.
 - 3. Motor controllers.
 - 4. Control and monitoring devices.
 - 5. Accessories.
 - 6. Identification.
- B. Related Requirements:
 - 1. Section 262213 “Low-Voltage Distribution Transformers” for drive isolation transformers.
 - 2. Section 432520 “Submersible Turbine Pumps (For Water Well)” for pumps.
 - 3. Division 40 for process automation requirements.

1.3 DEFINITIONS

- A. CPT: Control power transformer.
- B. GFCI: Ground-fault circuit interrupter.
- C. MCCB: Molded-case circuit breaker.
- D. MCP: Motor circuit protector.
- E. NEC: National Electrical Code.
- F. RVSS: Reduced voltage soft start.
- G. RVAT: Reduced voltage autotransformer start.
- H. SCCR: Short-circuit current rating.
- I. SPD: Surge protective device.
- J. UL: Underwriter’s Laboratories.

- K. VFC: Variable frequency motor controller. See VFD.
- L. VFD: Variable frequency drive. Used interchangeably with the term VFC.

1.4 ACTION SUBMITTALS

- A. Product Data: For each control panel.
 - 1. Include materials, switching and overcurrent protective devices, SPDs, accessories, and components indicated.
 - 2. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.
- B. Shop Drawings: For each control panel. Submit in PDF and AutoCAD format.
 - 1. Include dimensioned plans, elevations, sections, and details.
 - 2. Bill of materials with part numbers, cross-referenced to plans.
 - 3. Nameplate schedule.
 - 4. Conduit entrance locations and mounting details.
 - 5. Power and control schematics.
 - 6. Certification for compliance with UL 508A.
 - 7. Identification per NEC 409.110.

1.5 INFORMATIONAL SUBMITTALS

- A. Startup reports.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: include the following if applicable:
 - 1. Manufacturer's written instructions for testing and adjusting thermal-magnetic circuit breaker and motor-circuit protector trip settings.
 - 2. Manufacturer's written instructions for setting field-adjustable overload relays.
 - 3. Manufacturer's written instructions for testing, adjusting, and reprogramming microprocessor control modules.
 - 4. Manufacturer's written instructions for setting field-adjustable timers, controls, and status and alarm points.
 - 5. Load-Current and Overload-Relay Heater List: Compile after motors have been installed and arrange to demonstrate that selection of heaters suits actual motor nameplate, full-load currents.
 - 6. Load-Current and List of Settings of Adjustable Overload Relays: Compile after motors have been installed and arrange to demonstrate that switch settings for motor-running overload protection suit actual motors to be protected.

1.7 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Control fuses: Equal to 10 percent of total quantity installed for each size and type, but no fewer than two of each size and type.
 - 2. Power fuses: Equal to 10 percent of total quantity installed for each size and type, but no fewer than three of each size and type.
 - 3. Corrosion Inhibitor: Equal to 100 percent of total number of control panels. (One spare per panel.)

1.8 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Accredited by NETA.
 - 1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Store control panels indoors in clean, dry space with uniform temperature to prevent condensation. Protect control panels from exposure to dirt, fumes, water, corrosive substances, and physical damage.
- B. If stored in space that is not permanently enclosed and air conditioned, remove loose packing and flammable materials from inside enclosures and install temporary electric heating, with at least 50 W per enclosure.

1.10 FIELD CONDITIONS

- A. Ambient Environment Ratings: Rate equipment for continuous operation under the following conditions unless otherwise indicated:
 - 1. Ambient Temperature: Not less than 23 degrees F and not exceeding 104 degrees F.
 - 2. Altitude: Not exceeding 6600 feet for electromagnetic and manual devices.

1.11 WARRANTY

- A. Manufacturer's Warranty: Manufacturer agrees to repair or replace control panels that fail in materials or workmanship within specified warranty period.
- B. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace SPD that fails in materials or workmanship within specified warranty period.
 - 1. SPD Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

- A. Product Selection for Restricted Space: Drawings indicate maximum dimensions for control panels clearances between control panels and adjacent surfaces and other items. Comply with indicated maximum dimensions.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Comply with NEMA 250: Enclosures for Electrical Equipment (1000 Volts Maximum).
- D. Comply with NEMA ICS 6: Industrial Control and Systems: Enclosures.
- E. Comply with NFPA 70.
- F. Comply with UL 508A.
- G. Complete and fully functional control to manually or automatically operate the control system as specified herein and in other applicable sections of these specifications. Include manufacturer's recommended safety devices to protect operators. All control devices, unless specified otherwise, mounted in the Control Panel.
- H. The control panel shall operate on a power supply of 480 volts, 3-phase, 60 hertz unless otherwise noted.
- I. Control panel consists of a main circuit breaker, motor circuit protector (MCP) and motor controller for each motor, and a 120-volt control power transformer (fused on primary and secondary) along with other devices specified. Mount all control components in one common enclosure.
- J. All electronic control equipment (i.e. controllers, isolators, signal boosters, transmitters, PLC's, etc.) shall be as specified in Division 40.
- K. Control panels containing PLC's shall contain UPS or battery ride-through for the PLC in accordance with Division 40 specifications.
- L. SCCR: Control panels shall have a minimum SCCR of 42kA, unless specifically noted elsewhere.

2.2 ENCLOSURES

- A. Enclosures: Surface-mounted, dead-front cabinets rated for environmental conditions at installed location. Unless noted elsewhere, NEMA rating shall be NEMA 4X, Type 316 stainless steel, minimum 14-gauge, factory painted white with water shield and mounting legs.
- B. Construction: The door shall be mounted via continuous stainless steel hinged and provided with a pad-lockable vault type 3-point latch. The enclosure shall be equipped with a door and incorporate a removable back panel on which control components shall be mounted. Back panel shall be secured to enclosure with collar studs. Door(s) shall be interlocked with main circuit breaker and provided with pad-locking provision. All hardware shall be stainless steel.

- C. Conduit Entrance: Bottom entry only.
- D. All motor branch circuit breakers, motor starters and control relays shall be of highest industrial quality, securely fastened to the removable back panels with screws and lock washers. Back panels shall be tapped to accept all mounting screws. Self-tapping screws shall not be used to mount any component.
- E. Operating handle for main circuit breaker: flange mounted.
- F. Outdoor enclosures shall be provided with sun shields where indicated on Drawings.
- G. Provide additional temperature control if required to meet UL temperature rating of internal components. If forced air ventilation is required, the enclosure shall be pressurized. Air filters shall be of commercially available types and sizes.
- H. All operating control and instruments shall be securely mounted on the exterior door. All controls and instruments shall be clearly labeled to indicate function. All exterior mounted equipment shall be NEMA 4X.
- I. Print storage pockets shall be provided on the inside of each panel. Pocket shall be of sufficient size as required to hold all prints necessary to service the equipment.

2.3 COMPONENTS

- A. Main Breaker: Thermal-magnetic air circuit breaker, Schneider Electric/Square D PowerPact Type JJ (250 amp frame, 65 kAIC), Allen Bradley 140G J Frame (250 amp frame, 65kaic) or equal.
- B. MCP: Molded case motor circuit protector with adjustable magnetic trip only, Schneider Electric/Square D “Mag-Gard”, Allen Bradley 140MG or equal.
 - 1. Reduced voltage motor starting: VFD, refer to VFD Article for requirements.
- C. Overload relays shall be self-powered solid-state type and provide the following features: tamper guard over trip adjustment setting, ambient insensitive, harmonic immunity, phase loss and phase unbalance protection, manual reset, and push-to-test.
- D. Overload reset buttons (30.5 mm) shall be mounted on dead front door.
- E. Normally open and normally closed auxiliary motor overload contacts wired to terminal blocks shall be provided for each motor starter within the control panel.
- F. SPD: By Schneider Electric/Square D SDSA4040 or equal. The control panel shall be provided with a surge protective device (SPD) rated for 200kA per mode for the incoming power. SPD shall be mounted within the control panel enclosure. Lead lengths shall not be longer than 12 inches from the main circuit breaker.
- G. Control Power Transformer: 480-120V CPT, fused on primary and secondary sides, capacity as required.

2.4 CONTROL DEVICES AND ACCESSORIES

A. Control Operators and Indictors:

1. Heavy duty type, full size (30.5mm), NEMA 4X or 7 as required.
2. Each motor shall include HAND-OFF-AUTO selector switches to permit override of automatic control and manual actuation of shutdown.

B. Indicating Lights:

1. LED, full size (30.5mm), full voltage and push-to-test type.
2. Indicators shall be provided for individual motor run and an indicator for each failure condition.

C. Elapsed Time Meters (ETM):

1. Six (6) digit, non-reset elapsed time meter to indicate the total running time of each motor in "hours" and "tenth of hours". Series T50 as manufactured by the ENM Company or equal.
2. Provide an ETM for each motor.

D. Relays:

1. Control relays shall be 10 amp rated contacts (minimum), 11 pin with mounting base, 3PDT (minimum), with LED indicators to show relay status, relays shall be manufactured by Potter Brumfield or equal.
2. Timing relays shall be solid state, with pin (octal) and bases, relays shall be T-series as manufactured by Diversified Electronics Inc. or equal.

E. Interior enclosure light shall be provided for the control panel, the light shall be model Panelite LED24V15 as manufactured by nVent Hoffman, or equal.

F. MCCB for MPZ: Include molded case circuit breaker of the same manufacturer and type as the control panel main circuit breaker. The circuit breaker shall be sized per the Mini-Power-Zone (MPZ) manufacturer's standard.

G. A duplex GFCI utility receptacle (circuit breaker protected) providing 120 volts, 60 Hertz, single phase current shall be mounted inside of enclosure.

H. Auxiliary contacts shall be provided for remote run indication and indication of each status and alarm condition. Additional controls shall be provided as specified herein and as required by Divisions 40, 26 and as shown on Drawings.

I. A phase monitor shall be provided for the control panel, monitors shall be model SLA-440-ASA as manufactured by Diversified Electronics Inc. or equal.

J. Provide remote mount Human Machine Interface (HMI), type 4X/12 by Allen Bradley 20-HIM-C6S mounted on the front of the enclosure with HMI hinged snap latch cover kit by Allied Moulded or equal.

K. Corrosion Inhibitor Emitter: Inclusion of an industrial corrosion inhibitor emitter, selected by the manufacturer, to protect internal components of control panel from corrosion for up to one year.

- L. Breather assemblies, to maintain interior pressure and release condensation in Type 4X enclosures installed outdoors or in unconditioned interior spaces subject to humidity and temperature swings.
- M. Space heaters, with NC auxiliary contacts, to mitigate condensation in Type 4X enclosures installed outdoors or in unconditioned interior spaces subject to humidity and temperature swings.

2.5 VFD AND ACCESSORIES

A. VFD:

- 1. Allen Bradley Power Flex 753, six pulse drive, no exceptions.
- 2. Input Voltage: 480V, 3 phase.
- 3. Output Current: 96 FLA for Well 118N pump and for Well 120N pump.
- 4. EMC Filtered.
- 5. Control and interface to SCADA system via Ethernet cable using Ethernet/IP communications protocol.

B. DV/dT Output Filter:

- 1. Comprised of passive components only.
- 2. Limits peak voltage at motor terminals to 150 percent or less of VFD's DC bus voltage for motor leads of 1000 feet or shorter.
- 3. Maximum dV/dT waveform pulses at motor terminal of 200 volts per microsecond.
- 4. Insertion loss of 3 percent of rated voltage maximum.
- 5. UL listed.
- 6. MTE Series A dV/dT Filter or equivalent.

C. Input Drive Isolation Transformer:

- 1. Separate enclosure, not mounted within pump control panel.
- 2. Refer to specification Section 262213 "Low-Voltage Distribution Transformers".

2.6 WIRING

- A. Power and control wire shall be 600 Volt class, Type MTW insulated stranded copper and shall be of the sizes required for the current to be carried, but not smaller than No. 14 AWG. All wiring shall be enclosed in PVC wire trough with slotted side openings and removable cover.
- B. Wiring shall be stranded copper, minimum size #14 AWG (except for shielded instrumentation cable), with 600 Volt, 90 degree C, flame retardant, Type MTW thermoplastic insulation.
- C. Provide clear shock protection barriers over any exposed terminal with over 120-volts to ground potential voltage.
- D. All interconnecting wires between panel mounted equipment and external equipment shall be terminated at numbered terminal blocks.
- E. Terminal blocks shall be 600 Volt heavy duty rated, tubular clamp type. Terminal strips shall be Allen Bradley catalog #1492-CA-1 or equal.

- F. A copper ground bar with sufficient terminals for all field and panel ground connections shall be provided.
- G. All signal wiring entering and exiting the control panel shall be provided with surge protection. Surge protection shall be as specified in Division 40.
- H. An 8-inch (minimum) clear space within the enclosure shall be provided horizontally along the entire top and bottom of the control panel. A 4-inch (minimum) clear space within the enclosure shall be provided vertically along the entire sides of the control panel. No devices, terminals, etc. shall be installed within this space, the space shall be provided for field conduit and wiring access only.

2.7 IDENTIFICATION

- A. All control panel wiring shall be numbered at both ends with type written heat shrinkable wire markers.
- B. The control diagrams and overload tables shall be laminated to the inside of the door except where door space is limited the laminated documents shall be in the print storage pocket.
- C. The control panel shall be provided with nameplates identifying each component, selector switches, pilot lights, etc. Nameplates shall be permanently affixed using an epoxy process (inner door nameplates shall be fastened with stainless steel screws). Nameplates shall be laminated plastic, engraved black letters with a white background.
- D. All control panels shall be provided with two nameplates located on the exterior door. The first nameplate shall identify the control panel name. The second nameplate shall identify the power source.
- E. Where applicable provide a nameplate which reads as follows "CAUTION - THIS PANEL CONTAINS A VOLTAGE FROM AN EXTERNAL SOURCE." Letters shall be black on a high visibility yellow background.
- F. Each terminal at terminal blocks shall be individually labeled.
- G. Incoming phase conductor terminals shall be clearly identified. All wiring within the control panel shall be color coded or coded using electrical tape in sizes where colored insulation is not available. The following coding shall be used.

System	Wire	Color
Incoming line voltage	Phase conductors	Black
	Ground	Green
	Neutral (as required)	Gray
Internal control voltage	AC	Red
Internal control voltage	DC	Blue
External source	All	Yellow

2.8 FACTORY TESTS

- A. Inspect and test control panel for correct operation. Test each circuit for continuity, short circuits, and ground faults.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Comply with NECA 1.
- B. Inspect anchorage, alignment, grounding, and clearances.
- C. Compare equipment nameplate data for compliance with Drawings and Specifications.
- D. Verify that electrical wiring installation complies with manufacturer's written installation requirements.
- E. Motor Overload Relays: Select and set overloads on the basis of full-load current rating as shown on motor nameplate. Adjust setting value for special motors as required by NFPA 70 for motors that are high-torque, high-efficiency, and so on.
- F. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260510 "Limited Electrical for Small Projects."
- G. Arc Flash Labels: Install as specified in Section 260573 "Power System Studies."

3.2 STARTUP SERVICE

- A. Complete startup checks according to manufacturer's written instructions.
- B. Verify motor running protection is appropriate for actual motors installed.
- C. Test control panel with all field wiring connected. Set adjustable set points and time delays for proper operation of equipment. Adjust as required.
- D. Perform infrared inspection of panel interior during periods of maximum possible loading. Remove all necessary covers prior to the inspection. Comply with the recommendations of NFPA 70B, "Testing and Test Methods" Chapter, "Infrared Inspection" Article.
- E. Prepare test and inspection reports.
- F. Install a set of legible "as built" laminated control panel drawings (11 x 17 or 8.5 x 11), in the storage pocket.

3.3 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain equipment.

END OF SECTION 262505

SECTION 263600 - TRANSFER SWITCHES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes nonautomatic transfer switches rated 600 V and less, including the following:

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for transfer switches.
 - 2. Include rated capacities, operating characteristics, electrical characteristics, and accessories.

1.4 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For each type of product to include in emergency, operation, and maintenance manuals.

1.6 QUALITY ASSURANCE

- A. Testing Agency Qualifications:
 - 1. Member company of NETA.
 - a. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

1.7 FIELD CONDITIONS

- A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service:
 - 1. Notify Owner no fewer than two days in advance of proposed interruption of electrical service.
 - 2. Do not proceed with interruption of electrical service without Owner's written permission.

1.8 WARRANTY

- A. Manufacturer's Warranty: Manufacturer agrees to repair or replace components of transfer switch or transfer switch components that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: 18 months from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with NEMA ICS 1.
- C. Comply with NFPA 110.
- D. Comply with UL 1008 unless requirements of these Specifications are stricter.
- E. Indicated Current Ratings: Apply as defined in UL 1008 for continuous loading and total system transfer, including tungsten filament lamp loads not exceeding 30 percent of switch ampere rating, unless otherwise indicated.
- F. Neutral Switching: Where four-pole switches are indicated, provide neutral pole switched simultaneously with phase poles.
- G. Factory Wiring: Train and bundle factory wiring and label, consistent with Shop Drawings, by color-code or by numbered or lettered wire and cable shrinkable sleeve markers at terminations.
 - 1. Designated Terminals: Pressure type, suitable for types and sizes of field wiring indicated.
 - 2. Power-Terminal Arrangement and Field-Wiring Space: Suitable for top, side, or bottom entrance of feeder conductors as indicated.
 - 3. Control Wiring: Equipped with lugs suitable for connection to terminal strips.
 - 4. Accessible via front access.

- H. Enclosures: General-purpose NEMA 250, Type 4X, free-standing with sunshield, complying with NEMA ICS 6 and UL 508, unless otherwise indicated.

2.2 NONAUTOMATIC TRANSFER SWITCHES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. ASCO Power Technologies.
 - 2. Russ Electric, Inc.
- B.
- C. Electrically Operated: Electrically actuated by push buttons designated "Normal Source" and "Alternative Source." Switch shall be capable of transferring load in either direction with either or both sources energized.
- D. Double-Throw Switching Arrangement: Incapable of pauses or intermediate position stops during switching sequence.
- E. Pilot Lights: Indicate source to which load is connected.
- F. Source-Available Indicating Lights: Supervise sources via transfer-switch normal- and alternative-source sensing circuits.
 - 1. Normal Power Supervision: Green light with nameplate engraved "Normal Source Available."
 - 2. Emergency Power Supervision: Red light with nameplate engraved "Alternative Source Available."
- G. Discrete Output to SCADA: Normal Power Voltage Sensing Indication.
- H. Unassigned Auxiliary Contacts: Switch shall have one set of normally closed contacts for each switch position, rated 10 A at 240-V ac.
- I. Switch Characteristics: Designed for continuous-duty repetitive transfer of full-rated current between active power sources.
 - 1. Switch Action: Double throw; mechanically held in both directions.
 - 2. Contacts: Silver composition or silver alloy for load-current switching.
 - 3. Conductor Connectors: Suitable for use with conductor material and sizes.
 - 4. Material: Hard-drawn copper, 98 percent conductivity.
 - 5. Main and Neutral Lugs: Mechanical type.
 - 6. Ground Lugs and Bus-Configured Terminators: Mechanical type.
 - 7. Ground bar.
 - 8. Connectors shall be marked for conductor size and type according to UL 1008.

2.3 SOURCE QUALITY CONTROL

- A. Factory Tests: Test and inspect components, assembled switches, and associated equipment according to UL 1008. Ensure proper operation. Check transfer time and voltage, frequency, and time-delay settings for compliance with specified requirements. Perform dielectric strength test complying with NEMA ICS 1.
- B. Prepare test and inspection reports.
 - 1. For each of the tests required by UL 1008, performed on representative devices, for emergency systems. Include results of test for the following conditions:
 - a. Overvoltage.
 - b. Undervoltage.
 - c. Loss of supply voltage.
 - d. Reduction of supply voltage.
 - e. Alternative supply voltage or frequency is at minimum acceptable values.
 - f. Temperature rise.
 - g. Dielectric voltage-withstand; before and after short-circuit test.
 - h. Overload.
 - i. Contact opening.
 - j. Endurance.
 - k. Short circuit.
 - l. Short-time current capability.
 - m. Receptacle withstands capability.
 - n. Insulating base and supports damage.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Floor-Mounting Switch: Anchor to floor by bolting.
 - 1. Install transfer switches on cast-in-place concrete equipment base(s) or as indicated in the drawings.
 - 2. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases.
 - 3. Provide workspace and clearances required by NFPA 70.
- B. Identify components according to Section 260510 "Limited Electrical for Small Projects."
- C. Set field-adjustable intervals and delays, relays, and engine exerciser clock.
- D. Comply with NECA 1.

3.2 CONNECTIONS

- A. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii.

- B. Ground equipment according to Section 260510 "Limited Electrical for Small Projects."
- C. Final connections to equipment shall be made with liquidtight, flexible metallic conduit no more than 18 inches (457 mm) in length.

3.3 FIELD QUALITY CONTROL

- A. Testing Agency: Engage qualified testing agency to perform tests and inspections.
- B. Manufacturer's Field Service: Engage factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- C. Perform the following tests and inspections:
 - 1. After installing equipment, test for compliance with requirements according to NETA ATS.
 - 2. Visual and Mechanical Inspection:
 - a. Compare equipment nameplate data with Drawings and Specifications.
 - b. Inspect physical and mechanical condition.
 - c. Inspect anchorage, alignment, grounding, and required clearances.
 - d. Verify that the unit is clean.
 - e. Verify appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.
 - f. Verify that manual transfer warnings are attached and visible.
 - g. Verify tightness of all control connections.
 - h. Inspect bolted electrical connections for high resistance using one of the following methods, or both:
 - 1) Use of low-resistance ohmmeter.
 - 2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method according to manufacturer's published data.
 - i. Perform manual transfer operation.
 - j. Verify positive mechanical interlocking between normal and alternate sources.
 - k. Perform visual and mechanical inspection of surge arresters.
 - 3. Electrical Tests:
 - a. Perform insulation-resistance tests on all control wiring with respect to ground.
 - b. Perform contact/pole-resistance test. Compare measured values with manufacturer's acceptable values.
 - c. Verify settings and operation of control devices.
 - d. Calibrate and set all relays and timers.
 - e. Verify phase rotation, phasing, and synchronized operation.
 - f. Verify correct operation and timing of the following functions:
 - 1) Normal source voltage-sensing and frequency-sensing relays.
 - 2) Alternative source voltage-sensing and frequency-sensing relays.
 - 3) Interlocks and limit switch function.

4. Measure insulation resistance phase-to-phase and phase-to-ground with insulation-resistance tester. Include external annunciation and control circuits. Use test voltages and procedure recommended by manufacturer. Comply with manufacturer's specified minimum resistance.
 - a. Check for electrical continuity of circuits and for short circuits.
 - b. Inspect for physical damage, proper installation and connection, and integrity of barriers, covers, and safety features.
 - c. Verify that manual transfer warnings are properly placed.
 - d. Perform manual transfer operation.
- D. Coordinate tests with tests of generator and run them concurrently.
- E. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation and contact resistances and time delays. Attach label or tag to each tested component indicating satisfactory completion of tests.
- F. Transfer switches will be considered defective if they do not pass tests and inspections.
- G. Remove and replace malfunctioning units and retest as specified above.
- H. Prepare test and inspection reports.
- I. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform infrared scan of each switch. Remove all access panels so joints and connections are accessible to portable scanner.
 1. Instrument: Use infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
 2. Record of Infrared Scanning: Prepare certified report that identifies switches checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.
 3. Follow-up Infrared Scanning: Perform additional follow-up infrared scan of each switch 11 months after date of Substantial Completion.

END OF SECTION 263600

SECTION 264113 - LIGHTNING PROTECTION FOR STRUCTURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Provide new lightning protection system (LPS) at the NRO Well 180N and NRO Well 120N located in Collier County, Florida.
- B. LPS consists of conductors, air terminals, and accessories bonded together and grounded to the system ground grid at regular intervals. Submittal of alternate methods of lightning protection must provide equal or greater lightning protection than specified.
- C. Employ a licensed LPS engineering company to design and install the LPS in compliance with NFPA 780 and UL 96. Design to include detailed installation drawings and material specification.
- D. Provide for UL field inspection upon completed installation and UL Master label. Make all corrections and additions required by UL inspector. Pay all costs for UL inspection and any subsequent re-inspections. If structure is not eligible upon the standards of UL 96A, provide a Letter of Findings for the installation at completion of work.
- E. Related Requirements:
 - 1. Section 260510 "Limited Electrical for Small Projects" for grounding and bonding materials and PVC conduit.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings:
 - 1. Include layouts of the lightning protection system, with details of the components to be used in the installation.
 - 2. Include raceway locations needed for the installation of conductors.
 - 3. Details of air terminals, ground rods, ground rings, conductor supports, splices, and terminations, including concealment requirements.
 - 4. Include roof attachment details, coordinated with roof installation.
 - 5. Calculations required by NFPA 780 for bonding of metal bodies.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
- B. Product Certificates: For each type of roof adhesive for attaching the roof-mounted air terminal assemblies, approved by the roofing-material manufacturer.
- C. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For lightning protection system to include in maintenance manuals.
 - 1. Include the following:
 - a. Dimensioned site plan showing dimensioned route of the ground loop conductor and the ground rod locations.
 - b. A system testing and inspection record, listing the results of inspections and ground resistance tests, as recommended by NFPA 780, Annex D.
- B. Completion Certificate:
 - 1. UL Master Label Certificate.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: UL-listed installer, category OWAY or LPI Master Installer.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. NFPA Lightning Protection Standard: Comply with NFPA 780 requirements for Class I buildings.
- B. UL Lightning Protection Standard: Comply with UL 96A requirements for Class I buildings.
- C. Lightning Protection Components, Devices, and Accessories: Listed and labeled by qualified testing agency as complying with UL 96, and marked for intended location and application.

2.2 MATERIALS

- A. General:
 - 1. Use new materials.
 - 2. Comply with minimum weight, size, and composition requirements of UL and NFPA unless higher standard is included herein.

3. Comply with Section 260510 "Limited Electrical for Small Projects" for grounding materials and methods.
 4. Comply with Section 260510 "Limited Electrical for Small Projects" for PVC conduit. Use PVC schedule 80.
- B. Static Dissipator Type Air Terminals:
1. Static dissipator / streamer delaying type as manufactured by Lightning Master Corp.
 2. High quality solid stainless steel electrode material, 300 series stainless preferred.
 3. Minimum of five hundred (500) dissipator electrode wires, none of which exceed 0.010-inch diameter.
 4. Cast bronze base with stainless steel bolt pressure connectors. Provide base specific to the attachment surface. Adhesive type for flat roof areas.
- C. Class 1 Main Conductors (Structures 75 Feet and Less):
1. Aluminum: 14 AWG, 28 strand (weighing 105 lbs per 1,000 feet).
 2. Copper: Tinned, 17 AWG, 32 strand (weighing 220 lbs per 1,000 feet).
- D. Secondary Conductors Fasteners: Non-corrosive metal, rated to support conductors.
- E. Conductor Splices and Connectors:
1. Compression fittings that are installed with hydraulically operated tools, or exothermic welds, approved for use with the class type.
 2. Bronze when joining dissimilar metals. Stainless steel bolts and nuts.
 3. Exothermic type at buried and non-accessible locations.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Coordinate work with electrical contractor and other trade contractors.
- B. Install materials by UL listing lightning protection contractor and in accordance with the approved shop drawings, and UL 96A and NFPA 780 recommended practices.
- C. LPS engineering company to provide assistance and supervision of the installation as required and be present during the UL inspection.
- D. Install in a neat and inconspicuous manner.
- E. Coordinate mounting and penetration of roof surface with roofing contractor to assure maximum roofing guarantee. Through-roof penetration flashings shall be furnished, sealed, and guaranteed by a licensed roofing contractor.
- F. Excavate and backfill as required. Finish grade and restore to original condition.
- G. Bond metal bodies within 6 feet of the LPS conductor to the LPS with approved fittings and conductors. Use approved bimetallic connectors for connections between dissimilar metals.

- H. Legibly record field changes on a set of project contract drawings as work progresses. Furnish a complete set of reproducible “As-built” drawings for the Project Record Documents when work is complete.
- I. Air Terminals:
 - 1. Space air terminals so as not to exceed 20 feet apart around the outside perimeter of the roof or ridge and not over 50 feet apart through the center of flat roof areas.
 - 2. Do not project air terminals more than 24 inches nor less than 10 inches above the protected object.
- J. Conductor Routing:
 - 1. Maintain a downward or horizontal course on main conductors, free from “U” or “V” pockets.
 - 2. Do not form conductors with an angle of less than 90 degrees nor less than an 8 inch radius bend.
 - 3. Do not use metal roofing and siding, eave downspouts or other metal parts subject to displacement as part of the lightning conductor system.
 - 4. Space fasteners not more than 3 feet horizontally or vertically.
 - 5. Use fasteners of the same material as the conductor.
 - 6. Use bimetallic fittings for connections between dissimilar metals.
- K. Down Conductors:
 - 1. Follow the most direct patch possible between roof conductors and ground terminals.
 - 2. Provide a minimum of two down conductors installed at the diagonally opposed corners of the building for buildings with a ground perimeter less than 250 feet.
 - 3. Provide down conductors as required so the distance between the conductors does not exceed 100 feet for all buildings with a ground perimeter in excess of 250 feet.
 - 4. Conceal down conductors to greatest extent possible.
 - 5. Use Schedule 80 PVC conduit for any required physical protection of down conductors.
 - 6. Install down conductors within a building within the wall and provide physical protection within the wall.
 - 7. Where down conductors are installed on the exterior of structures, provide physical protection of the conductor from grade level to a height of at least 6 feet.
 - 8. Make connections through roof with through-roof connectors.
 - 9. Splices are not permitted on conductors embedded in concrete.
 - 10. Do not route conductors through any chemical spill containment area.
- L. Roof Conductors:
 - 1. Interconnect and provide a two-way path from air terminals.
 - 2. Bond together air terminals and installed exposed except where connections are made to equipment located under roof.
 - 3. Form closed loops on perimeters of flat roofs.
 - 4. Dead end air terminals are not permitted.
 - 5. Interconnecting cables from air terminals to roof conductors or metal roof decks shall be similar to roof conductor.
- M. Roof Penetrations and Pitch Pockets: By qualified roofing contractor.

N. Grounding System:

1. Provide ground rods at each down conductor, a minimum of 3 feet away from the foundation walls.
2. Provide LPS ground rods in addition to the ground rods provide for the system grounding grid as required.
3. Interconnect ground terminals with the electric system grounding grid and all grounding mediums. This includes electric and telephone service grounds and underground metallic piping systems.
4. Use an exothermic weld process to bond down conductors to ground rods and any bonds or splices in concealed locations.
5. Notify design Engineer prior to concealment for Engineer's inspection.

O. Identification:

1. Attach corrosion resistant stamped metal tags to, or adjacent to, each down conductor indicating in feet the exact vertical depth in the ground of each ground terminal.
2. Indicate location of down leads connected to water pipes.
3. Place tags at a height of 5 feet above finished grade.

3.2 CONNECTIONS

- A. Aboveground concealed connections, and connections in earth or concrete, shall be done by exothermic welds or by high-compression fittings listed for the purpose.
- B. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance, except where routed through short lengths of conduit.
1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
 2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install bonding so vibration is not transmitted to rigidly mounted equipment.

3.3 CORROSION PROTECTION

- A. Do not install copper lightning protection materials on aluminum roofing, siding or other aluminum surfaces.
- B. Do not embed aluminum lightning protection materials in concrete, masonry, or on or below copper surfaces.
- C. Do not combine materials that can form an electrolytic couple that will accelerate corrosion in the presence of moisture unless moisture is permanently excluded from junction of such materials.
- D. Use conductors with protective coatings where conditions would cause deterioration or corrosion of conductors.

3.4 FIELD QUALITY CONTROL

- A. Special Inspections: Engage qualified special inspector to perform the following special inspections:
 - 1. Perform inspections as required to obtain UL Master Label for system.
 - 2. Test LPS for continuity of all conductors and air terminals.
 - 3. Do not exceed system resistance of five ohms, unless otherwise specified or scheduled.
- B. Prepare test and inspection reports and certificates.

END OF SECTION 264113

SECTION 264313 - SURGE PROTECTIVE DEVICES FOR LOW-VOLTAGE ELECTRICAL POWER CIRCUITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes: Surge protective devices (SPDs) for power distribution systems. SPDs installed integral to electrical equipment shall meet electrical performance criteria specified herein. SPDs for telecommunications systems, antenna systems, SCADA systems and instruments are included in other Divisions.

1.3 DEFINITIONS

- A. I_n : Nominal discharge current.
- B. Maximum Continuous Operating Voltage (MCOV): The maximum designated RMS value of the power frequency voltage that may be continuously applied to the mode of protection of an SPD.
- C. Metal-Oxide Varistor (MOV): An electronic component with a significant bidirectional, nonlinear current-voltage characteristic.
- D. Mode(s), Modes of Protection, or Protection Modes: Electrical paths where the SPD offers defense against transient overvoltages. Examples include: line to neutral (L-N), line to ground (L-G), line to line (L-L), and neutral to ground (N-G).
- E. SCCR: Short-circuit current rating.
- F. Type 1 SPDs: Permanently connected SPDs intended for installation between the secondary of the service transformer and the line side of the service disconnect overcurrent device.
- G. Type 2 SPDs: Permanently connected SPDs intended for installation on the load side of the service disconnect overcurrent device, including SPDs located at the branch panel.
- H. Voltage Protection Rating (VPR): A rating selected from UL 1449 list of preferred values assigned to each mode of protection.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product used on project. Include physical and electrical characteristics, features, and options.
- B. Specification Compliance:
 - 1. Include copy of this specification confirming compliance with each paragraph. For deviations, provide detailed commentary to explain the deviation.

1.5 INFORMATIONAL SUBMITTALS

- A. Sample Warranty: For manufacturer's special warranty.
- B. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For SPDs to include in operation and maintenance manuals.
- B. Warranty documentation.

1.7 WARRANTY

- A. Manufacturer's Special Warranty: Manufacturer agrees to repair or replace SPDs for a period not less than warranty specified in PART 2 for each model described.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Subject to compliance with requirements, ABB, Eaton, Schneider Electric, or Siemens products are acceptable.
- B. Source Limitations: Obtain devices from single source from single manufacturer.

2.2 PERFORMANCE CRITERIA

- A. Electrical Components, Devices, and Accessories: Listed and labeled in accordance with NFPA 70, by qualified electrical testing agency recognized by authorities having jurisdiction, and marked for intended location and application.

- B. Comply with the following standards as applicable:
 - 1. UL 96A, Lightning Protection System Master Label.
 - 2. UL 1283, Electromagnetic Interference Filters for EMI/RFI noise filtration.
 - 3. UL 1449, Surge Protective Devices, CCN VZCA.
- C. MCOV: Not less than 115 percent.
- D. Nominal discharge current (I_n): 20 kA, unless noted otherwise.
- E. Maximum VPR:
 - 1. 277 V (L-N), Systems: 1200 V.
 - 2. 240 V (L-L) Systems: 1200 V.
 - 3. 120 V (L-N) Systems: 700 V.
- F. Enclosure: NEMA 1 (minimum) for indoor dry locations and NEMA 4X (non-metallic) for outdoor, wet, damp, chemical or corrosive areas.
- G. Type 1 or 2, as indicated by connection point on Drawings. Include integral disconnect for Type 1 SPDs.
- H. Match voltage, phasing, and frequency of connected power system equipment to be protected.
- I. Provide all modes of protection based on the power system configuration.
- J. The SCCR rating of the SPD shall have at least the same rating of electrical equipment being protected.
- K. Protect against surges produced by a 1.2 / 50 microsecond and 8 / 20 microsecond combination waveform generator.
- L. Provide LED indicator lights for continuous positive operational status of each protected phase. Lights to be visible without the need to open any compartments.
- M. Response Time: One nanosecond or less for any individual component and be self-restoring and fully automatic.
- N. Switchgear, switchboards, distribution panelboards, motor control centers, 800 A and higher equipment bus (480 V):
 - 1. Minimum surge current ratings:
 - a. Greater than 2500 A equipment bus: 200 kA per mode, 400 kA per phase.
 - b. From 1600 A to 2500 A equipment bus: 150 kA per mode, 300 kA per phase.
 - c. From 800 A to 1200 A equipment bus: 100 kA per mode, 200 kA per phase.
 - d. Warranty: 10 years.
 - 2. Additional Features:
 - a. EMI / RFI noise filtration.
 - b. Include surge counter.

- O. Branch panels and control panels, up to 600 A equipment bus (480 V): Minimum surge current 100 kA per phase, nominal discharge current 10 kA, 5-year warranty.
- P. Branch circuit panels (120/208/240 V single or three phase): Minimum surge current 50 kA per phase, nominal discharge current 10 kA, 5-year warranty.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Layout disconnect and SPD locations to minimize SPD lead length to less than 24 inches and to avoid sharp bends or kinks in leads. Rearrange circuit breakers as necessary in panelboards to achieve.

3.2 INSTALLATION

- A. Install SPDs as shown on Drawings and in accordance with manufacturer's instructions.
- B. Install SPD lead conductors as short as possible (not to exceed 24 inches), gently twist together where practicable with wire size, and route to avoid sharp bends or kinks. Do not splice or extend SPD leads unless specifically permitted by manufacturer and approved by Engineer. Spliced extensions using wire nuts are unacceptable.

3.3 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections with the assistance of a factory-authorized service representative.
 - 1. Compare equipment nameplate data for compliance with Drawings and Specifications.
 - 2. Inspect anchorage, alignment, grounding, and clearances.
 - 3. Verify that electrical wiring installation complies with manufacturer's installation requirements.
- B. SPDs that do not pass tests and inspections will be considered defective.
- C. Prepare test and inspection reports.

3.4 STARTUP SERVICE

- A. Complete startup checks in accordance with manufacturer's instructions.
- B. Where alarm contacts report to SCADA system, confirm correct operation.
- C. Do not perform insulation-resistance tests of the distribution wiring equipment with SPDs installed. Disconnect SPDs before conducting insulation-resistance tests; reconnect them immediately after the testing is over.

- D. Energize SPDs after power system has been energized, stabilized, and tested.

END OF SECTION 264313

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SECTION 310515 - SOILS AND AGGREGATES FOR EARTHWORK

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Soils: Soil materials and topsoil materials.
 - 2. Aggregates: Coarse aggregate materials and fine aggregate materials.
- B. Related Sections:
 - 1. Section 312333 "Trenching and Backfilling"

1.3 ACTION SUBMITTALS

- A. Quality Control Testing: Submit conformance testing performed by a certified independent laboratory engaged by Contractor for all fill materials. Verify maximum density, gradation, Atterberg limits, sand equivalent, and other applicable criteria at least 72 hours prior to importing or placing any fill. Perform additional conformance testing at a minimum frequency of 1 per every 2000 cubic yards or change in material.

1.4 INFORMATIONAL SUBMITTALS

- A. Materials Source: Submit name and location of imported materials suppliers.
- B. Material Test Reports: For each on-site and borrow soil and aggregate material proposed for fill and backfill as follows:
 - 1. Classification according to ASTM D2487.
 - 2. Laboratory compaction curve according to ASTM D1557.
 - 3. Test Reports: Submit any test reports required by this Section to the Engineer.

1.5 QUALITY ASSURANCE

- A. Furnish each soil and topsoil material from single source throughout the Work, unless an alternate source is approved by Engineer.

- B. Furnish each coarse and fine aggregate material from single source throughout the Work, unless an alternate source is approved by Engineer.
- C. Maintain one copy of each standard affecting Work of this Section on Site.

1.6 FIELD CONDITIONS

- A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during earth-moving operations.
 - 1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.
 - 2. Provide alternate routes around closed or obstructed traffic ways if required by Owner or authorities having jurisdiction.

PART 2 - PRODUCTS

2.1 SOIL MATERIAL

- A. Structural Fill:
 - 1. Consist of mineral soil free of organic material, loam, debris, or other deleterious material which may be compressible, or which cannot be properly compacted.
 - 2. Liquid Limit: 10 percent maximum.
 - 3. Plasticity Index: 5 percent maximum.
 - 4. Dry Density: 95 pcf maximum, as determined by ASTM D1557.
 - 5. Meets the following gradation for Sieve Size and Percent Fines by Weight:
 - a. 3-inch: 100.
 - b. No. 4: 20 to 70.
 - c. No. 40: 5 to 35.
 - d. No. 200: 0 to 10.

2.2 TOPSOIL MATERIAL

- A. Topsoil:
 - 1. Excavated and reused material.
 - 2. Graded.
 - 3. Free of roots, rocks larger than 1/2 inch, subsoil, debris, large weeds, and foreign matter.
 - a. Screening: Double screened.

2.3 PIPE BEDDING MATERIALS

- A. Coarse Aggregate - Crushed Stone: Natural stone; washed, free of clay, shale, organic matter; conforming to Florida Department of Transportation (FDOT) standard.

1. Coarse Aggregate Designation: No. 57 in accordance with Standard 901 of the FDOT Standard Specifications for Road and Bridge Construction.

2.4 SOURCE QUALITY CONTROL

- A. Soil Material - Testing and Analysis: Perform in accordance with ASTM D1557.
- B. When tests indicate materials do not meet specified requirements, change material and retest.
- C. Furnish materials of each type from same source throughout the Work.

PART 3 - EXECUTION

3.1 EXCAVATION - SOILS

- A. Stockpile excavated material meeting requirements for structural fill and topsoil materials.
- B. Remove excess excavated materials not intended for reuse, from site.
- C. Remove excavated materials not meeting requirements for structural fill and topsoil from site.

3.2 STOCKPILING

- A. Stockpile materials on site at locations indicated on Drawings.
- B. Stockpile in sufficient quantities to meet Project schedule and requirements.
- C. Separate different soil and aggregate materials with dividers or stockpile individually to prevent mixing. Prevent intermixing of soil types or contamination.
- D. Direct surface water away from stockpile site to prevent erosion or deterioration of materials.
- E. Stockpile unsuitable materials on impervious liner and cover to prevent erosion and leaching, until disposed of.

3.3 STOCKPILE CLEANUP

- A. Remove stockpile, leave area in clean and neat condition. Grade site surface to prevent free standing surface water.

END OF SECTION 310515

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SECTION 312333 - TRENCHING AND BACKFILLING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes delegated design of trench excavation and support, backfilling, and compaction.
- B. Related Requirements:
 - 1. Section 310515 “Soils and Aggregates for Earthwork” for materials used as backfill and for sheeting and bracing.

1.3 DEFINITIONS

- A. Percent Compaction: Means at least the stated percentage of maximum density as determined by ASTM D1557, Method D.

1.4 ACTION SUBMITTALS

- A. Construction and Operations Plan: Submit proposed methods of construction, including earthwork operations, excavation limits, slopes, fill material moisture conditioning and handling, compaction equipment, excavation support systems design, backfilling and filling and compaction, and material sources.
- B. Submit laboratory test results for fill materials that include maximum density, gradation, Atterberg limits, and other applicable criteria, at least 72 hours prior to importing or placing fill.
- C. Submit copies of field daily reports by soil technician at the end of each workday that earthwork and grading operations occur.

1.5 INFORMATIONAL SUBMITTALS

- A. Material Test Reports: For material excavated from trench for re-use as backfill, by qualified testing agency.

1.6 QUALITY ASSURANCE

- A. Professional Engineer Qualifications: Licensed Professional Engineer experienced in design of specified Work and licensed in the jurisdiction of Project location; having a minimum of 5 years' experience in design and construction of trench excavation and support.
- B. Provide excavation, trenching, related sheeting, bracing, and related materials to comply with requirements of the Florida "State Safety Act" (CS/SB 2626) which incorporates, by reference, OSHA's excavation safety standards, 29 CFR 1926 Subpart P.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Store excavated materials to prevent erosion of soil type materials and contamination of adjacent water sources.

PART 2 - PRODUCTS

- A. Refer to Section 310515 "Soils and Aggregates for Earthwork" for soil and aggregate materials.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine that erosion and sedimentation controls are in place and comply with project requirements and authorities having jurisdiction.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Where excavation activities occur across active vehicular or pedestrian circulation paths, use temporary controls specified in Division 01 to maintain circulation during operations required by this Section. Maintain temporary controls for each day circulation paths are restricted.
- B. Identify required lines, levels, contours, and datum locations.
- C. Protect features to remain-in-place including benchmarks, existing structures, fences, sidewalks, paving, curbs, etc. from excavating equipment and vehicular traffic.
- D. Maintain and protect above and below grade utilities indicated to remain.

3.3 TRENCH EXCAVATION

- A. Trench excavation includes material of every description and substance encountered.
- B. Strip and stockpile topsoil from grassed areas crossed by trenches.
 - 1. At Contractor's option when required, topsoil may be disposed of and replaced with approved topsoil of equal quality.
- C. While excavating and backfilling is in progress, maintain traffic and protect utilities and other property.
- D. Excavate trenches to indicated depths and in widths sufficient and of practical minimum for pipe laying, bracing, and pumping and drainage facilities.
- E. Accomplish excavation and dewatering by methods preserving undisturbed state of subgrade soils. Excavate trench by machinery to or just below designated subgrade, if material remaining in trench bottom is no more than slightly disturbed.
 - 1. Remove subgrade soils that become soft, loose, quick, or otherwise unsatisfactory due to inadequate excavation, dewatering, or other construction methods and replace with structural fill at Contractor's expense.
- F. Use care when working in fine-grained soils, which are particularly susceptible to disturbance due to construction operations. When excavation is to end in such soils, use a smooth-edge bucket to excavate the last 12 inches of depth.
- G. Where pipe is to be laid in bedding material, excavate trench by machinery to normal depth of pipe, provided material remaining in trench bottom is no more than slightly disturbed.

3.4 DISPOSAL OF MATERIALS

- A. Stack excavated material without excessive surcharge on trench bank or obstructing free access to hydrants and gate valves. Avoid inconvenience to traffic and abutters. Segregated excavated material for use in backfilling as specified below.
- B. Do not remove excavated material from work site, except as directed by the Engineer. When removal of surplus materials is approved by the Engineer, dispose of such surplus material in approved designated areas.
- C. Should conditions make it impracticable or unsafe to stack material adjacent to trench, haul and store material at a location provided. When required, re-handled and use it in backfilling trench.

3.5 TEMPORARY EXCAVATION SUPPORT

- A. Provide and maintain temporary excavation support required by Federal, State, or local safety requirements to support sides of excavation and prevent loss of ground which could endanger personnel, damage, adjacent structures, or delay the work.

1. Engineer may order additional supports placed at Contractor's expense if it is determined that at any point sufficient or proper supports have not been provided. Provide sufficiency of supports even with compliance of such order. Take care to prevent voids outside of excavation support; if voids are formed, immediately fill and ram them.
- B. When moveable trench bracing such as trench boxes, moveable sheeting, shoring or plates are used to support trench sides, take care in placing and moving the boxes or supporting bracing to prevent pipe movement, disturbance of pipe bedding, or backfill material.
 1. Rigid Pipe Installation (such as R.C., V.C., A.C.): Raise that portion of box extending below mid-diameter above this point prior to moving box ahead to install next pipe. Perform to prevent separation of installed pipe joints due to box movement.
 2. Flexible Pipe Installation (such as PVC): Do not allow trench boxes, moveable sheeting, shoring, or plates to extend below mid-diameter of pipe. As trench boxes, moveable sheeting, shoring, or plates are moved, place backfill material voids created. Re-compact backfill material to provide uniform side support for pipe.
- C. Carefully remove temporary excavation support in manner to not endanger construction of other structures, utilities, or property, whether public or private. Immediately refill voids left after withdrawal of temporary excavation support using sand by ramming with tools especially adapted to that purpose and watering or otherwise directed by the Engineer.
- D. No payment will be given for temporary excavation support during progress of the work. No payment will be given for temporary excavation support left in trench for Contractor's convenience.

3.6 TEST PITS

- A. Excavation of test pits may be required for purpose of locating underground utilities or structures as an aid in establishing the precise location of new work.
- B. Backfill test pits as soon as desired information has been obtained. Maintain backfilled surface appropriate for travel until resurfaced.

3.7 EXCAVATION BELOW GRADE AND REFILL

- A. Include material of every description and of whatever substance encountered as an unclassified excavation.
- B. Drain trench completely and effectively be in-the-dry (i.e., two feet below excavation bottoms), whatever the nature of unstable material encountered or groundwater conditions.
- C. If excavating below grade through error or for their own convenience, through failure to properly dewater the trench, or disturbs subgrade before dewatering is sufficiently complete, the Engineer may direct Contractor to excavate below grade as set forth in following Paragraph, where work shall be performed at Contractor's own expense.
- D. If material at trench bottom consists of fine sand or fine-grained soils, which may work into the pipe bedding material, even with effective drainage, remove subgrade material to extent

directed by Engineer. Refill excavation with a 6 inch layer of coarse sand or a mixture graded from coarse sand to pipe bedding material to form a filter layer preserving voids in pipe bedding material. Place pipe bedding in 6 inch layers thoroughly compacted up to normal grade of pipe.

- E. Subsurface Drainage Geotextile: Non-woven filter fabric may be substituted for filter layer, if approved by the Engineer.

3.8 BACKFILLING

- A. Begin backfilling as soon as practicable after laying and jointing pipe and continue expeditiously. Place pipe bedding material of specified type for pipe installed up to 12 inches over the pipe. Fill remainder of trench with approved backfill material in layers not to exceed 12 inches.
- B. To prevent longitudinal pipe movement, do not dump backfill material into trench and then spread, until pipe bedding material has been placed and compacted to a level at least 12 inches over the pipe.
- C. Bring backfill up evenly on all sides. Thoroughly compact each layer of backfill material by rolling, tamping, or vibrating with mechanical compacting equipment or hand tamping to 95 percent compaction according to ASTM D1557. If rolling, use a suitable roller or tractor being careful to compact backfill throughout full width of trench.
- D. Do not compact by puddling or water jetting.
- E. Use hand or pneumatic ramming with tools weighing at least 20 pounds for compacting in confined areas. Spread and compact material in layers not exceeding 6 inches thick, an uncompacted loose measurement.
- F. Use structural fill material as backfill around structures. Spread and compact specified backfill under and over pipes connected to structures.
- G. Do not place bituminous paving in backfill.

3.9 FIELD QUALITY CONTROL

- A. Test and observe materials as described in this Article. Cooperate by allowing free access to work for selection of test materials and observations.
- B. General Testing Requirements:
 - 1. Backfill and Fill: Prior to and during the placement of backfill and fill coordinate with Soils Testing Laboratory to perform in-place soil density tests to verify that backfill and fill material has been placed and compacted in accordance with specified compaction requirements.
 - a. Provide minimum 48 hours' notice prior to placement of backfill and fill.
 - 2. Subgrade: Do not cover with fill without observation, testing, and approval by Soils Testing Laboratory.

- a. Earthwork activities performed without properly scheduled inspection are subject to removal and replacement or additional testing as directed by the Engineer without additional compensation.
 - C. Test materials by a certified independent laboratory, engaged by Contractor and acceptable to the Engineer, demonstrating conformance with project requirements. Deliver test reports and material certifications to the Engineer before using any material in the work.
 - D. If field test results are not in conformance with project requirements, costs involved in correcting deficiencies in compacted materials to satisfaction of the Engineer without additional compensation.
 - E. Earthwork activities performed without properly scheduled inspection are subject to removal and replacement or additional testing as directed by the Engineer without additional compensation.
 - F. Testing methods shall comply with latest ASTM or equivalent AASHTO Standards applicable during bidding.
 - G. During placement of bedding, backfill, and fill, perform in-place soil density testing to confirm that fill material has been compacted in accordance with project requirements. The Engineer may designate areas to be tested. Notify Engineer at least 72 hours in advance of scheduled compaction testing. In place soil density tests on backfill and fill material shall be as required by authorities having jurisdiction, project geotechnical report, but in no instance, shall less than those listed:
 - 1. Trench Excavations: At least one nuclear density and one moisture content test at a maximum of 250 feet intervals for each lift of fill placed or as directed by the Engineer.
 - 2. The Engineer may designate supplemental areas to be tested at additional compensation.
 - H. Materials which have been previously tested may be subjected to further testing from time to time and may be rejected if it is determined that results do not conform to project requirements. Immediately remove rejected materials when directed by Engineer, notwithstanding results of previous testing.
 - I. The Engineer or Owner may conduct additional soil testing. Cooperate fully in allowing additional test to be made, including free access to the work.
- 3.10 RESTORING TRENCH SURFACE
- A. Where trench occurs adjacent to paved streets, in shoulders, or sidewalks, thoroughly compact backfill and maintain surface as the work progresses. If settlement takes place, immediately place additional fill to restore ground level.
 - B. Restore surface of driveways or other areas which are disturbed by trench excavation to a condition at least equal to that existing before work began.

- C. In areas where pipeline passes through grassed areas, remove and replace sod or loam and seed surface at Contractor's own expense.

END OF SECTION 312333

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SECTION 400506 - COUPLINGS, ADAPTERS, AND SPECIALS FOR PROCESS PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:

- 1. Disassembly Joints.

- B. Related Requirements:

- 1. Section 400507 “Hangers and Supports for Process Piping” for hangers, anchors, sleeves, and sealing of piping to adjacent structures.
 - 2. Section 400523 “Stainless Steel Process Pipe and Tubing” for stainless steel piping materials and appurtenances.
 - 3. Section 400551 “Common Requirements for Process Valves” for common product requirements for valves for placement by this Section.

1.3 DEFINITIONS

- A. FM: Factory Mutual Insurance Company; FM Global is the communicative name of the company.
- B. WH: Warnock Hersey; indicates compliance to relevant building codes, association criteria, and product safety and performance standards.

1.4 COORDINATION

- A. Coordinate Work of this Section with installation of piping, valves and equipment connections specified in other Sections and indicated on Drawings.

1.5 ACTION SUBMITTALS

- A. Product Data:

- 1. Submit manufacturer catalog information for each specified product, including installation instructions.
 - 2. Flexible Pipe Connectors: Indicate maximum temperature and pressure rating, face-to-face length, live length, hose wall thickness, hose convolutions per foot and per

- assembly, fundamental frequency of assembly, braid structure, and total number of wires in braid.
- 3. Expansion Joints: Indicate maximum temperature, pressure rating, and expansion compensation.

B. Shop Drawings:

- 1. Identification:
 - a. Submit list of wording, symbols, letter size, and color coding for pipe identification.
 - b. Comply with ASME A13.1.
- 2. Indicate restrained joint details and materials.
- 3. Submit layout drawings showing piece numbers and location, indicating restrained joint locations.
- 4. Indicate layout of piping systems, including flexible connectors, expansion joints and compensators, loops, offsets, and swing joints.

1.6 INFORMATIONAL SUBMITTALS

- A. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
- B. Welder Certificates: Certify welders and welding procedures employed on Work, verifying AWS or ASME qualification within previous 12 months.
- C. Manufacturer Instructions: Submit special procedures and setting dimensions.
- D. Source Quality-Control Submittals: Indicate results of factory tests and inspections.
- E. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.
- F. Qualifications Statements:
 - 1. Submit qualifications for manufacturer, installer, and licensed professional.
 - 2. Submit manufacturer's approval of installer.
 - 3. Welders: Qualify procedures and personnel according to ASME BPVC-IX or AWS D1.1/D1.1M.

1.7 CLOSEOUT SUBMITTALS

- A. Project Record Documents: Record actual locations of piping appurtenances.
- B. Identify and describe unexpected variations to pipe routing or discovery of uncharted utilities.

1.8 QUALITY ASSURANCE

- A. Materials in Contact with Potable Water: Certified to NSF Standards 61 and 372.
- B. Perform Work according to ASME B31.9 for installation of piping systems and according to ASME BPVC-IX or AWS D1.1/D1.1M for welding materials and procedures.
- C. Perform Work according to ASME B31.3 for installation of piping systems.

1.9 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum five years' documented experience.
- B. Welders: AWS or ASME qualified within previous 12 months for employed weld types.

1.10 DELIVERY, STORAGE, AND HANDLING

- A. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.
- B. Store materials according to manufacturer instructions.
- C. Protection:
 - 1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
 - 2. Furnish temporary end caps and closures on piping and fittings and maintain in place until installation.
 - 3. Provide additional protection according to manufacturer instructions.

1.11 EXISTING CONDITIONS

- A. Field Measurements:
 - 1. Verify field measurements prior to fabrication.
 - 2. Indicate field measurements on Shop Drawings.

1.12 WARRANTY

- A. Furnish one year manufacturer's warranty from time of substantial completion for products specified within this section.

PART 2 - PRODUCTS

2.1 DISASSEMBLY JOINTS

A. Manufacturers:

1. Victaulic Style 489 rigid coupling.
2. Or approved equal.

B. Description:

1. Housing: Type 316 stainless steel, conforming to ASTM A351, A743 and A744, Grade CF8M.
2. Gaskets:
 - a. Material: Grade "E" EPDM, Compatible with service conditions.
 - b. ANSI/NSF 61 compliant.
3. Hardware: Stainless steel oval neck track bolts meeting mechanical property requirements of ASTM F593, Group 2 (Type 316 stainless steel), condition CW. Stainless steel heavy nuts meeting mechanical property requirements of ASTM F594, Group 2 (Type 316 stainless steel), condition CW, with galling reducing coating.
4. Connecting piping: Type 316 stainless steel with ends formed with Victaulic OGS groove profile or equal.

2.2 FINISHES

- #### A. Prepare piping appurtenances for field finishes.

2.3 SOURCE QUALITY CONTROL

- #### A. Provide shop inspection and testing of completed assemblies.

B. Certificate of Compliance:

1. If manufacturer is approved by authorities having jurisdiction, submit certificate of compliance indicating Work performed at manufacturer's facility conforms to Contract Documents.
2. Specified shop tests are not required for Work performed by approved manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

- #### A. Verify that field dimensions are as indicated on Shop Drawings.

- B. Inspect existing flanges for nonstandard bolthole configurations or design and verify that new pipe and flanges mate properly.
- C. Verify that pipe grooved ends conforms to coupling manufacturer's requirements.

3.2 PREPARATION

- A. Cleaning: Thoroughly clean end connections before installation.
- B. Close pipe and equipment openings with caps or plugs during installation.
- C. Surface Preparation: Clean surfaces to remove foreign substances.

3.3 INSTALLATION

- A. According to ASME B31.3.
- B. Coating: Finish piping appurtenances as specified for service conditions.
- C. Disinfection: Disinfect raw and potable water piping as specified.

3.4 FIELD QUALITY CONTROL

- A. After installation, inspect for proper supports and interferences.
- B. Repair damaged coatings with material equal to original coating.

3.5 CLEANING

- A. Keep equipment interior clean as installation progresses.

END OF SECTION 400506

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SECTION 400507 - HANGERS AND SUPPORTS FOR PROCESS PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes:
 - 1. Hangers and supports for piping.
 - 2. Delegated Design.
- B. Related Requirements:
 - 1. Section 400506 “Couplings, Adapters, and Specials for Process Piping”.
 - 2. Section 400523 “Stainless Steel Process Pipe and Tubing”.

1.3 DEFINITIONS

- A. Ferrous Metal: Iron, steel, stainless steel, and alloys with iron as principal component.
- B. Wetted or submerged: Submerged, less than 1-foot above liquid surface, below top of channel or tank wall, under cover or slab of channel or tank, or in other damp locations.
- C. “Pipe” or “Piping”: Piping, piping system(s), hose, tube, fittings, joints, valves, and similar appurtenances.
- D. Supports: Wherever the word “supports” or “pipe supports” are used, pipe supports, hangers, structural connections, concrete inserts (if allowed), anchors, guides, bolts, expansion units, restraints and all restraint, hanging, supporting, allowing controlled expansion, or other means of attaching piping along with the necessary appurtenances.

1.4 ACTION SUBMITTALS

- A. Product Data: Submit manufacturer's catalog data including load capacity.
- B. Shop Drawings: Submit scaled piping layouts for each system. Indicate flow stream, pipe size(s) material(s), schedule(s), lining(s), critical dimensions between pipes, equipment and building features. Indicate by schedule pipe hanger/support type and locations. Provide detail of each type of hangers, supports, anchors, and guides.

1.5 DELEGATED DESIGN SUBMITTALS

A. Delegated Design Submittal: For hangers and supports for piping.

1. Where Drawings show support types and/or locations, analyze them for adequacy to support loads and stresses, modify if required, install generally where shown, and integrate with pipe support system design.
2. Engage the services of independent registered professional engineer licensed in the State of Florida ordinarily engaged in the business of pipe support systems analysis and design, to analyze system piping and service conditions, and to develop a detailed support system design, specific to the piping material, pipe joints, valves, and piping appurtenances proposed for use.
 - a. Support system engineering groups include the following:
 - 1) SAC Incorporated <https://www.sacincorporated.com/contact-us/>
 - 2) Fenny Engineering <http://www.fennyengineering.com/contact/>
 - 3) Piping Solutions and Energy Associates <https://www.pseassoc.com/request-for-service/>
 - 4) Newman Associates <https://newmanassoc.com/>
3. The support system design shall include:
 - a. Criteria by piping system.
 - b. Summary of Contractor-selected related components including joints, class, valves, appurtenances, etc., and commercial supports and especially including pipe materials.
 - c. Dead weight and dynamic analysis, including system thermal effects and pressure thrusts. Computer-based software system equivalent to Bentley Systems AutoPIPE or SST Systems CAEPIPE.
 - 1) Present each system in an isometric graphic and show the resolved and resultant force and moment systems, as well as all recommended hangers, supports, anchors, restraints, and expansion/flexible joints.
 - d. Submit support system design to the Engineer for review. The submittal needs to be stamped by a professional engineer registered in State of Florida.
 - e. All aspects of the analysis and design to comply with the provisions of ANSI B31.1 and the referenced standards.
4. Coordinate support arrangements to eliminate interference with similar systems to be installed under Electrical, to account for structural expansion joints and to maintain access for both personnel and for the removal of equipment.

B. Manufacturers' Instructions: Submit special procedures and assembly of components.

C. Qualifications Statement: Submit qualifications for licensed professional.

1.6 INFORMATIONAL SUBMITTALS

- A. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
- B. Welders' Certificate: Submit welders' certification of compliance with ASME Section IX or AWS D1.1, verifying qualification within previous 12 months.
- C. Qualifications Statements:
 - 1. Submit qualifications for manufacturer, fabricator, installer, and licensed professional.
 - 2. Submit manufacturer's approval of installer.

1.7 DELIVERY, STORAGE AND HANDLING

- A. All supports and hangers shall be crated, delivered and uncrated so as to protect against any damage.
- B. All parts shall be properly protected so that no damage or deterioration shall occur during a prolonged delay from the time of shipment until installation is completed.
- C. Finished metal surfaces not galvanized, that are not of stainless steel construction, or that are not coated, shall be grease coated, to prevent rust and corrosion.

1.8 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing Products specified in this Section with minimum three years' documented experience.
- B. Fabricator: Company specializing in fabricating products specified in this Section with minimum three years' documented experience.
- C. Installer: Company specializing in performing Work of this Section with minimum three years' documented experience and approved by manufacturer.
- D. Licensed Professional: Professional engineer experienced in design of specified Work and licensed in State of Florida.
 - 1. Have at least 5 years of experience in the analysis and design of similar systems, including the use of commercial and custom pipe supports and in the use of commercial pipe stress software programs.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Inspection: Accept materials on-Site in original factory packaging, labeled with manufacturer's identification.
- B. Protect products from weather and construction traffic, dirt, water, chemical, and damage by storing in original packaging.

1.10 EXISTING CONDITIONS

- A. Field Measurements: Verify field measurements prior to fabrication. Indicate field measurements on Shop Drawings.

1.11 WARRANTY

- A. Furnish two-year manufacturer's warranty for pipe hangers and supports.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Support pipe and appurtenances connected to equipment to prevent any strain being imposed on the equipment. Comply with manufacturer's requirements regarding piping loads being or not being transmitted to their equipment. Submit certification stating that such requirements have been met.
- B. Support and secure all pipe and tubing in the intended position and alignment to prevent significant stresses in the pipe or tubing material, valves, fittings, and other pipe appurtenances. Design all supports to adequately secure the pipe against excessive dislocation due to thermal expansion and contraction, internal flow forces, and all probable external forces such as equipment, pipe, and personnel contact. Any structural steel members required to brace any piping from excessive dislocation and shall be furnished and installed under this Section.
- C. Contractor may propose minor adjustments to the piping arrangements in order to simplify the supports, or in order to resolve minor conflicts in the work. Such an adjustment might involve minor change to a pipe centerline elevation so that a single trapeze support may be used.
- D. Where flexible sleeve, split ring, vibration, or other couplings are required at equipment, tanks, etc., the end opposite to the piece of equipment, tank, etc., shall be rigidly supported to prevent transfer of force systems to the equipment. Do not install fixed or restraining supports between a flexible coupling and the piece of equipment.
- E. Pipe Supports:
 - 1. Shall not induce point loadings but shall distribute pipe loads evenly along the pipe circumference.
 - 2. Provide supports at changes in direction and elsewhere as shown in the Drawings or as specified herein.
 - 3. No piping shall be supported from other piping or from metal stairs, ladders, and walkways, unless specifically directed or authorized by Engineer.
 - 4. Provide pipe supports to minimize lateral forces through valves, both sides of flexible split ring type couplings and sleeve type couplings, and to minimize all pipe forces on pump housings. Pump housings shall not be utilized to support connecting pipes.
 - 5. Effects of thermal expansion and contraction of the pipe to be accounted for in the pipe support selection and installation.

- F. Insofar as is possible, floor supports shall be given preference. Where specifically indicated, concrete supports, as shown on the Drawings, may be used. Base elbow and base tees shall be supported on concrete pedestals.
- G. Restraints, flexible connections, expansion items, and related items as included in other specifications (especially Section 400506 “Couplings, Adapters, and Specials for Process Piping” and other individual pipe sections) and shown on Drawings.

2.2 PERFORMANCE REQUIREMENTS/DESIGN CRITERIA

- A. Delegated Design: Engage a qualified professional engineer to design hangers and supports for piping.
- B. All supports and appurtenances shall be standard products from approved manufacturers wherever possible and shall be adequate to maintain the supported load in proper position under all operating conditions. Any reference to a specific figure number of a specific manufacturer is for the purpose of establishing a type and quality of product and shall not be considered as proprietary. Note that different materials required, as specified in Part 2 MATERIALS, may require different figures or model numbers than those shown.
 - 1. The minimum working factor of safety for all items, with the exception of springs, shall be five times the ultimate tensile strength of the material, assuming 10 feet of water-filled pipe being supported and normal test pressures.
 - 2. Design for all loads using a safety factor of 5.
- C. Piping schedule is included in Contract Drawings.
- D. All items shall be designed with strength and stiffness to support, restrain, and allow expansion of the respective pipes under the maximum combination of peak loading conditions to include pipe weight, liquid weight, liquid movement and pressure forces, thermal expansion and contraction, vibrations, and all probable externally applied forces.
- E. Support spacing shall be per ASME B31.1.
- F. Complete design details of the pipe system components shall be submitted for review and approval as specified in Part 1. No support shall be installed without approved support system Drawings.
- G. The pipe support system shall not impose loads on the supporting structures in excess of the loads for which the supporting structure is designed.
- H. Seismic Design and restraint requirements, in accordance with the Structural Design criteria.

2.3 MATERIALS

- A. Metallic Pipe Support:
 - 1. Submerged, buried, or within outdoor structures (vaults, etc.): Type 316 stainless steel (SS).

2. Within chemical areas: Vinyl ester fiberglass reinforced plastic (FRP) for pipe size up to 2 inch, epoxy coated steel for 2-1/2 inches size and larger.
3. Other locations: steel with galvanizing where noted.
4. Additional requirements (including dielectric insulation) in ACCESSORIES Article.

B. Non-Metallic Pipe Support:

1. Submerged, buried, or within vaults: Type 316 stainless steel or FRP.
2. Within chemical areas: vinyl ester FRP.
3. Other locations: steel with galvanizing where noted; all with local stress protection shields.
4. Additional requirements (including stress protection shields) in ACCESSORIES Article.

C. Wherever stainless steel is noted, it shall be Type 316 unless noted otherwise.

2.4 SUPPORT AND RESTRAINT SYSTEMS

A. Steel or Ductile Iron Piping:

1. Cast iron and ductile iron, steel, and stainless steel piping shall be supported at a maximum support spacing of 10 feet with a minimum of one support per pipe section at the joints.
2. Support spacing for ductile iron, steel, and stainless steel piping 2-inch and smaller diameter shall not exceed 5 feet.

B. Copper Piping:

1. Supports for copper pipe shall be copper plated or shall have a 1/16 inch plastic coating.
2. Support spacing for copper piping and tubing 2 inch and smaller diameter shall not exceed 5 feet and greater than 2 inch diameter shall not exceed 8 feet.
3. Where pipe supports come in contact with copper piping, provide protection from galvanic corrosion by: wrapping pipe with 1/16 inch thick neoprene sheet material and galvanized protection shield; isolators similar to Cooper B-Line B3195CT; or copper-plated or PVC-coated hangers and supports.

C. Non-Metallic Piping:

1. All uninsulated non-metallic piping such as PVC, CPVC, HDPE, PVDF, etc., shall be protected from local stress concentrations at each support point. Protection shall be provided by non-metallic protection shields or other method as approved by Engineer.
 - a. Where pipes are bottom supported 180 degrees, arc shields shall be furnished. Where 360-degree arc support is required, such as U-bolts, protection shields shall be provided for the entire pipe circumference. All U-bolts or clamps for non-metallic pipes shall be plastic coated.
 - b. Protection shields shall have an 18-gauge minimum thickness, not be less than 12 inches in length and be securely fastened to pipe with Type 316 stainless steel straps not less than 1/2 inch wide.

2. Individually supported PVC pipes shall be supported as recommended by the pipe manufacturer except that support-spacing shall be manufacturers recommendation minus 2-feet down to 5 feet spacing recommendation, then spacing shall be 3 feet.
3. Supports for horizontal multiple PVC plastic piping:
 - a. Shall be continuous wherever possible.
 - b. Multiple, suspended, horizontal plastic PVC pipe runs, where possible, shall be supported by ladder type cable trays such as: Husky Ladder Flange Out by MPHusky; or equal.
 - c. Rung spacing shall be 12 inches. Tray width shall be approximately 6 inches for single runs and 12 inches for double runs.
 - d. Ladder type cable trays shall be furnished complete with all hanger rods, rod couplings, concrete inserts, hanger clips, etc., required for a complete support system. Individual plastic pipes shall be secured to the rungs of the cable tray by strap clamps or fasteners similar to: Globe, Series 600; Unistrut Pipe/Conduit Clamps and Hangers; or equal.
 - e. Spacing between clamps shall not exceed 9 feet. The cable trays shall provide continuous support along the length of the pipe. Individual clamps, hangers, and supports in contact with plastic PVC pipe shall provide firm support but not so firm as to prevent longitudinal movement due to thermal expansion and contraction.

D. Framing Support System:

1. See Part 2 MATERIALS for materials of construction.
2. Beams: Size such that beam stress does not exceed 25,000 psi and maximum deflection does not exceed 1/240 of span.
3. Column Members: Size in accordance with manufacturer's recommended method.
4. Support Loads: Calculate using weight of pipes filled with water.
5. Maximum Spans:
 - a. Steel and ductile iron pipe 3 inch diameter and larger: 10 foot centers, unless otherwise shown.
 - b. Other pipelines and special situations: Same as noted in previous paragraphs. Supplementary hangers and supports may be required.

- E. All vertical pipes shall be supported at each floor or at intervals of not more than 12 feet by approved pipe collars, clamps, brackets, or wall rests and at all points necessary to ensure rigid construction. All vertical pipes passing through pipe sleeves shall be secured using a pipe collar.

2.5 ANCHOR BOLTS/SYSTEMS

- A. Anchoring Devices: Design, size, and space support anchoring devices, including anchor bolts, inserts, and other devices used to anchor support, to withstand shear, and pullout loads imposed by loading and spacing on each particular support. DO NOTE USE ADHESIVE ANCHOR BOLTS ON ANY PIPE SUPPORT HUNG FROM A ROOF OR CEILING, unless specifically noted otherwise.

- B. All post-installed anchors in concrete shall have current published ICC-ES Evaluation Report indicating the anchor is approved for installation in cracked concrete.
- C. The latest edition of the following specification and recommended practices shall become part of this specification as if written herein. Wherever requirements conflict, the more stringent shall govern.
 - 1. ACI 318, Appendix D.
 - 2. ACI 355.2, Mechanical Anchors “Qualification of Post-Installed Mechanical Anchors in Concrete”.
 - 3. Anchor manufacturer’s published installation requirements.
- D. Expansion Anchors:
 - 1. The length of expansion bolts shall be sufficient to place the wedge portion of the bolt a minimum of 1 inch behind the steel reinforcement.
 - 2. Manufacturers:
 - a. Power-Stud+ SD4 and Power-Stud+ SD6 by Powers Fasteners, Brewster, NY.
 - b. Kwik Bolt as manufactured by Hilti USA, Tulsa, Oklahoma.
 - c. Wej-it by Wej-it Expansion Products, Inc., Broomfield, Colorado.
- E. Unless otherwise noted: Use Type 304 stainless steel anchoring parts/bolts and hardware for non-submerged supports, Type 316 stainless steel for submerged anchors.
- F. Size of anchor bolts as designed by manufacturer, 1/2 inch minimum diameter, or as shown on the Drawings.
- G. Anchors to concrete in chemical areas shall be epoxy secured vinyl ester FRP all thread, insertion depth and size as required by the manufacturer for the design loads. Nuts, bolts and hardware shall all be vinyl ester FRP construction.

2.6

2.6 SINGLE PIPE SUPPORTS FROM BELOW

- A. Single pipes located in a horizontal plane close to the floor shall be Pedestal type: Schedule 40 pipe stanchion, saddle, and anchoring flange.
 - 1. Nonadjustable Saddle: MSS SP 58, Type 37 with U-Bolt.
 - a. Anvil, Figure 259.
 - b. Cooper B-Line, Figure B3090.
 - 2. Adjustable Saddle: MSS SP 58, Type 38 without clamp.
 - a. Anvil, Figure 264.
 - b. Cooper B-Line, Figure B3093.

B. Pipes less than 3 inch in diameter:

1. Hold in position by supports fabricated from steel C channel, welded post base similar to Unistrut, Figure P2072A, where use of steel is allowed; and pipe clamps similar to Unistrut, Figures P1109 through 26.
2. Where required to assure adequate support, fabricate supports using two vertical members and post bases connected by horizontal member of sufficient load capacity to support pipe.
3. Fasten supports to nearby walls or other structural member to provide horizontal rigidity.
4. More than one pipe may be supported from a common fabricated support.

C. Pipes 3 inch in diameter and larger:

1. Support by adjustable stanchions.
2. Provide at least 4 inches adjustment.
3. Flange mount to floor.

D. Use yoked saddles for piping whose centerline elevation is 18 inches or greater above the floor and for all exterior installations.

E. Pipe roller type supports shall be used where required to accommodate thermal movement in conjunction with axial supports.

2.7 BASE ANCHOR SUPPORT

A. Bend Support: Where pipes change direction from horizontal to vertical via a bend, install a welded or cast base bend support to carry the load. Fasten to the floor, pipe stanchion, or concrete pedestal using expansion anchors or other method as approved by Engineer.

B. Concrete Supports: Where indicated, securely fasten pipe bends to concrete supports with suitable metal bands as required and approved by Engineer. Isolate piping from poured concrete with a neoprene insert.

2.8 SHOP FACTORY FINISHING

A. Prepare and prime metallic (except stainless steel) supports.

2.9 ACCESSORIES

A. Insulation Shield: Install on insulated non-steel piping. Oversize the rollers and supports, as required. Manufacturers:

1. Anvil, Figure 167.
2. Cooper B-Line, Series B3151.

B. Welding Insulation Saddle: Install on insulated metal pipe. Oversize the rollers and supports, as required. Manufacturers:

1. Anvil, Figure 160.
 2. Cooper B-Line, Series B3160.
- C. Vibration Isolation Pad: Install under base flange of pedestal type pipe supports adjacent to equipment, and where required to isolate vibration.
1. Isolation pads to be neoprene, waffle type.
 2. Manufacturers:
 - a. Mason Industries, Type W.
 - b. Korfund.
- D. Dielectric Barrier:
1. Install between carbon steel members and copper or stainless steel pipe.
 2. Install between stainless steel supports and non-stainless steel ferrous metal piping.
 3. All stainless steel piping shall be isolated from all ferrous materials, including galvanized steel by use of neoprene sheet material and protection shields.
- E. Electrical Isolation: Install 1/4 by 3 inch neoprene rubber wrap between submerged metal pipe and oversized clamps.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify field dimensions as indicated on Shop Drawings.

3.2 INSTALLATION

- A. Obtain permission from Engineer before using powder-actuated anchors.
- B. Obtain permission from Engineer before drilling or cutting structural members.
- C. Inserts:
1. Install inserts for placement in concrete forms. Before setting inserts, all drawings and figures shall be checked that have a direct bearing on the pipe location. Responsibility for the proper location of pipe supports is included under this Section.
 2. Provide hooked rod to concrete reinforcement section for inserts carrying pipe 4 inch and larger.
 3. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.
 4. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut above slab.
- D. Pipe Hangers and Supports:
1. Install according to: ASME B31.1.
 2. Support horizontal piping as indicated on Shop Drawings, depending upon pipe size.

3. Support horizontal cast iron pipe adjacent to each hub, with 5 feet maximum spacing between hangers.
4. Support riser piping independently of connected horizontal piping.
5. Support piping independently so that equipment is not stressed by piping weight or expansion in piping system.
6. Support large or heavy valves, fittings, and appurtenances independently of connected piping.
7. Proceed with installation of piping and supports only after any building structural work has been completed and new concrete has reached its 28-day compressive strength.
8. The installation of pipe support systems shall not interfere with the operation of any overhead bridge cranes, monorails, access hatches, etc. No piping shall be supported from stairs, other pipes, ladders, and walkways unless authorized by Engineer.
9. Repair mounting surfaces to original condition after attachments are made.
10. Brace horizontal pipe movements by both longitudinal and lateral sway bracing.
11. Where supports are required in areas to receive chemical resistant seamless flooring, install supports prior to application of flooring system.

E. Equipment Bases and Supports:

1. Provide housekeeping pads as detailed on Drawings.
2. Using templates furnished with equipment, install anchor bolts and accessories for mounting and anchoring equipment.
3. Construct supports of steel pipe and fittings. Brace and fasten with flanges bolted to structure.
4. Provide rigid anchors for pipes after vibration isolation components are installed.

F. Prime Coat:

1. Prime coat exposed steel hangers and supports.
2. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.

3.3 FIELD QUALITY CONTROL

- A. All pipe support systems shall be tested after installation in conjunction with the respective piping pressure tests. If any part of the pipe support system proves to be defective or inadequate, it shall be repaired, augmented or replaced to the satisfaction of Engineer.
- B. After the work is installed, but before it is filled for start-up and testing, the Support System Design Engineer shall inspect the work and shall certify its complete adequacy. Each system shall be inspected and certified in the same way.
- C. Submit a report, including all field modifications and including all certificates.
 1. Insert state where project is located.
 2. The report shall bear the stamp of a professional engineer registered in State of Florida and shall be subject to the review of Engineer.

END OF SECTION 400507

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SECTION 400523 - STAINLESS STEEL PROCESS PIPE AND TUBING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:

- 1. Stainless steel pipe and fittings.
 - 2. Stainless steel tube and fittings.
 - 3. Accessories.

- B. Related Requirements:

- 1. Section 400506 "Couplings, Adaptors, and Specials for Process Piping" for pipe disassembly joints.
 - 2. Section 400551 "Common Requirements for Process Valves" for common product requirements for valves for placement by this Section.
 - 3. Section 400507 "Hangers and Supports for Process Piping" for hangers, anchors, sleeves and sealing of piping to adjacent structures.

1.3 ACTION SUBMITTALS

- A. Product Data: Submit manufacturer information on pipe materials, tube materials, and fittings.

- B. Shop Drawings:

- 1. Indicate piping layouts and schedules, with dimensions, fittings, expansion joints, locations of valves and appurtenances, joint details, wall penetration details, methods, types and locations of hangers and supports, and pertinent technical specifications for piping to be furnished.
 - 2. Include data and information required for complete piping systems. Base dimensions on actual equipment to be furnished. Show types and locations of pipe hangers and/or supports on layouts for each pipe submittal. Since not all dimensions will be checked by Engineer, nor will every detail be reviewed by Engineer, Contractor will be responsible for accurate dimensioning of piping systems.

- C. Cleaning Methods:

- 1. Include pre-cleaning, descaling, chemicals to be used, or mechanical descaling method, post-weld cleaning to restore corrosion resistance and final cleaning/passivation/pickling.

2. Include method and schedule for drying pipe so that it is ready for service as part of proposed cleaning method.
3. Include name and qualifications of firm that will be doing cleaning.
4. Include name and qualifications of independent firm that will be doing inspection of cleaned pipe.

D. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

E. Welder Certificates: Submit welders' certification of compliance with ASME BPVC, Section IX or AWS D1.1/D1.1M, verifying qualification within previous 12 months.

1.4 INFORMATIONAL SUBMITTALS

A. Source Quality-Control Submittals: Indicate results of shop tests and inspections.

B. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.

C. Qualifications Statements:

1. Submit qualifications for manufacturer, installer, and licensed professional.
2. Submit manufacturer's approval of installer.

1.5 CLOSEOUT SUBMITTALS

A. Project Record Documents: Record actual locations of valves, fittings, and appurtenances, connections, and centerline elevations.

B. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.

1.6 QUALITY ASSURANCE

A. Furnish stainless steel pipe and fittings by a single manufacturer who is fully experienced, reputable, qualified and regularly engaged for the last 5 years in manufacture of materials to be furnished.

B. Permanently mark each length of pipe with manufacturer's name or trademark, and compliance with standards.

C. Materials in Contact with Raw Water: In Conformance to NSF 61 and NSF 372.

D. Fabricator Qualifications: Factories, including mills, foundries, factories and machine shops, which hold a current ISO 9001 Certificate of Quality System Registration. Furnish documentation necessary to verify Supplier's certification and registration.

E. Furnish work in new and unused condition. Include products and services from Suppliers having successful record of manufacturing and servicing Work specified herein for a minimum of 10 years prior to Effective Date of Agreement.

- F. Perform and document quality control (QC) and quality assurance (QA) procedures performed during manufacturing at factory; during loading of Work for transport at factory; during transport to Site; during unloading and storage of Work at Site; and during installation and startup at Site, all part of Work specified herein.
- G. Design, manufacture, deliver and install products in accordance with requirements of specified herein. Provide new and unused products specified herein from Suppliers having a successful record of manufacturing and servicing products specified herein for a minimum of 5 years.
- H. Submit to Engineer, four copies of certified mill test reports (MTRs) for chemical analysis, mechanical properties including tensile, impact, and bend test results for materials used in manufacture of products specified herein. Verify MTRs identify products, for which material will be used, and information necessary to verify compliance with requirements specified herein.
- I. If there are difficulties in operation of systems included under this Contract due to defective Work, provide additional services to correct defective Work and meet acceptance testing requirements.
- J. Inspection by Owner or Engineer or failure to inspect does not relieve Contractor of his responsibility to provide materials and perform Work in accordance with Contract Documents.

1.7 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum five years' documented experience.
- B. Installer: Company specializing in performing Work of this Section with minimum five years' documented experience and approved by manufacturer.
- C. Welders: AWS or ASME qualified within previous 12 months for employed weld types.
- D. Welding Qualifications: Qualify procedures according to AWS D1.1/D1.1M, "Structural Welding Code – Steel."
- E. Pipe and Pressure-Vessel Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.
- B. Store materials according to manufacturer instructions.
- C. Protection:
 - 1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.