IMMOKALEE WATER & SEWER DISTRICT

CARSON RD WTP ELECTRICAL UPGRADE

TECHNICAL SPECIFICATIONS

IMMOKALEE WATER AND SEWER DISTRICT
CARSON RD WTP ELECTRICAL UPGRADE
TECHNICAL SPECIFICATIONS
TABLE OF CONTENTS

DIVISION 01 – GENERAL REQUIREMENTS

01026 – MEASUREMENT AND PAYMENT
01039 – COORDINATION AND MEETINGS
01300 – SUBMITTALS
01700 – CONTRACT CLOSEOUT

DIVISION 16 – ELECTRICAL

GENERAL PROVISIONS
16015 – ELECTRICAL REFERENCE SYMBOLS
16020 – WORK INCLUDED
16025 – CODE FEES & STANDARD
16040 – IDENTIFICATION
16050 – BASIC MATERIALS AND METHODS
16051 – SPECIAL ELECTRICAL REQUIREMENTS

BASIC MATERIALS & METHODS
16110 – RACEWAYS AND CONDUITS
16120 – LOW VOLTAGE WIRES AND CABLES
16134 – PANELBOARDS
16180 – OVERCURRENT PROTECTIVE DEVICES
16190 – SUPPORTING DEVICES
16450 – GROUNDING
16460 – LOW VOLTAGE TRANSFORMERS

SPECIAL SYSTEMS
16709 – SURGE SUPPRESSION EQUIPMENT

IMMOKALEE WATER & SEWER DISTRICT
IMMOKALEE, FLORIDA
CARSON RD WTP ELECTRICAL UPGRADE
Professional Engineer's Certifications

The following Technical Specifications for Carson Rd WTP Electrical Upgrade, were prepared under my direction and supervision:

DIVISION 01 – GENERAL REQUIREMENTS	**ALL SECTIONS**

Gary C. Ferrante, P.E.
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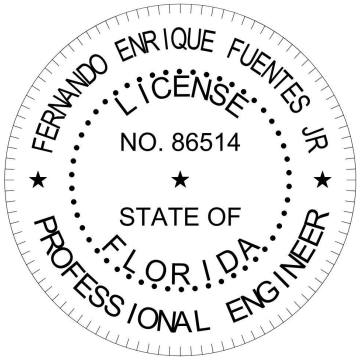
IMMOKALEE WATER & SEWER DISTRICT
IMMOKALEE, FLORIDA
CARSON RD WTP ELECTRICAL UPGRADE
Professional Engineer's Certifications

The following Technical Specifications for Carson Rd WTP Electrical Upgrade, were prepared under my direction and supervision:

DIVISION 16 – ELECTRICAL	**ALL SECTIONS**



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SECTION 01026

MEASUREMENT AND PAYMENT

PART 1 PART 1 GENERAL

1. 1 SECTION INCLUDES

A. Explanation and Definitions

B. Measurement

C. Payment

D. Schedule of Values

E. Application for Payment

1. 2 EXPLANATION AND DEFINITIONS

A. The following explanation of the Measurement and Payment for the bid form items is made for information and guidance. The omission of reference to any item in this description shall not, however, alter the intent of the bid form or relieve the CONTRACTOR of the necessity of furnishing such as a part of the Contract.

1. 3 MEASUREMENT

A. The quantities set forth in the bid form are lump sum.

B. Project Restoration: Restoration Work items that will be measured for payment are identified on the bid form and are described in the contract documents. No other restoration items will be measured for payment nor will payment be made for their work. These prices and payment shall constitute full and complete payment for all project restoration. The costs of all other restoration items which the contractor anticipates will be required shall be merged with the appropriate bid item. No further payment will be made to repair damage caused by the contractor, his sub-contractors, employees, suppliers, or others associated with his operations.

1. 4 PAYMENT

A. Payment shall be made for the items listed on the Bid Schedule on the basis of the work actually performed and completed, such work including but not limited to, the furnishing of all necessary labor, materials, equipment, transportation, clean up, restoration of disturbed areas, and all other appurtenances to complete the construction and installation of the work as shown on the drawings and described in the specifications.

B. Unit prices are used as a means of computing the final figures for bid and Contract purposes, for periodic payments for work performed, for determining value of additions or deletions and wherever else reasonable.

1. 5 SCHEDULE OF VALUES

A. Approval of Schedule: Submit for approval a preliminary schedule of values, in duplicate, for all of the Work. Prepare preliminary schedule in accordance with the General Conditions. Submit preliminary schedule of values within 10 calendar days after the Effective Date of the Agreement. Submit final schedule of values in accordance with the General Conditions.

B. Format: Utilize a format similar to the BID FORM, which will be part of the Contract Documents. Identify each line item with corresponding Item Number and Item Description. Identify site mobilization, bonds and insurance. Include within each line item, a direct proportional amount of CONTRACTOR's overhead profit.

C. Revisions: With each Application for Payment, revise schedule to list approved Change Orders.

1. 6 APPLICATION FOR PAYMENT

A. Required Copies: Submit three copies of each application on EJCDC Form No. C-620 (2013 Ed.) or approved equal. Present required information in typewritten form or on electronic media printout.

B. Execute certification by signature of authorized officer.

C. Use data from approved Schedule of Values.

D. Stored Materials: When payment for materials stored is permitted, submit a separate schedule for Materials Stored showing line item, description, previous value received, value incorporated into the Work and present value.

E. Change Orders: List each authorized Change Order as an extension on continuation sheet, listing Change Order number and dollar amount as for an original item of work.

F. Final Payment: Prepare Application for Final Payment as required in the General Conditions.

G. Submit an updated construction schedule for each Application for Payment.

H. Submit application for payment to ENGINEER on, or before, the 2nd Friday of each month.

PART 2 PART 2 PRODUCTS

Not Used

PART 3 PART 3 EXECUTION

3. 1 MEASUREMENT AND PAYMENT

A. Payment shall be made on the basis of work actually performed completing each item in the Bid, such work including, but not limited to, the furnishing of all

necessary labor, materials, equipment, transportation, cleanup, and all other appurtenances to complete the construction and installation of the work to the configuration and extent as shown on the drawings and described in the specifications. Payment for each item includes compensation for cleanup and restorations. Cleanup and surface restorations (including pavement replacement) will be considered as ten percent (10%) of each pay item and complete payment will not be made until cleanup, restorations and as-builts are completed.

DIVISION 1 MOBILIZATION & DEMOBILIZATION

1. 1 MOBILIZATION

General Description: Perform preparatory work and operations in mobilizing for beginning work on the project.

What Pay Item Includes: This item shall include, but is not limited to, those operations necessary for the movement of personnel, equipment, supplies, and incidentals to the project site and for the establishment of temporary offices, buildings, safety equipment and first aid supplies, sanitary, other facilities, and the costs of bonds and any required insurance, obtaining building permits and any other pre-construction expense necessary for the start of the work, excluding the cost of construction materials.

Payment Determination: Payment will be made at the contract lump sum price.

1. 2 PREPARATION OF AS-BUILT DRAWINGS

General Description: Preparation of digital and paper copy of as-built drawings to be submitted to OWNER.

What Pay Item Includes: This item shall include, but is not limited to, all labor, equipment, certifications, and materials necessary to provide the OWNER with one (1) set of redline plans and one (1) electronic file of as-built information of the project. Current acceptable software platform is AutoCAD 2019 or later. AutoCAD drawings will only be acceptable if drawn to the NAD 1983 State Plane Florida East (feet) coordinate system and with the United States Survey Feet (USFEET) units, as established by a registered Florida surveyor and mapper. The following items shall be accurately depicted on the Record Drawings:

- Locations of buried conduits with reference distances to above ground features.
- Wiring diagrams

Payment Determination: Payment will be made at the contract lump sum price.

DIVISION 2 UNIT PRICE ITEMS

2. 1 WELL 102 ELECTRICAL MODIFICATIONS

General Description: Provide labor, equipment, and material to refeed power to existing well 102 from the MCC in the new building as shown on the contract documents (Refer to sheets E-3 & E-6).

What Pay Item Includes: The work shall include, but is not limited to, utilizing existing MCC bucket with starter, furnishing & installing new disconnect switch and new step-down transformer, furnishing and installing electrical connections and terminations, routing of duct banks, electrical cables, conduit, I&C cables, core drilling, pull boxes, appurtenances and sufficient functional testing and start-up including simulating power failure and stand by generator operations to provide a complete working installation. The Contractor shall provide any manufacturer's documentation necessary to operate and maintain the installed equipment.

Payment Determination: Payment will be made at the appropriate contract lump sum price.

2. 2 NEW PANELBOARD - PNL-A

General Description: Provide labor, equipment, and materials necessary to install new panelboard A with power feed from MCC in the new building as shown on the contract documents (Refer to sheets E-3, E-6 & E-7).

What Pay Item Includes:

The work shall include, but is not limited to, furnishing & installing new disconnect switch & new step-down transformer, furnishing power connection, furnishing & installing new Panel -A, routing of duct banks, core drilling, conduits, electrical cables, pull boxes, appurtenances and sufficient functional testing and start-up including simulating power failure and stand by generator operations to provide a complete working installation. The Contractor shall provide any manufacturer's documentation necessary to operate and maintain the installed equipment.

Payment Determination: Payment will be made at the appropriate contract lump sum price.

2. 3 PANEL – PNL-B POWER REFEED

General Description: Provide labor, equipment, and materials necessary to refeed power to existing panel B from new panel A as shown on the contract documents (Refer to sheets E-3, E-6 & E-7).

What Pay Item Includes:

The work shall include, but is not limited to, furnishing and installing power, connection to the existing Panel -B, routing of duct banks, conduits, electrical cables, junction boxes, core drilling, functional testing, simulating power failure and stand by generator operations and appurtenances to provide a complete working installation.

Payment Determination: Payment will be made at the appropriate contract lump sum price.

2. 4 PANEL – PNL-C POWER REFEED

General Description: Provide labor, equipment, and materials necessary to refeed power to existing panel C from new panel A as shown on the contract documents (Refer to sheets E-3, E-6 & E-7).

What Pay Item Includes:

The work shall include, but is not limited to, furnishing and installing power, connection to the existing Panel -C, conduits, core drilling, electrical cables, junction boxes, functional testing including simulating power failure and stand by generator operations, and appurtenances to provide a complete working installation.

Payment Determination: Payment will be made at the appropriate contract lump sum price.

2. 5 WELL 103/104 REMOTE I&C MODIFICATIONS

General Description: Provide labor, equipment, and material to relocate the existing well 103/104 remote I&C components and installation of new control termination cabinet as shown on the contract documents (Refer to sheets E-3 & E-4).

What Pay Item Includes: The work shall include, but is not limited to, furnishing and installing the connection to available power, telemetry connection, functional testing and start-up including simulating power failure and stand by generator operations, I&C cables, junction box modifications, control termination cabinet, conduit, pull boxes, core drilling and appurtenances to provide a complete working installation. The Contractor shall provide any manufacturer's documentation necessary to operate and maintain the installed equipment.

Payment Determination: Payment will be made at the appropriate contract lump sum price.

2. 6 LIFT STATION C ELECTRICAL CONNECTION

General Description: Provide labor, equipment, and material to refeed power to existing Lift Station C from the MCC in the new building as shown on the contract documents (Refer to sheets E-3 & E-6).

What Pay Item Includes: The work shall include, but is not limited to, furnishing and installing the connection to available power, connection to the existing control panel, sufficient functional testing and start-up, simulating power failure and stand by generator operations, electrical cables, routing of duct banks, conduit, pull boxes, furnishing & installing new disconnect switch and step-down transformer,

core drilling and appurtenances to provide a complete working installation. The Contractor shall provide any manufacturer's documentation necessary to operate and maintain the installed equipment.

Payment Determination: Payment will be made at the appropriate contract lump sum price.

2. 7 MOTOR CONTROL CENTER (MCC) MODIFICATIONS

General Description: Provide labor, equipment, and material for the Motor Control Center (MCC) Modifications as shown on the contract documents (Refer to sheet E-6).

What Pay Item Includes: The work shall include, but is not limited to, functional testing and start-up including simulating power failure and stand by generator operations, wiring, nameplates, phase fail signal contacts and appurtenances to provide a complete working installation. The Contractor shall provide any manufacturer's documentation necessary to operate and maintain the installed equipment.

Payment Determination: Payment will be made at the appropriate contract lump sum price.

2. 8 DEMOLITION

General Description: Provide Labor, Equipment and Materials necessary to saw cut, remove & dispose, or abandon various existing items depicted on the plans. (Refer to sheets E-2, E-4, E-5 & E-6)

What Pay Item Includes: This item includes, but is not limited to, all necessary labor, equipment, and materials for saw-cutting and removing the existing pavement to facilitate the installation of the new power ductbank, capping & abandoning existing ductbanks, wire removal and selective demolition of existing connection to well 102, and removal and disposal of the existing electrical equipment found at the existing pump building in accordance with the details shown on the plans to the limits indicated on the plans. Any damage outside of the payment limits shown on the plans will not be measured for payment and shall be replaced by the Contractor at his own expense.

The CONTRACTOR will turnover any existing materials or equipment requested by the OWNER, otherwise the existing materials or equipment not requested by the OWNER will be disposed of properly by the CONTRACTOR. Underground conduits that are to remain shall be capped and abandoned in place.

Payment Determination: Payment will be made at the contract lump sum price.

2. 9 RESTORATION

General Description: Provide labor, equipment, and materials necessary to restore the project site to its previous condition as shown on the contract drawings.(Refer to sheet G002)

What Pay Item Includes: The work shall include, but not be limited to, providing all the labor and materials required for site clean-up, sod placement if grass is disturbed, sidewalks, pavement, storm sewers and other surface materials to restore the site to the condition before construction commenced.

Payment Determination: Payment will be made at the appropriate contract lump sum price.

END OF SECTION 01026

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SECTION 01039

COORDINATION AND MEETINGS

PART 1 - GENERAL

1.01 PERFORMANCE

A. Section generally defines CONTRACTOR's responsibilities, unless otherwise indicated, for the following:

1. Coordination.

2. Building Permits & Inspections.

3. Cutting and patching.

4. Preconstruction conference.

5. Progress meetings.

1.02 COORDINATION

A. Other construction work may be under constriction concurrent with the work of this contract. CONTRACTOR shall coordinate with work of other contractors.

1. The CONTRACTOR must comply with all local ordinances, which may affect construction activities. All associated work activities shall take place within public right-of-way.

2. Equivalent sound levels shall not exceed 50 dBA for any construction activities between 9:00 p.m. and 8:00 a.m. on weekdays and Saturdays (non-holidays). Equivalent sound levels shall not exceed 50 dBA for any construction activities on Sundays and legal holidays.

B. Coordinate scheduling, submittals, and work to assure efficient and orderly sequence of installation of interdependent construction elements, with provisions for accommodating items that shall be installed later.

C. Coordinate completion and clean up of Work of separate sections in preparation for Substantial Completion.

D. Coordinate shutdowns of any kind with IWSD at least 48 hours prior to proposed shut down. Obtain written authorization prior to shutting down any IWSD facility or performing tie-ins.

1.03 BUILDING PERMITS & INSPECTIONS

A. CONTRACTOR shall obtain all required building permits for the work.

B. CONTRACTOR shall schedule required county inspections as necessary.

C. CONTRACTOR shall pay all costs associated with building permits and inspections.

1.04 CUTTING AND PATCHING

A. Employ skilled and experienced installer to perform cutting and patching.

B. Submit written request in advance of cutting or altering elements, which affects:

1. Structural integrity of element.

2. Integrity of weather-exposed or moisture-resistant elements.

3. Efficiency, maintenance, or safety of element.

4. Visual qualities of sight-exposed elements.

5. Work of OWNER or separate CONTRACTOR.

C. Execute cutting, fitting, and patching including excavation and fill, to complete Work, and to:

1. Fit the several parts of the Work together, to integrate with other Work.

2. Uncover Work for installation of subsequent Work or to correct ill-timed Work.

3. Remove and replace defective and non-conforming Work.

4. Remove samples of installed Work for testing.

5. Provide openings in elements of Work for penetrations by mechanical and electrical Work.

D. Execute work by methods, which will avoid damage to other Work, and provide proper surfaces to receive patching and finishing.

E. Cut rigid materials using masonry saw or core drill, as required.

F. Restore Work with new Products in accordance with requirements of Contract Documents.

G. Construct a tight fit between the Work and pipes, sleeves, ducts, conduit, and other penetrations through surfaces.

H. Maintain integrity of wall, ceiling, or floor construction; completely seal any voids, with approved method.

I. Refinish surfaces to match adjacent finishes. For continuous surfaces, refinish to nearest intersection; for an assembly, refinish entire unit.

J. Identify any hazardous substance or condition exposed during the Work to the ENGINEER.

1.05 PRECONSTRUCTION CONFERENCE

A. ENGINEER will schedule a conference after Notice of Award.

B. Attendance Required: OWNER, ENGINEER, and CONTRACTOR.

C. OWNERs of all utilities within the project area shall be notified.

D. Agenda:

1. Designation of personnel representing the parties in Contract, and the ENGINEER.

2. Procedures and processing of field decisions, submittals, substitutions, applications for payments, proposal request, Change Orders and Contract closeout procedures.

3. Scheduling.

1.06 PROGRESS MEETINGS

A. Schedule and administer meetings throughout progress of the Work at maximum monthly intervals.

B. Make arrangements for meetings, prepare agenda with copies for participants, preside at meetings, record minutes, and distribute copies within two days to ENGINEER, OWNER, participants, and those affected by decisions made at the meeting.

C. Attendance Required: Job superintendent, major Subcontractors and suppliers, OWNER, ENGINEER, as appropriate to agenda topics for each meeting.

D. Agenda:

1. Review minutes of previous meetings.

2. Review of Work progress.

3. Field observations, problems, and decisions.

4. Identification of problems which impede planned progress.

PART 2 - PRODUCTS

Not Used.

PART 3 - EXECUTION

Not Used.

END OF SECTION

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SECTION 01300

SUBMITTALS

PART 1 - GENERAL

1.01 DESCRIPTION OF REQUIREMENTS

A. The type of submittals controlled by these general requirements includes shop drawings, product data, samples and miscellaneous work-related submittals. The individual submittal requirements are specified in applicable sections for each unit of work.

1. Unless otherwise noted, each item of submittal shall be submitted to the ENGINEER for review prior to construction or installation.

2. ENGINEER's review is for general conformance with the design concept and Contract Documents.

B. The submittal will not be accepted for review unless it contains complete information, complies with the specifications, and has been certified by the CONTRACTOR. Submittals that are not accepted will be returned with attached notations of requirements necessary for acceptance. Resubmit after the material has been amended to comply with the comments.

C. When submitting "or equal" submittals for review, one of the ENGINEER's copies shall contain catalog sheets for the specified items marked, FOR COMPARISON ONLY, as well as sheets for the proposed substitutions, otherwise substitutions will not be considered.

D. Prior to prosecution of the work, the CONTRACTOR shall submit to the ENGINEER a schedule of shop drawings that shall include a list of shop drawings he anticipates submitting and the respective date for submittal.

1.02 DEFINITIONS

A. The work-related submittals of this section, in addition to the definitions of the General Conditions and elsewhere in the Contract Documents, are defined as follows:

1. Shop drawings include custom-prepared data of all forms including drawings, diagrams, performance curves, data sheets, schedules, templates, patterns, reports, calculations, instructions, measurements and similar information not in standard printed form applicable to other projects.

2. Product data includes standard printed information on materials, products and systems not custom-prepared for this project, other than the designation of selections from available choices.

3. Samples include both fabricated and unfabricated physical examples of materials, products and work, both as complete units and as smaller portions of

units of work; either for limited visual inspection or (where indicated) for detailed testing and analysis.

4. Mock-ups are a special form of samples which are, because of size, usually constructed on the project site.

B. Miscellaneous submittals related directly to the work (non-administrative) include extended warranties or guarantees, maintenance agreements, project photographs and videography, survey data and reports, physical work records, statements of applicability, quality testing, calculations and certifying reports, copies of industry standards, record drawings, operating and maintenance materials, overrun stock, and similar information, devices and materials applicable to the work.

1.03 GENERAL SUBMITTAL REQUIREMENTS

A. Coordination and Sequencing

Coordinate the preparation and processing of submittals with the performance of the work and in accordance with the schedules prepared and referred to in the paragraph(s) on Schedules and Progress Reports of the General Conditions, so that work will not be delayed by submittals. Coordinate and sequence different categories of submittals for the same work, and for interfacing units of work, so that one will not be delayed for coordination with another. Do not proceed with purchasing, fabrication and delivery of work related to a submittal until submittal procedure has been successfully completed. No extension of time will be allowed because of failure to properly coordinate and sequence submittals.

B. Preparation of Submittals

1. Transmit each submittal with an ENGINEER-accepted form. The transmittal form should use sequential transmittal numbers. Resubmittals should have the original number with an alphabetic suffix.

2. Provide permanent marking on each submittal to identify it by project; date; CONTRACTOR, subcontractor, or supplier; submittal name; pertinent contract Drawing sheet or detail number(s); and specification Section number. Submittals which are received directly from sources other than through the CONTRACTOR's office will be returned without review.

3. Where manufacturer's data sheets, catalog pages or drawings have several items shown or a selection of characteristics is shown in charts and graphs, clearly mark the information indicating exactly what will be supplied.

4. Apply CONTRACTOR’s stamp, signed or initialed, certifying that the review, verification of Products required, field dimensions, adjacent construction Work, and coordination of information is in accordance with the requirements of the Work and Contract Documents.

C. Number of Copies Required for Each Submittal

See Paragraph 1.05 D. of this section for the number of copies required for each submittal.

D. Submittal Log

The CONTRACTOR is to maintain an accurate updated submittal log and will bring this log to each scheduled progress meeting with the OWNER and/or ENGINEER. This log should include the following items:

1. Submittal description and number assigned
2. Date to ENGINEER
3. Date returned to CONTRACTOR (from ENGINEER)
4. Status of submittal (Approved/Resubmit/Rejected)
5. Date of resubmittal and return (as applicable)
6. Date material released (for fabrication)
7. Projected date of fabrication
8. Projected date of delivery to site
9. Status of O&M submittal

1.04 SPECIFIC CATEGORY REQUIREMENTS

A. General: Except as otherwise indicated in individual work sections, comply with the general requirements specified for each indicated category of submittal. Provide and process intermediate submittals (where required between initial and final) similar to initial submittals.

B. Construction Progress Schedules

1. Submit initial progress schedule in duplicate within 15 days after date of OWNER/CONTRACTOR Agreement for ENGINEER review.

2. Revise and resubmit as required.

3. Submit revised schedules with each Application for Payment, identifying changes since previous version.

4. Submit a horizontal bar chart with separate line for each major section of the Work or operation, identifying first workday of each week.

5. Show complete sequence of construction by activity, identifying Work of separate stages and other logically grouped activities. Indicate the early and late start, early and late finish, float dates, and duration.

6. Indicate estimated percentage of completion for each item of Work at each submission.

B. Shop Drawings

Provide newly-prepared information; show dimensions and note which are based on field measure, identify materials and products in the work shown, indicate compliance with standards, and special coordination requirements. Do not allow shop drawing copies without appropriate final review markings by the ENGINEER to be used in connection with the work.

C. Product Data

1. Collect the required data into one submittal for each material, product or system; and mark each copy to show which choices and options are applicable to the project. Include manufacturer's standard printed recommendations for application and use, compliance with standards, application of labels and seals, notation of field measurements which have been checked, and special coordination requirements. Maintain one set of product data (for each submittal) at the project site, available for reference by the ENGINEER or others.

2. Installer's Copy: Do not proceed with the installation of materials, products or systems until a copy of the applicable product data is in the possession of the installer.

D. Samples

1. Provide units identical to the final condition of the proposed materials or products for the work. Include "range" samples (not less than three units) where variations occur, and identify each unit of each set. Provide full set of optional samples where ENGINEER's selection is required. Prepare samples to match ENGINEER's sample where so indicated. Include information with each sample to show generic description, source or product name and manufacturer, limitations, and compliance with standards.

2. Samples as submitted for review and confirmation of color, pattern, texture and "kind" by the ENGINEER, who will not "test" them (except as otherwise indicated) for other requirements, which are therefore the exclusive responsibility of the CONTRACTOR.

a. Submittal: At his option, the CONTRACTOR may provide a preliminary submittal of a single set of samples for the ENGINEER's review and "Action." Otherwise, the initial submittal is the final submittal unless it is returned with "Action" which requires an additional submittal.

1) Submit three sets of samples in the final submittal; two sets will be returned.

2) Quality Control Set: Maintain one of the returned final sets of samples at the project site, in suitable condition and available for quality control comparisons by the ENGINEER and by others.

b. Reusable Samples: Samples which are intended or permitted to be returned and actually incorporated in the work are so indicated in the individual work sections, but must be in undamaged condition at the time of use.

E. Mock-ups

Where mock-ups and similar descriptions of large samples are indicated in individual work sections of these specifications, it is recognized that these are a special type of sample which cannot be readily "transmitted" as specified for submittal of samples. Therefore, comply with the requirements for "samples" and process a transmittal form for each mock-up to provide a record of the activity.

F. Inspection and Test Reports

Submittal is classified either as "shop drawings" or "product data", depending upon whether the report is uniquely prepared for the project or a standard publication of regular product or workmanship control testing at the point of production (respectively).

G. Guarantees, Operating and Maintenance Instructions

1. Refer to individual sections for specific general requirements on the submittal of warranties, guarantees, product/workmanship bonds, and maintenance agreements which are uniquely prepared and executed for the project. Furnish two executed copies, except furnish five additional (conformed) copies where required, for maintenance manual.

2. The CONTRACTOR shall furnish to the OWNER five sets of brochures containing spare parts data and operating and maintenance instructions on all major equipment furnished for the project, and copies of all manufacturer's guarantees and warranties. This material shall be furnished before the completion of the project and before final payment is made to the CONTRACTOR.

H. Trench Safety Act Compliance Certification

The CONTRACTOR shall complete the Trench Safety Act Certification and submit it in triplicate with appropriate signature and corporate seal.

1.05 ENGINEER'S ACTION

A. The ENGINEER will review each required submittal and return it with the action required marked on it.

B. The mark will be a self-explanatory action stamp, marked and executed to indicate whether required submittal is approved, approved as noted, returned for corrections, or rejected.

C. Where marked returned for corrections, do not proceed with work covered by submittal (purchasing, fabrication, delivery or other activity); revise submittal or prepare a new submittal and resubmit without delay, in accordance with ENGINEER's notations stating reasons for returning submittal; repeat if necessary to obtain a different action marking.

D. Email to the ENGIENEER one (1) electronic copy (PDF format) of manufacturer's product data or shop drawings for each specification section item. The original marked document will be retained by the ENGINEER, scanned PDF copies will be sent to the OWNER and the CONTRACTOR.

1.06 CLOSEOUT SUBMITTALS

A. Record Document Copies: Furnish one set of electronic drawings, one set of reproducible drawings and two sets of plain paper drawings unless noted otherwise in the individual sections of these specifications.

B. Maintenance/Operating Manuals: See paragraph 1.07 of this section.

C. Spare Parts and Special Tools: See paragraph 1.08 of this section.

1.07 OPERATIONS AND MAINTENANCE MANUAL

A. The CONTRACTOR shall submit complete technical operation and maintenance information for each item of mechanical, electrical and instrumentation equipment in an organized manner. Information, as it pertains to preventative maintenance, shall be submitted with the shop drawings.

B. Upon 50% of project completion, based on the length of contract time awarded, the CONTRACTOR shall begin organization of the information, and shall submit to the ENGINEER in its entirety no later than 75% of the date of project completion, based on the length of contract time awarded.

C. The CONTRACTOR shall submit one electronic PDF document containing all O&M information to the engineer.

1.08 SPARE PARTS AND SPECIAL TOOLS LIST

A. The CONTRACTOR shall furnish as a part of Shop Drawing submittals to the ENGINEER a complete list of spare parts and special tools information for all mechanical, electrical, and instrumentation equipment. The spare parts list shall include the current list price of each spare part and special tool. The spare parts and special tools list shall be limited to those spare parts and spare tools which each manufacturer recommends be maintained by the OWNER in inventory at the plant site. Each manufacturer or supplier shall indicate the name, address, and telephone number of its nearest outlet of spare parts and special tools to facilitate the OWNER in ordering. The CONTRACTOR shall cross-reference all spare parts and spare tools lists to the equipment numbers designated in the Contract Documents. The spare parts and special tools list shall be a single electronic PDF document.

B. The CONTRACTOR shall furnish to the OWNER all spare parts and special tools stated on the spare parts and special tools list that each manufacturer recommends be maintained by the OWNER in inventory at the plant site. The spare parts and special tools for all mechanical, electrical and instrumentation equipment shall be furnished by the CONTRACTOR to the OWNER at no additional cost and prior to the OWNER's acceptance of the work.

PART 2 – PRODUCTS

NOT USED

PART 3 – EXECUTION

NOT USED

END OF SECTION

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SECTION 01700

CONTRACT CLOSEOUT

PART 1- GENERAL

1.01 PERFORMANCE

A. Section generally defines CONTRACTOR's responsibilities, unless otherwise indicated, for the following:

1. Closeout Procedures.

2. Final Cleaning.

3. Adjusting.

4. Warranties.

1.02 CLOSEOUT PROCEDURES

A. Submit written certification that Contract Documents have been reviewed, Work has been inspected, and that Work is complete in accordance with Contract Documents and ready for ENGINEER's inspection.

B. Provide submittals to ENGINEER that are required by governing or other authorities.

C. Submit final Application for Payment identifying total adjusted Contract Sum, previous payments, and sum remaining due.

D. Submit final as-builts (two sets signed and sealed by the Surveyor and one electronic copy each in DWG and PDF formats).

1.03 FINAL CLEANING

A. Execute final cleaning prior to final inspection by OWNER and ENGINEER.

B. Clean interior and exterior surfaces exposed to view; remove temporary labels, stains and foreign substances, polish transparent and glossy surfaces.

C. Clean equipment and fixtures to a sanitary condition.

D. Clean site; rake clean landscaped surfaces.

E. Remove waste and surplus materials, rubbish, and construction facilities from the site.

1.04 ADJUSTING

A. Adjust operating Products and equipment to ensure smooth and unhindered operation.

1.05 WARRANTIES

A. Provide duplicate notarized copies.

B. Execute and assemble documents from Subcontractors, suppliers, and manufacturers.

C. Provide Table of Contents and assemble in binder with durable plastic cover.

D. Submit prior to final Application for Payment.

E. For items of Work delayed beyond date of Substantial Completion, provide updated submittal within ten days after acceptance, listing date of acceptance as start of warranty period.

F. Provide operation and maintenance documentation.

PART 2 - PRODUCTS

Not used

PART 3 - EXECUTION

Not used

END OF SECTION

DIVISION 16 - ELECTRICAL INDEX
Immokalee Water & Sewer District
Carson Road WTP

GENERAL PROVISIONS
- 16015 Electrical Reference Symbols
- 16020 Work Included
- 16025 Code Fees & Standards
- 16040 Identification
- 16050 Basic Materials and Methods
- 16051 Special Electrical Requirements

BASIC MATERIALS & METHODS
- 16110 Raceways and Conduits
- 16120 Low Voltage Wires and Cables
- 16134 Panelboards

- 16180 Overcurrent Protective Devices
- 16190 Supporting Devices
- 16450 Grounding
- 16460 Low Voltage Transformers

SPECIAL SYSTEMS
- 16709 Surge Suppression Equipment

SECTION 16015

ELECTRICAL REFERENCE SYMBOLS

1.01 Symbols

A. In general the symbols used on the drawings conform to the Standard Symbols of the Institute of Electrical and Electronic Engineers with the exception of special systems or agencies as hereinafter noted or as shown in schedules or legends.

1.02 Abbreviation

A. The following abbreviations or initials are used.

A/C	Air Conditioning
A.C.	Alternating Current
AFF	Above Finished Floor
AFG	Above Finished grade
AHU	Air Handler Unit
AIC	Amps interrupting Capacity
AL	Aluminum
AMP	Ampere
ANSI	American National Standards Institute
ASA	American Standards Association
ATS	Automatic Transfer Switch
AUX	Auxiliary
AWG	American Wire Gauge
b.c.	Bare Copper
BIL	Basic Impulse Level
BKR	Breaker
^{o}C	Degrees Centigrade
CAB	Cabinet
C.	Conduit or Conductor
C.B.	Circuit Breaker
CBM	Certified Ballast Manufacturers
CFM	Cubic Feet per Minute
CKT.	Circuit
Clg.	Ceiling
COND.	Conductor
Conn.	Connection
CPU	Central Processing Unit
CRT	Cathode Ray Terminal
CSP	Closed Standpipe (Sprinkler)
CSTC	Communications System Terminal Cabinet
C.T.	Current Transformer
CU.	Copper
C.W.	Cold Water
D.C.	Direct Current
Deg.	Degree
Disc.	Disconnect
D.O.	Draw Out
DN.	Down
DPST	Double Pole Single Throw

E.C.	Electrical Contractor
EEPTS	Elevator Emergency Power Transfer Switch
EMT	Electric Metallic Tubing
E.O.	Electrically Operated
ESIC	Elevator/Systems Interface Cabinet
^{o}F	Degrees Fahrenheit
FLA	Full Load Amperes
FM	Factory Mutual
FPS	Feet per Second
FT.	Feet
FZ	Fire Protection Zone (Sprinkler)
GFI	Ground Fault Interrupting
gnd.	Ground
Horiz.	Horizontal
hp.	Horsepower
hr.	Hour
I/C	Intercom
ICU	Intensive Care Unit
IEEE	Institute of Electrical and Electronic Engineers
IES	Illuminating Engineering Society
IMC	Intermediate Metallic Conduit
in.	Inches
IPCEA	Insulated Power Cable Engineers Association
J.B.	Junction Box
KV	Kilovolt
KVA	Kilo-Volt-Amps
KW	Kilowatts
LBS	Pounds
LED	Light Emitting Diode
lt.	Light
ltg.	Lighting
max.	Maximum
MCB	Main Circuit Breaker
MCP	Motor Circuit Protector
MIC	Microphone
min.	Minimum
M.L.O.	Main Lugs Only
MPH	Miles Per Hour
MTD	Mounted
MUX	Multiplex (Transponder) Panel
MVA	Mega Volt Amps
N.	Neutral
NEC	National Electric Code
NECA	National Electrical Contractors Association
NEMA	National Electrical Manufacturers Association
NFPA	National Fire Protection Association
NIC.	Not in Contract
NF	Non Fused
No.	Number
O/	Phase
O.L.	Overload
OLS	Overloads

OSHA	Occupational Safety and Health Act
OS&Y	Outside Screw and Yoke (Sprinkler)
P.	Pole
PB	Pullbox
Ph.	Phase
PNL	Panel
PR	Pair
PWR	Power
PF	Power Factor
Pri.	Primary
psi	Pounds Per Square Inch
P.T.	Potential Transformer
PVC	Polyvinyl Chloride
RMS	Root-Means-Square
RPM	Revolutions Per Minute
Recept.	Receptacle
RSTC	Radio/Sound Terminal Cabinet
RTD	Resistance Temperature Device
SCA	Short Circuit Amps
Sec.	Secondary
S/N	Solid Neutral
SPKR	Speaker
SPST	Single Pole Single Throw
SW.	Switch
SWBD	Switchboard
TEL	Telephone
TSP	Twisted Shielded Pair
TTB	Telephone Terminal Board
TTC	Telephone Terminal Cabinet
TYP	Typical
temp.	Temperature
U.L.	Underwriters Laboratories
UNO (U.N.O.)	Unless Noted Otherwise
V	Volt
VFC	Variable Frequency Controller
VFD	Variable Frequency Drive
W	Wire
W.P.	Weatherproof

END OF SECTION

SECTION 16020

WORK INCLUDED

1.01 Description of System

A. Furnish all labor, materials, equipment and incidentals required and install complete and make operational, electrical and process instrumentation systems for the Immokalee Water & Sewer District as shown on the Drawings and as specified herein.

B. The work shall include furnishing, installing and testing the equipment and materials specified in other Sections of the Specifications and shown on the Drawings. Provide all required coordination and supervision where work connects to or is affected by work of others, and comply with all requirements affecting this Division. Work required under other divisions, specifications or drawings, indicated to be performed by this Division shall be coordinated with the Contractor and such work performed at no additional cost to Owner including but not limited to electrical work required for roll-up doors, control panel installation, instrumentation and control installation, etc.

C. It is the intent of these Specifications that the electrical system shall be suitable in every way for the service required. All material and all work which may be reasonably implied as being incidental to the work of this Section shall be furnished at no extra cost. The work shall include but not be limited to furnishing and installing the following:

1. Complete distribution system for power, including feeders and connections to control panels, pumps, float switches and other power loads.
2. Furnish and install underground, concealed and surface mounted branch circuit systems for power, instrumentation and control signal distribution.
3. Furnishing & Installation of control Termination cabinet.
4. Furnishing & Installation of Panelboard.
5. Modifications to Existing MCC.
6. Modifications to Existing PLC panel.
7. Relocation of existing RIO.
8. Furnish and install racks and stands.
9. Power, instrumentation and control Surge Suppression systems.
10. Power, Instrumentation and control, and Telemetry conduit and wiring systems.
11. Complete grounding system and special grounds as required or noted.
12. Concrete work for pad mounted equipment.

END OF SECTION

SECTION 16025

CODES, FEES, AND STANDARDS

PART 1 - GENERAL

1.01 CODES AND FEES

A. Install in accordance with latest edition of the National Electric Code and the regulations of governing local, State, County and other applicable codes, including the Utilities Company. All articles, products, materials, fixtures, forms or types of construction covered in the specifications will be required to meet or exceed all applicable standards of manufacturer, testing, performance, capabilities, procedures and installation according to the requirements of ANSI, NEMA, IEEE, and NEC referenced documents where indicated and the manufacturer's recommended practices. Requirements indicated on the contract documents, which exceed but are not contrary to governing codes shall be followed.

B. Compliance and Certification: The installation shall comply with the governing state and local codes or ordinances.

C. All work and equipment under this Division shall be in strict compliance with the latest edition of the following codes and standards:

1. National Electrical Safety Code (NESC)
2. Occupational Safety and Health Administration (OSHA)
3. National Fire Protection Association (NFPA)
4. National Electrical Manufacturers Association (NEMA)
5. American National Standards Institute (ANSI)
6. Insulated Cable Engineers Association (ICEA)
7. Instrument Society of America (ISA)
8. Underwriters Laboratories (UL)
9. Factory Mutual (FM)
10. International Electrical Testing Association (NETA)
11. Institute of Electrical and Electronic Engineers (IEEE)
12. American Society for Testing and Materials (ASTM)
13. Electrical Safety in the Workplace (NFPA70E-2012)
14. Florida Building Code
15. Local Codes and Ordinances

1.02 STANDARDS

A. All electrical equipment and materials shall be listed by Underwriter's Laboratories, Inc., or a nationally recognized Electrical Testing Agency and shall bear the appropriate UL listing mark or classification marking. Equipment, materials, etc. utilized not bearing a UL certification shall be field or factory UL certified prior to equipment acceptance and use. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

B. All materials shall be new and free of defects, and shall be U.L. listed, bear the U.L. label or be labeled or listed with an approved, nationally recognized Electrical Testing Agency. Where no labeling or listing service is available for certain types of equipment, test data shall be submitted to prove to the Engineer that equipment meets or exceeds available standards.

END OF SECTION

SECTION 16040

IDENTIFICATION OF ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 General

A. Provide materials and installation for the identification of electrical equipment, components, cables and wiring and safety signs.

B. Related Work Specified in Other Sections Includes:
Section 16050-Basic Electrical Materials and Methods; Section 16120-Wires and Cables; Section 16910-Control Panels,

1.02 References:

A. Codes and standards incorporated within this Section are:
1. ANSIC2/NFPA70E National Electrical Safety Code (NESC)
2. ANSI Z535.1 Safety Color Code
3. ANSI Z535.2 Environmental and Facility Safety Signs
4. ANSI Z535.3 Criteria for Safety Symbols
5. OSHA Occupational Safety and Health Act: specification 1910.145, Standards for Accident Prevention, Signs and Tags

1.03 Submittals: Furnish all product submittals used.

A. Product Data and Information: Furnish manufacturer's catalog data for safety signs, nameplates, labels and markers.

B. Furnish manufacturer's instructions indicating application conditions and limitations of use; and storage, handling, protection, examination and installation of product.

PART 2 – PRODUCTS

2.01 Manufacturers:

A. Acceptable Manufacturers: Acceptable manufacturers are listed below. Other manufacturers of equivalent products may be submitted for review.
1. W. H. Brady Company
2. Seton
3. Thomas & Betts A.
4. Approved Equal

2.02 Materials

A. General: Provide identification materials listed and classified by UL or tested by an acceptable Electrical Testing Company certifying the equivalence of the materials to UL listing requirements and OSHA approved.

B. Laminated Plastic Nameplates: Provide engraved three layer laminated plastic nameplates with black letters on white background with lettering etched through the outer covering and fastened with corrosion resistant brass or stainless steel screws. Do not use mounting cement for fastening nameplates.

1. Provide nameplates with 1-inch high lettering for main breakers, automatic transfer switches, panelboards, transformers, VFD's, control panels and disconnect switches.
2. Provide nameplates for each motor identifying service or function and lettering of an appropriate size to suit each motor. Submersible motor nameplates to be affixed to equipment disconnect.
3. Provide approved directories of circuits with typewritten designations of each branch circuit in each panelboard.
4. Provide smaller lettering for a neat, legible nameplate where the amount of lettering causes excessively large nameplates.

2.03 Wire Markers: Identify wire bundles and each individual wire.

A. Wire bundles: Provide a permanent waterproof brass or rigid fiber identifying tag attached with nylon self locking "Ty-Raps".

B. Wire identification markers: Provide a printed white, heat-shrink, seamless tubing type with black bold lettering for wires size No. 10 AWG and smaller. Provide a printed self-laminating white, vinyl type with black bold lettering for wires No. 8 AWG and larger

C. Color-Coding Conductor Tape: Colored, self-adhesive vinyl tape not less than 3 mils thick by 1 to 2 inches wide.

D. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.

E. Write-On Tags: Polyester tag, 0.015-inch thick, with corrosion-resistant grommet and polyester or nylon tie for attachment to conductor or cable: Marker for Tags: Permanent, waterproof, black-ink marker recommended by tag manufacturer.

2.04 Safety Signs: Provide safety signs in accordance with OSHA standards meeting the requirements of ANSI C2, ANSI Z535.1 , ANSI Z535.2 and ANSI Z535.3. Comply with NFPA 70 and 29 CFR 1910.145

A. Provide safety signs manufactured from vinyl having a minimum thickness of 60 mils with red and black letters and graphics on a white background.

B. Size: Provide 7-inch by 10-inch signs or smaller if larger size cannot be applied.

C. Mount safety signs using corrosion-resistant screws. Do not use mounting cement.

D. Self-Adhesive Warning Labels: Factory printed, multicolor, pressure-sensitive adhesive labels, configured for display on front cover, door, or other access to equipment, unless otherwise indicated.

E. All receptacles and switches shall be identified on the inside of the cover plate by circuit number and panelboard.

F. Baked-Enamel Warning Signs: Preprinted aluminum signs, punched or drilled for fasteners, with colors, legend, and size required for application and with 1/4-inch grommets in corners for mounting. Nominal size, 7 by 10 inches.

G. Metal-Backed, Butyrate Warning Signs: Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs with 0.0396-inch galvanized-steel backing, and with

colors, legend, and size required for application and with 1/4-inch grommets in corners for mounting. Nominal size, 10 by 14 inches.

2.05 Equipment Identification Labels

A. Engraved, Laminated Acrylic or Melamine Label: Punched or drilled for screw mounting. White letters on a dark-gray background. Minimum letter height shall be 3/8 inch. Identification plates shall be furnished for lighting and power panelboards, motor control centers, all line voltage heating and ventilating control panels, fire detector and sprinkler alarms, pilot lights, disconnect switches, manual starting switches, magnetic starters, and all miscellaneous controls, switches and enclosures.

B. Process control devices and pilot lights shall have identification plates. Identification plates shall be furnished for all line-voltage enclosed-circuit breakers; the plates shall identify the equipment served, voltage, phase(s), and power source. Circuits 480 volts and above shall have conspicuously located warning signs in accordance with OSHA requirements.

C. Identification plates shall be three-layer white-black-white, engraved to show black letters on a white background. Letters shall be uppercase. Identification plates 1-1/2 inches high and smaller shall be 1/16 inch thick with engraved lettering 1/8 inch high. Identification plates larger than 1-1/2 inches high shall be 1/8 inch thick with engraved lettering not less than 3/16 inch high. Identification plates having edges of 1-1/2 inches high and larger shall be beveled:

D. Provide nameplates of minimum letter height as follows: Panelboards, switchboards, safety switches and motor control centers: 1/4-inch, identify panel name; 1/8-inch, identify voltage, phase, number of wires, and source.

E. Safety color coding for identification of warning signs shall conform to NEMA Z 535. Red identification plates reading CAUTION: 480/277 VOLTS shall be provided in switch and outlet boxes containing 277-or 480-volt circuits. An identification plate marked DANGER: 480 VOLTS shall be provided on the outside of 480-volt enclosures. Identification plate shall use white lettering on a red laminated plastic.

F. Any equipment with externally powered wiring shall be marked with a laminated plastic name plate having 3/16-inch-high white letters on a red background as follows: DANGER – EXTERNAL VOLTAGE SOURCE.

PART 3 - EXECUTION

3.01 Installation

A. General: Install nameplates on the front of equipment, parallel to the equipment lines and secured with corrosion resistant screws. Labels to be consistent with wiring diagrams, schedules, and the Operation and Maintenance Manual designations. Warning Labels for Cabinets, Boxes, and Enclosures for Power and Lighting: Comply with 29 CFR 1910.145 and apply metal-backed, butyrate warning signs. Identify system voltage with black letters on an orange background. Apply to exterior of door, cover, or other access.

B. Install laminated nameplates identifying, each electrical equipment enclosure and Individual equipment and devices. The following items shall be equipped with nameplates: All motors; motor starters, motor-control centers, pushbutton stations,

control panels, time switches, disconnect switches panelboards, circuit breakers, contactors, recorders, transmitters, instruments or relays in separate enclosures, thermostats, photocells, power receptacles, switches controlling equipment or receptacles, switches controlling lighting fixtures where the fixtures are not located within the same space as the controlling switch, termination cabinets, manholes and pull boxes, instrumentation and control terminal cabinets, pull boxes manholes and cabinets. Special electrical systems shall be identified at junction and pull boxes, terminal cabinets and equipment racks.

C. Electrical contractor is responsible for nameplates on electrical equipment supplied by other divisions and installed and wired by electrical including all instrumentation and controls equipment. A portion of existing equipment affected by this contract shall also receive nameplates as determined by the engineer.

D. Surface Preparation: Degrease and clean surfaces to receive nameplates, labels and marking paint.

E. Nameplates shall adequately describe the function of the particular equipment involved. Nameplates for panelboards and switchboards shall include the panel designation, voltage and phase of the supply. For example, "Panel A, 277/480V, 3-phase, 4-wire". The name of the machine on the nameplates for a particular machine shall be the same as the one used on all motor starters, disconnect and P.B. station nameplates for that machine. Equipment Requiring Workspace Clearance shall be labeled According to NFPA 70 applied to door or cover of equipment.

F. Rework or reuse of existing equipment will require new identification tags for some existing equipment.

G. Wire Markers: Identify each individual wire with identification tags as follows:
   1. Wire identification markers: Provide wire identification markers on each wire at all termination points.
      a. On power and lighting circuits: The branch circuit or feeder number as indicated on drawings
      b. On control circuits terminated in motor control centers, switchgears, control panels and alike: The field device and terminal number of the opposite end connection.
      c. On control circuits at each field device: The panel or compartment number and terminal number of the opposite end connection.
   2. Provide oversize wire markers so that after heat shrinking the wire marker can be rotated on the wire. Rotate wire markers so that wire identification number is visible.

H. Raceway Tags
   Provide raceway tags to identify origin and destination of conduit. Install tags at each terminus and at midpoint of run. Provide tags at minimum intervals of every 50 feet of above grade raceway except where concealed in walls. Provide brass tags and nylon straps for attachment.

I. Safety Signs: Provide safety signs as follows or as shown:
   1. Wording: "DANGER -ELECTRICAL EQUIPMENT, AUTHORIZED PERSONNEL ONLY"
      Location: On the outside door of all electrical equipment rooms or areas. On the outside door of all electrical equipment cabinets.
   2. Wording: "DANGER -POWERED FROM MORE THAN ONE SOURCE"

Location: Outside all equipment that operates from more than one power source; ATS, PLCs, Main Tie Main switchgear/MCCs, etc.

3. Wording: "NOTICE -KEEP DOOR CLOSED" Location: On all doors with another safety sign installed.
4. Wording: "CAUTION -CONTROLS & INTERLOCKS POWERED FROM MULTIPLE SOURCES". Location: On all control panel doors, MCCs I&C terminal cabinets, etc.

END OF SECTION

SECTION 16050

BASIC ELECTRICAL MATERIALS AND METHODS

PART 1 – GENERAL

1.01 General

A. Section Includes: General requirements for providing basic electrical materials and methods.

B. Related Work Specified in Other Sections Includes:

1. Certain items of equipment, and various control devices including conduit and wiring which are indicated on electrical drawings to be connected, but are specified in other sections pertaining to plumbing, heating, ventilating, air conditioning, temperature control systems, process equipment, process control systems, and instrumentation. Install and connect these items to the electrical system as indicated or required in accordance with the Contract Documents.

C. Overall Application of Specifications: This Section applies to all sections of Division 16 and to other sections that include electrical equipment requirements except when in these individual sections requirements are otherwise specified to provide and install all materials necessary for a complete operational system.

D. Temporary Requirements: This Section applies to any temporary circuits, overcurrent devices, conduit, wiring, and other equipment required during changeover from existing to a new electrical system. This Section also applies to temporary rewiring of lighting and power circuits, instruments and devices.

1.02 Definitions

A. Hazardous Areas: Equipment, materials and installation in areas designated as hazardous on the Drawings shall comply with NEC Articles 500, 501, 502 and 503. Hazardous areas as defined by the NEC as Class I, Division 1, Group D, or Class I, Division 2, Group D; hazardous areas as follows:

1. Class 1, Division 1, Group D
   Wet Wells
   Pretreatment
2. Class 1, Division 2, Group D
   Pump Rooms and Dry Well
   Odor control

1.03 System Description

A. Design Requirements: Design requirements are specified in the applicable sections.

B. Performance Requirements: Performance requirements are specified in the applicable sections.

1.04 Submittals

A. General: Provide submittals for all electrical material and devices. Including the following.

B. Product Data and Information: Provide complete list of electrical equipment and materials to be furnished showing manufacturer, catalog number, size, type, voltage rating and other pertinent information.

1. Provide catalog data on manufacturer's standard equipment and materials. Clearly indicate on catalog cuts the equipment and devices being proposed.
2. Identification: Provide complete schedule and listing of system and equipment identification labels with legends.
3. Material shall not be ordered or shipped until the shop drawings have been approved.
4. The Engineer's shop drawing review shall be for conformance with the design concept of the project and compliance with the Specifications and the Drawings. Errors and omissions on approved shop drawings shall not relieve the Contractor from the responsibility of providing materials and workmanship required by the Specifications and the Drawings.
5. Shop drawings shall be stamped with the date checked by the contractor and a statement indicating that the shop drawings conform the Specifications and the Drawings. This statement shall also list all exceptions to the Specifications and the Drawings. Shop drawings not so checked and noted shall be returned.

C. CONTRACTOR's Shop Drawings: Provide shop drawings on items manufactured for the Contract.

1. Provide connection diagram and schematic for each piece of electrical equipment. A manufacturer's standard connection diagram or schematic showing more than one method of connection is not acceptable unless it is clearly marked to show the intended method of connection.
2. Provide diagrams showing connections to field equipment. Clearly differentiate between manufacturer's wiring and field wiring.
3. Provide raceway layout drawings showing conduits, boxes, and panels which contain the conductors to be provided. Include schedules listing conduit sizes and conductor content and identification.
4. Where additions and modifications are made to existing equipment, provide drawings which include both retained existing equipment and new Work.

D. Coordination Drawings: Prepare to scale coordination drawings (1/4"=1'-0"); detailing major elements, components, and systems of electrical equipment and materials in relationship with other systems, installations, and building components. Indicate locations where space is limited for installation and access and where sequencing and coordination of installations are of importance to the efficient flow of the Work, including but not necessarily limited to the following:

1. Indicate the proposed locations of major raceway systems, equipment, and materials. All dimensions shall be field verified at the job site and coordinated with the work of all other trades. Include the following:
    a. Clearances for servicing equipment, including space for equipment disassembly required for periodic maintenance.
    b. Exterior wall and foundation penetrations.
    c. Fire-rated wall and floor penetrations.
    d. Equipment connections and support details.
    e. Sizes and location of required concrete pads and bases.

E. Record Documents: Prepare record documents, and in addition to the requirements specified in Division 1. As the work progresses, legibly record all field changes on a set of Project Contract Drawings, (the "Record Drawings"). indicate installed conditions for:

1. Major raceway systems, size and location, for both exterior and interior; locations of control devices; distribution and branch electrical circuitry; and fuse and circuit breaker size and arrangements.
2. Equipment locations (exposed and concealed), dimensioned from prominent building lines.
3. Approved substitutions, and actual equipment and materials installed.
4. Record Drawings shall accurately show the installed condition of the following items: Power Riser Diagram(s). Equipment elevations (front views). Raceways and pullboxes. Conductor sizes and conduit fills. Control Wiring Diagram(s). Underground raceway and duct bank routing. Plan view, sizes and locations of distribution transformers and outdoor electrical equipment enclosure.
5. Submit a schedule of control wiring raceways and wire numbers, including the following information: Circuit origin, destination and wire numbers. Field wiring terminal strip names and numbers.
6. In addition to the schedule, provide point to point connection diagrams showing the same information submitted in the schedule of control wiring raceways including all designations and wire numbers. Comply with PLC tag designation on all instrumentation and control cabling in and out of PLC racks.
7. The schedule of control wiring raceways and wire numbers and the point to point connection diagrams shall be in electronic Autocad and Word format (i.e. no hand-written or drawn schedules, drawings, or diagrams will be accepted)

F. Operation and Maintenance Manuals: Prepare operation and maintenance manuals, and in addition to the requirements specified in other Divisions, include the following information for equipment items:

1. Description of function, normal operating characteristics and limitations, performance curves, engineering data and tests, and complete nomenclature and catalog numbers of replacement parts. Complete parts list with stock numbers, including spare parts. A complete bill of material supplied, including serial numbers, ranges and pertinent data.
2. Manufacturer's printed operating procedures to include start-up, break-in, and routine and normal operating instructions; regulation, control,

stopping, shutdown, and emergency instructions; and summer and winter operating instructions. The operating instructions shall also incorporate a functional description of the entire system, with references to the systems schematic drawings and instructions.

3. Maintenance procedures for routine preventative maintenance and troubleshooting; disassembly, repair, and reassembly; aligning and adjusting instructions.
4. A comprehensive index.
5. A complete "As Built" set of approved shop drawings.
6. A table listing of the "as left" settings for all timing relays and alarm and trip setpoints. A complete listing of As left programmable parameters for all drives, soft-starters and other microprocessor controlled equipment.
7. System schematic drawings "As Built", illustrating all components, piping and electric connections of the systems supplied under this Section.

1.05 Delivery Storage and Handling

A. General: Deliver, store and handle all products and materials as specified in Division 1 and as follows:

1. Shipping and Packing: Provide materials and equipment suitably boxed, crated or otherwise completely enclosed and protected during shipment, handling, and storage. Clearly label such boxes, crates or enclosures with manufacturer's name, and name of material or equipment enclosed.
2. Acceptance at Site: Conform to acceptance requirements as required in Division 1. Repair or replace all materials and equipment damaged by handling and storage as directed at no additional Contract cost.
3. Storage and Protection: Protect materials and equipment from exposure to the elements and keep them dry at all times. Handle and store to prevent damage and deterioration in accordance with manufacturer's recommendations.

PART 2 - PRODUCTS

NOT USED

PART 3 - EXECUTION

NOT USED

END OF SECTION

SECTION 16051

SPECIAL ELECTRICAL REQUIREMENTS

PART 1 – GENERAL

1.01 SUMMARY

A. General requirements for providing basic electrical materials and methods.

B. Related Work Specified in Other Sections Includes:

1. Certain items of equipment, and various control devices including conduit and wiring which are indicated on electrical drawings to be connected, but are specified in other sections pertaining to plumbing, heating, ventilating, air conditioning, temperature control systems, process equipment, process control systems, and instrumentation. Install and connect these items to the electrical system as indicated or required in accordance with the Contract Documents.
2. Excavation and backfilling, including gravel or sand bedding for underground electrical work is specified in other Divisions.
3. Cast in place concrete work, including concrete encasements for electrical duct banks, equipment pads, and reinforcing steel, is specified in other Divisions.

C. Overall Application of Specifications: This Section applies to all sections of Division 16 and to other sections that include electrical equipment requirements except when in these individual sections requirements are otherwise specified to provide and install all materials necessary for a complete operational system.

D. Where the requirements of another Division, section, or part of these specifications exceed the requirements of this Division, those requirements shall govern

E. Temporary Requirements: This Section applies to any temporary circuits, overcurrent devices, conduit, wiring, and other equipment required during changeover from existing to a new electrical system. This Section also applies to temporary rewiring of lighting and power circuits, instruments and devices.

D. Each bidder or their authorized representatives shall, before preparing their proposal, visit all areas of the existing site and structures in which work under this Division is to be performed and inspect carefully the present installation. The submission of the proposal by this bidder shall be considered evidence that their representative has visited the site and structures and noted the locations and conditions under which the work will be performed and that the bidder takes full responsibility for a complete knowledge of all factors governing the work.

E. Field verify all existing underground electrical and mechanical piping. Locate all openings required for work performed under this section.

F. Provide sleeves, guards or other approved methods to allow passage of items installed under this section.

G. The Contractor shall prepare and furnish electrical and instrumentation conduit layout shop drawings for yard electrical, within and under all roads, buildings and structures to the Engineer for approval prior to commencing work. Layouts shall include but not be limited to equipment, pull boxes, conduit routing, dimensioning, methods and locations of supports, reinforcing, encasement, materials, conduit sizing, equipment access, potential conflicts, building and yard lighting, and all other pertinent technical specifications for all electrical and instrumentation conduits and equipment to be furnished. All layouts shall be drawn to scale on 22 x 34 sheets.

H. The work shall include complete testing of all equipment and wiring at the completion of work and making any minor correction changes or adjustments necessary for the proper functioning of the system and equipment. All workmanship shall be of the highest quality; substandard work will be rejected.

I. A single manufacturer shall provide panelboards, main breakers, transformers, disconnect switches, etc.

J. Contractor shall provide their own temporary power for miscellaneous power (drills, pumps, etc.). No facility circuits shall be used unless approved by the engineer. Any temporary added shall be removed at job completion.

K. Complete coordination with other contractors. Contractor shall coordinate with all other contractors equipment submittals and obtain all relevant submittals.

L. Mount transmitters, process instruments, operator's stations, etc. furnished under other Divisions of these specifications.

M. Concrete electrical duct encasement, including but not limited to excavation, concrete, conduit, reinforcement, backfilling, grading and seeding is included. Excavation, bedding material, forms, concrete and backfill for underground raceways; forms and concrete for electrical equipment furnished herein is included in this Division.

1.02 QUALIFICATIONS

A. The electrical contractor shall have regularly engaged in the installation of industrial electrical power systems for a minimum period of ten (10) years. When requested by the engineer, an acceptable list of installations with similar equipment shall be provided demonstrating compliance with this requirement.

B. Provide a Florida Licensed field superintendent who has had a minimum of ten (10) years previous successful experience on projects of comparable size and complexity. Superintendent shall be present at all times that work under this Division is being installed or affected. A resume of the Superintendent's experience shall be submitted to Engineer before starting work.

C. The contractor shall provide the following with their Bid submittal:
   1. A copy of the business' Florida electrical contractor's license.
   2. A copy of the field superintendent's Florida electrical contractor's license.
   3. A copy of the business' active registration with the Florida Department of state – Division of Corporation (must be active)

1.03 QUALITY ASSURANCE

A. Codes: Provide all electrical Work in accordance with applicable local codes, regulations and ordinances. If there is a conflict between the requirements specified in the Contract Documents and the codes, follow the more stringent requirements as determined and approved.

B. Testing: As a minimum, provide standard factory and field tests for each type of equipment. Other tests may be specified in the applicable equipment section.

C. Labeling: Provide all electrical equipment and materials listed and approved by Underwriters Laboratories with the UL label or other OSHA recognized testing laboratories attached to it.

D. Standard Products: Unless otherwise indicated, provide electrical materials and equipment which are the standard products of manufacturers regularly engaged in the production of such materials and equipment. Provide the manufacturer's latest standard design that conforms to these Specifications. When two or more units of the same class of material and equipment are required, provide the products of the same manufacturer.

1.04 ENCLOSURE TYPES

A. Unless otherwise specified herein or shown on the Drawings, electrical enclosures shall have the following ratings:
   1. NEMA 1 for dry, non-process indoor locations.
   2. NEMA 12 for "DUST" locations.
   3. NEMA 4X for all outdoor locations, rooms below grade (buried vaults), "DAMP" and "WET" locations.
   4. NEMA 4X for "CORROSIVE" locations.
   5. NEMA 7 (and listed for use in the area classifications shown) for "Class I Division 1 Group D", "Class I Division 2 Group D" and "Class II Division 1" hazardous locations shown on the Drawings.

1.05 CODES, INSPECTION AND FEES

A. Equipment, materials and installation shall comply with the requirements of the local authority having jurisdiction. The installation shall comply with the governing state and local codes or ordinances. Completed electrical installation shall be inspected and certified by all applicable agencies that it is in compliance with all codes. Comply with latest utility company regulations.

B. Obtain all necessary permits and pay all fees required for permits and inspections. It is the contractor's responsibility to contact the required Utility Company to determine if any fees, charges or costs will be due the Utility Company, as required by the Utility Company for temporary power, installations, hook-ups, etc. This fee, charge or cost will be invoiced to the County paid directly by the County.

1.06 PHASE BALANCING

A. The Drawings do not attempt to balance the electrical loads across the phases. Circuits on panelboards shall be field connected to result in evenly balanced loads across all phases.

B. Field balancing of circuits shall not alter the conductor color coding requirements as specified herein.

1.07 SAFETY REQUIREMENTS

A. The Contractor shall make every effort to keep all employees and/or subcontractors aware of the danger inherent in working in dangerous proximity to the existing power lines. The minimum recommended precautionary measures are as follows:

1. Make sure that all persons responsible for operating cranes, draglines and other mobile equipment have a copy of, and are familiar with the State Department of Commerce Regulations for Use of Cranes, Draglines and Similar Equipment Near Power Lines, as well as the U.S. Department of Labor OSHA Regulations, before commencing operation of said equipment.
2. Make sure that all cranes, draglines and other mobile equipment have attached to them the black and yellow Department of Commerce warning signs required by the said Regulations of State Department of Commerce.
3. Warn all employees on the ground, new and old employees alike, of the danger of holding on to or touching a cable or other piece of equipment or machinery that is located or working close to any overhead power line.
4. If, during the course of construction, it becomes necessary for the contractor, or subcontractor, and their employees, to operate cranes, draglines, or their mobile equipment, in dangerous proximity of any overhead power lines, or in such a manner that such equipment might come close to any overhead power lines, the Contractor shall give the Power Company or overhead power line owner prior notice of such proposed operation.

1.08 PROJECT CONDITIONS

A. The Drawings indicate the extent and general arrangement of the principal electrical elements, outlets and circuit layouts. Connect and install all electrical elements and devices to form a workable system as required by the Contract Documents whether the connections and installations are specifically stated in the Specifications or shown. Provide necessary materials and installation wherever required to conform to the specific requirements of the furnished equipment and for proper installation of the Work.

B. Schematics: In general the runs of feeders are shown schematically and are not intended to show exact routing and locations of raceways. Verify actual and final arrangement, equipment locations, and prepare circuit and raceway layouts before ordering materials and equipment. Equipment locations are approximate and are subject to modifications as determined by equipment dimensions.

C. Coordination of Work: Coordinate the Work so that the electrical equipment may be installed without altering building components, other equipment or installations.

D. Coordinate arrangement, mounting, and support of electrical equipment:To allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated. To provide for ease of disconnecting the equipment with minimum interference to other installations. To allow the right of way for piping and conduit installed at the required slope. To clear connecting raceways, cables, wireways, cable trays, and busways of obstructions and of the working and access space of other equipment. Coordinate the installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural

components as they are constructed. Coordinate electrical testing of electrical, mechanical, and architectural items, so that functionally interdependent equipment and systems demonstrate successful interoperability.

E. Departure from Design: If departures are deemed necessary due to structural conditions, obstructions or other problems, provide details of such departures and the reasons for requesting approval as soon as practicable but not later than the submittal of the raceway layout drawings. Do not make any departures without written approval.

1.09 MATERIALS

A. Reference: "General Conditions of the Contract".

B. Where several brand names, make or manufacture are listed as acceptable each shall be regarded as equally acceptable. Where a manufacturer's model number is listed, this model shall set the standard of quality and performance required. Where no brand name is specified, the source and quality shall be subject to Engineer's review and acceptance.

C. When a product is specified to be in accordance with a trade association or government standard, at the request of Engineer, Contractor shall furnish a certificate that the product complies with the referenced standard. Upon request of Engineer, Contractor shall submit supporting test data to substantiate compliance.

1.10 SUBSTITUTIONS

A. Each bidder represents that his bid is based upon the materials and equipment described in this division of the specifications.

B. No substitutions will be considered unless written request has been submitted to the Engineer for approval at least ten days prior to the bid date. Submittal shall include the name of the material or equipment for which it is to be substituted, drawings, cuts, performance and test data and any other data or information necessary for the Engineer to determine that the equipment meets all specification and requirements. If the Engineer approves any proposed substitutions, such approval will be set forth in an addendum.

C. Substituted equipment or optional equipment where permitted and approved, must conform to space requirements. Any substituted equipment that cannot meet space requirements, whether approved or not, shall be replaced at the Contractor's expense. Any modifications of related systems as a result of substitutions shall be made at the Contractor's expense.

PART – 2 PRODUCTS (NOT USED)

PART – 3 EXECUTION

3.01 ROUGH-IN

A. Final Location: Verify final locations for rough-ins with field measurements, vendor shop drawings and with the requirements of the actual equipment to be connected.

B. The Drawings are not intended to show exact locations of conduit runs. Coordinate

the conduit installation with other trades and the actual supplied equipment.

C. Install each 3 phase circuit in a separate conduit unless otherwise shown.

D. Except where dimensions are shown, the locations of equipment, fixtures, outlets and similar devices shown on the Drawings are approximate only. Exact locations shall be determined by the Contractor and approved by the Engineer during construction. Obtain information relevant to the placing of electrical work and in case of any interference with other work, proceed as directed by the Engineer and furnish all labor and materials necessary to complete the work in an approved manner.

E. Surface mounted panel boxes, junction boxes, conduit, etc., shall be supported by spacers to provide a clearance between wall and equipment.

F. All floor mounted electrical equipment shall be placed on 4-inch thick (3/4-inch, 45 degree chamfer at all exposed edges) concrete pads, provide reinforcement, anchors, etc.

3.02 SLEEVES AND FORMS FOR OPENINGS

A. Provide and place all sleeves for conduits penetrating floors, walls, partitions, etc. Locate all necessary slots for electrical work and form before concrete is poured.

B. Exact locations are required for stubbing-up and terminating concealed conduit. Obtain shop drawings and templates from equipment vendors or other subcontractors and locate the concealed conduit before the floor slab is poured.

C. Where setting drawings are not available in time to avoid delay in scheduled floor slab pours, the Engineer may allow the installations of such conduit to be exposed. Requests for this deviation must be submitted in writing. No additional compensation for such change will be allowed.

D. Seal all openings, sleeves, penetration and slots.

3.03 CONCRETE PADS

A. Furnish and install reinforced concrete pads for transformers, switchgear, and motor control centers, of size as shown on the drawings or required. Unless otherwise noted, pads shall be four (4) inches high and shall exceed dimensions of equipment being set on them, including future sections, by three (3) inches on all sides, except when equipment is flush against a wall, then the side or sides against the wall shall be flush with the equipment. Chamfer top edges 1". Trowel all surfaces smooth. Reinforce pads with 6" X 6" X 6/6 welded wire fabric. Conduit stub up area within the pad area shall remain void. Coordinate with equipment shop drawings stub up areas.

3.04 CUTTING AND PATCHING

A. Perform cutting and patching as specified in Division 1. In addition to the requirements specified in Division 1, the following requirements apply:

1. Perform cutting, fitting, and patching of electrical equipment and materials required to:
    a. Uncover Work to provide for installation of ill-timed Work.
    b. Remove and replace defective Work.

c. Remove and replace Work not conforming to requirements of the Contract Documents.
d. Remove samples of installed Work as specified for testing.
e. Install equipment and materials in existing structures.
f. Locate existing structural reinforcing where core drilled penetrations are required so as not to cut the steel reinforcing.

2. Cut, remove, and properly dispose of selected electrical equipment, components, and materials as indicated, including but not limited to removal of electrical items indicated to be removed and items made obsolete by the new Work. Deliver all the existing removed to the OWNER as directed.
3. Protect the structure, furnishings, finishes, and adjacent materials not indicated or scheduled to be removed.
4. Provide and maintain temporary partitions or dust barriers adequate to prevent the spread of dust and dirt to adjacent areas.
5. Protection of Installed Work: During cutting and patching operations, protect adjacent installations.
6. Provide non-destructive imaging methods (radar, x-ray) to locate embedded conduit in concrete prior to demolition, saw cutting and core drilling. Relocate and reconstruct affected conduit and wire per electrical specifications.
7. Patch finished surfaces and building components using new materials as specified for the original installation and experienced Installers. Installers' qualifications refer to the materials and methods required for the surface and building components being patched.

B. Supplementary Requirements: Any cutting of work in place shall be patched and decorated by such mechanics and in such a manner that the quality of workmanship and finish shall be compatible with that of adjacent construction.

3.05 INSTALLATION

A. Any work not installed according to the Drawings and this Division or without approval by the Engineer shall be subject to change as directed by the Engineer. No extra compensation will be allowed for making these changes.

B. Electrical equipment shall at all times during construction be adequately protected against mechanical injury or damage by water. Electrical equipment shall not be stored out-of-doors. Electrical equipment shall be stored in dry permanent shelters. If an apparatus has been damaged, such damage shall be repaired at no additional cost. If any apparatus has been subject to possible injury by water, it shall be replaced at no additional cost to the Owner, the damaged unit(s) or systems shall remain on site and returned to the manufacturer after the replacement unit(s) or systems have been delivered to the site. Under no circumstances will electrical equipment damaged by water be rehabilitated or repaired, new equipment shall be supplied and all cost associated with replacement shall be borne by the Contractor.

C. Equipment that has been damaged shall be replaced or repaired by the equipment manufacturer, at the Engineer's discretion.

D. Repaint any damage to factory applied paint finish using touch-up paint furnished by the equipment manufacturer. The entire damaged panel or section shall be repainted at no additional cost to the Owner.

E. Sequence, coordinate, and integrate the various elements of electrical systems, materials, and equipment. Comply with the following requirements:

1. Coordinate electrical systems, equipment, and materials installation with other building components.
2. Verify all dimensions by field measurements. Investigate each space in the structure through which equipment must pass to reach its final location. Coordinate shipping splits with the manufacturer to permit safe handling and passage through restricted areas in the structure.
3. The equipment shall be kept upright at all times during storage and handling. When equipment must be tilted for passage through restricted areas, brace the equipment to ensure that the tilting does not impair the functional integrity of the equipment.
4. Arrange for chases, slots, and openings in other building components during progress of construction, to allow for electrical installations.
5. Coordinate the installation of required supporting devices and sleeves to be set in cast-in-place concrete and other structural components, as they are constructed.
6. Sequence, coordinate, and integrate installations of electrical materials and equipment for efficient flow of the Work. Give particular attention to large equipment requiring positioning prior to closing in the building.
7. Where mounting heights are not detailed or dimensioned, install systems, materials, and equipment to provide the maximum headroom possible.
8. Coordinate connection of electrical systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies. Provide required connection for each service.
9. Install systems, materials, and equipment to conform with approved submittal data, including coordination drawings, to greatest extent possible. Conform to arrangements indicated by the Contract Documents, recognizing that portions of the Work are shown only in diagrammatic form. Where coordination requirements conflict with individual system requirements, refer conflict to the ENGINEER for resolution.
10. Install systems, materials, and equipment level and plumb, parallel and perpendicular to other building systems and components, where installed exposed in finished spaces.
11. Install electrical equipment to facilitate servicing, maintenance, and repair or replacement of equipment components. As much as practical, connect equipment for ease of disconnecting, with minimum of interference with other installations.
12. Install access panel or doors where units are concealed behind finished surfaces.
13. Install systems, materials, and equipment giving right-of-way priority to systems required to be installed at a specified slope.

F. Surface mounted fixtures, outlets, cabinets, conduit, panels, etc. shall have finish or shall be painted as directed by Engineer. Paint shall be in accordance with other applicable sections of these specifications.

3.06 TESTS AND SETTINGS

A. Test systems and equipment furnished under Division 16 and other divisions

supplying electrical equipment. Repair or replace all defective work and equipment. Refer to Acceptance Testing section and the individual equipment sections for additional specific testing requirements.

B. Make adjustments to the systems and instruct the Owner's personnel in the proper operation of the systems.

C. In addition to the specific testing requirements listed and the individual Sections, the following minimum tests and settings shall be performed. Submit test reports upon completion of testing.
   1. Mechanical inspection, testing and settings of circuit breakers, disconnect switches, motor starters, overload relays, control circuits and equipment for proper operation.
   2. Check the full load current draw of each motor. Where power factor correction capacitors are provided the capacitor shall be in the circuit at the time of the measurement. Check ampere rating of thermal overloads for motors and submit a typed record to the Engineer of the same, including driven load designation, motor service factor, horsepower, and Code letter. If incorrect thermal overloads are installed replace same with the correct size overload.
   3. Check power and control power fuse ratings. Replace fuses if they are found to be of the incorrect size.
   4. Check settings of the motor circuit protectors. Adjust settings to lowest setting that will allow the motor to be started when under load conditions.
   5. Check motor nameplates for correct phase and voltage. Check bearings for proper lubrication.
   6. Check rotation of motors prior to testing the driven load. Disconnect the driven equipment if damage could occur due to wrong rotation. If the rotation is incorrect for the driven equipment correct motor connections at the motor terminal box.
   7. Check interlocking, control and instrument wiring for each system and/or part of a system to prove that the system will function properly as indicated by control schematic and wiring diagrams.
   8. Inspect each piece of equipment in areas designated as HAZARDOUS to ensure that equipment of proper rating is installed.
   9. Verify all terminations at transformers, equipment, panels and enclosures by producing a 1, 2, 3 rotation on a phase sequenced motor when connected to "A", "B" and "C" phases.
   10. Check all wire and cable terminations. Verify to the Engineer connections meet the equipments torque requirements.
   11. Field set all transformer taps as required to obtain the proper secondary voltage.

3.07 MANUFACTURERS SERVICE

A. Provide manufacturer's services for testing and start-up of all major electrical equipment: VFDs, ATS, Gensets, MCCs, Switchboards, Switchgear, Etc.

B. Testing and startup shall not be combined with training. Testing and start-up time shall not be used for manufacturers warranty repairs.

C. The manufacturers of the above listed equipment shall provide experienced Field Service Engineer to accomplish the following tasks:
   1. The equipment shall be visually inspected upon completion of installation and prior to energization to assure that wiring is correct, interconnection complete and the installation is in compliance with the manufacturer's criteria. Documentation shall be reviewed to assure that all Drawings, operation and maintenance manuals, parts list and other data required to check out and sustain equipment operation is available on-site. Documentation shall be red-lined to reflect any changes or modifications made during the installation so that the "as-built" equipment configuration will be correctly defined. Spare parts shall be inventoried to assure correct type and quantity.
   2. The Field Service Engineers shall provide engineering support during the energization and check-out of each major equipment assembly. They shall perform any calibration or adjustment required for the equipment to meet the manufacturer's performance specifications.
   3. Upon satisfactory completion of equipment test, they shall provide engineering support of system tests to be performed in accordance with manufacturer's test specifications.
   4. A final report shall be written and submitted to the Contractor within fourteen days from completion of final system testing. The report shall document the inspection and test activity, define any open problems and recommend remedial action. The reports after review by the Contractor shall be submitted to the Engineer.

3.08 TRAINING

A. The cost of training programs to be conducted with Owner's personnel shall be included in the Contract Price. The training and instruction, insofar as practicable, shall be directly related to the system being supplied.

B. Provide detailed O&M manuals to supplement the training courses. The manuals shall include specific details of equipment supplied and operations specific to the project.

C. The training program shall represent a comprehensive program covering all aspects of the operation and maintenance including trouble-shooting of each system.

D. All training schedules shall be coordinated with and at the convenience of the Owner. Shift training may be required to correspond to the Owner's working schedule. The training shall be conducted with record "as-built" drawings sufficient for each class member.

E. The Contractor shall submit an overview of the proposed training plan. This overview shall include, for each course proposed:
   1. An overview of the training plan.
   2. Course title and objectives.
   3. Recommended types of attendees.
   4. Course Content - A topical outline.
   5. Course Format - Lecture, laboratory demonstration, etc.
   6. Schedule of training courses including dates, duration and locations of each class.

3.09 WARRANTY

A. The work under this Division shall include a two-year warranty. This warranty shall be by the Contractor to the Owner for any defective workmanship or material that has been furnished under this Contract at no cost to the Owner for a period of two years from the date of substantial completion of the System. This guarantee shall not include light bulbs or batteries in service after six months from date of Substantial Completion of the System.

END OF SECTION

SECTION 16110

CONDUIT SYSTEMS

PART 1 - GENERAL

1.01 Description

A. Description of System: This Section includes requirements for raceways, fittings, boxes, enclosures, and cabinets for electrical, instrumentation and control system wiring.

B. Use heavy wall PVC (Schedule 80) for all raceways trapped underground without concrete encasement protection. Conduits in concrete encasement use Schedule 40-PVC. Above ground use Schedule 80-PVC. Where PVC conduit penetrates a floor from underground or in a slab; a black mastic coated rigid aluminum conduit ells shall be used for all conduits.

C. Minimum conduit size for all systems shall be 3/4". All conduits shall be U.L. listed and labeled. Conduit sizes shown on the drawings are to aid the contractor in bidding only; the contractor is responsible for conduit sizes as required by NEC fill tables but do not provide smaller conduits than indicated. The contractor is responsible to coordinate the required conduit sizes and conductor quantities for all control and instrumentation system conduit and wiring with the controls subcontractor prior to installation.

D. Provide stainless steel or non-metallic conduit supports and 316 stainless steel hardware in all areas except air conditioned spaces.

1.02 Submittals

A. Product Data:
   1. Product data shall be submitted on:
      a. Conduit, raceways, wireways.
      b. Conduit fittings, boxes, enclosures and cabinets.
      c. Surface metal raceway

PART 2 - PRODUCTS

2.01 Flexible Conduit

A. Flexible, Nonmetallic, Liquid-Tight Conduit: Type B
   1. Material: PVC core with fused flexible PVC jacket. UL 1660 listed for:
      a. Dry Conditions: 80 degrees C insulated conductors.
      b. Wet Conditions: 60 degrees C insulated conductors.
   2. Manufacturers and Products:
      a. Carlon; Carflex or X Flex.;
      b T & B; Xtraflex LTC or EFC.

2.02 PVC Conduit

A. PVC conduit shall be composed of High Impact Virgin homopolymer, PVC (polyvinyl chloride C-200 Compound), and shall conform to industry standards, and be UL 651 listed in accordance with Article 347 of National Electrical Code for underground and exposed use and NEMA standard TC-2. Materials must have tensile strength of 55 PSI, at 70oF, flexural strength of 11,000 PSI, compression strength of 8600 PSI. Manufacturer shall have five years' extruding PVC experience. Consistent with requirements provide PVC conduit products by one of the following manufacturers:
   1. Carlon
   2. Cantex
   3. J.M. Eagle
   4. Queen City Plastics

2.03 Conduit Fitting

A. Fittings for Conduit (Including all Types and Flexible and Liquidtight), EMT, and Cable: NEMA FB 1; listed for type and size raceway with which used, and for application and environment in which installed.

B. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 886.

C. Fittings, surface boxes and conduit bodies for Rigid Aluminum Conduit shall be heavy cast aluminum with external raised hubs and mounting lugs;- Appleton, Crouse Hinds or approved substitution. Cover plates cast aluminum. Zinc die cast not acceptable.

D. Conduit locknuts shall be aluminum throughout except steel is acceptable within air conditioned spaces.

E. Conduit expansion fittings shall be copper free Aluminum. These fittings shall have a four-inch expansion chamber to allow approximately two-inch movement parallel to conduit run in either direction from normal. They shall have factory-installed packing and internal tinned copper braid packing to serve as an emergency bonding jumper. Unless the fitting used is listed by Underwriters' Laboratories for use "without external bonding jumpers", an external copper bonding jumper shall be installed with each expansion fitting with one end clamped on each conduit entering fitting.

F. Flexible, Nonmetallic, Liquid-Tight Conduit shall meet requirements of UL 514B with High strength plastic body, complete with lock nut, O-ring seal, threaded ferrule, sealing ring. Threaded ferrule designed to ensure high mechanical pullout strength and watertight seal. Manufacturer, Carlon; Type LN or approved equal.

PART 3 - EXECUTION

3.01 Installation

A. All raceways shall be run in neat and workmanlike manner and shall be properly supported in accordance with latest edition of NEC with approved conduit clamps, hanger rods and structural fasteners except for PVC conduit installed in exterior locations. PVC conduit installed in exterior locations shall be supported at two foot

intervals. Supporting conduit and boxes with wire or tie wraps is not approved. All raceways except those from surface-mounted switches, outlet boxes or panels shall be run concealed from view. Exposed raceways shall be supported with clamp fasteners with toggle bolt on hollow walls, and with lead expansion shields on masonry. Rigid steel box connections shall be made with double locknuts and bushings. Where PVC penetrates a floor from underground or in slab, a black mastic coated aluminum conduit ell shall be used on all conduits. All individual bare copper ground conductors (i.e. service, transformer, or lightning protection grounds) shall be installed in PVC conduit, not metal conduit. This does not apply to bare copper ground conductors run with feeders (as specified in this section). Conduits shall be run parallel to building walls wherever possible, exposed or concealed, and shall be grouped in workmanlike fashion. Crisscrossing of conduits shall be minimized.

B. All raceways runs, whether terminated in boxes or not, shall be capped during the course of construction and until wires are pulled in, and covers are in place. No conductors shall be pulled into raceways until construction work which might damage the raceways has been completed.

C. All raceways shall be kept clear of plumbing fixtures to facilitate future repair or replacement of said fixtures without disturbing wiring. Except where it is necessary for control purposes, all raceways shall be kept away from items producing heat.

D. All raceways shall be run from outlet to outlet exactly as shown on the drawings, unless permission is granted to alter arrangement shown. If permission is granted arrangement shall be marked on field set of drawings as previously specified.

E. All underground raceways (with exception of raceways installed under floor slab) shall be installed in accordance with Section 300-5 of the NEC except that the minimum cover for any conduit shall be two feet. Included under this Section shall be the responsibility for verifying finished lines in areas where raceways will be installed underground before the grading is complete.

F. All raceways shall have an insulated copper system ground conductor throughout the entire length of circuit installed within conduit in strict accordance with NEC. Grounding conductor shall be included in total conduit fill determining conduit sizes, even though not included or shown on drawings. Grounding conductors run with feeders shall be bonded to portions of conduit that are metal by approved ground bushings.

G. Spare conduit stubs shall be capped and location and use marked with concrete marker set flush with finish grade or terminated in a manhole. Marker shall be 6" round X 6" deep with appropriate symbol embedded into top to indicate use. Also, tag conduits in panels where originating.

H. All conduit stubbed above floor shall be separated with plastic interlocking spacers manufactured specifically for this purpose, or shall be strapped to Kindorf channel supported by conduit driven into ground or tied to steel.

I. Raceways which do not have conductors furnished under this Division of the specifications shall be left with an approved nylon pullcord in raceway.

J. Flexible conduit and PVC conduit shall be manufactured within the United States.

K. All connections to motors or other vibrating equipment (except dry type transformers) or at other locations where required shall be made with not less than 12" nor more than 20” of flexible liquid-tight conduit, using special type of connectors with strain relief fittings at both terminations of conduit. Flex connectors shall have insulated throat and shall be T & B 3100 Series or approved substitution. Use angle connectors wherever necessary to relieve angle strain on flex conduit. Connections to dry type transformers shall be made with flexible conduit. Typical length of flex conduit shall be limited to 20” unless specifically approved by the engineer.

L. PVC joints shall be solvent welded. Threads will not be permitted on PVC conduit and fittings, except for rigid steel to PVC couplings. Installation of PVC conduit shall be in accordance with manufacturer's recommendations. PVC conduit shall not be used to support fixture or equipment. Field bends shall be made with approved hotbox. Heating with flame and hand held heat guns are prohibited.

M. Expansion fittings shall be installed in the following cases: In each conduit run wherever it crosses an expansion joint in the concrete structure; on one side of joint with its sliding sleeve end flush with joint, and with a length of bonding jumper in expansion equal to at least three times the normal width of joints; in each conduit run which mechanically attached to separate structures to relieve strain caused by shift on one structure in relation to the other; in straight conduit run above ground which is more than fifty feet long and interval between expansion fittings in such a runs shall not be greater than 100 feet for steel conduit and 50 feet for PVC conduit.

N. Underground cable identification: bury a continuous, pre-printed, bright colored metalized plastic (electronically traceable) ribbon cable marker with each underground conduit (or group of conduits), regardless of whether conduits are in ductbanks. Locate directly over conduits, 6" to 8" below finished grade. Delete this requirement under building slabs.

O. Provide for separation of instrumentation, control and power conductors. Provide a minimum of 24" inch separation for parallel runs of power conduit to instrumentation or control conduit with either conduit being PVC or Aluminum. This separation can be reduced to 8" if metallic grounded separation is provided (aluminum conduit).

P. Duct seal all conduit entrances. Foam seal is not acceptable.

END OF SECTION

SECTION 16120

LOW VOLTAGE WIRES AND CABLES

PART 1 – GENERAL

1.01 General

A. Referenced Standards:
1 Institute of Electrical and Electronics Engineers, Inc./American National Standards Institute (IEEE/ANSI):
2. Standard for Flame Testing of Cables for Use in Cable Tray in Industrial and Commercial Occupancies.
3. National Electrical Manufacturers Association (NEMA): ICS 4, Industrial Control and Systems: Terminal Blocks.
4. National Electrical Manufacturers Association/Insulated Cable Engineers Association (NEMA/ICEA): WC 57/S-73-532, Standard for Control Cables: WC 70/S-95-658, Non-Shielded Power Cables Rated 2000 Volts or Less for the Distribution of Electrical Energy.
5. National Fire Protection Association NFPA-70, National Electrical Code (NEC).
6. Underwriters Laboratories, Inc. (UL44): Standard for Safety Thermoset-Insulated Wires and Cables; (UL83): Standard for Safety Thermoplastic-Insulated Wires and Cables; UL467 Standard for Safety Grounding and Bonding Equipment. UL486A Standard for Safety Wire Connectors and Soldering Lugs for use with Copper Conductors; UL 486C, Standard for Safety Splicing Wire Connections. UL510, Standard for Safety Polyvinyl Chloride, Polyethylene and Rubber Insulating Tape.

1.02 Definitions:

A. Building Wire: Copper single conductor, cross link polyethylene insulated; type XHHW-2;

B. Cable: Multi-conductor, insulated, with outer sheath containing either building wire or instrumentation wire.

C. Instrumentation Cable (Analog signal cable): Multiple conductor, insulated, twisted Pair/Triad, with individual Pair/Triad shield and outer overall shield and outer sheath. Used for the transmission of low current (e.g., 4-20mA DC) using No. 16 AWG conductors. Common Types, TSP: Twisted shielded pair, TST: Twisted shielded triad.

D. Control Cable: Multi-conductor, insulated, with outer sheath containing building wires, No. 14, AWG. With overall shield where specified. Type SIS and MTW approved for use in the wiring of control equipment within control panels and field wiring of control equipment within switchgear, switchboards, motor control centers; otherwise type XHHW-2.

E. Power Cable: Multi-conductor, insulated, with outer sheath containing building wire, No. 12 AWG and larger. Rated XHHW-2

F. Digital signal cable: Used for the transmission of digital signals between computers,

PLC's, RTU's, Ethernet field devices etc. Common Types: Ethernet UTP-unshielded twisted pair.

PART 2 – PRODUCTS

2.01 Power Conductors:

A. Branch circuits and feeder conductors for all three phase electric power shall be stranded copper type XHHW-2 cross-link polyethylene (XLP) insulation and derated to 75 degrees Centigrade. No aluminum wiring shall be permitted. Wire shall be in accordance to NEC and minimum No. 12, except that branch "homeruns" over 50 ft. in length shall be minimum No. 10 for 120/208V circuits. All branch lighting circuits serving HID and Fluorescent fixtures shall be minimum #10 with each circuit provided with a separate neutral. All wire shall be manufactured in the USA.

B. Motor leads from variable frequency drives to driven motor shall be shielded VFD drive cable for all VFD motors. Provide flexible VFD shielded drive cables, 3 Class-I conductor cable plus 3 trisectional green insulated ground wires. Provide electrostatic shielding of tinned copper braided shield with aluminum-polyester laminated tape shielding system. Cross-linked polyolefin insulation system and neoprene outer jacket, type TC cable as manufactured by Rockbestos-Surprenant Cable Corp. or equal. Shielded VFD motor cables require increased conduit sizes over standard wire installations. Contractor to verify conduit sizes.

C. Taps and Splices:

1. All power wiring taps and splices in No. 8 or smaller wire shall be fastened together by means of terminal strips except within lighting fixtures and wiring devices where conformance to NEC practices will be acceptable (Twist/screw on type connectors). All taps and splices in wire larger than No. 8 shall be made with compression type connectors and taped to provide insulation equal to wire. Tape shall be heavy duty, flame retardant and weather resistant vinyl electrical tape, minimum 7 mil premium grade with an operating temperature of 0 degree F. to 220 degree F. Provide tape meeting UL 510 and CSA standard C22.2.

2. All taps and splices in manholes or in ground pull boxes, etc. shall be approved by the engineer on a case by case basis; be made with high press long barrel double crimp compression type connectors and covered with Raychem heavy wall cable sleeves (type CTE or WCS) with type "S" sealant coating. Install sleeve kits as per manufacturer's installation instructions.

D. Color Coding:

1. All power feeders and branch circuits No. 6 and smaller shall be wired with color-coded wire with the same color used for a system throughout the building. Power feeders above No. 6 shall either be fully color-coded or shall have black insulation and be similarly color-coded with tape or paint in all junction boxes and panels. Tape or paint shall completely cover the full length of conductor insulation within the box or panel except for the wire markings.

2. Unless otherwise approved, color-code shall be as follows: Neutrals to be

white for 120/208V system, natural grey for 277/480V system; ground wire green, bare or green with yellow strips. Nominal Voltage: 120/208V, Phase A -black; Phase B - red; Phase C - blue. 480/277V, Phase A brown; Phase B - orange; Phase C -yellow. All switch legs, other voltage system wiring, control and interlock wiring shall be color-coded other than those above. In exiting or expansion projects, comply with existing color coding established within the facility.

2.02 Instrumentation and Control Cable:

A. Multiconductor and Multi pair Process instrumentation cable shall be #16 AWG stranded, twisted pair, 600 V, (XLP) cross link polyethylene insulated, aluminum tape pair shielding, cross link polyethylene or chlorinated polyethylene (CPE) overall sheathed and shielded, type TC instrument cable as manufactured by the American Insulated Wire Co., Belden Wire Co. or equal.

B. Multiconductor control cable shall be #14 AWG stranded, 600V, (XLP) cross link polyethylene insulated or polyolefin, with cross link polyethylene or chlorinated polyethylene (CPE or Hypalon) overall sheathed type TC control cable except for control cable into and out of VFD cabinets. Multiconductor control cable into and out of VFD cabinets shall be as indicated above and in addition include an aluminum polyester tape overall shield and drain wire. As a contractor alternate to shielded control cable into and out of VFD cabinets, provide twisted shielded instrument cable as specified above. Contractor to provide increased conduit size as required if instrument cable alternate is used into and out of VFD cabinets.

C. Connections:
1. All conductor connections shall be on terminal strips including all spare conductors. Provide terminal strips in all cabinets; motor control centers; etc.
2. All connections of stranded wire to screw terminals shall be by insulated spade lugs, crimp fastened to wire. Provide stranded wire crimp ferrules for all stranded wire connections not requiring spade lugs for screw type terminal blocks. The stranded wire ferrule is to be crimped to all stranded wire using a crimping tool specifically approved for crimping the size and type of ferrule.
3. All conductors shall be marked with mylar wrap type "Brady" labels. Identification labels shall be permanent type and be machine printed. All terminal block terminations shall be labeled. The inside portion of the terminal cabinet doors shall display a protected terminal cabinet drawing with all connections shown and described as to color code, number assigned to connection function of conductor and destination.
4. Wire shall be guided within terminal cabinets by cable supports. All conductors shall be neatly led to terminations.
5. Instrumentation and control field cables on the unprotected side of SPD devices within the cabinet shall not run in parallel to the cables on the protected side of the SPD device. Separate cable supports (duct) will be provided.
6. Cabinets: All cabinets shall be labeled with an engraved plastic laminate label riveted to the door.
7. No splices shall be made within a conduit run or in manholes.

D. All plant control system field wiring shall be labeled per the instrumentation and control contractor loop drawings from the field device, through the intermediate cabinets, to the PLC cabinet. The labeling system shall be consistent throughout the loop and follow the standard tag designation: PLC#-Rack#-Slot#-Point# (example PLC1-R2-S3-P4).

E. Provide for separation of instrumentation, control and power conductors. Provide a minimum of 24" inch separation for parallel run of power conduit and instrumentation or control conduit. This separation can be reduced to 8" if metallic grounded separation is provided.

PART 3 - SUBMITTALS

3.01 Submit:

A. Cut sheets on all major types of wires and cables including splicing tape, and terminating/splicing lugs, conductor identification systems and connectors and cable sleeves. Submit sample of all instrumentation and control cable. Sample shall be a minimum of 24" with exterior sheath clearly marked.

B. Sample of all cable identification systems products.

END OF SECTION

SECTION 16134

PANELBOARDS

PART 1 – GENERAL

1.01 SCOPE

A. The CONTRACTOR shall provide panelboards and general purpose dry-type transformers, complete and operable, in accordance with the Contract Documents.

B. Single Manufacturer: Like products shall be the end product of one manufacturer in order to achieve standardization of appearance, operation, maintenance, spare parts, and manufacturer's services.

1.02 REFERENCES: The latest edition of the following codes or standards shall apply.

A. NEC (NFPA 70) National Electrical Code
B. NEMA 250 Enclosure for Electrical Equipment (1,000 Volts Maximum)
C. UL 50 - Standard for Safety for Enclosures for Electrical Equipment
D. UL 67 - Panelboards

1.03 SUBMITTALS: General: Submittals shall be in accordance section 26 05 02 Basic Materials and Methods.

A. Breaker layout drawings with dimensions and nameplate designations
B. Drawings of conduit entry/exit locations.
C. Assembly ratings including: Short circuit rating, Voltage; Continuous current
D. Cable terminal sizes
E. Descriptive bulletins
F. Product sheets

PART 2 – PRODUCTS

2.01 GENERAL: Provide panelboards by Square-D or Cutler Hammer.

A. Panelboard shall be dead front factory assembled. Panelboards shall comply with NEMA PB-1-Panelboards, as well as the provisions of UL 50 - Safety Enclosures for Electrical Equipment and UL 67 - Panelboards. Panelboards used for service equipment shall be UL labeled for such use. Lighting panelboards shall be rated for 120/208-volt, 3-phase operation or 120/240-volt for single phase operation as indicated. Power panelboards shall be rated for 480 volts, 3-phase, 3 wire operation as indicated.

B. The manufacturer of the panelboard shall be the manufacturer of the major components within the assembly, including circuit breakers.

C. Panelboards rated 240 VAC or less shall have short circuit ratings not less than 10,000 amperes RMS symmetrical or as indicated by the Short Circuit Study, whichever is greater.

D. Panelboards rated 480 VAC shall have short circuit ratings not less than 42,000 amperes RMS symmetrical or as indicated by the Short Circuit Study, whichever is greater.

E. Panelboards shall be labeled with a UL short circuit rating. Series ratings are not acceptable.

2.02 CONSTRUCTION

A. All lighting and power distribution panels shall have copper bus bars density rated for maximum of 1,000 amps/sq-in. Enclosures for panelboards shall be galvanized and painted steel except enclosures for panelboards located in corrosive, damp or wet locations shall be stainless steel and NEMA-4X

B. Breakers shall be one, two, or three pole as indicated, with ampere trip ratings as required by the equipment. Breakers shall be quick-make and quick-break, inverse time trip characteristics, to trip free on overload or short circuit, and to indicate trip condition by the handle position. Double and triple pole breakers shall be of the common trip, single handle type.

C. The panels shall have hinged doors with combination catch and latch. The front panels shall be so arranged that when the plates are removed, the gutters, terminals and wiring will be exposed and accessible. The doors shall have inner doors within the plates to have only the breaker operating mechanism exposed when they are opened. Live conductors and terminals shall be concealed behind the plates.

D. All circuit breakers shall be interchangeable and bolt on type capable of being operated in any position as well as being removable from the front of the panelboard without disturbing adjacent units. Plug-in circuit breakers are not acceptable.

E. Panelboards shall be UL listed.

F. Size of wiring gutters and gauge of steel shall be in accordance with NEMA Standards Publication No. PBI 57 and UL Standards No. 67. Cabinets shall be minimum 20" wide for all panels.

PART 3 – EXECUTION

3.01 GENERAL

A. Surface mount panelboards on wall, as indicated on project drawings, at an elevation convenient for operation and as required in the latest NEC.

B. Install typewritten or computer generated circuit directory in panelboards. The directory shall be coordinated with the identification of equipment as shown on the contract drawings and clearly indicating the serving load.

END OF SECTION

SECTION 16180

OVERCURRENT PROTECTIVE DEVICES

PART 1 – GENERAL

Not Used

PART 2 - PRODUCTS

2.01 Manufacturers

A. Provide Cutler Hammer or Square-D circuit breakers to match equipment provided. The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions

2.02 Molded Case Circuit Breakers – 800 A and Below

A. Protective devices shall be molded case circuit breakers with inverse time and instantaneous tripping characteristics.

B. Circuit breakers shall be operated by a toggle-type handle and shall have a quick-make, quick-break over-center switching mechanism that is mechanically trip-free. Automatic tripping of the breaker shall be clearly indicated by the handle position. Contacts shall be nonwelding silver alloy and arc extinction shall be accomplished by means of DE-ION arc chutes. A push-to-trip button on the front of the circuit breaker shall provide a local manual means to exercise the trip mechanism.

C. Circuit breakers shall have a minimum symmetrical interrupting capacity as indicated on the drawings.

D. Circuit breakers 400ampere frame and below shall have thermal-magnetic trip units and inverse time-current characteristics.

PART 3 – EXECUTION

Not Used

END OF SECTION

SECTION 16190

SUPPORTING DEVICES

PART 1 - GENERAL

1.01 Scope;

A. The work under this sections includes conduit and equipment supports, straps, clamps, steel channel, etc, and fastening hardware for supporting electrical work. Furnish and install all supports, hangers and inserts required to mount fixtures, conduit, cables, pull boxes and other equipment furnished under this Division. All supporting devices and hardware exterior of buildings or interior of structures except in air conditioned spaces shall be stainless steel. Aluminum and non metallic supports (fiberglass) and hardware will be reviewed by the Engineer on a case-by-case basis.

B. All items shall be supported from the structural portion of the building. Supports and hangers shall be of a type approved by Underwriters' Laboratories. Wire shall not be used as a support. Boxes and conduit shall not be supported or fastened to ceiling suspension wires or to ceiling channels.

C. The Contractor shall furnish and install all sleeves that may be required for openings through floors, wall etc. Where plans call for conduit to be run exposed, the Contractor shall furnish and install all inserts and clamps for the supporting of conduit. If the Contractor does not properly install all sleeves and inserts required, contractor to provide cutting and patching to the satisfaction of the Engineer.

1.02 Related Work: Applicable provisions of Division 1 govern work under this Section. Section 16110 – Conduit Systems

1.03 Submittals: Product Data: Provide data for support channel.

1.04 Quality Assurance: Support systems shall be adequate for weight of equipment and conduit, including wiring, which they carry.

PART 2 - PRODUCTS

2.01 Material

A. Support Channel: Stainless steel throughout except galvanized steel in conditioned interior areas.

B. Hardware: Stainless steel throughout

C. Minimum sized threaded rod for supports shall be 3/8”.

D. Conduit clamps, straps, supports, etc., shall be stainless steel or malleable iron. One-hole straps shall be heavy duty type.

PART 3 - EXECUTION

3.01 Installation

A. All PVC conduits shall be securely fastened in place on maximum of 3 foot intervals vertically and 2 foot intervals horizontally. Hangers, supports or fastenings shall be provided at each elbow and at the end of each straight run terminating at a box or cabinet. The required strength of the supporting equipment and size and type of anchors shall be based on the combined weight of conduit, hanger and cables. Horizontal and vertical conduit runs may be supported by two-hole malleable straps, clamp-backs, or other approved devices with suitable bolts, expansion shields (where needed) or beam-clamps for mounting to building structure or special brackets.

B. All screws, bolts, washers, etc., used for supporting conduit or outlets shall be fabricated from stainless steel, or approved substitution.

C. File and de-bur cut ends of support channel and spray paint with cold galvanized paint to prevent rusting. Do not fasten supports to piping, ductwork, mechanical equipment, cable tray or conduit. Do not drill structural steel members unless approved by the engineer.

D. Fabricate supports from stainless steel or aluminum channel, rigidly welded or bolted to present a neat appearance. Use hexagon head bolts with spring lock washers under all nuts. Install surface-mounted cabinets and panelboards with minimum of four anchors. Provide steel channel supports to stand cabinet one inch (25 mm) off wall.

E. Furnish and install all supports as required to fasten all electrical components required for the project, including free standing supports required for those items remotely mounted from the building structure, catwalks, walkways etc.

END OF SECTION

SECTION 16450

GROUNDING AND BONDING

PART 1 - GENERAL

1.01 Description; the terms “connect”, “ground” and “bond” are used interchangeably in this specification and have the same meaning

A. This section specifies general grounding and bonding requirements of electrical equipment operations and to provide a low impedance path for possible ground fault currents.

B. “Grounding electrode system” refers to all electrodes required by NEC, as well as including made, supplementary, perimeter counterpoise ground, lightning protection system grounding electrodes.

1.02 Related Work

A. Section 16050, Basic Material and Methods: General electrical requirements.

B. Section 16120, Conductors & Cables

1.03 Submittals

A. Submit in accordance with Section 16050

B. Shop Drawings:
1. Sufficient information, clearly presented, shall be included to determine compliance with drawings and specifications.
2. Include the location of system grounding electrode connections and the routing of aboveground and underground grounding electrode conductors.

C. Test Reports: Provide certified test reports of ground resistance.

D. Certifications: Two weeks prior to final inspection, submit four copies of the following to the Project Engineer:
1. Certification, by the Contractor, that the complete installation has been properly installed and tested.

1.04 Applicable Publications

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

B. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System

C. National Fire Protection Association (NFPA):
. National Electrical Code (NEC) 2011

D. Underwriters Laboratories, Inc. (UL):
Thermoset-Insulated Wires and Cables
Thermoplastic-Insulated Wires and Cables
Grounding and Bonding Equipment
Wire Connectors

PART 2 – PRODUCTS

2.01 Grounding and Bonding Conductors

A. Equipment grounding conductors shall be UL 83 insulated stranded copper, except that sizes 2 AWG and smaller may be solid copper unless noted otherwise noted on the drawings. Insulation color shall be continuous green for all equipment grounding conductors, except that wire sizes 4 AWG and larger shall be permitted to be identified per NEC.

B. Bonding conductors shall be ASTM B8 bare stranded copper, except that sizes 2 AWG and smaller may be ASTM B1 solid bare copper wire.

C. Electrical System Grounding: Conductor sizes shall not be less than what is shown on the drawings and not less than required by the NEC, whichever is greater.

2.02 Splices and Termination Components

A. Components shall meet or exceed UL 467 and be clearly marked with the manufacturer, catalog number, and permitted conductor size(s).

2.03 Ground Connections

A. Above Grade:
1. Bonding Jumpers: compression type connectors, using zinc-plated fasteners and external tooth lock washers.
2. Ground Busbars: Two-hole compression type lugs using tin-plated copper or copper alloy bolts and nuts.

PART 3 – EXECUTION

3.01 General

A. Ground in accordance with the NEC, as shown on drawings, and as hereinafter specified.

B. System Grounding:
1. Secondary service neutrals: Ground at the supply side of the secondary disconnecting means and at the related transformers.
2. Separately derived systems (transformers downstream from the service entrance): Ground the secondary neutral.

C. Equipment Grounding: Metallic structures (including ductwork and building steel), enclosures, raceways, junction boxes, outlet boxes, cabinets, machine frames,

and other conductive items in close proximity with electrical circuits shall be bonded and grounded.

3.02 Grounding Connections

A. Make grounding connections that are below grade by exothermic weld. Make grounding connections that are above grade but are otherwise normally inaccessible (poured columns, within walls) with exothermic weld.

3.03 Secondary Equipment and Connections

A. Transformers:
1. Exterior: Exterior transformers supplying interior service equipment shall have the neutral grounded at the transformer secondary. Provide a grounding electrode at the transformer.
2. Separately derived systems (transformers downstream from service equipment): Ground the secondary neutral at the transformer. Provide a grounding electrode conductor from the transformer to the ground bar at the service equipment.

B. Conduit Systems:
1. Ground all metallic conduit systems. All conduit systems shall contain an equipment grounding conductor (except service entrance with grounded neutral). Ground conductor shall be bonded to metallic conduit systems at the entrance and exit from the conduit.

C. Boxes, Cabinets, Enclosures, and Panelboards:
1. Bond the equipment grounding conductor to each pullbox, junction box, outlet box, device box, cabinets, and other enclosures through which the conductor passes.
2. Provide lugs in each box and enclosure for equipment grounding conductor termination.
3. Provide ground bars in panelboards, bolted to the housing, with sufficient lugs to terminate the equipment grounding conductors.

D. Motors and Starters: Provide lugs in motor terminal box and starter housing or motor control center compartment to terminate equipment grounding conductors.

E. Receptacles shall not be grounded through their mounting screws. Ground with a jumper from the receptacle green ground terminal to the device box ground screw and the branch circuit equipment grounding conductor.

3.04 Corrosion Inhibitors

A. When making ground and ground bonding connections, apply a corrosion inhibitor to all contact surfaces. Use corrosion inhibitor appropriate for protecting a connection between the metals used.

3.05 Conductive Piping

A. Bond all conductive piping systems, interior and exterior, to the building to the grounding electrode system.

3.06 Ground Resistance

A. Grounding system resistance to ground shall not exceed 2 ohms. Make necessary modifications or additions to the grounding electrode system for compliance without additional cost to the owner. Final tests shall assure that this requirement is met.

B. Resistance of the grounding electrode system shall be measured using a four-terminal fall-of-potential method as defined in IEEE 81. Ground resistance measurements shall be made before the electrical distribution system is energized and shall be made in normally dry conditions not less than 48 hours after the last rainfall. Resistance measurements of separate grounding electrode systems shall be made before the systems are bonded together below grade. The combined resistance of separate systems may be used to meet the required resistance, but the specified number of electrodes must still be provided.

C. Below-grade connections shall be visually inspected by the Project Engineer prior to backfilling. Provide ground inspection wells at all ground rod locations.

3.07 Ground Rod Installation

A. Drive each rod vertically in the earth, not less than 20 feet in depth.

B. Where permanently concealed ground connections are required, make the connections by the exothermic process to form solid metal joints. Make above grade accessible ground connections with mechanical pressure type ground connectors.

C. Where rock prevents the driving of vertical ground rods, drill rock then install rod. Backfill with flowable fill or concrete mix. Obtain the necessary permits if required for drilling.

END OF SECTION

SECTION 16460

LOW-VOLTAGE TRANSFORMERS

PART 1 – GENERAL

1.01 DESCRIPTION-this section specifies the furnishing, installation and connection of the dry type general-purpose transformers.

1.02 RELATED WORK
- A. Section 16051, Special Electrical Requirements
- B. Section 16110, Conduit Systems
- C. Section 16120, Low-Voltage Wire and Cables
- D. Section 16450, Grounding and Bonding For Electrical Systems:

1.03 SUBMITTALS
- A. In accordance with Section 16050 Basic Electrical Materials and Methods.

- B. Shop Drawings:
  1. Sufficient information, clearly presented, shall be included to determine compliance with drawings and specifications.
  2. Include electrical ratings, impedance, dimensions, weight, mounting details, decibel rating, terminations, temperature rise, no load and full load losses, and connection diagrams.
  3. Complete nameplate data including manufacturer's name and catalog number.
- C. Manuals:
  1. Submit, simultaneously with the shop drawings, companion copies of complete maintenance and operating manuals including technical data sheets and wiring diagrams.

1.04 REFERENCES
- A. National Fire Protection Association (NFPA) 70-08 National Electrical Code (NEC)

- B. National Electrical Manufacturers Association (NEMA): ST 20-97 Dry-Type Transformers for General Applications

PART 2 – PRODUCTS

2.01 GENERAL PURPOSE DRY TYPE TRANSFORMERS
- A. Unless otherwise specified, dry type transformers shall be in accordance with NEMA, NEC and as shown on the drawings. Transformers shall be UL listed or labeled.

- B. Dry type transformers shall have the following features:
  1. Self-cooled by natural convection, isolating windings, indoor, dry type. Autotransformers will not be accepted.
  2. Rating shall be as shown on the drawings. Ratings shown on the drawings are for continuous-duty without the use of cooling fans.

3. Transformers shall have copper windings.
4. Insulation systems:
   a. Transformers 30 KVA and larger: UL rated 220 degrees C system having an average maximum rise by resistance of 150 degrees C in a maximum ambient of 40 degrees C.
   b. Transformers below 30 KVA: Same as for 30 KVA and larger or UL rated 185 degrees C system having an average maximum rise by resistance of 115 degrees C in a maximum ambient of 40 degrees C.
5. Core and coil assemblies:
   a. Rigidly braced to withstand the stresses caused by short circuit currents and rough handling during shipment.
   b. Cores shall be grain oriented, non-aging, and silicon steel.
   c. Coils shall be continuous windings without splices except for taps.
   d. Coil loss and core loss shall be minimum for efficient operation.
   e. Primary and secondary tap connections shall be brazed or pressure type.
   f. Coil windings shall have end fillers or tie downs for maximum strength.
6. Certified sound levels determined in accordance with NEMA, shall not exceed the following:

Transformer Rating	Sound Level Rating
0 - 9 KVA	40 dB
10 - 50 KVA	45 dB
51 - 150 KVA	50 dB
151 - 300 KVA	55 dB
301 - 500 KVA	60 dB

7. Nominal impedance shall be as per NEMA.
8. Single phase transformers rated 15 KVA through 25 KVA shall have two, 5 percent full capacity taps below normal rated primary voltage. All transformers rated 30 KVA and larger shall have two, 2-1/2 percent full capacity taps above, and four, 2-1/2 percent full capacity taps below normal rated primary voltage.
9. Core assemblies shall be grounded to their enclosures by adequate flexible ground straps.
10. Enclosures:
    a. Not less than code gage steel.
    b. Outdoor enclosures shall be NEMA 3R stainless steel.
    c. Temperature rise at hottest spot shall conform to NEMA Standards, and shall not bake and peel off the enclosure paint after the transformer has been placed in service.
    d. Ventilation openings shall prevent accidental access to live components.

e. Thoroughly clean and paint enclosure at the factory with manufacturer's prime coat and standard finish.

11. Standard NEMA features and accessories including ground pad, lifting provisions and nameplate with the wiring diagram and sound level indicated on it.
12. Dimensions and configurations shall conform to the spaces designated for their installations.
13. Transformers shall meet the minimum energy efficiency values per NEMA TP1 as listed below:

kVA Rating	Output efficiency (%)
15	97
30	97.5
45	97.7
75	98
112.5	98.2
150	98.3
225	98.5
312	98.6

PART 3 – EXECUTION

3.01 INSTALLATION

A. Installation of transformers shall be in accordance with the NEC, as recommended by the equipment manufacturer and as shown on the drawings.

B. Install the transformers with adequate clearance at a minimum of 4 inches from wall and adjacent equipment for air circulation to remove the heat produced by transformers.

C. Install transformers on vibration pads designed to suppress transformer noise and vibrations.

D. Use flexible metal conduit to enclose the conductors from the transformer to the raceway systems.

END OF SECTION

SECTION 16709

SURGE PROTECTIVE DEVICES (SPDs)

PART 1 - GENERAL

1.01 SCOPE

A. The Contractor shall furnish and install the Surge Protective Device (SPD) equipment having the electrical characteristics, ratings, and modifications as specified herein and as shown on the contract drawings. To maximize performance and reliability and to obtain the lowest possible let-through voltages, the ac surge protection shall be integrated into electrical distribution equipment such as switchgear, switchboards, panelboards, busway (integrated within bus plug), or motor control centers. Refer to related sections for surge requirements in:

1.02 RELATED SECTIONS

A. Section 16910 – Control Panels, Section 16180 – Overcurrent Protective Devices

1.03 REFERENCES

A. SPD units and all components shall be designed, manufactured, and tested in accordance with the latest applicable UL standard (ANSI/UL 1449 3rd Edition).

1.04 SUBMITTALS

A. The following information shall be submitted to the Engineer:
   1. Provide verification that the SPD complies with the required ANSI/UL 1449 3rd Edition listing by Underwriters Laboratories (UL) or other Nationally Recognized Testing Laboratory (NRTL). Compliance may be in the form of a file number that can be verified on UL's website or on any other NRTL's website, as long as the website contains the following information at a minimum: model number, SPD Type, system voltage, phases, modes of protection, Voltage Protection Rating (VPR), and Nominal Discharge Current (I_n).
   2. For sidemount mounting applications (SPD mounted external to electrical assembly), electrical/mechanical drawings showing unit dimensions, weights, installation instruction details, and wiring configuration.

B. Where applicable the following additional information shall be submitted to the engineer:
   1. Descriptive bulletins
   2. Product sheets

C. The following information shall be submitted for record purposes:
   1. Final as-built drawings and information for items listed and shall incorporate all changes made during the manufacturing process

1.05 QUALIFICATIONS

A. The manufacturer of the assembly shall be the manufacturer of the major components within the assembly.

B. For the equipment specified herein, the manufacturer shall be ISO 9001 or 9002 certified.

C. The manufacturer of this equipment shall have produced similar electrical equipment for a minimum period of five (5) years. When requested by the Engineer, an acceptable list of installations with similar equipment shall be provided demonstrating compliance with this requirement.

1.06 OPERATION AND MAINTENANCE MANUALS

A. Operation and maintenance manuals shall be provided with each SPD shipped.

1.07 MANUFACTURERS

A. Eaton / Cutler-Hammer products
B. Square-D products
C. General Electric products
D. APT

The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features, and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety. Products in compliance with the specification and manufactured by others not named will be considered only if pre-approved by the Engineer ten (10) days prior to bid date.

1.08 SYSTEM APPLICATION

A. The SPD applications covered under this section include distribution and branch panel locations, busway, motor control centers (MCC), switchgear, and switchboard assemblies. All SPDs shall be tested and demonstrate suitability for application within ANSI/IEEE C62.41 Category C, B, and A environments.

B. Surge Current Capacity – The minimum surge current capacity the device is capable of withstanding shall be as shown in the following table:

Minimum surge current capacity based on ANSI / IEEE C62.41 location category			
Category	Application	Per Phase	Per Mode
C	Service Entrance Locations (Switchboards, Switchgear, MCC, Main Entrance)	450kA	225 kA
B	High Exposure Roof Top Locations (Distribution Panelboards)	250 kA	125 kA
A	Branch Locations (Panelboards, MCCs, Busway)	250kA	125 kA

C. SPD Type – all SPDs installed on the line side of the service entrance disconnect shall be Type 1 SPDs. All SPDs installed on the load side of the service entrance disconnect shall be Type 1 or Type 2 SPDs.

PART 2 – PRODUCTS

2.01 VOLTAGE SURGE SUPPRESSION – GENERAL

A. Electrical Requirements

1. Unit Operating Voltage – Refer to drawings for operating voltage and unit configuration.
2. Maximum Continuous Operating Voltage (MCOV) – The MCOV shall not be less than 115% of the nominal system operating voltage.
3. The suppression system shall incorporate thermally protected metal-oxide varistors (MOVs) as the core surge suppression component for the service entrance and all other distribution levels. The system shall not utilize silicon avalanche diodes, selenium cells, air gaps, or other components that may crowbar the system voltage leading to system upset or create any environmental hazards.
4. Protection Modes – The SPD must protect all modes of the electrical system being utilized. The required protection modes are indicated by bullets in the following table:

	Protection Modes			
Configuration	L-N	L-G	L-L	N-G
Wye	●	●	●	●
Delta	N/A	●	●	N/A
Single Split Phase	●	●	●	●
High Leg Delta	●	●	●	●

5. Nominal Discharge Current (I_n) – All SPDs applied to the distribution system shall have a 20kA I_n rating regardless of their SPD Type (includes Types 1 and 2) or operating voltage. SPDs having an I_n less than 20kA shall be rejected.
6. ANSI/UL 1449 3rd Edition Voltage Protection Rating (VPR) – The maximum ANSI/UL 1449 3rd Edition VPR for the device shall not exceed the following:

Modes	208Y/120	480Y/277	600Y/347
L-N; L-G; N-G	700	1200	1500
L-L	1200	2000	3000

B. SPD Design

1. Maintenance Free Design – The SPD shall be maintenance free and shall not require any user intervention throughout its life. SPDs containing items such as replaceable modules, replaceable fuses, or replaceable batteries shall not be accepted. SPDs requiring any maintenance of any sort such as periodic tightening of connections shall not be accepted. SPDs requiring user intervention to test the unit via a diagnostic test kit or similar device shall not be accepted.
2. Balanced Suppression Platform – The surge current shall be equally distributed to all MOV components to ensure equal stressing and maximum performance.

The surge suppression platform must provide equal impedance paths to each matched MOV.

3. Electrical Noise Filter – Each unit shall include a high-performance EMI/RFI noise rejection filter. Noise attenuation for electric line noise shall be up to 50 dB from 10 kHz to 100 MHz using the MIL-STD-220A insertion loss test method. Products unable able to meet this specification shall not be accepted.
4. Internal Connections – No plug-in component modules or printed circuit boards shall be used as surge current conductors. All internal components shall be soldered, hardwired with connections utilizing low impedance conductors.
5. Monitoring Diagnostics – Each SPD shall provide the following integral monitoring options:
    a. Protection Status Indicators - Each unit shall have a green / red solid-state indicator light that reports the status of the protection on each phase.
        i. For wye configured units, the indicator lights must report the status of all protection elements and circuitry in the L-N and L-G modes. Wye configured units shall also contain an additional green / red solid-state indicator light that reports the status of the protection elements and circuitry in the N-G mode. SPDs that indicate only the status of the L-N and L-G modes shall not be accepted.
        ii. For delta configured units, the indicator lights must report the status of all protection elements and circuitry in the L-G and L-L modes.
        iii. The absence of a green light and the presence of a red light shall indicate that damage has occurred on the respective phase or mode. All protection status indicators must indicate the actual status of the protection on each phase or mode. If power is removed from any one phase, the indicator lights must continue to indicate the status of the protection on all other phases and protection modes. Diagnostics packages that simply indicate whether power is present on a particular phase shall not be accepted.
    b. Surge Counter – The SPD shall be equipped with an LCD display that indicates to the user how many surges have occurred at the location. The surge counter shall trigger each time a surge event with a peak current magnitude of a minimum of 50 ± 20A occurs. A reset pushbutton shall also be standard, allowing the surge counter to be zeroed. The reset button shall contain a mechanism to prevent accidental resetting of the counter via a single, short-duration button press. In order to prevent accidental resetting, the surge counter reset button shall be depressed for a minimum of 2 seconds in order to clear the surge count total.
        i. The ongoing surge count shall be stored in non-volatile memory. If power to the SPD is completely interrupted, the ongoing count indicated on the surge counter's display prior to the interruption shall be stored in non-volatile memory and displayed after power is restored. The surge counter's memory shall not require a backup battery in order to achieve this functionality.
6. Overcurrent Protection
    a. The unit shall contain thermally protected MOVs. These thermally protected MOVs shall have a thermal protection element packaged together with the MOV in order to achieve overcurrent protection of the MOV. The thermal protection element shall disconnect the MOV(s) from the system in a fail-safe

manner should a condition occur that would cause them to enter a thermal runaway condition.

7. Safety Requirements
   a. The SPD shall minimize potential arc flash hazards by containing no user serviceable / replaceable parts and shall be maintenance free.
   b. SPDs designed to interface with the electrical assembly via conductors shall require no user contact with the inside of the unit.
   c. Sidemount SPDs shall be factory sealed in order to prevent access to the inside of the unit. Sidemount SPDs shall have factory installed phase, neutral, ground and remote status contact conductors factory installed and shall have a pigtail of conductors protruding outside of the enclosure for field installation.

2.02 LIGHTING AND DISTRIBUTION PANELBOARD REQUIREMENTS

A. The SPD application covered under this section includes lighting and distribution panelboards. The SPD units shall be tested and demonstrate suitability for application within ANSI/IEEE C62.41 Category B environments.
   1. The SPD shall not limit the use of through-feed lugs, sub-feed lugs, and sub-feed breaker options.
   2. SPDs shall be installed immediately following the load side of the main breaker. SPDs installed in main lug only panelboards shall be installed immediately following the incoming main lugs.
   3. The panelboard shall be capable of re-energizing upon removal of the SPD.
   4. The SPD shall be interfaced to the panelboard via a direct bus bar connection. Alternately, an SPD connected to a 30A circuit breaker for disconnecting purposes may be installed using short lengths of conductors as long as the conductors originate integrally to the SPD. The SPD shall be located directly adjacent to the 30A circuit breaker.
   5. The SPD shall be included and mounted within the panelboard by the manufacturer of the panelboard.
   6. The SPD shall be of the same manufacturer as the panelboard.
   7. The complete panelboard including the SPD shall be UL67 listed.

B. Sidemount Mounting Applications Installation (SPD mounted external to electrical assembly)
   1. Lead length between the breaker and suppressor shall be kept as short as possible to ensure optimum performance. Any excess conductor length shall be trimmed in order to minimize let-through voltage. The installer shall comply with the manufacturer's recommended installation and wiring practices.

C. Switchgear, Switchboard, MCC and Busway Requirements
   1. The SPD application covered under this section is for switchgear, switchboard, MCC, and busway locations. Service entrance located SPDs shall be tested and demonstrate suitability for application within ANSI/IEEE C62.41 Category C environments.
   2. The SPD shall be of the same manufacturer as the switchgear, switchboard, MCC, and busway
   3. The SPD shall be factory installed inside the switchgear, switchboard, MCC, and/or bus plug at the assembly point by the original equipment manufacturer

4. Locate the SPD on the load side of the main disconnect device, as close as possible to the phase conductors and the ground/neutral bar.
5. The SPD shall be connected through a disconnect (30A circuit breaker). The disconnect shall be located in immediate proximity to the SPD. Connection shall be made via bus, conductors, or other connections originating in the SPD and shall be kept as short as possible.
6. The SPD shall be integral to switchgear, switchboard, MCC, and/or bus plug as a factory standardized design.
7. All monitoring and diagnostic features shall be visible from the front of the equipment.

2.04 ENCLOSURES

A. All enclosed equipment mounted for indoor application shall be NEMA 1 general purpose enclosures. Provide NEMA 4X enclosures for all outdoor applications.
   1. NEMA 1 – Constructed of a polymer (units integrated within electrical assemblies) or steel (sidemount units only), intended for indoor use to provide a degree of protection to personal access to hazardous parts and provide a degree of protection against the ingress of solid foreign objects (falling dirt).
   2. NEMA 4X – Constructed of stainless steel intended for either indoor or outdoor use to provide a degree of protection against access to hazardous parts; to provide a degree of protection of the equipment inside the enclosure against ingress of solid foreign objects (dirt and windblown dust); to provide a degree of protection with respect to the harmful effects on the equipment due to the ingress of water (rain, splashing water, and hose directed water).

PART 3 - EXECUTION

3.01 BONDING AND GROUNDING CONDUCTORS AND MATERIALS

A. Conductors utilized for surge suppressor bonding shall be a minimum of #6 AWG solid insulated copper unless otherwise specified.

B. Ground bus or strip material shall be copper, a minimum of 26 gauge in thickness and three inches wide unless otherwise specified. Bus materials may be secured to surfaces with an appropriate mastic material or mechanical fasteners. Bus connections shall be bolted or brazed and reinforced as necessary on thin bus material to provide a permanent and secure connection.

C. Unless otherwise specified, all surge suppression grounding electrodes shall be 5/8" diameter copperweld rods, twenty feet in length.

D. Connectors, splices, and other fittings used to interconnect grounding conductors, bond to equipment or ground bars, shall comply with requirements of the National Electric Code and be approved by Underwriters Laboratories for the purpose.

E. Connectors and fittings for grounding and bonding conductors shall be of the compression or set-screw type in above grade locations. Connections below grade shall be exothermically welded or brazed.

F. Bonding connections between electrically dissimilar metals shall be made using exothermic welds or using bi-metal connectors designed to prevent galvanic

corrosion.

3.02 SEGREGATION OF WIRING

A. All system wiring shall be classified into protected and non-protected categories. Wiring on the exposed side of suppression devices shall be considered unprotected. Surge suppressor grounding and bonding conductors shall also fall into this category.

B. All wiring between surge suppressors and protected equipment shall be considered protected. Isolated circuitry exempted from surge suppression requirements in part one of this section shall also be considered protected.

C. A minimum of three inches of separation shall be provided between parallel runs of protected and unprotected wiring in control panels, terminal cabinets, terminal boards and other locations. In no case shall protected and unprotected wiring be bundled together or routed through the same conduit. Where bundles of protected and unprotected wiring cross, such crossings shall be made at right angles.

3.03 INSTALLATION OF SUPPRESSORS

A. Suppressors shall be installed as close as practical to the equipment to be protected consistent with available space. Where space permits and no code restrictions apply, suppressors may be installed within the same cabinet as the protected equipment. Suppressors installed in this manner shall utilize the equipment chassis as a medium for bonding of their ground terminals. Bonding jumpers not exceeding two inches in length shall be installed between the chassis and suppressor ground terminals. Bolted connections with star washers shall be used to insure electrical and mechanical integrity of connections to the equipment chassis.

B. Suppressors shall be installed in a neat, workmanlike manner. Lead dress shall be consistent with recommended industry practices for the system on which these devices are installed.

C. Bonding between ground terminals for power and signal line suppressors serving a particular item or cluster of equipment shall be kept as short as possible. Where practical, suppressors shall be installed in a common location for the cluster with their ground terminals bonded closely together. For installations requiring separation between the various suppressor grounds and equipment chassis within an equipment cluster, the following table shall be used to determine bonding conductor requirements (distances are measured between most distant suppressor or chassis grounds):

BONDING DISTANCE	MATERIAL
0 - 10 feet	#6 AWG Bare Copper (Solid)
10- 25 feet	1-1/2" Copper Strip 26ga. Min.
25- 50 feet	3" Copper Strip 26ga. Min.
Over 50 feet	6" Copper Strip 26ga. Min.

Care shall be exercised to avoid connection of incidental grounds to the bonding bus system.

D. Where terminal cabinets are used to house surge suppressors, painted steel backboards shall be used to serve as a low impedance ground plane for bonding surge suppressor leads together. Terminal boards used for the same purpose shall be laminated with a single sheet of 14 ga. galvanized steel to serve as a ground plane for suppressors. Suppressors with ground terminals not inherently bonded to the ground plane through their mounting shall be bonded to this plane using a two-inch maximum length of #12AWG copper wire and suitable lug. Ground planes and backboards shall be drilled to accept self tapping screws, any paint in the area of the bond shall be removed and star washers shall be used.

E. Supplementary grounding and bonding connections required between the bonding bus or ground plane for each equipment cluster and other locations as indicated herein shall be accomplished using #6 AWG bare copper conductors and approved connections unless otherwise noted.

3.04 WARRANTY

A. The manufacturer shall provide a full ten (10) year warranty from the date of shipment against any SPD part failure when installed in compliance with manufacturer's written instructions and any applicable national or local code.

END OF SECTION